Comment Letter re: EPA Proposed Rule – Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review (86 Fed. Reg. 63110)

Introduction

Bridger Photonics, Inc. ("Bridger") appreciates the opportunity to provide comments on the Environmental Protection Agency's ("EPA") Proposed Rule – Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review (86 Fed. Reg. 63110) ("Proposed Rule"). Bridger is a technical and market leader in the detection, localization, and quantification of methane emissions. Bridger commercialized its aerial light detection and ranging (LiDAR) technology, Gas Mapping LiDAR™, in 2019 as a data product offering, which has been rapidly and broadly adopted by the oil and gas industry in North America over the past three years.

Bridger's demonstrated ability to detect and quantify more than 90% of basin-wide methane emissions at scale allows us to clearly project the impact that detection sensitivity has on emissions reduction. This places us in a unique position to assess the appropriateness of aspects of the Proposed Rule to achieve the stated goals of the EPA. These goals include to "significantly reduce emissions of greenhouse gases and other harmful air pollutants from the Crude Oil and Natural Gas source category."[1] Officials have put a figure to the reduction goals of reducing methane emissions by 75% as compared to current levels.[2] And the EPA's proposed leak detection and repair program with optical gas imaging (OGI) is intended to achieve 80% reduction from current emission levels.[3] We consistently frame our comments relative to the ability to achieve at least 75% reduction in methane emissions compared to current baseline emission levels.

Bridger is confident that detection of 75% of current emissions can be accomplished while meeting the other critical EPA goal to "minimize any significant economic impact of the proposed rule …" on the oil and gas industry. Given Bridger's experience, performance, and data collection, we believe that alternative methane detection technologies to replace and supplement traditional OGI detection provides the flexibility and economic advantage to the oil and gas industry that it needs to impactfully and cost-effectively reduce methane emissions. Bridger's comments below pertain to the alternative work practice aspects of the Proposed Rule.

Comment Topic 1. The proposed detection sensitivity metric requires additional information to be meaningful.

In the Proposed Rule, the EPA solicited feedback on the suitability of 10 kg/hr as a methane emission rate detection sensitivity performance metric (referred to as "minimum detection threshold" in the Proposed Rule). *See* 86 FR 63197 (November 15, 2021) ("the EPA believes setting a minimum detection threshold of 10 kg/hr methane might be appropriate for use in determining what technologies and in what deployment platforms … are appropriate for a potential screening alternative.").

Our first comment addresses the need for the EPA to fully specify a required detection sensitivity performance metric. A value for detection sensitivity (e.g. 10 kg/hr) *by itself* is insufficient for specifying a detection sensitivity performance metric. This value could be interpreted to mean a technology must detect all emissions greater than 10 kg/hr, or that a technology must have once detected an emission of this size under ideal or laboratory conditions. Lacking further information, there's no way to assess whether detection sensitivity of 10 kg/hr will achieve 75% emissions reduction from current baseline levels. And the difference in emissions reduction outcomes between those two possible interpretations of detection sensitivity is massive. To solve this problem, in addition to the value for detection sensitivity, the standard must include (1) a required probability of detection, and (2) a specification of conditions under which the alternative work practice must achieve this metric. Each additional requirement is further described below:

(1) Probability of Detection. Emissions detection is statistical and probabilistic in nature. This means that a technology might detect a leak of a given size (e.g. 10 kg/hr) one time and miss a leak of the same size the next time (or the next thousand times!). The problem is, lacking anything more than the statement that a technology can detect 10 kg/hr, there's no way to know how likely it is that the technology would detect a leak of that size, and therefore no way to assess the emissions reduction potential of the technology. To enable such assessment, one needs to know whether leaks of that size were detected with high confidence (e.g. >90% probability of detection), whether leaks of that size were statistically detected half of the time (50% probability of detection), or whether there was negligible likelihood (e.g. <1% probability of detection) of detecting a leak of that size. To remove this ambiguity, we therefore urge the EPA to require the detection sensitivity value to be coupled with a probability of detection (e.g. 10 kg/hr with a required >50% probability of detection). Probability of detection is sometimes referred to herein as "PoD".

(2) Conditions Under Which Performance is Achieved. In addition to the probabilistic nature of detections under a given set of conditions, different operational and environmental conditions significantly impact the probability of detection. No matter the detection technology, there will be conditions under which the technology performs better and conditions under which the technology performs worse. Operational parameters are often within an aerial technology solution provider's control (e.g. flight altitude, flight speed, etc.), while many factors that can affect the detection sensitivity are often outside of the solution provider's control (e.g. ground wind speed, the reflectivity of the ground surface, cloud cover, etc.). The problem is that the difference in emissions reduction outcomes between achieving the required detection sensitivity under "typical" or "all" conditions, versus under "ideal" conditions that don't represent actual application of the work practice, can be massive. To remove this ambiguity, and in addition to requiring a probability of detection along with the stated detection sensitivity value, we urge the EPA to require that the specified detection sensitivity be achieved under "typical" conditions for which the alternative work practice is applied. If a technology cannot meet the detection sensitivity metric with, for example, high winds, wet ground, or cloud cover, then the technology must not be used to satisfy the rule under those conditions. Bridger suggests a simple and objective auditing mechanism to ensure the detection sensitivity metric is achieved in typical conditions in Comment Topic 6.

