QUANTIFICATION PROTOCOL FOR SOLUTION GAS CONSERVATION

Version 1.0

February 2012

Specified Gas Emitters Regulation

Government of Alberta

Alberta

Disclaimer:
The information provided in this document is intended as guidance only and is subject to revisions as learnings and new information comes forward as part of a commitment to continuous improvement. This document is not a substitute for the law. Please consult the *Specified Gas Emitters Regulation* and the legislation for all purposes of interpreting and applying the law. In the event that there is a difference between this document and the *Specified Gas Emitters Regulation* or legislation, the *Specified Gas Emitters Regulation* or the legislation prevail.

All Quantification Protocols approved under the *Specified Gas Emitters Regulation* are subject to periodic review as deemed necessary by the Department, and will be re-examined at a minimum of every 5 years from the original publication date to ensure methodologies and science continue to reflect best-available knowledge and best practices. This 5-year review will not impact the credit duration stream of projects that have been initiated under previous versions of the protocol. Any updates to protocols occurring as a result of the 5-year and/or other reviews will apply at the end of the first credit duration period for applicable project extensions.

Any comments, questions, or suggestions regarding the content of this document may be directed to:

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1.0 Offset Project Description

Solution gas is the gas trapped in well bore and reservoir fluids. These gases typically consist of methane emissions and are released during well production. Solution gas is often vented to atmosphere, although the Energy Resources Conservation Board Directive 060 requires larger volumes of vented gas over the combustion threshold of 500 meters cubed (m^3) per day to be captured and combusted.

The emissions reduction opportunity under this protocol is to capture small, uneconomic vent streams released as part of oil and bitumen extraction processes by sending the captured solution gas to flare. Vented methane emissions in the baseline are combusted (converted to carbon dioxide (CO_2)) in the project resulting in a net reduction in greenhouse gas emissions for the project expressed as units of CO_2e.

This quantification is written for the solution gas conservation system operator or a solution gas conservation project developer. Familiarity with and general understanding of the operation of a solution gas conservation facility is required.

1.1 Protocol Scope

Solution gas is the natural gas consisting mainly of methane (CH_4) produced in association with crude oil and bitumen extraction. These greenhouse gas emissions associated with solution gas venting are included in Canada's National Greenhouse Gas Inventory. In 2007, 672 million cubic meters (or 42 per cent) of all solution gas produced in Alberta was flared or vented making this a common source of provincial greenhouse gas emissions associated with oil and gas production.

The Alberta Energy Resource Conservation Board's (ERCB) regulates oil and gas production in Alberta. *Directive 060: Upstream Petroleum Industry Flaring, Incinerating and Venting* outlines regulatory requirements for solution gas handling in the province including setting out minimum thresholds for flaring and gas conservation.

Conservation of solution gas can generally be achieved in three ways:

i) injection into a natural gas pipeline;
ii) on-site use as fuel gas; and/or
iii) combustion to generate electrical power.

This protocol **only** applies to solution gas conservation that is not required by *Directive 060* where vented solution gas flow rates do not support combustion as outlined in Section 8.1.2 in *Directive 060.*

For the purposes of this protocol, baseline greenhouse gas emissions are considered to be vented solution gas emissions from sources less than 500 m^3 per day. Vented emission sources over 500 m^3 per day are required to be combusted by the Energy Resources Conservation Board's Directive 060 and are **excluded** from the scope of this protocol.

Conservation of solution gas from flare is also **excluded** from this scope of this protocol because it is assumed that the conserved gas will be combusted in the project condition. Therefore, no net reductions in greenhouse gas emissions will occur over the lifecycle of the conserved gas.

Use of solution gas for on-site fuel production and or electricity production is considered business as usual for the sector and is **excluded** from the scope of this protocol.

Table 1: List of Included and Excluded Emission Sources

Included	Excluded
▪ Vent gas sources less than 500 m^3 per day ▪ On-site use of solution gas for fuel or electricity production for streams below 500 m^3 per day	▪ Vent gas sources over 500 m^3 per day; ▪ Flared solution gas

Projects implemented under this protocol must meet the quantification requirements outlined in this protocol and must result in a reduction in provincial greenhouse gas emissions.

Table 2: Relevant Greenhouse Gases Applicable for Solution Gas Conservation

Specified Gas	Formula	100-year GWP	Applicable to Project
Carbon Dioxide	CO_2	1	✓
Methane	CH_4	21	✓
Nitrous Oxide	N_2O	310	✓
Sulphur Hexafluoride	SF_6	23,900	×
Perfluorocarbons*	PFCs	Variable	×
Hydrofluorocarbons*	HFCs	Variable	×

* A complete list of perfluorocarbons and hydrofluorocarbons regulated under the *Specified Gas Emitters Regulation* is available in Technical Guidance for Offset Project Developers.

1.2 Protocol Applicability

To demonstrate that a project meets the requirements under this protocol, the project developer must provide evidence that:

1. The baseline condition for the solution gas immediately prior to implementing the offset project was venting to the atmosphere.
2. The volume of solution gas being vented to the atmosphere in the baseline condition was under 500 m^3 per day and was therefore not required by the Alberta Energy Resource Conservation Board's (ERCB) *Directive 060: Upstream*

Petroleum Industry Flaring, Incinerating and Venting at the time the project was commissioned.

3. All projects must comply with current regulations and may be required to adjust the project baseline to reflect any changes in regulatory requirements;
4. Metering of solution gas volumes is required for solution gas that is flared or injected into a natural gas pipeline in the project condition and used to calculate the baseline emissions.
5. The quantification of reductions achieved by the project is based on actual measurement and monitoring and must be done in accordance with the Energy Resources Conservation Board *Directive 017: Measurement Requirements for Upstream Oil and Gas Operations;* and
6. The project must meet the requirements for offsets eligibility as specified in the applicable regulation and guidance documents for the Alberta offset system.

1.3 Protocol Flexibility

Flexibility in applying the quantification protocol is provided to project developers in the following ways:

1. Site specific emission factors may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these factors must comply with *Directive 017* methodology in order to ensure a reasonable level of accuracy; and

2. The project developer may aggregate offsets from multiple projects to facilitate offset commoditization

If applicable, the project developer must indicate and justify why flexibility provisions have been used.

