Comment Letter re: Proposed Regulatory Framework for Reducing Oil and Gas Methane Emissions to Achieve 2030 Target

Bridger Photonics, Inc. ("Bridger") appreciates the opportunity to provide comments on the proposed regulatory framework ("Proposed Framework") for reducing oil and gas methane emissions to achieve Canada's 2030 target. 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 (O&G) industry in North America over the past nearly four years. Bridger partners with Canadian air service provider Airborne Energy Solutions (AES) to provide oil and gas operators throughout Canada with data on their methane emissions.

Bridger's experience studying O&G methane emissions at scale allows us to clearly project the impact that monitoring programs can have on emissions reductions. This places us in a unique position to provide recommendations on regulatory provisions that advance Canada's goal of a "75% reduction in oil and gas methane by 2030 relative to 2012."[1]

In the Proposed Framework, ECCC indicates the potential to expand the existing alternative leak detection and repair (LDAR) program for more comprehensive methane emissions monitoring. In this context, Bridger supports rules that make it easy for operators to achieve regulatory compliance using advanced methane measurement technologies. This letter provides three sets of recommendations on how to structure provisions that promote the application of advanced technologies towards regulatory compliance. Recommendations are centered on three topics: (1) emissions monitoring for comprehensive emissions management at O&G facilities, (2) a centralized advanced technology approval process that ensures technical rigor, and (3) a technology agnostic framework for emissions monitoring that is designed to achieve desired methane emissions reductions.

Recommendation Area 1: Emissions Monitoring for Comprehensive Methane Emission Management at Oil & Gas Facilities

Introduction. The Proposed Framework describes low emission performance requirements for most emission sources. It is noted that the key to effective performance-based regulation includes effective monitoring methods and furthermore that alternative leak detection and repair methods can contribute to near-continuous monitoring of all methane emissions at a facility-level.[1] Bridger supports the adoption of regulatory provisions that enable alternative leak detection technologies to be used for compliance verification of the low- or zero-emission performance requirements described in the Proposed Framework and we recommend that operators should be able to use their LDAR monitoring programs for this purpose.

Emissions Monitoring for Demonstrating Compliance with Numerical Performance Requirements. Optical gas imaging (OGI) cameras and many advanced methane measurement technologies used in LDAR programs can detect emissions from most or all designated emission sources and can also be used to ensure the correct function and integrity of emissions conservation or destruction equipment used to eliminate emissions. For performance rules requiring a source not to emit, detection technologies with sufficient detection sensitivity could demonstrate compliance by no emissions being detected from that source. However, certain conservation and destruction equipment (such as vapor recovery units and

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enclosed combustion devices) is designed to emit some percentage of emissions routed to it, and the Proposed Framework describes efficiency requirements for these types of equipment. In this case, compliance would be demonstrated by no emissions indicating abnormal operation being detected from those sources.

Previously Demonstrated Emissions Reductions Enabled by Comprehensive Monitoring. The impact of addressing emissions identified during comprehensive emissions monitoring is demonstrated through the Alberta Energy Regulator's (AER) Alternative Fugitive Emission Management Program (Alt-FEMP). Operators implement Gas Mapping LiDAR in Alt-FEMP to detect emissions, both vented and fugitive, at their facilities. Operators such as Cenovus Energy report that using Bridger's Gas Mapping LiDAR aerial methane detection as part of their Alt-FEMP plan enables them to efficiently "detect, quantify and mitigate methane emissions."[2,3] The emissions reductions achieved by Alt-FEMP pilots are documented in annual reports submitted to the AER. Bridger has confirmed that most operators utilizing Gas Mapping LiDAR for the Alt-FEMP program have seen year-over-year reductions in their overall methane emissions, including vented emissions, moving closer to the 75% reduction goal. Although we describe the application of Gas Mapping LiDAR for abating vented emissions, and the proposed framework requires these to be eliminated (for facilities with > above 5 m^3/day combined flare and vent volume), it is likely that some process failures will manifest as vented emissions which can then be detected and remediated.

Summary of Recommendation Area 1. Bridger recommends that ECCC enables operators to use their LDAR monitoring programs not only to mitigate fugitive emissions but also as a streamlined tool to comprehensively demonstrate compliance with other emissions performance requirements at O&G facilities.