As a concrete example of the danger that a lack of specificity for the detection sensitivity presents, a recent journal article published in 2021 by Cusworth, et al., using an aerial solar infrared spectrometer, indicates a “10-20 kg/hr detection limit”.[4] The results from another article quantifying this technology’s detection sensitivity in controlled release testing can be used to estimate that it should certainly achieve a detection sensitivity of better than 20 kg/hr with >50% probability of detection.[5,6] However, rigorous analysis of the Cusworth data under deployment conditions in the Permian basin reveals that the solar infrared imaging spectrometer technology used in the study achieved a detection sensitivity of 10 kg/hr with <1% probability of detection and missed approximately half of leaks (i.e. ~50% PoD) that were twenty times that size (i.e. 200 kg/hr).[7] This can be qualitatively observed quite simply by noting the emission rate at which the asymptotic “roll-off” behavior occurs in the emissions distribution [e.g. blue data in Figure 2(A)]. This roll-off is due to the decreased probability of detection for the technology, not the decreased emissions. We know this because the emissions distributions that Bridger measures with Gas Mapping LiDAR continue to climb beyond 200 kg/hr until an emission rate of approximately 3 kg/hr, where Gas Mapping LiDAR begins to miss leaks under typical conditions (see Figure 1 below and discussion related to Comment Topic 2). It is imperative that aerial detection technologies used for the alternative work practice perform to the required standard during actual application of the work practice, not merely in “ideal” conditions of a controlled release (e.g. known emitter location, controlled calibration parameters, no ramifications of false positives, favorable sunlight and cloud conditions, etc.). The difference between 50% probability of detection and <1% probability of detection, and between “typical” and “ideal” conditions can result in orders of magnitude differences in emissions reduction.

Summary of Comment 1: To establish a meaningful detection sensitivity performance metric, we urge the EPA to specify a probability of detection with the detection sensitivity value (e.g. 10 kg/hr with a required >50% probability of detection), and require that the specified performance be achieved under typical conditions in which the alternative work practice is applied.

Comment Topic 2. An emission rate detection sensitivity metric of 10 kg/hr with a required >50% probability of detection in typical conditions strikes the correct balance of emissions reduction and operational efficiency.

Bridger has worked closely with the oil and gas industry to identify a methane detection sensitivity that balances two factors: (a) the ability to detect the vast majority of methane emissions in production basins, and (b) enabling efficient, impactful, and cost-effective repair and mitigation activities. With broad input from the oil and gas community, Bridger implemented for its own technology a detection sensitivity of 3 kg/hr coupled with a >90% probability of detection, achievable under typical conditions. Bridger supports EPA’s adoption of 10 kg/hr detection sensitivity in the Final Rule as long as that detection sensitivity is coupled with the requirement of >50% probability of detection under typical conditions in which the work practice is applied. The EPA's proposed detection sensitivity value is also consistent with their statement that a 10 kg/hr leak "would constitute a significant emissions event" [Ref 1, pg. 63175].

Bridger has the ability to detect much smaller emission rates, but our selected production-sector detection sensitivity already detects >90% of basin-wide emissions, while not wasting operator time and resources repairing leaks that don't appreciably impact emissions.[7] In fact, third-party studies have shown that Bridger's detection sensitivity level detects *more* emissions than ground crews with OGI cameras, but requires far *fewer* repair events due to the larger size of emission events uncovered by the Gas Mapping LiDAR scans.[8] Moreover, the broad adoption by oil and gas operators of Bridger's methane detection solution *without* regulatory pressure speaks to the fact that the repair activities resulting from Bridger's detections are not overly burdensome on the operators. The following are quotes from ExxonMobil[9] and Pioneer Natural Resources[10] establishing the value of Bridger's chosen detection sensitivity.

> *"At a minimum, we believe that Bridger Photonics was going to get at least 90% of the emissions from our assets."*
> - Matt Kolesar, ExxonMobil

> *"... using a higher sensitivity technology allows us to ... understand the full picture of our methane emissions."*
> - Pioneer Sustainability Report

In addition to client testimonials, Figure 1 supports the appropriateness of Bridger's recommendation that EPA adopt a standard in the Final Rule of 10 kg/hr detection sensitivity coupled with a required >50% probability of detection under typical conditions. The figure shows emissions distributions for over 12,000 production facilities in five major North American oil and gas basins (Alberta,[11] Anadarko, Bakken, Denver-Julesburg, and Permian, in alphabetical order) measured by Bridger's aerial LiDAR technology. The emissions distributions are displayed as measured at the source level (Gas Mapping LiDAR achieves equipment-level spatial resolution). The distributions are not aggregated to the site level for the cases when there are multiple emission sources on a single site, and the distributions include both fugitive and normal operating process emissions (NOPEs).

These emissions distributions can be used to determine the detection sensitivity required to detect a given percentage of Bridger's detected emissions in each basin. First, note that Bridger's emission rate detection sensitivity is 3 kg/hr (>90% PoD under typical conditions) for the production sector, which is represented by the black vertical line in Figure 1. So, there is high confidence of detecting emission sources with rates greater than this threshold (to the left of the black line in Figure 1). For lower emission rates (to the right of the black line in Figure 3), the probability of detection decreases and the asymptotic "roll-off" behavior displayed by each distribution is a result of this decreased probability of detection convolved with the decreased aggregate emissions from the smaller emissions sources (i.e. the actual emissions distribution). Note also that Bridger still detects emission events more than an order of magnitude below their stated detection sensitivity (nearly as low as 0.1 kg/hr), but such "lucky" detections should not be the benchmark by which detection sensitivity is defined. The probability of these detection events diminishes as the emissions become smaller. Again, this highlights the critical importance of including a probability of detection, and the conditions under which it is valid, along with any emission rate detection sensitivity value (see Comment Topic 1 above).