1.4 Glossary of New Terms

Conservation	Is the recovery of solution gas for use as fuel for production facilities, other useful purposes (e.g. power generation), sale, or beneficial injection into an oil or gas pool.
Directive 007	*Volumetric and Infrastructure Requirements* outlines regulatory requirements for facility construction. http://www.ercb.ca/docs/documents/directives/Directive007.pdf
Directive 017	*Measurement Requirements for Upstream Oil and Gas Operations* outlines regulatory requirements for monitoring and record retention for upstream oil and gas projects. http://www.ercb.ca/docs/documents/directives/Directive017.pdf

Directive 060	*Upstream Petroleum Industry Flaring, Incinerating, and Venting* outlines regulatory requirements for flaring and vented emissions management in oil and gas operations. http://www.ercb.ca/docs/documents/directives/Directive060.pdf
Flaring	Is the controlled combustion of a gas stream produced on site for purposes other than producing energy. This includes, but is not limited to, the incineration of waste petroleum and other hazardous materials, safety flares, and test wells. All project flaring is subject to requirements set out in relevant Alberta regulations and directives.
Gas Gathering System	Consists of pipelines used to move gas production from oil batteries, gas batteries and/or other facilities to another facility (usually gas plant) and may include compressors, line heaters, dehydrators, measurement and other equipment.
Injection Facility	Is a system or arrangement of surface equipment associated with the injection of solution gas into a natural gas pipeline.
Solution Gas	Refers to dissolved gas in well bore or reservoir fluids. This gas is largely comprised of methane and remains in solution until the pressure or temperature conditions within the reservoir change at which time it may break out of solution to become a free gas.
Transmission Line	Refers to the system of pipes used for transporting liquids and /or gases.
Venting	Is the intentional, controlled release of uncombusted gas streams.

2.0 Baseline Condition

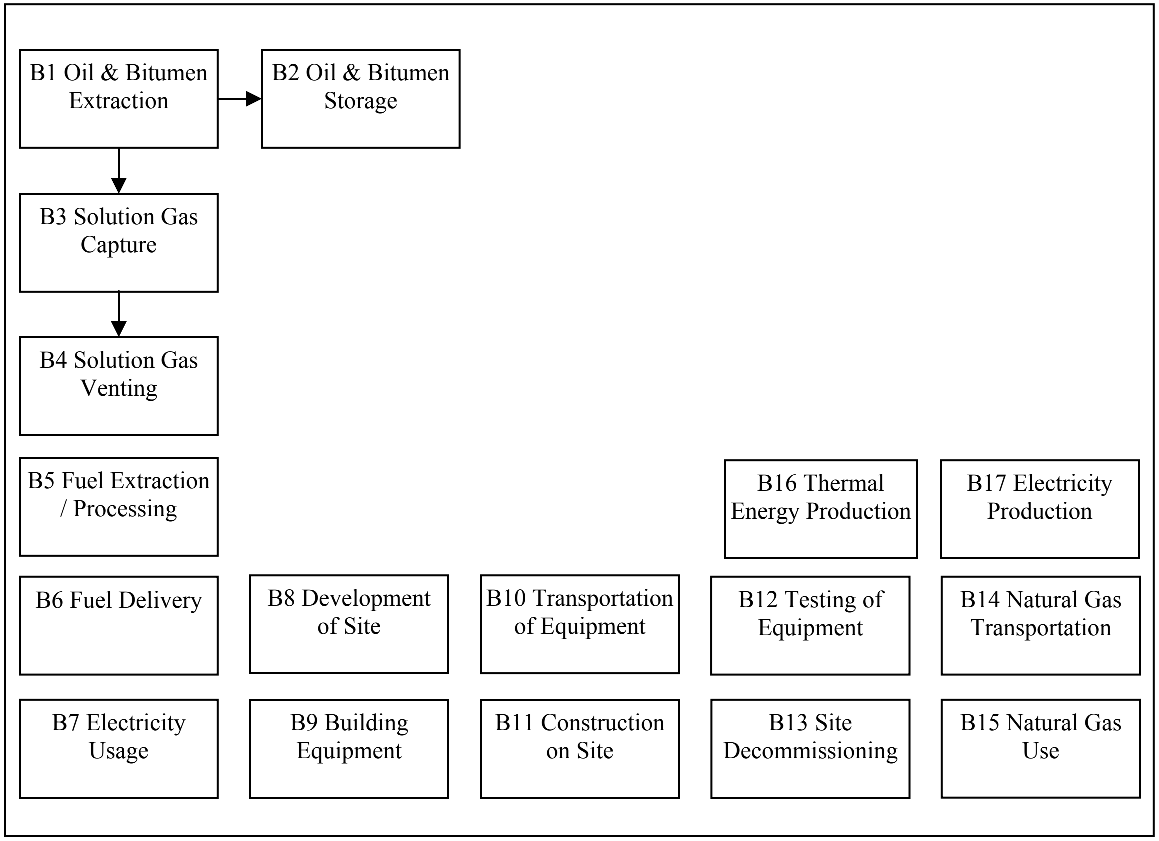
This protocol uses a **dynamic, site-specific** baseline. Under this scenario, each facility or site being included in the project condition is required to prove that the baseline operations for the site were to vent solution gas (methane) to atmosphere as a result of oil and/or bitumen extraction. That is, the baseline emissions from the project are calculated on the basis of how much solution gas was actually conserved and injected into the gas pipeline rather than being vented. The baseline is recalculated annually based on the total solution gas conserved that would otherwise have been vented, and that is below the *Directive 060* combustion rate of 500 m^3 per day.

Baseline measurements must be from direct metering of the conserved solution gas supported by periodic gas analyses following the requirements of Directive 017. Direct measurement is required to account for the variability of solution gas volumes over time and by emission source.

Figure 1 below offers a process flow diagram for a typical baseline configuration.

The baseline condition, including the relevant source and sinks, and processes, is shown in Figure 1 below**.**

Figure 1: Process Flow Diagram for the Project Baseline



2.1 Identification of Baseline Sources and Sinks

Based on the process flow diagrams provided in Figure 1 the project sources/sinks were organized into life cycle categories in Figure 2. Descriptions of each of the sources/sinks and their classification as either 'controlled', 'related' or 'affected' is provided in Table 2**.**

Controlled:	The behaviour or operation of a controlled source and/or sink is under the direction and influence of a Project Developer through financial, policy, management, or other instruments.
Related:	A related source and/or sink has material and/or energy flows into, out of, or within a project but is not under the reasonable control of the project developer.
Affected:	An affected source and/or sink is influenced by the project activity through changes in market demand or supply for projects or services associated with the project.