Recommendation Area 2: A Centralized Approval Process for Advanced Methane Measurement Technologies to be Used for Regulatory LDAR Programs

Introduction. Currently, advanced methane measurement technologies can only be used in alternative LDAR programs that individual operators get approved. This is a significant barrier to the application of next-generation technology, which can provide many benefits. To make it easy for operators to use advanced methane detection technologies for emissions monitoring, Bridger recommends that ECCC develops a centralized technology approval process. We also recommend that the approval process is transparent and open to public comment.

Advanced Technology Benefits. Bridger recommends ECCC to continue to develop provisions that promote application of advanced methane measurement technologies because these technologies can help operators to comprehensively, efficiently, safely, and cost effectively mitigate methane emissions. Here, Bridger's Gas Mapping LiDAR technology is used as an example of the benefits that advanced methane measurement technologies can provide:

- Early research indicates that a greater volume of emissions is detected by Gas Mapping LiDAR compared to OGI surveys[4a] and, relationally, a greater volume is expected to be detected compared to EPA Method 21.[5]
    - Complete spatial coverage is achieved within line of sight from the air, which means emissions resulting from venting, equipment malfunction, and abnormal operating

[a]Within this study, OGI measurements encompassed a narrower scope of measurements due, in part, to instrumental limitations but also due to ground-based survey scope.

conditions are all characterized without respect to whether the emission source is anticipated and required to be screened.
  - Methane from poorly performing flares and methane entrained in compressor exhaust can be empirically characterized.
  - Emission sources that are high off the ground such as unlit flares and improperly seated thief hatches are easily measured without compromising worker safety.
- Reduced opportunity for instrument user error
  - Methane emissions are automatically processed, imaged, and superimposed onto geo-registered, concurrently acquired digital photographs (Figure 1). The only two notable variables controlled in the field are flight speed and height.
  - A scan coverage audit is included as part of the data product.
  - Measurement metadata such as date and time is automatically recorded in the data set.
- Reduced burden on operators
  - Aerial deployment means rapid and expanded coverage at a reduced cost.[6]
  - With a greater volume of emitted methane detected, if remediation results in retention and sale of natural gas, then recovered revenue can help offset the costs of LDAR monitoring.
  - Safety is increased by reducing time field personnel spend on site and driving. Typically, emissions are found on 10-40% of sites scanned, significantly reducing the number of sites that need to be visited for OGI follow-up. Correspondingly, ground traffic—a notable safety concern—is also reduced.
  - Emissions can be quantified without placing personnel next to toxic and explosive gas sources.
  - Instrument and data quality assurance are handled by the technology provider which has deep expertise.

These bullet points are expanded on in our comments for the ECCC's Reducing Methane Emissions from Canada's Oil and Gas Sector – Discussion Paper.[7]

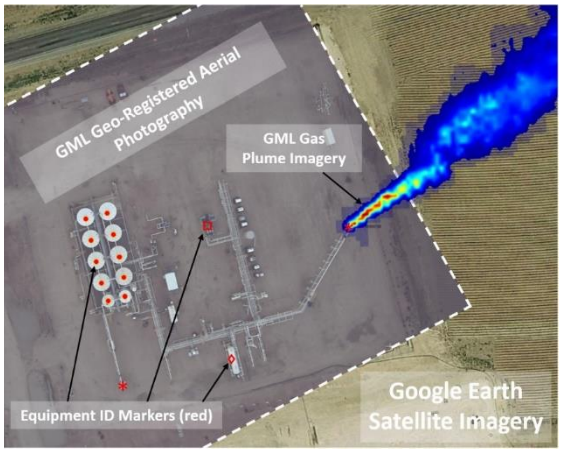

Figure 1. Example of Gas Mapping LiDAR data that is used by operators to efficiently identify and remediate emissions.

Recommended Process to Approve Advanced Technologies for Regulatory LDAR Programs. To eliminate the burden of each operator needing to apply to use advanced measurement technologies within an alternative LDAR program, Bridger recommends that the ECCC develop provisions for the centralized approval of advanced methane measurement technologies to be used for regulatory LDAR programs. A single application would be submitted to either ECCC or the ensemble of federal and provincial regulators provided they have equivalency agreements in place. Operators would then only need to specify the approved technology in their LDAR monitoring plans and not individually seek approval. To ensure that technology approval has a sound scientific basis and earns stakeholder confidence, the approval process for individual technologies should be transparent and open to public comment.

