

REPORT ON WORKSHOPS

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This document provides a summary report on the individual workshops conducted as part of the subject project. The workshops comprised participation in the UNEP and CCAC sponsored workshop conducted in Bogota, Colombia on 27 February 2020. The presentation made at that workshop is appended in both an English and Spanish version. This was followed by a series of six separate workshops/meetings with Operator 1. Except as specifically noted below, each of these workshops began with making the same presentation as used at the UNEP/CCAC workshop, and was followed by the presentation of additional information specific to each of the six facilities surveyed for that operator. Operator 2 had gone through some recent downsizing and personnel changes, which precluded any opportunity to meet before finalizing the reports for its two surveyed facilities.

Indications are that Operator 1 will be acting on the flaring mitigation opportunity at Sites 1 to 3 in the near term, at Site 4 in the medium term and at Site 5 subject to additional due diligence. The opportunity at Site 6 did not meet Operator 1's minimum investment criteria. For Sites 1 to 5, the mitigation measures would be self-funded by Operator 1.

Feedback from Operator 2 was not available. The opportunities at Sites 7 and 8 are smaller, but easy to implement and financially attractive. Hence, they would be expected to have a reasonable probability of proceeding.

An overarching outcome of the workshop series was agreement by Operator 1 to participate in a follow-on series of measurement programs to develop country-specific emission and control factors as well as identify cost-effective mitigation opportunities related to fugitive equipment leaks, casinghead venting at well sites, and flashing losses from production storage tanks. This work is being sponsored by Environment and Climate Change Canada (ECCC) and Natural Resources Canada (NRCan) through Canada's funding commitments to clean growth and climate change under the Paris Agreement, the Joint Declaration on Partnership between Canada and the Pacific Alliance, and the Energy Innovation Program. It builds on the foundation established through the subject CCAC sponsored project, and provides a holistic approach to the mitigation of short-lived climate pollutants (i.e., black carbon and methane) and greenhouse gas emissions, while also helping to reduce emission of criteria air contaminants (e.g., volatile organic

compounds, carbon monoxide, particulate matter, oxides of nitrogen and reduced sulphur compounds), as well as air toxics (e.g., benzene, toluene, ethyl benzene, and xylenes).

SITE 1 – Workshop and Meeting for Senior Management and Operations Personnel

The prefeasibility assessment and recommended mitigation strategy were reviewed with the engineering and operations groups responsible for the facility, and with representation from the corporate environmental department, at an in-person meeting held in Colombia on 5 March 2020. A total of seven senior management personnel and technical specialists from the operator participated in the review. Copies of the draft site report were supplied to the operator well in advance of the meeting. Additionally, a process flow diagram (PFD) showing details of the preferred mitigation option and how it would be implemented at the site was provided. A copy of the PFD is presented in the final site report.

The workshop/meeting began with a MS PowerPoint presentation on the work done, the results obtained, and the recommended mitigation strategy.

The presentation was followed by open and constructive technical discussions. The operator expressed strong interest in acting on the assessed flaring mitigation opportunity; however, they advised that operating conditions at Site 1, including characteristics of the solvent used, had changed since the initial site visit. It was agreed to re-run all the modelling work. This activity is being sponsored by Environment and Climate Change Canada (ECCC) and Natural Resources Canada (NRCan) through Canada's funding commitments to clean growth and climate change under the Paris Agreement, the Joint Declaration on Partnership between Canada and the Pacific Alliance, and the Energy Innovation Program.

The operator provided electronic copies of the current input information prior to the end of the review meeting, and this information proved to be far more detailed than the information package originally provided for the prefeasibility assessment. This exceptional level of interest, openness and cooperation is a strong indicator of the positive impact of the mitigation evaluation completed for this facility, and the proactive commitment of the operator.

Indications are that the operator will be advancing the mitigation opportunity at Site 1 to the implementation stage, and this will be self-funded.

SITE 2 – Workshop and Meeting for Senior Management and Operations Personnel

The prefeasibility assessment and recommended mitigation strategy were reviewed with the engineering and operations groups responsible for the facility, and with representation from the corporate environmental department, at an in-person meeting held in Colombia on 6 March 2020.

A total of seven senior management personnel and technical specialists from the operator participated in the review. Copies of the draft site report were supplied to the operator well in advance of the meeting. Additionally, a process flow diagram (PFD) showing details of the preferred mitigation option and how it would be implemented at the site was provided. A copy of the PFD is presented in the final site report.

The meeting began with a MS PowerPoint presentation on the work done, the results obtained, and the recommended mitigation strategy.

The presentation was followed by open and constructive technical discussions. The operator expressed strong interest in acting on the assessed flaring mitigation opportunity, and proposed an alternative (potentially-lower-capital-cost) means of implementing the recommended mitigation strategy. The alternative implementation strategy is detailed in *Appendix 9 – Design Drawings and Process Simulation Results* of the final site report as Option 2. Insufficient information was available to fully evaluate the economic merits of Option 2; however, it was agreed that regardless, the flaring mitigation opportunity at Site 2 is viable and worth pursuing.