Figure 2: Baseline Sources and Sinks for Solution Gas Venting

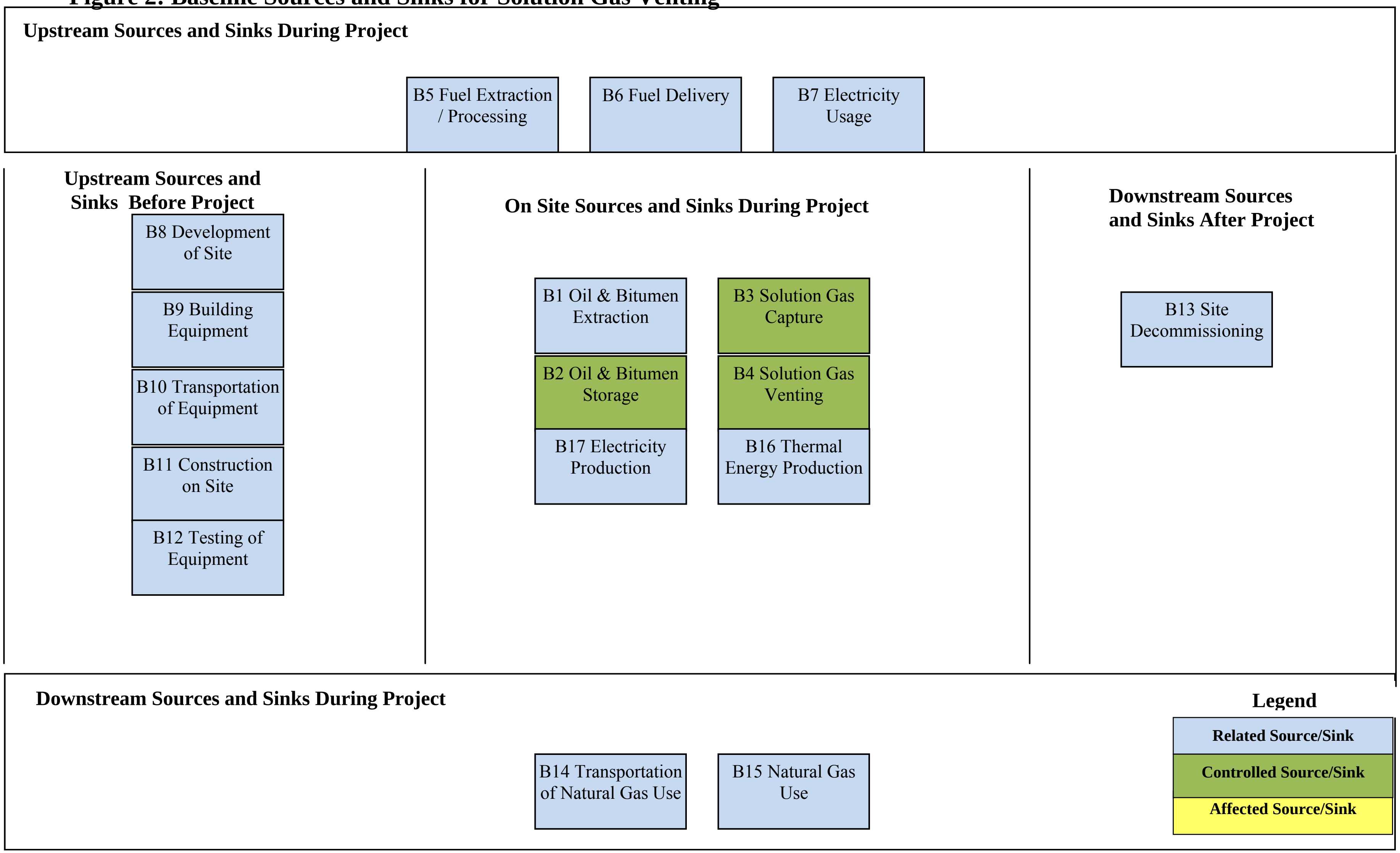


Table 3: Baseline Sources and Sinks

1. Sources and Sinks	2. Description	3. Controlled, Related or Affected
Upstream Sources/Sinks During Baseline		
B5 Fuel Extraction / Processing	Each of the fuels used throughout the on-site component of the project will need to be sourced and processed. The total volumes of fuel for each of the on-site SS's are considered under this source/sink. Volumes and types of fuels are the important characteristics to be tracked.	Related
B6 Fuel Delivery	Each of the fuels used throughout the on-site component of the project will need to be transported to the site. This may include shipments by tanker truck or pipeline, increasing greenhouse gas emissions. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the site is captured under other sources/sinks.	Related
B7 Electricity Usage	Electricity may be produced off-site. Measurement of the quantity of electricity required by the facility would need to be tracked.	Related
Onsite Sources/Sinks During Baseline		
B1 Oil & Bitumen Extraction	Oil and bitumen is extracted from a single or group of adjacent wells. The oil and bitumen gas is piped to a storage tank to await transportation. The types and quantities of fuels used in extraction equipment would need to be tracked.	Related
B2 Oil & Bitumen Storage	On-site oil and bitumen storage tanks may be heated via combustion of fossil fuels such as propane, or solution gas. Quantities and types for each of the energy inputs may need to be tracked.	Controlled
B3 Solution Gas Capture	The compressor and dehydration systems may be fuelled by fossil fuels; these additional greenhouse gas emissions are incremental to the project. Quantities and types for each of the energy inputs may need to be tracked.	Controlled
B4 Solution Gas Venting	Under the baseline condition, solution gas is released directly to the atmosphere post-capture. The quantity and characteristics of the vented solution gas would need to be tracked.	Controlled
B16 Thermal Energy Production	The production of thermal energy may be required to meet the demands of facilities being provided with thermal energy from the project site. This thermal energy may have been derived from waste heat recovery systems resulting in an energy burden on the systems from which the heat is being recovered or directly from combustion of fossil fuels. Energy requirements, fuel volumes and fuel types will need to be tracked.	Controlled
B17 Electricity	Electricity may be produced off-site to match the electricity being produced by the energy	Controlled