Recommended Elements in Regulatory Use Approval Applications. Every technology class has limitations that must be addressed in the application. For example, Gas Mapping LiDAR provides complete spatial coverage but requires a certain level of ground reflectivity for a given level of detection sensitivity, meaning that snow cover can influence the probability of detecting an emission. Therefore, ground reflectivity would need to be addressed. In addition, high ground wind speeds can reduce the probability of detecting an emission, which limits deployment during high winds. In contrast to Bridger's aerially deployed technology, fixed sensor systems may be subject to systematic false negative detections due to incomplete spatial coverage (e.g., lofted emissions from tanks or flares could be missed and very specific sensor configurations and numbers may be required at individual facilities; certain wind angles and speeds may be necessary for these systems to appropriately detect, quantify, and localize emissions).

Bridger recommends that an application to seek regulatory approval for an advanced methane detection technology contains the following elements:

- Technology description
- Standard operating procedures
- Quality assurance/control measures
- Allowable operating conditions
- Evidence that the required detection sensitivity is realized under allowable operating conditions
- Description of localization capabilities tied to empirical demonstration
- A description of data types and reporting procedures.

To reduce administrative workload and expedite technology approval, applications should only be allowed for technologies that are commercially tested and commercially available in Canada. Applicants should also be required to be experts in the technical aspects and deployment of the technology.

Summary of Recommendation Area 2. **Bridger recommends that ECCC establish a centralized approval process for advanced methane detection technologies so that operators can specify their use in LDAR programs without individually needing to seek approval for the technology. This approval process should be transparent and include concrete evidence that the technology meets performance requirements.**

Recommendation Area 3: A Technology Agnostic Framework for Implementing Advanced Technologies in Regulatory LDAR Programs

Introduction. For operators to be able to specify advanced methane measurement technologies within their LDAR plans without needing to develop individual alternative programs, it will be necessary to establish a framework that ensures the effective application of these technologies. Based on Bridger's experience in mapping out methane emissions throughout major production basins, we present recommendations for this framework that we believe are suitable for accomplishing Canada's emissions reduction goals while enabling operators to take advantage of efficiencies provided by these technologies. The framework we present includes detection sensitivity performance requirements tied to a frequency of deployment to achieve desired emissions reductions. Bridger also recommends appropriate requirements for responding to detected emissions.

Recommendations for Technology Sensitivity Requirements and Monitoring Frequencies. Bridger recommends a sensitivity performance requirement for advanced methane measurement technologies based on research on Canadian upstream O&G methane emissions led by Professor Matt Johnson of Carleton University in Ottawa. This work indicated that first-generation Gas Mapping LiDAR technology[b] (stated 3 kg hr^{-1} sensitivity with 90% probability of detection, also known as "PoD", for the upstream sector) directly characterized an estimated 80% of the emissions at typical upstream facilities in Canada with 16% of unmeasured emissions estimated to come from normal process emissions from pneumatic devices.[8] Considering that pneumatic devices will be required to be non-emitting in the Proposed Framework, if those pneumatic device emissions estimated by the Johnson group are subtracted from the total then Bridger could directly measure 95.2%[c] of the otherwise unperturbed emissions at typical upstream facilities, and therefore enable response to these emissions. To approximate emissions reductions possible from these measurements as a function of monitoring frequency, we tie in fugitive emissions reductions estimated by the USA EPA for OGI surveys at well sites (Table 1). This calculation methodology indicates that quarterly monitoring with a 3 kg hr^{-1} (90% PoD) detection sensitivity would enable 76% of emissions to be reduced in line with Canada's 75% 2030 goal (95.2% × 80.0% = 76%). Therefore, we recommend a monitoring framework in which a technology with 3 kg hr^{-1} detection sensitivity (90% PoD) used for quarterly monitoring to provide compliance with LDAR monitoring requirements.