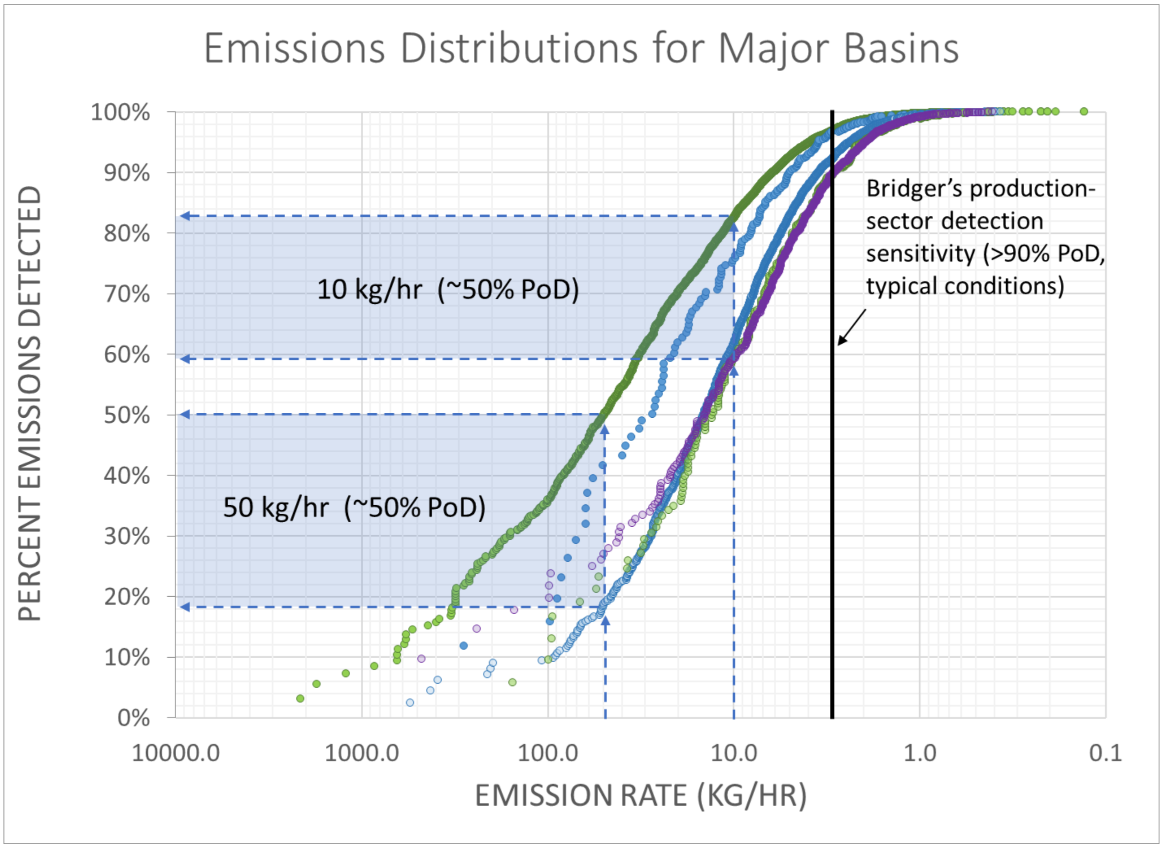

Figure 1. Emissions distributions for five major oil and gas basins in North America (in alphabetical order): Alberta,[11] Anadarko, Bakken, Denver-Julesburg, and Permian. The shaded regions show the percentage of emissions detected for detection sensitivity of 10 kg/hr with ~50% PoD (59% to 82%) and 50 kg/hr with ~50% PoD (18% to 50%), depending on the basin.

In the high-confidence region of emission rates to the left of the vertical black line, the emissions distributions of Figure 1 reliably map the percentage of emissions that would have been detected if other detection sensitivity with equipment-level spatial resolution would have been used instead of Bridger's technology. A 10 kg/hr step-function detection sensitivity threshold, which gives approximately equivalent results as 50% probability of detection, would have resulted in detection of between 59% and 83% of the emissions detected by Bridger, depending on the basin. This is consistent with the stated goal of the Proposed Rule to "significantly reduce emissions of greenhouse gases and other harmful air pollutants from the Crude Oil and Natural Gas source category,"[1] and more specifically to reduce methane emissions by 75% as compared to current levels.[2]

However, Figure 1 also highlights the negative impact of using poorer detection sensitivity. If a detection sensitivity of 50 kg/hr (~50% probability of detection) is used, only between 18% and 50% of the emissions detected by Bridger would be detected (i.e. 50% to 82% of emissions would be *undetected*), depending on the basin. It's important to understand that the undetected percentage of emissions will never be detected by the aerial technology, no matter how many times the sites are flown/scanned (see Comment Topic 4 regarding matrix solution below). To "lock in" more than half of existing emissions would be devastating to the environment and counter to the stated goal of the Proposed Rule. Moreover, there is mounting evidence that the proposed annual ground crew OGI scan won't detect these emissions either because OGI scans are largely independent of, and complementary to, aerial scans (i.e. the two scans find different, separate emission sources).[8]

The present study reports directly what was measured during Bridger's scans and does not attempt to estimate the impacts of (a) better detection sensitivity on the low-emission ends of the emissions distributions, (b) larger sample size on the high-emission ends of the emissions distributions, (c) using poorer spatial resolution to aggregate multiple emission events on a site, and (d) fugitive versus normal operating process emissions (NOPEs). The impacts of (a) through (c) are treated rigorously in an auxiliary publication,[7] but the data presented herein stands on its own on an as-measured basis.