1. Sources and Sinks	2. Description	3. Controlled, Related or Affected
Production	from the solution gas net of parasitic loads. This electricity will be produced at an emissions intensity as deemed appropriate by the Program Authority. Measurement of the gross quantity of electricity produced by the facility will need to be tracked to quantify this source. The gross quantity of electricity produced should be net of any electricity sold as Renewable Energy Credits (RECs) as defined by the Environmental Choice Program.	
Downstream Sources/Sinks During Baseline Operation		
B14 Transportation of Natural Gas	Compressed natural gas may be shipped via natural gas pipeline for use in a variety of applications. Fugitive emissions may occur from equipment used to transport the natural gas. The quantity of fugitive emissions would need to be tracked.	Related
B15 Natural Gas Use	Natural gas in pipelines is assumed to be combustion during end-use. Because the methane contained in the solution gas is not destroyed with 100 per cent efficiency, the volume of solution gas injected into the pipeline would need to be tracked.	Related
Other Sources/Sinks		
B8 Development of Site	Development of the site could include clearing, grading, building access roads as well as civil infrastructure such as access to electricity, gas, water supply and water treatment. Building and structures on the site including offices, storage facilities, storm water drainage, and structures to enclose, support and house equipment may need to be developed. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site.	Related
B9 Building Equipment	Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related
B10 Transportation of Equipment	Equipment built off-site and the materials to build equipment on-site, will all need to be delivered to the site. Transportation may be completed by truck, barge and/or train. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
B11 Construction on Site	The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity	Related
B12 Testing of	Equipment may need to be tested to ensure that it is operational. This may result in	Related

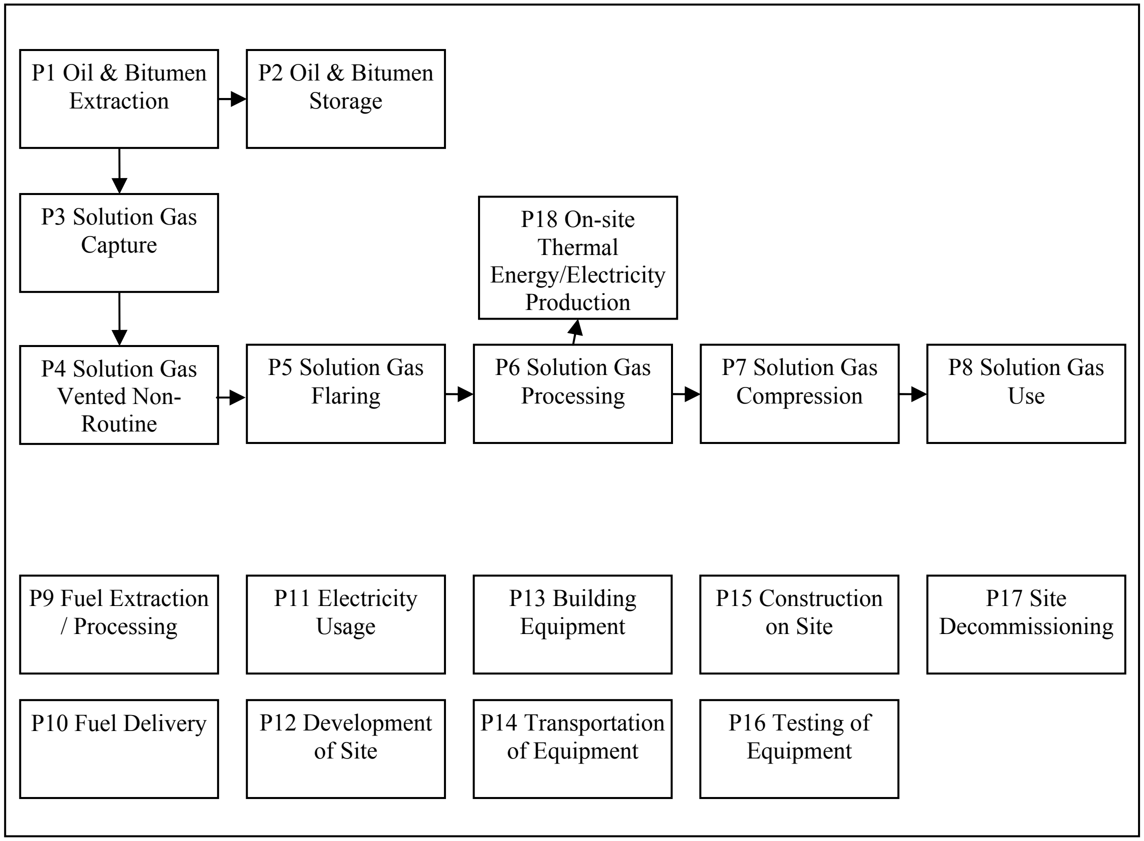
1. Sources and Sinks	2. Description	3. Controlled, Related or Affected
Equipment	running the equipment using fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	
B13 Site Decommissioning	Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site.	Related

3.0 Project Condition

The project condition is represented by the flaring and/or conservation of the solution gas stream by combustion or injection into a natural gas pipeline that would otherwise have been vented to the atmosphere. The project emissions are calculated through direct metering of conserved solution gas supported by periodic gas composition analysis.

The process flow diagram for a typical solution gas conservation project is provided in Figure 3 below.

Figure 3: Process Flow Diagram for the Project Condition



3.1 Identification of Project Sources and Sinks

Based on the process flow diagrams provided in Figure 3, the project sources/sinks are organized into life cycle categories in Figure 4. Descriptions of each of the source/sink and its classification as controlled, related or affected are provided in Table 3