Indications are that the operator will be advancing the mitigation opportunity at Site 2 to the implementation stage, and this will be self-funded.

SITE 3 – Workshop and Meeting for Senior Management and Operations Personnel

The prefeasibility assessment and recommended mitigation strategy were reviewed with the engineering and operations groups responsible for the facility, and with representation from the corporate environmental department, at an in-person meeting held in Colombia on 5 March 2020. A total of eight senior management personnel and technical specialists from the operator participated in the review. Copies of the draft site report were supplied to the operator well in advance of the meeting. Additionally, a process flow diagram (PFD) showing details of the preferred mitigation option and how it would be implemented at the site was provided. A copy of the PFD is presented along with the process simulation results in *Appendix 9 – Design Drawings and Process Simulation Results* of the final site report.

The meeting began with a MS PowerPoint presentation on the work done, the results obtained, and the recommended mitigation strategy.

The presentation was followed by open and constructive technical discussions. Overall, the operator expressed strong interest in acting on the assessed flaring mitigation opportunity. The operator commented that the flaring rate measured during the fieldwork understated the normal amount of flaring, and consequently, that the potential feasibility of the flaring mitigation opportunity at Site 3 is understated. It was acknowledged that challenges occurred in finding

acceptable process ports for use during the flow measurements, which, when coupled with the limited time available at this particular site, contributed to increased uncertainty in the measurement results. Nonetheless, it was recognized that the results are at least conservative in terms of the viability of the mitigation opportunity.

The operator expressed particular appreciation of the rigor of the applied prefeasibility assessment as well as the applicability and completeness of the assessed mitigation options. Currently, the operator is soliciting bids to implement a solution that would first extract condensable hydrocarbons from the recovered flare gas, and then use the residue gas to fuel a combined heat and power (CHP) process.

At the operator's request, it was agreed that *CSimOnline* would be used to model and provide a comparative analysis of the different bids once they are received. Additionally, the operator requested assistance in estimating the time required to implement each option. These two activities are being sponsored by Environment and Climate Change Canada (ECCC) and Natural Resources Canada (NRCan) through Canada's funding commitments to clean growth and climate change under the Paris Agreement, the Joint Declaration on Partnership between Canada and the Pacific Alliance, and the Energy Innovation Program.

Indications are that the operator will be advancing the mitigation opportunity at Site 3 to the implementation stage, and this will be self-funded.

SITE 4 – Workshop and Meeting for Senior Management and Operations Personnel

The prefeasibility assessment and recommended mitigation strategy were reviewed with the engineering and operations groups responsible for the facility, and with representation from the corporate environmental department, at an in-person meeting held in Colombia on 3 March 2020. A total of six senior management personnel and technical specialists from the operator participated in the review. Copies of the draft site report were supplied to the operator well in advance of the meeting. Additionally, a process flow diagram (PFD) showing details of the preferred mitigation option and how it would be implemented at the site was provided. A copy of the PFD is presented along with the process simulation results in *Appendix 9 – Design Drawings and Process Simulation Results* of the final site report.

The meeting began without any presentation on the work done as the most senior representatives of the operator present were already familiar with the applied methodology and the results obtained. The general presentation given during the meetings for the other studied sites is available as a separate document.

The viability of flare gas mitigation opportunity at Site 4 was considered to be less compelling than for other sites. Key points raised by the operator during the discussions included the following:

- The development of a viable mitigation strategy for Site 4 should be tied to future drilling plans, so that as production increases, an awareness is maintained of the improving economics of the flaring mitigation opportunity.
- Electricity is currently purchased from the grid to power most field facilities, and this power is unreliable. Hence, using the flare gas from Site 4 to generate electric power for field use is a strategic medium-term objective. Moreover, producing its own electricity and reducing the demands it places on the grid, is a way of reducing the impact of blackouts on local residents, thereby improving the operator's social license in the region.
- Currently, the operator experiences some vandalism resulting in lost production. It is believed this is retaliation by local residents who blame the operator for the power blackouts.

Indications are that the operator will be advancing the mitigation opportunity at Site 4 in the medium term, and this will be self-funded.

SITE 5 – Workshop and Meeting for Senior Management and Operations Personnel

The prefeasibility assessment and recommended mitigation strategy were reviewed with the engineering and operations groups responsible for the facility, and with representation from the corporate environmental department, at an in-person meeting held in Colombia on 2 March 2020. A total of eight senior management personnel and technical specialists from the operator participated in the review; three of these participated by videoconferencing. Copies of the draft site report were supplied to the operator well in advance of the meeting. Additionally, a process flow diagram (PFD) showing details of the preferred mitigation option and how it would be implemented at the site was provided. A copy of the PFD is presented along with the process simulation results in *Appendix 9 – Design Drawings and Process Simulation Results* of the final site report.