Summary of Comment 2: We urge the EPA to set a detection sensitivity performance standard of 10 kg/hr (as proposed) with a required >50% probability of detection under typical conditions in which the alternative work practice is applied.

Comment Topic 3. Adopt quarterly rather than bi-monthly scan frequency until sufficient temporal data exists to inform policy.

The EPA solicited feedback on the suitability of the alternative work practice comprising a bi-monthly (six times per year) aerial scan frequency in addition to annual (once per year) OGI surveys. While significant theoretical modeling has been performed to predict the efficacy of using different scan frequencies, the model predictions vary widely depending on input parameters and assumptions. Bridger's position is that insufficient temporal data (i.e. on scan frequency) exists to validate those models or to confidently guide or inform policy. Specifically, to assess the impact of scan frequency on emissions reduction, Bridger needs to see the temporal equivalent of Figure 1: the percentage of emissions detected versus the number of scans per year (for a statistically significant sample size gathered over at least one year with comprehensive detection sensitivity). Due to the uncertainty in the modeling, and the financial, operational, and logistical burden on the industry for an "instant" ramp up to bi-monthly scanning, Bridger urges the EPA to adopt quarterly rather than bi-monthly scan frequency in the Final Rule (in addition to annual OGI) for the alternative aerial work practice as long as (a) the adopted detection sensitivity metric is no worse than 10 kg/hr with >50% probability of detection in typical conditions, and (b) there is a built-in mechanism to change (increase or decrease) that scan frequency when the aggregate temporal data becomes available to establish that a different scan frequency achieves the goal of detecting 75% of annual emissions. Bridger also advocates more generally for a built-in mechanism to allow individual operators with demonstrated low emissions to use lower scan frequencies.

We also emphasize that Bridger's aerial scans have been demonstrated in typical operational conditions to perform better than a one-to-one replacement for OGI scans. Yet the aerial scanning alternative work practice in the Proposed Rule implies that two aerial scans replace each of three OGI surveys (i.e. 1:2 swap). If the EPA's intent is to use OGI scans as the benchmark for performance (which we discourage), then quarterly scanning plus annual OGI is certainly more than justified. This is supported by third-party studies showing that Bridger's aerial LiDAR scans detect more, not less, emissions than OGI scans with ground crews.[8] Moreover, the same study finds that the aerial scans result in far fewer repair events due to the larger emission events uncovered by Bridger's scans. These findings have been repeated on much larger scale with consistent results,[11] are consistent with industry feedback from our clients, and are consistent with the findings detailed in Comment Topic 9.

Summary of Comment 3: We urge the EPA to adopt quarterly rather than bi-monthly scanning frequency in the Final Rule, with a built-in mechanism to change (increase or decrease) the scan frequency to achieve detection of 75% of current annual baseline emissions.

Comment Topic 4. Allow a "matrix" approach to aerial scanning only if detection of 75% of current baseline annual emissions will be achieved by the aerial detection sensitivity and scanning frequency combination.

The EPA solicited feedback on the possibility of using a so-called "matrix" approach to aerial scanning, whereby poorer detection sensitivity could be substituted for increased scanning frequency, or whereby better detection sensitivity could be substituted for lower scanning frequency. Again, Bridger's position is that insufficient experimental data exists regarding scan frequency to support or refute a matrix approach. Therefore, consistent with our Comment Topic 3, Bridger urges the EPA to gather comprehensive aggregate temporal data to show the percentage of emissions detected versus the number of scans per year (for a statistically significant sample size gathered over at least one year with comprehensive detection sensitivity). Once this data is gathered and analyzed, Bridger urges the EPA to adopt a matrix solution that achieves 75% emissions reduction compared to the current baseline, as measured by the percentage of current "snapshot" emissions detected times the percentage of emissions detected for the given scan frequency.

By way of a simplified example, if the EPA were to select Bridger's recommended quarterly scanning frequency, and if Bridger (or any other aerial scanning technology) demonstrates through aggregated emissions distributions in typical conditions[7] that it catches 95% of current baseline emissions (i.e. we miss 5% of emissions), and if aggregate temporal data demonstrates that the emissions reduction factor used by the EPA for quarterly OGI scans (80%)[12] is accurate or an underestimate for aerial scans, then Bridger will detect at least 80% × 95% = 76.5% of current baseline annual emissions, and thus quarterly scan frequency is acceptable for Bridger's technology.

Summary of Comment 4: We urge the EPA to only allow a matrix approach that substitutes detection sensitivity for scan frequency if detection of 75% of emissions (from the current baseline, and supported by aggregate data) will be achieved.

Comment Topic 5. Do not require OGI follow-up visits of identified normal operating process emissions.