Figure 4: Project Conditions Sources and Sinks for Solution Gas Conservation

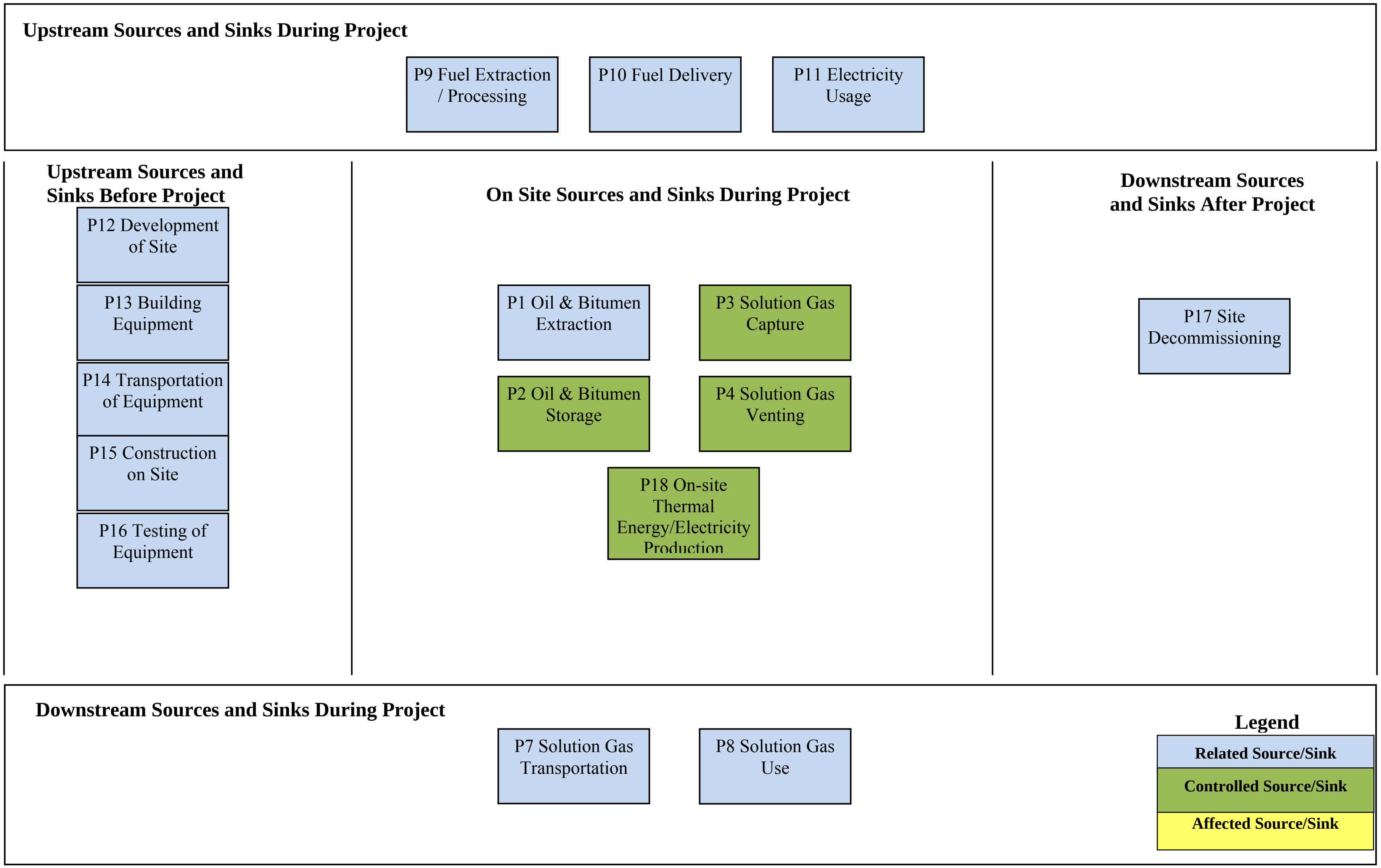


Table 4: Project Condition Sources and Sinks

1. Sources and Sinks	2. Description	3. Controlled, Related or Affected
Upstream Sources and Sinks During Project		
P9 Fuel Extraction / Processing	Each of the fuels used throughout the on-site component of the project will need to be sourced and processed. The total volumes of fuel for each of the on-site sources/sinks are considered under this source/sink. Volumes and types of fuels are the important characteristics to be tracked.	Related
P10 Fuel Delivery	Each of the fuels used throughout the on-site component of the project will need to be transported to the site. This may include shipments by tanker truck or pipeline, increasing greenhouse gas emissions. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the site is captured under other sources/sinks.	Related
P11 Electricity Usage	Electricity may be produced off-site. Measurement of the quantity of electricity required by the facility would need to be tracked.	Related
On-Site Sources and Sinks During Project		
P1 Oil & Bitumen Extraction	Oil and bitumen is extracted from a single or group of adjacent wells. The oil and bitumen is placed into a storage tank to await transportation. The types and quantities of the fuels used to operate the extraction equipment would need to be tracked.	Related
P2 Oil & Bitumen Storage	On-site oil and bitumen storage tanks may be heated via combustion of a fossil fuel such as propane, or solution gas. Quantities and types for each of the energy inputs may need to be tracked.	Controlled
P3 Solution Gas Capture/Processing	A processing system may be required to refine the solution gas prior to injection into a natural gas pipeline. The compressor, processing equipment and dehydration systems may be fuelled by fossil fuels; these additional greenhouse gas emissions are incremental to the project. Quantities and types for each of the energy inputs may need to be tracked.	Controlled
P4 Solution Gas Venting	Non-routine venting of solution gas may occur under the project condition during compressor maintenance or other scenarios. The quantity and characteristics of the vented solution gas would need to be tracked.	Controlled
P18 On-site Thermal Energy/Electricity Production	Captured solution gas may be used to generate on-site thermal energy and/or electricity. The quantity of solution gas or other fuel types used must be tracked.	Controlled
Downstream Sources and Sinks During Project		

P7 Solution Gas Transportation	Compressed solution gas may be shipped via natural gas pipeline for use in a variety of applications. Fugitive emissions may occur from equipment used to transport the solution gas in the natural gas pipeline. The quantity of fugitive emissions would need to be tracked.	Related
P8 Solution Gas Use	Once injected into the pipeline, the ultimate fate of the solution gas is assumed to be combustion during end-use.	Related
Other Sources and Sinks		
P12 Development of Site	Development of the site could include clearing, grading, building access roads as well as civil infrastructure such as access to electricity, gas, water supply and water treatment. Building and structures on the site including offices, storage facilities, storm water drainage, and structures to enclose, support and house equipment may need to be developed. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site.	Related
P13 Building Equipment	Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related
P14 Transportation of Equipment	Equipment built off-site and the materials to build equipment on-site, will all need to be delivered to the site. Transportation may be completed by truck, barge and/or train. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
P15 Construction on Site	The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity	Related
P16 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related
P17 Site Decommissioning	Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site.	Related

4.0 Quantification

The baseline and project conditions were assessed against each other to determine the scope for reductions quantified under this protocol. Sources and sinks were either included or excluded depending how they were impacted by the project condition. Sources that are not expected to change between baseline and project condition are excluded from the project condition. It is assumed that exclude activities will occur at the same magnitude and emission rate during the baseline and project and so will not be impacted by the project.