Table 1. Fugitive emissions reductions from OGI screening at well sites as a function of monitoring frequency (estimated by the US EPA).[9,10]

Monitoring Frequency	Biennial	Annual	Semiannual	Quarterly	Monthly
Emissions Reductions	30%	40%	60%	80%	90%

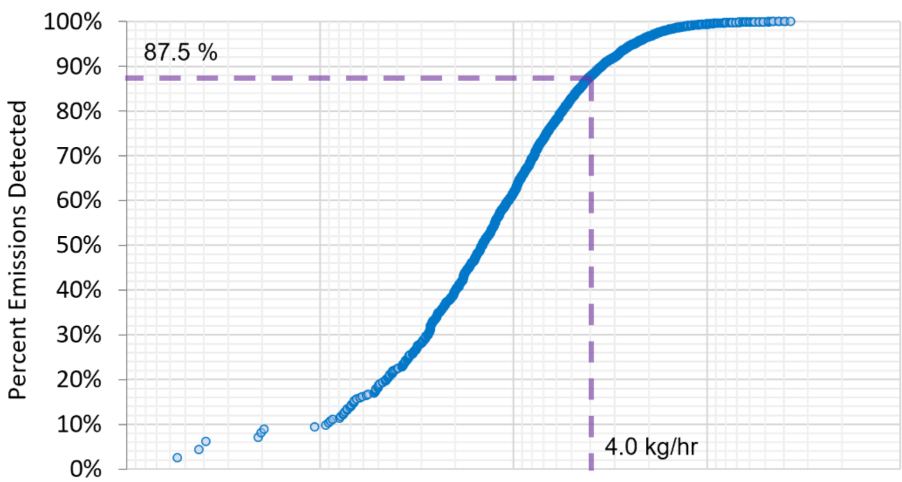

Figure 2. Alberta Basin cumulative emission rate distribution from Gas Mapping LiDAR measurements. Emissions with rates ≥ 4 kg hr^{-1} make up 87.5% of directly measured emissions and 83.3% of total estimated emissions when emissions from pneumatics are excluded.[8]

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[b] Bridger is currently evaluating improved performance of the second-generation of Gas Mapping LiDAR that is being deployed.

[c] $1_{\text{Total Emissions}} - 0.16_{\text{Pneumatic Device Emissions}} = 0.84_{\text{Remaining Emissions}}$, $(0.80_{\text{Bridger Measured Fraction of Total}} / 0.84_{\text{Remaining Emissions}})*100\% = 95.2\%$

The Proposed Framework indicates that future rules may require monthly LDAR monitoring. Under this paradigm, similar emissions reductions could be achieved with a less stringent detection sensitivity. However, this performance requirement could only be relaxed slightly because there are diminishing returns for increased monitoring frequency. Using the same calculation methodology described above, a 75% methane emissions reduction would require a detection sensitivity of approximately 4.0 kg hr^{-1}. This value is calculated as follows: emissions rates ≥ 4.0 kg hr^{-1} represent 87.5% of total Alberta Basin upstream emissions measured by Gas Mapping LiDAR (Figure 2), which are estimated here to represent 95.2% of emissions at typical facilities. Next, monthly monitoring is estimated to provide 90% emissions reduction (Table *1*) (87.5% × 95.2% × 90% = 75%). This analysis suggests that monthly monitoring with a detection sensitivity of 4.0 kg hr^{-1} (90% PoD) should be another LDAR monitoring option. We also recommend this sensitivity performance requirement for fixed sensor systems (i.e., technology agnostic). These systems typically require an appropriate time series of data points to identify emissions, and, in practice, these emissions cannot be immediately repaired. This likely places fixed sensors in a similar scan frequency tier as monthly periodic scans.

It is imperative that technologies' sensitivity performance requirements are defined by a probability of detection.[11] This is because during field measurements, the probability of detecting methane emissions with an instrument is statistical,[12–15] including when instruments like OGI cameras are used,[15] which is not represented by a minimum detection limit (e.g., Gas Mapping LiDAR measurements detects emissions with a rate far below 0.1 kg hr^{-1}, but these improbable detections should not be the basis of using Gas Mapping LiDAR for regulatory compliance).

There is the potential for significant challenges for LDAR monitoring during winter months. For example, reduced ground reflectivity from snow cover impacts Gas Mapping LiDAR detection sensitivity. Meanwhile, site access may be challenging for ground crews doing onsite measurements. As a result, there should be flexibility in the suggested framework. One point of flexibility is having the option to leverage any approved technology during a monitoring instance. For example, operators should be able to use OGI in place of approved advanced measurement technology for facility screening during a given quarter. We also recommend that operators should be able to perform three monthly scans instead of the quarterly scan in a given quarter to relax detection sensitivity requirements when environmental conditions are challenging. Logically, operators would need to indicate their intention to do so in monitoring plans to make sure that monthly scans are executed on time.