The EPA's Proposed Rule indicates that an emission source identified by an aerial scan must be investigated with ground crews and repaired in the case of fugitive emissions. However, a reasonable fraction of detected emissions is associated with Normal Operating Process Emissions (NOPEs) (e.g. a pneumatic valve) rather than fugitive emissions, and therefore no repair action is required as a result of the detection. While the NOPE components may be phased out by an operator over time and replaced with non-emitting components, operators should not be forced to perform an OGI follow-up visit to previously identified NOPEs upon repeat aerial detections. If a NOPE associated with an aerial scan detection is identified as such by a subsequent OGI survey, then Bridger urges the EPA to *not* require additional investigations of that NOPE except (a) during the single annual OGI survey required by the Proposed Rule, and (b) if the emission rate corresponding to the NOPE is outside the permitted bounds for that equipment/component, taking into account uncertainty in the aerial quantification.

Moreover, regarding NOPEs, the vast majority of our clients use our identification and reporting of NOPEs to schedule and prioritize replacements and retrofits of the subject components to eliminate these emissions sources in an effort to more rapidly meet their sustainability goals. We therefore discourage the EPA from implementing regulations or policy that would disincentivize the identification or reporting of NOPEs.

Summary of Comment 5: We urge the EPA to not require OGI follow-up visits to equipment corresponding to emission sources that have previously been identified as normal operating processing emissions as long as (a) the emission rate is within the permitted range for that equipment and (b) the equipment is scanned during the annual OGI scan.

Comment Topic 6. Require auditability of aerial scans.

The EPA, the operators, and third parties need assurance that the intended sites were actually scanned by the aerial technology, and that the scans met the detection sensitivity performance metric from a statistical standpoint. First, we therefore urge the EPA to require, as a provision of the alternative work practice program in the Final Rule, reporting of an auditable scan swath with GPS ground coordinates that documents the actual coverage area of the aerial scan. The GPS coordinates of the aircraft alone are insufficient because, for instance, the aircraft altitude impacts the scan swath width, and the aircraft “roll” impacts the lateral projection of the scan swath onto the ground. An accurate, geo-registered scan swath coverage, when combined with geo-registered gas plume concentration imagery, date-stamps, time-stamps, and detection sensitivity verification (see below) can also automate the auditing process for the EPA.

In addition to the documented scan swath to verify that valid data was acquired of the sites subject to the Final Rule, we urge the EPA to require that aggregate emissions data from each aerial scanning solution provider pass a simple and objective audit to prove that the detection sensitivity performance metric is achieved by the technology (a) prior to approval of the technology for an alternative work practice, and (b) periodically during application of the alternative work practice.

One can qualitatively observe from the asymptotic roll-of behavior in the emissions distributions of Figure 1 that missed leaks begin to occur around 3 kg/hr for Bridger’s technology under the deployed conditions. However, instead of this qualitative metric, Bridger recommends utilizing a rigorous and objective metric to determine detection sensitivity during application of the work practice. The detection sensitivity of a monitoring technology may be evaluated rigorously by analyzing the emissions distribution computed from aggregate scan data like in Figure 1. Emissions distributions measured by the solar infrared imaging spectrometer described in the Cusworth study, and those measured by Bridger's Gas Mapping LiDAR in the Permian, Denver-Julesburg, and Alberta (Canada), indicate that a Pareto distribution provides an accurate representation of emission count versus emission rate in the range between 10 kg/hr and 1000 kg/hr.[13,7] We therefore recommend fitting the number of emissions as a function of emission rate with a Pareto distribution, or other probability density function that is proven suitable to represent the actual distribution. Deviations between the fitted distribution and the measured number of emissions on the low-emission end of the distribution may be used to estimate the emission rate at which the associated monitoring technology misses a given fraction of emissions in typical operating conditions. Specifically, the 50% probability of detection point may be identified as the emission rate at which the fitted Pareto distribution (i.e. the actual emissions distribution) deviates from the measured data by a factor of two. Based on this objective calculation, if the aerial scan technology's measured distribution deviates from the Pareto distribution by less than a factor of two at an emission rate less than the EPA's detection sensitivity metric (10 kg/hr as proposed), then the technology may be allowed to enter the alternative program. Additionally, if this condition continues to be satisfied by the aggregate data acquired by the solution provider during the application of the work practice, then the solution provider is allowed to continue participation in the alternative program.

This solution offers many advantages. First, it is simple to implement and maintain by the EPA. All that is required is a file with the anonymous aggregated emission source detections for each aerial solution provider in the alternative program (i.e. that data in Figure 1). Evaluating both the detection sensitivity and the spatial coverage auditing can be fully automated. The solution provides an even playing field for all technologies, and ensures, in the aggregate, that the detection sensitivity metric is achieved under the conditions under which the work practice is applied (as opposed to merely "ideal" conditions). The metric for success is objective based on measured probability density functions.

Summary of Comment 6: We urge the EPA to require verifiable and auditable geo-registered scan coverage with GPS ground coordinates and implement an objective probability-density-function test to determine if an aerial scanning technology achieves the detection sensitivity performance metric (i.e. 10 kg/hr with >50% PoD under typical conditions).