Emissions that increase or decrease as a result of the project must be included and associated greenhouse gas emissions must be quantified as part of the project condition.

All sources and sinks identified in Table 2 and 3 above are listed in Table 4 below. Each source and sink is listed as include or excluded. Justification for these choices is provided.

Table 5: Comparison of Sources and Sinks

1. Identified Sources and Sinks	2. Baseline (C, R, A)	3. Project (C, R, A)	4. Include or Exclude from Quantification	5. Justification
Upstream Sources and Sinks				
P9 Fuel Extraction / Processing	N/A	R	**Included**	This source is included as captured solution gas may displace fossil fuels that would have been used fro on-site energy generation..
B5 Fuel Extraction / Processing	R	N/A		
P10 Fuel Delivery	N/A	R	Exclude	Excluded as emissions from fuel delivery are not impacted by the implementation of project and as such baseline and project conditions will be functionally equivalent.
B6 Fuel Delivery	R	N/A		
P11 Electricity Usage	N/A	R	Exclude	Excluded as these sources/sinks are not relevant to the project as the emissions from these practices are covered under proposed greenhouse gas regulations.
B7 Electricity Usage	R	N/A		
Onsite Sources and Sinks				
P1 Oil & Bitumen Extraction	N/A	R	Exclude	Excluded as the extraction of solution gas is functionally equivalent under the baseline and project conditions.
B1 Oil & Bitumen Extraction	R	N/A		
P2 Oil & Bitumen Storage	N/A	C	Exclude	Excluded as the storage of solution gas is functionally equivalent under the baseline and project conditions.
B2 Oil & Bitumen Storage	C	N/A		
P3 Solution Gas Capture/Processing	N/A	C	**Included**	Included as the capture of solution gas will be greater in the project period relative to the baseline condition.
B3 Solution Gas Capture	C	N/A		
P4 Solution Gas Venting	N/A	C	**Include**	Included because this is the baseline scenario for this reduction activity. All venting of the captured solution gas occurring in the project must be quantified.
B4 Solution Gas Venting	C	N/A		
B16 Thermal Energy Production	C	N/A	**Include**	Included as thermal energy and/or electricity that is generated through the use of captured solution gas will displace the on-site use of fossil fuels in the baseline period.
B17 Electricity Production	C	N/A		

1. Identified Sources and Sinks	2. Baseline (C, R, A)	3. Project (C, R, A)	4. Include or Exclude from Quantification	5. Justification
P18 On-Site Thermal Energy/Electricity Production	N/A	C		
Downstream Sources and Sinks				
P7 Solution Gas Transportation	N/A	R	Exclude	Excluded as fugitive emissions from the transportation of natural gas and solution gas are functionally equivalent under the baseline and project conditions.
B14 Natural Gas Transportation	R	N/A		
P8 Solution Gas Use	N/A	R	Exclude	Excluded as emissions from the use (i.e. combustion) of natural gas and solution gas are functionally equivalent under the baseline and project conditions.
B15 Natural Gas Use	R	N/A		
Other Sources and Sinks				
P12 Development of Site	N/A	R	Exclude	Emissions from site development are not material given the long project life and the minimal site development typically required.
B8 Development of Site	R	N/A		
P13 Building Equipment	N/A	R	Exclude	Emissions from building equipment are not material given the long project life and the minimal equipment typically required.
B9 Building Equipment	R	N/A		
P14 Transportation of Equipment	N/A	R	Exclude	Emissions from transportation of equipment are not material given the long project life and the minimal transportation of equipment typically required.
B10 Transportation of Equipment	R	N/A		
P15 Construction on Site	N/A	R	Exclude	Emissions from construction on site are not material given the long project life and the minimal construction on site typically required.
B11 Construction on Site	R	N/A		
P16 Testing of Equipment	N/A	R	Exclude	Emissions from testing of equipment are not material given the long project life and the minimal testing of equipment typically required.
B12 Testing of Equipment	R	N/A		
P17 Site Decommissioning	N/A	R	Exclude	Emissions from site decommissioning are not material given the long project life and the minimal site decommissioning typically required.
B13 Site Decommissioning	R	N/A		

4.1 Quantification Methodology

Quantification of the reductions, removals and reversals of relevant sources for each of the greenhouse gases will be completed using the methodologies outlined in Table 5 below. A listing of relevant emission factors is provided in Appendix A. These calculation methodologies serve to complete the following three equations for calculating emission reductions from the comparison of baseline and project conditions

$$\text{Emissions Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Solution Gas Venting}} + \text{Emissions}_{\text{Fuel Extraction and Processing}} + \text{Emissions}_{\text{Thermal Energy Production}} + \text{Emissions}_{\text{Electricity Production}}$$

$$\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Solution Gas Venting}} + \text{Emissions}_{\text{Solution Gas Capture/Processing}} + \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{On-Site Thermal Energy/Electricity Production}}$$

Where:

Emissions Baseline = sum of the emissions under the baseline condition.

Emissions Solution Gas Venting = emissions under B4 Solution Gas Venting

Emissions Fuel Extraction and Processing = emissions under B5 Fuel Extraction / Processing

Emissions Thermal Energy Production = emissions under B16 Thermal Energy Production

Emissions Electricity Production = emissions under B17 Electricity Production

Emissions Project = sum of the emissions under the project condition.