The meeting began with a MS PowerPoint presentation on the work done, the results obtained, and the recommended mitigation strategy.

The presentation was followed by open and constructive technical discussions. The operator expressed interest in acting on the assessed flaring mitigation opportunity, and commented that the proposed mitigation strategy seemed to be a logical solution. Key discussion points during the meeting included the following:

- The flare at Site 5 is in emergency service, but is experiencing noteworthy residual waste gas flows. The gas is contributed by two main branches of the flare header: one coming from the inlet separation area of the oil production portion of the facility, and the other coming from the associated gas processing portion of the facility.
- The operator advised that the developed PFD had some inaccuracies. In particular, it was noted that the pressure relief valves associated with the inlet compressors relieve to the atmosphere and not into the flare header as initially indicated in the PFD. The PFD has since been updated.
- A concern was also raised regarding the potential introduction of backpressure restrictions in the flare header by installing a flare gas recovery system. The operator also proposed a differed tie-in point to the flare header (i.e., downstream of the knockout drum), rather than at the initially proposed upstream location. The PFD was updated to reflect this change. The use of a liquid-seal drum was added to the proposed design to provide both flashback protection and ensure compliance with the pressure vessel code by precluding any material pressure restrictions in the flare system.
- An alternative design option for the proposed flare-gas recovery system was presented for the operator's consideration; it would allow the gas to potentially be recovered from upstream of the flare header. This option assumes that the flare gas is primarily contributed by variable flow conditions at the facility inlet and a bottleneck in the existing inlet compression during peak flow periods, which would need to be further assessed. This alternative is presented as Option 2 in *Appendix 9 – Design Drawings and Process Simulation Results* of the final site report.

Indications are that the operator will, subject to some additional due diligence, be advancing the mitigation opportunity at Site 5 to the implementation stage, and this will be self-funded.

A key outcome of the discussions was agreement by the operator to participate in a project to demonstrate the merits of retrofitting an air-assist or gas-assist system to existing flares to mitigate black carbon (smoke) emissions during flaring periods. This demonstration project is being sponsored by Environment and Climate Change Canada (ECCC) and Natural Resources Canada (NRCan) through Canada's funding commitments to clean growth and climate change under the Paris Agreement, the Joint Declaration on Partnership between Canada and the Pacific Alliance, and the Energy Innovation Program.

Although the operator has some air-assist flares at its production facilities, it was unaware of the option to retrofit this feature to existing flares. Upgrading of the flare at Site 5 will also include the installation of a retractable pilot, auto-ignition and flame-failure detection system for improved flare reliability, and a purge gas reduction seal and purge-gas-supply control system. The project will demonstrate the practicability and benefits of upgrading existing flares to optimize their performance in the following areas:

- Minimization of black carbon emissions.
- Flare reliability.
- Minimization of purge gas consumption.
- Management of residual flows to emergency flares.

It is expected that this demonstration project will also produce best practices for optimizing air and gas assist systems, flare ignition system and purge gas systems. The overall aim is to help inform the operator's future flare design practices, as well as develop a business case for the operator to consider upgrading other flares across its operations. The results will be beneficial to other jurisdictions that have an oil and natural gas sector.

SITE 6 – Workshop and Meeting for Senior Management and Operations Personnel

The prefeasibility assessment and recommended mitigation strategy were reviewed with the engineering and operations groups responsible for the facility, and with representation from the corporate environmental department, at an in-person meeting held in Colombia on 2 March 2020. A total of three senior management personnel and technical specialists from the operator participated in the review. Copies of the draft site report were supplied to the operator well in advance of the meeting. Additionally, a process flow diagram (PFD) showing details of the preferred mitigation option and how it would be implemented at the site was provided. A copy of the PFD is presented along with the process simulation results in *Appendix 9 – Design Drawings and Process Simulation Results* of the final site report.

The meeting began without any presentation on the work done as the most senior representatives of the operator present were already familiar with the applied methodology and the results obtained. The general presentation given during the meetings for the other studied sites is available as a separate document.

The flare-gas mitigation opportunity at Site 6 did not meet the operator's criteria for minimum acceptable viability. Accordingly, indications are that the operator will not be advancing the mitigation opportunity at Site 6.

Notwithstanding this, the flare at Site 6 is in emergency service. Current residual waste-gas flow to the flare is attributed to one or more of the following potential causes:

- Leakage from valves and pressure relief devices connected to the flare header.
- Pressure relieving of excess gas flows received by the facility's gas conservation system.
- Manual addition of purge gas by operations personnel at the facility to help avoid potential flameout conditions.

The operator expressed an interest in better understanding opportunities to manage residual flows in emergency flare systems. This was a contributing factor in the operator agreeing to participate in a relevant demonstration project at Site 5.