Comment Topic 7. Allow for swap of aerial scan for OGI scan on per-scan basis

The EPA proposes allowing operators "… the option to comply with this alternative fugitive Emissions standard instead of the proposed ground based OGI surveys …." Bridger fully supports the alternative option in general. However, one challenge we foresee is when certain conditions exist that prevent an alternative technology from meeting the detection sensitivity metric only for a portion of the scans. For example, most aerial scanning technologies achieve worse detection sensitivity with snow cover than dry ground. This could prevent a technology from meeting the detection sensitivity metric only during certain months/scans. We therefore urge the EPA to allow application of the alternative option on a per-OGI-scan basis. For example, if the EPA were to adopt Bridger's recommended quarterly scan frequency for the alternative work practice, then any of the four aerial scans could be swapped for an OGI scan during conditions that prevented the aerial scan from achieving the detection sensitivity metric.

Summary of Comment 7: We urge the EPA to provide sufficient flexibility in the alternative work practice to allow for aerial/OGI swaps on a per-scan basis.

Comment Topic 8. Adopt "tiered" response timelines.

The EPA is soliciting comment on how to "structure a requirement that would tier repair deadlines based on the severity of the fugitive emissions." First, we urge the EPA to require the OGI follow-up period (14-days in the Proposed Rule) to begin upon notification of the emission event to the operator by the aerial scan provider. The time it takes for the aerial scan provider to deliver the data to the operator is out of the operator's control.

Second, we urge the EPA to adopt a tiered approach to OGI follow up and repair activities. Based on Figure 1, we suggest the following tiers:

Tier	Emission Rates	Response Timeline
Tier 1	>100 kg/hr	As fast as commercially reasonable
Tier 2	10 kg/hr – 100 kg/hr	Intermediate timeline
Tier 3	<10 kg/hr	Time between successive aerial scans

We urge the EPA to gather input from operators of many sizes and geographies to determine what is a commercially reasonable timeline is for the Tier 1 response timeline, which represents visits to less than 1% of sites.

Summary of Comment 8: We urge the EPA to adopt tiers for follow-up and repair activity deadlines to prioritize large emitters.

Comment Topic 9. The proposed alternative program with Gas Mapping LiDAR enables strong cost, emissions reduction, and other advantages compared to the standard OGI program.

The EPA solicited information to allow further evaluation of the potential costs and emission reductions achieved through an alternative screening program. To meet this request, Figure 2 shows a detailed analysis and comparison of both cost and emissions reduction between the standard OGI program (4 × OGI) and the aerial alternative work practice in the Proposed Rule using Bridger's Gas Mapping LiDAR [(1 × OGI) + (6 × GML)]. All of the OGI information in Figure 2 is from the EPA supplemental information spreadsheet (EPA-HQ-OAR-2021-0317-0166_attachment_11). The primary outcomes of the analysis are:

(1) Lower Gross GML Program Cost: The aerial alternative work practice using Bridger's Gas Mapping LiDAR is less expensive on a straight gross cost comparison basis for all deployment scenarios considered, and conservative assumptions, than the standard OGI program. The gross

GML program cost decreases further if Bridger's recommended quarterly scan frequency is adopted instead of bi-monthly scanning in the Final Rule.

(2) Large Net Savings When Gas is Recaptured: The aerial alternative work practice using Bridger's Gas Mapping LiDAR is predicted to yield a "worst-case" net *savings* of $3,204 per site per year when the gas corresponding just to the repaired leaks (not including NOPE retrofits) is retained for revenue generation.

(3) Low Cost Per Ton of Emissions Reduced: Again, with the conservative assumptions the alternative program yields a cost of emissions reduction of $3.79 per ton of CO2e.

We were conservative regarding the Gas Mapping LiDAR (GML) analysis and assumptions throughout the analysis in Figure 2. The conservative assumptions include:

<u>Costs</u>

(1) Price. To avoid disclosing pricing information, we artificially set the price per facility scan for GML to $250. However, the actual price per scan for GML is currently always under this value for all deployment scenarios (rotary-wing and fixed-wing), assuming bi-monthly scanning in regions with reasonable site density and for sufficient site count.

(2) Scan Frequency. Bridger assumes bi-monthly scan frequency instead of our recommended quarterly scan frequency. The analysis shows that both quarterly and bi-monthly alternative programs will be lower cost than the standard OGI program.

(3) Site Visits. When Bridger identifies an emission source, the Proposed Rule requires that the entire site be scanned with OGI. So, we included "# visit events per year per site (snapshot)" that represents the average fraction of sites on which we detect an emission. First, this is conservative because this number includes NOPEs. Per our Comment Topic 5, we urge the EPA to *not* require visits to emission sources that have been previously identified as NOPEs. Second, this number is conservative because we assume that this OGI scan visit is independent of the repair visit. In practice, we find that these two visits can often be combined into one visit and accomplished with a single repair crew. Or, in cases like open thief hatches or unlit flares, for example, a repair crew is not even needed, and the fix can be performed during routine operations.

(4) Snapshot Repair Events. For "# repair events per year per site (snapshot)", we used the actual number of detection events divided by the actual total number of sites scanned from the data shown in Figure 1. Again, this is conservative because this number includes NOPEs (see Comment Topic 5). This is also conservative because our number doesn't account for the occurrence of multiple repair events on the same site.

(5) Annual Repair Events. For "Factor from snapshot to actual scan frequency", we conservatively extrapolated the EPA's emission reduction factor from between quarterly and monthly scanning to determine that for bi-monthly scans.

(6) Independence of OGI & GML. We assumed the repair events resulting from the single OGI scan were independent of those from the six GML scans. While there is evidence that OGI and

GML are complementary and independent to a large degree,[8] they do detect some of the same emissions, so simply summing the repair events from OGI and GML double counts some repair events and is therefore conservative.