Emissions Solution Gas Venting = emissions under P4 Solution Gas Venting

Emissions Solution Gas Capture = emissions under P5 Solution Gas Processing + emissions under P6 Solution Gas Compression

Emissions Fuel Extraction / Processing = emissions under P9 Fuel Extraction / Processing

Emissions On-Site Thermal Energy/Electricity Production = emissions under P18 On-Site Thermal Energy/Electricity Production

Table 6: Quantification Methodology

Source/Sink	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
Project Sources and Sinks						
P3 Solution Gas Capture/Processing	$Emissions_{Solution\ Gas\ Capture/Processing} = \Sigma (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}) ; \Sigma (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \Sigma (Vol.\ Fuel_i * EF\ Fuel_{i\ N2O}); Vol._{Solution\ Gas\ Capture/Processing} * \%\ CH_4 * EF\ NG_{CO2\ producer}; Vol._{Solution\ Gas\ Capture/Processing} * \%\ CH_4 * EF\ NG_{CH4\ producer}; Vol._{Solution\ Gas\ Capture/Processing} * \%\ CH_4 * EF\ NG_{N2O\ producer}$;					
	$Emissions_{Solution\ Gas\ Capture/Processing}$	kg of CO_2; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel use on site is likely aggregated for each of these SS's.
	Volume of Each Type of Fuel Used / Vol. $Fuel_i$	L / m^3 / other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliatio n	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence. This volume may be excluded if the corresponding volume is not included under the baseline.
	CO_2 Emissions Factor for Each Type of Fuel / EF $Fuel_{i\ CO2}$	kg CO_2 per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – Propane (1.51 kg CO_2/L)	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
	CH_4 Emissions Factor for Each Type of Fuel / EF $Fuel_{i\ CH4}$	kg CH_4 per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – Propane (0.000027 kg CH_4/L)	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
	N_2O Emissions Factor for Each Type of Fuel / EF $Fuel_{i\ N2O}$	kg N_2O per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – Propane (0.000108 kg N_2O/L)	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.

Source/Sink	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
	Volume of Solution Gas Used for Processing / Vol. $_{\text{Solution Gas Capture/Processing}}$	L/ m^3/ other	Measured	Direct metering of volume of solution gas used for processing.	Continuous metering	Direct metering is standard practice. Frequency of metering is highest level possible.
	CO_2 Emissions Factor for Combustion by Producer/ EF $NG_{CO2\ producer}$	kg CO_2 per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – 2.389 kg CO_2 / m^3	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
	CH_4 Emissions Factor for Combustion by Producer/ EF $NG_{CH4\ producer}$	kg CH_4 per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – 0.0065 kg CH_4 / m^3	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
	N_2O Emissions Factor for Combustion by Producer / EF $NG_{N2O\ producer}$	kg N_2O per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) - 0.00006 kg N_2O / m^3	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
P9 Fuel Extraction and Processing	Emissions $_{\text{Fuel Extraction / Processing}}$ = Σ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$) ; Σ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; Σ (Vol. Fuel $_i$ * EF Fuel $_{i\ N2O}$)					
	Emissions $_{\text{Fuel Extraction / Processing}}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on-site is likely aggregated for each of these SS's.
	Volume of Fuel Combusted for On-Site Thermal Energy and/or Electricity Production / Vol. Fuel	L/ m^3/ other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CO2}$	kg CO_2 per L/ m^3/ other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

Source/Sink	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
	CH_4 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CH4}$	kg CH_4 per L/ m^3/ other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{N2O}$	kg N2O per L/ m^3/ other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P4 Solution Gas Venting	Emissions $_{\text{Solution Gas Venting}}$ = Vol. $_{\text{Solution Gas Vented}}$ * % CH_4 * ρ_{CH4}					
	Emissions $_{\text{Solution Gas Venting}}$	kg CH_4	N/A	N/A	N/A	Quantity being calculated.
	Volume of Solution Gas Vented During Non-Routine Procedures / Vol. $_{\text{Solution Gas Vented}}$	L/ m^3/ other	Measured	Direct metering of volume of solution gas vented.	Continuous metering	Direct metering is standard practice. Frequency of metering is highest level possible. This volume may be excluded if this volume of gas is excluded from the baseline.
	Methane Composition of Solution Gas / % CH_4	%	Measured	Direct Measurement as outlined in *Directive 017*. Measurement of the concentration may take place anywhere within the project boundary.	Annual sampling	Gas composition should remain relatively stable. Frequency of reconciliation provides for reasonable diligence.
	Density of CH_4 / ρ_{CH4}	kg/m^3	Constant	0.68 kg/m^3 at STP[1]	N/A	Accepted value.
	Emissions $_{\text{On-Site Thermal Energy/Electricity Production}}$ = Σ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); Σ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; Σ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)					

[1] STP (Standard Temperature and Pressure) is defined in this case as 15°C and 101.3 kPa.

Source/Sink	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
P18 On-Site Thermal Energy/Electricity Production	Emissions $_{\text{On-Site Thermal Energy/Electricity Production}}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SS's.
	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CO2}$	Kg CO_2 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N2O per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
Baseline Sources and Sinks						
B3 Solution Gas Capture	Emissions $_{\text{Solution Gas Capture}}$ = Σ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$) ; Σ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; Σ (Vol. Fuel $_i$ * EF Fuel $_{i\ N2O}$); Vol. $_{\text{Solution Gas Capture}}$* % CH_4 * EF $NG_{\text{CO2 producer}}$; Vol. $_{\text{Solution Gas Capture}}$ * % CH_4 * EF $NG_{\text{CH4 producer}}$; Vol. $_{\text{Solution Gas Capture}}$ * % CH_4 * EF $NG_{\text{N2O producer}}$;					
	Emissions $_{\text{Solution Gas Capture}}$	kg of CO_2; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel use on site is likely aggregated for each of these SS's.
	Volume of Each Type of Fuel Used / Vol. $Fuel_i$	L / m^3 / other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence. This volume may be excluded if the corresponding volume is not included under the baseline.

Source/Sink	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
	CO_2 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – Propane (1.51 kg CO_2/L)	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
	CH_4 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – Propane (0.000027 kg CH_4/L)	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
	N_2O Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N_2O per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – Propane (0.000108 kg N_2O/L)	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
	Volume of Solution Gas Used for Processing / Vol. $_{Solution\ Gas\ Capture/Processing}$	L/ m^3/ other	Measured	Direct metering of volume of solution gas used for processing.	Continuous metering	Direct metering is standard practice. Frequency of metering is highest level possible.
	CO_2 Emissions Factor for Combustion by Producer/ EF $NG_{CO2\ producer}$	kg CO_2 per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – 2.389 kg CO_2 / m^3	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
	CH_4 Emissions Factor for Combustion by Producer/ EF $NG_{CH4\ producer}$	kg CH_4 per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) – 0.0065 kg CH_4 / m^3	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.
	N_2O Emissions Factor for Combustion by Producer / EF $NG_{N2O\ producer}$	kg N_2O per L / m^3 / other	Estimate	From Environment Canada reference documents. (Appendix A) - 0.00006 kg N_2O / m^3	Annual	Reference values adjusted annually as part of Environment Canada's emissions inventory.