Often, LDAR programs are evaluated using models such as FEAST or LDAR-Sim.[16,17] The results from models depend heavily on the quality of inputs and to our knowledge, predicted emission reduction outcomes have yet to be empirically validated. Two model inputs that heavily influence modeled emission reductions are the leak production rate and empirical emission rate distributions. Leak production rates may be derived from regionally/technologically constrained datasets and can introduce significant uncertainty into modeling results.[16,18] Regardless, by assuming leaks appear at O&G facilities monotonically over time, it becomes clear that there are diminishing returns on overall emissions reductions with increasing monitoring frequency. In contrast to the leak production rate estimates underlying the EPA's emissions reduction estimates (Table 1), we have very high confidence in the empirical emission rate distribution (Figure 2) that we used to formulate our detection sensitivity recommendation. This distribution covers a larger range of emission rates compared to previously available distributions. It is also produced by a technology that provides spatially complete measurements whereas there is evidence that onsite measurement technologies used to generate some distributions can miss certain types of high emission rate events.[19]

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It must be noted that in our analysis, emissions reductions are approximated using EPA's estimated fugitive emissions reductions. Meanwhile the Alberta Basin emission rate distribution shown involves all emission types. In addition, although our analysis targets 75% methane emissions reduction from upstream O&G systems through response to detected emissions, actual emission reductions would also involve infrastructure and operational changes.

Recommended Follow-up Requirements for Emissions Detected with an Advanced Technology. A regulatory framework for monitoring methane emissions with advanced measurement technologies should include the requirements for following up on detected emissions. For technologies that do not detect emissions at the component level, it is standard practice to follow up on detected emissions with an instrument such as an OGI camera so that the emitting componentry can be identified and repaired. To eliminate uncertainty about the source or sources of an emission detected by advanced technologies, we recommend straightforward requirements based on the technology's localization precision.

For a given site, the amount of infrastructure that requires screening to localize emissions to specific components should depend on the emission source localization precision of the advanced measurement technology. For example, Gas Mapping LiDAR has equipment scale resolution and localizes emission to within 2 m (1σ) of the emission source, therefore the specific piece of emitting equipment can be identified from Gas Mapping LiDAR data and only this piece of equipment should be required to be screened with the handheld instrument. Another technology might localize emissions to within 150 m meaning an entire production facility would need to be screened. Localization precision must be based on field performance vs. technology capabilities. For example, a sensor may have 2 m pixel resolution but in practice may only localize emissions with facility scale resolution. Facilities such as METEC[d] or Canada's proposed Centre for Excellence on Methane Detection and Elimination would be useful for demonstrating localization capabilities.

It should not be required to follow up on emissions that can be directly identified as coming from normal operating processes based on data from the advanced technology. For example, allowable methane slip from a compressor engine might be detected during every facility screening and this should not prompt an onsite follow-up.

Recommended Repair Timeline for Emissions Detected with an Advanced Technology Advanced measurement technologies can often be deployed more efficiently than handheld instruments used in existing regulatory LDAR programs. This means that a large workload for follow up and repair of emitting infrastructure can be generated quickly, and additional time is reasonably needed relative to the 30-day repair deadline in the proposed framework. Furthermore, data post processing to provide mass emission rate data and other data types has an associated delay following emission screening. Therefore, Bridger recommends a reasonable repair deadline (e.g. 40 days) for emissions detected via advanced technology. However, we also recommend that a repair attempt be required prior to successive LDAR screening at a facility to ensure emissions are dealt with between rounds.

Summary of Recommendation Area 3. Bridger recommends at least two pathways to be established for compliance with LDAR monitoring program requirements: (1) quarterly monitoring using a technology providing 3 kg hr^{-1} 90% PoD detection sensitivity and (2) monthly monitoring or monitoring with fixed sensor systems using a technology providing 4 kg hr^{-1} 90% PoD detection sensitivity. Both pathways are anticipated to be consistent with Canada's methane emissions reduction goals. Bridger also recommends follow-up requirements for detected emissions that

[d] https://energy.colostate.edu/metec/

involves additional screening of infrastructure according to the localization the uncertainty for detected emissions. An extended repair deadline is recommended for advanced technologies considering that additional data processing may be required, and efficient deployment can produce a large repair workload.

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