Summary of Cost Findings. Even with all of these conservative assumptions, including an upper limit price estimate, the gross cost of the alternative GML program is lower than that of the standard OGI program. This economic advantage becomes even greater when cost per emissions reduction ($/ton) is considered and if the gas can be recaptured for revenue. Also, note that the full six GML scans result in fewer repair events than the single OGI scan of the alternative work practice. This is consistent with third party studies[8] and anecdotal evidence from our clients.

Reduced Emissions

(1) Average Site Emissions. For "Average emission rate per site", we used the actual aggregate emissions divided by the total number of sites scanned from the data shown in Figure 1. For some basins, we measure significantly greater average emission rate per site.

(2) Annual Emissions. For "Annual emissions per site", the EPA spreadsheet (EPA-HQ-OAR-2021-0317-0166_attachment_11) does not give an "average" site emission. We used a 10 tpy site for the OGI program and the actual average for the alternative GML program. However, the alternative work practice with GML still achieves greater emissions reduction that the standard OGI program assuming a 50 tpy site (i.e. the largest considered by the EPA).

(3) Percent Requiring Repair. For "Percent detected that require repair (vs NOPE)", we removed the percentage of emissions that were identified to us as NOPEs based on information from a collaborative industry partner. This is conservative because our clients often use our identification of NOPEs to inform and prioritize the replacement of NOPE components. Our analysis conservatively does not include the emissions reductions associated with replacement of identified NOPE components.

Summary of Reduced Emissions Findings. Again, using conservative assumptions, the EPA's data for OGI, and Bridger's actual GML data, the alternative program with GML detects far greater emissions from an average production site than the standard OGI program for a 10 tpy site. This finding is consistent with third party studies[8] and anecdotal evidence from our clients that find GML detects far more emissions than ground crews with OGI cameras, but requires far fewer repair events. The alternative program with GML even detects more average emissions than the standard OGI program for a 50 tpy site (the highest category of site considered in the EPA spreadsheet).

Cost/Benefit Analysis of Gas Mapping LiDAR (GML)					
	Standard	**Alternative**			
Costs	**Quarterly**	**Annual**	**Bi-Monthly**	**Combined**	
Scan Costs	**OGI**	**OGI**	**GML**	**Total**	
Cost per site per scan ($/site/scan)	$ 483	$ 483	$ 250	$ 733	
Number of scans per year	4	1	6		
Annual scanning cost per site ($/yr/site)	$ 1,931	$ 483	$ 1,500	$ 1,983	
Repair Costs					
# visit events per year per site (snapshot)	0	0	0.36	0.36	Fraction sites w/ GML detections (incl. NOPEs)
# repair events per year per site (snapshot)	3	3	0.63	3.63	Avg. emission sources per site (incl. NOPEs)
Factor from snapshot to actual scan frequency	2	1	2.2		From (or extrapolated from) EPA.
# repair/visit events per year per site with scan frequenc	6	3	2.18	5.18	
Annual repair cost per site ($/yr/site)	$ 533	$ 267	$ 193	$ 460	Uses EPA equation from # repair events
All Other Costs (independent of monitoring)	$ 1,740			$1,740	From EPA. Assumed equal admin/implement costs.
Gross Program Cost Per Year Per Site	**$ 4,204**			**$ 4,183**	
Emissions Reduced					
Average emission rate per site (kg/hr/site, snapshot)	-	-	8.3		From 12,000+ sites across North America (Figure 1)
Annual emissions per site (tons/yr/site, snapshot)	10	10	80		Assume 10 tpy site for OGI
Percent detected that require repair (vs NOPE)	100%	100%	52%		Based on reporting from client collaborator
Percent emissions reduction for higher-freqeuncy scans	80%	40%	85%		From (or extrapolated from) EPA reduction fractors
Total annual emissions reduced per site (tons/yr/site)	**8**	4	35.42	**39.42**	Sum of OGI and GML for the alternative program
Gross Cost Per Reduced Emissions					
Scanning cost per ton of emissions reduced ($/ton)	$ 241.40			$ 50.29	
Repair cost per ton of emissions reduced ($/ton)	$ 66.63			$ 11.67	
Other cost per ton of emissions reduced ($/ton)	$ 217.47			$ 44.13	
Total cost per ton of CH4 emissions reduced ($/ton)	**$ 525.50**			**$ 106.10**	
Total cost per ton of CO2e emissions reduced	**$ 18.77**			**$ 3.79**	Assume 1 ton of CH4 = 28 tons CO2e per EPA GWP
Gas Savings Per Ton Recaptured Methane					
Natural gas cost used for savings (per 1,000 scf)	$ 3.90			$ 3.90	As of January, 2022
Savings per ton due to recaptured gas ($/ton)	$ 187			$ 187	
Savings due to recaptured gas	$ 1,499			$ 7,387	
Net Program Cost Per Year Per Site	**$ 2,705**			**$ (3,204)**	**GML Program Yields Net Savings if Gas Recaptured**
Net Cost Per Reduced CH4 Emissions ($/ton)	**$ 338.14**			**$ (81.27)**	

Figure 2. Worst-case cost / benefit analysis of using Gas Mapping LiDAR in alternative aerial program.

Other Benefits Not Quantified

In addition to the cost and emissions reduction benefits detailed in Figure 2, the alternative program offers other benefits that are not easily quantified. These include:

(1) Safety. The alternative program results in fewer site visits and plume imagery allows operators advanced warning and situational awareness. Fewer site visits mean less "windshield time" driving to sites for the alternative program compared to the standard OGI program. Bridger provides "safety alerts" to clients within 24 hours for emissions detected that exceed a preset threshold selected by the client. Bridger's crisp imagery shows crews what they're walking into when they visit the site.

(2) Efficiency. By providing high spatial resolution imagery and GPS emission source locations typically within 2 meters in all three dimensions (see example data products in Figure 3), our clients tell us that we save them considerable time locating and diagnosing the problem.

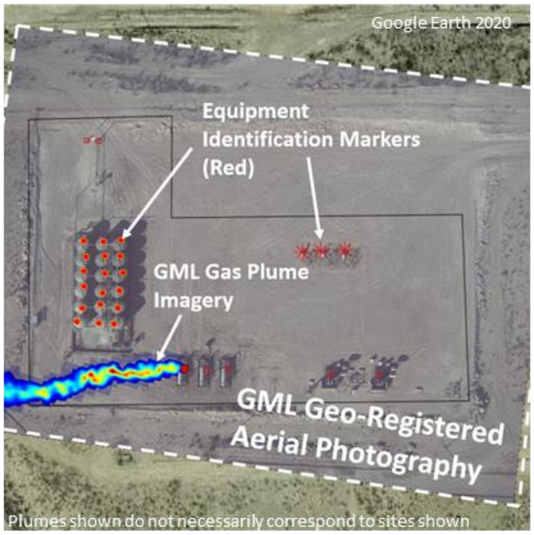

Figure 3. Example data from Bridger's Gas Mapping LiDAR showing satellite imagery, aerial digital photography, optional equipment identification markers, gas plume imagery, and emission source location (red circle).[14] All data is geo-registered and time stamped.

(3) Impact. We routinely hear from our clients that gas plume imagery impacts perception of emissions. Prior to crisp gas imagery, a liquids spill may have been addressed with much greater urgency and priority than a methane leak because the gas is invisible to the naked eye. By enabling visualization of the actual gas plumes, our clients tell us that their crews treat methane emissions with the appropriate urgency and priority.

(4) Objectivity. The standard OGI program is known to depend strongly on the instrument operator. Much of the detection and data processing for GML is automated and fully objective.

(5) Insensitivity to Temperature. OGI scans are known to be affected by heat, making them incompatible with measuring, for example, flare emissions and methane slip in compressor exhaust. The alternative work practice with GML has been shown to measure both of these emissions sources without any known degradation in performance. We also note that some operators inform us that Remote Methane Leak Detection (RMLD) hand-held sensors perform significantly better than OGI in detecting and locating leaks.

(6) Self-Auditing. We provide an auditable swath to ensure scan coverage. The data is time-stamped, date-stamped, GPS registered, with emission rate quantification. This enables simple reporting from clients to the EPA and it allows for the possibility of automated auditing to be performed by the EPA without utilization of EPA personnel resources in the field.

Summary of Comment 9: The data provided in this section supports the economic, emissions reduction, and other advantages of the proposed alternative work practice using GML as compared to the standard OGI program.

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References

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[1] 86 FR 63,110, 63,110 (November 15, 2021).

[2] https://www.whitehouse.gov/wp-content/uploads/2021/11/US-Methane-Emissions-Reduction-Action-Plan-1.pdf

[3] Emission reduction factor of 80% assumed for quarterly OGI surveys in EPA supplemental information EPA-HQ-OAR-2021-0317-0166_attachment_11

[4] Daniel H. Cusworth et al., Intermittency of Large Methane Emitters in the Permian Basin, 8, 7, Environmental Science & Technology Letters 567, 568 (2021).

[5] Andrew Thorpe et al., *Mapping methane concentrations from a controlled release experiment using the next generation airborne visible/infrared imaging spectrometer (AVIRIS-NG)*. Remote Sensing of Environment. 179. 104-115. 10.1016/j.rse.2016.03.032.

[6] Assuming the average wind speed in Midland, Texas of 5.3 m/s is indicative of the Permian basin, https://www.weather-us.com/en/texas-usa/midland-climate#wind.

[7] Manuscript in preparation.

[8] David R. Tyner, et al., *Where the Methane Is—Insights from Novel Airborne LiDAR Measurements Combined with Ground Survey Data,* Environmental Science & Technology 2021 55 (14), 9773-9783
DOI: 10.1021/acs.est.1c01572.

[9] Matt Kolesar, from his presentation at the *U.S. Environmental Protection Agency Methane Detection Technology Virtual Workshop*, August 24, 2021.

[10] Pioneer Natural Resources, 2021 Sustainability Report, https://www.pxd.com/sites/default/files/reports/0018021_SustainabilityReport_FINAL.pdf.

[11] Matt Johnson group at University of Carleton, manuscript in preparation.

[12] EPA supplemental information EPA-HQ-OAR-2021-0317-0166_attachment_11

[13] M.E.J. Newman, *Power laws, Pareto distributions and Zipf's law,* Contemporary Physics, Vol. 46, No. 5, September–October 2005, 323 – 351.

[14] Image courtesy Collaboratory to Advance Methane Science (CAMS) and the Gas Technology Institute (GTI). https://methanecollaboratory.com/wp-content/uploads/2021/08/Scientific-Insights-Aerial-Survey-in-Permian-August2021_vFinal.pdf