Source/Sink	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
B4 Solution Gas Venting	$Emissions_{Solution\ Gas\ Venting} = (Vol._{Solution\ Gas\ Injected} + Vol._{Solution\ Gas\ Capture/\ Processing}) * \%\ CH_4 * \rho_{CH4}$					
	$Emissions_{Solution\ Gas\ Venting}$	kg CH_4	N/A	N/A	N/A	Quantity being calculated.
	Volume of Solution Gas Injected into Pipeline / $Vol._{Solution\ Gas\ Injected}$	L/ m^3/ other	Measured	Direct metering of volume of solution gas injected into natural gas pipeline under project condition.	Continuous metering	Direct metering is standard practice. Frequency of metering is highest level possible.
	Volume of Solution Gas Used for Processing / $Vol._{Solution\ Gas\ Capture/\ Processing}$	L/ m^3/ other	Measured	Direct metering of volume of solution gas used for processing solution gas under project condition.	Continuous metering	Direct metering is standard practice. Frequency of metering is highest level possible. This volume may excluded as it is conservative to do so; if this volume is included, SS P3 must be included.
	Methane Composition of Solution Gas / % CH_4	%	Measured	Direct measurement of the concentration may take place anywhere within the project boundary.	Annual sampling	Gas composition should remain relatively stable during steady-state operation. Frequency of reconciliation provides for reasonable diligence.
	Density of CH_4 / ρ_{CH4}	kg/m^3	Constant	0.68 kg/m^3 at STP[2]	N/A	Accepted value.
B5 Fuel Extraction and Processing	$Emissions_{Fuel\ Extraction\ /\ Processing} = \Sigma\ (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2})\ ;\ \Sigma\ (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4})\ ;\ \Sigma\ (Vol.\ Fuel_i * EF\ Fuel_{i\ N2O})$					
	$Emissions_{Fuel\ Extraction\ /\ Processing}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on-site is likely aggregated for each of these SS's.
	Volume of Fuel Combusted for Baseline On-Site Thermal Energy/Electricity Production / Vol. Fuel	L/ m3/other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.

[2] STP (Standard Temperature and Pressure) is defined in this case as 15°C and 101.3 kPa.

Source/Sink	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
	CO_2 Emissions Factor for Fuel Including Production and Processing / EF $Fuel_{CO2}$	Kg CO_2 per L/m_3/other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Fuel Including Production and Processing / EF $Fuel_{CH4}$	Kg CH_4 per L/m_3/other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory
	N_20 Emissions Factor for Fuel Including Production and Processing / EF $Fuel_{N2O}$	Kg N2O per L/m_3/other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory
B16 Thermal Energy Produced	$Emissions_{Thermal\ Heat} = \Sigma\ (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2});\ \Sigma\ (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4})\ ;\ \Sigma\ (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$					
	$Emissions_{Thermal\ Heat}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated
	Volume of Each Type of Fuel / Vol $Fuel_i$	L CO_2 Emissions Factor for Each Type of Fuel / EF $Fuel_{i\ CO2}$, m_3 or other	Measured	Calculated relative to metered quantity of thermal energy delivered to the customer by the project facility, converted to an equivalent volume of fuel.	Continuous metering	Method is standard practise.
	CO_2 Emissions Factor for Each Type of Fuel / EF $Fuel_{i\ CO2}$	Kg CO_2 per L, m_3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Each Type of Fuel / EF $Fuel_{i\ CH4}$	Kg CH_4 per L, m_3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

Source/Sink	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
	N_2O Emissions Factor for Each Type of Fuel / EF $_{Fuel\ i\ N2O}$	Kg N2O per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
B17 Electricity Production	$Emissions_{Electricity} = Electricity * EF_{Elec}$					
	Emissions $_{Electricity}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated.
	Electricity Produced at Site / Electricity	kWh	Measured	Direct metering of all electricity produced at the facility, net of parasitic load.	Continuous metering	Continuous direct metering represents the industry practise and the highest level of detail.
	Emissions Factor for Electricity / EF $_{Elec}$	kg of CO2e per kWh	Measured	From Alberta Environment reference documents.	Annual	Reference values adjusted as appropriate by Alberta Environment.

5.0 Data Management

Data quality management must be of sufficient quality to fulfill the quantification requirements and be substantiated by company records for the purpose of verification.

The project developer must establish and apply quality assurance and quality controls (QA/QC) management procedures to manage project data and information. Written procedures must be established for each measurement task outlining responsibility, timing and record location requirements. The greater the rigour of the management system for the data, the more easily verification will be to conduct for the project.

5.1 Project Documentation

Data collection, management and project monitoring for solution gas conservation projects must be done according to the requirements stated in the Energy Resources Conservation Board's *Directive 017: Measurement Requirements for Upstream Oil and Gas Operations* and must meet all the requirements outlined in this protocol.

It is anticipated that projects compiled under this protocol will be small sites and that a number of sites will need be aggregated to create projects of sufficient volume to support verification, registration and transaction costs. Site visits for a sample set are required for verification. Justification for the selection of sites must be provided in the verification.

5.2 Record Keeping

Alberta Environment requires that project developers maintain appropriate supporting information for the project, including all raw data for the project for a period of 7 years **after** the end of the project credit period. The project developer must keep the information listed below and disclose all information to the verifier and/or government auditor upon request.

Record Keeping Requirements:

- Raw baseline period data, independent variable data, and static factors within the measurement boundary
- A record of all adjustments made to raw baseline data with justifications
- All analysis of baseline data used to create mathematical model(s)
- All data and analysis used to support estimates and factors used for quantification
- Expected end of life date of equipment removed or renovated under the project
- Common practices relating to possible greenhouse gas reduction scenarios discussed in this protocol
- Metering equipment specifications (model number, serial number, manufacturer's calibration procedures)
- A record of changes in static factors along with all calculations for non-routine adjustments
- All calculations of greenhouse gas emissions/reductions and emission factors
- Measurement equipment maintenance activity logs
- Measurement equipment calibration records

- Initial and annual verification records and audit results

In order to support the third party verification and the potential supplemental government audit, the project developer must put in place a system that meets the following criteria:

- All records must be kept in areas that are easily located;
- All records must be legible, dated and revised as needed;
- All records must be maintained in an orderly manner;
- All documents must be retained for 7 years after the project crediting period;
- Electronic and paper documentation are both satisfactory; and
- Copies of records should be stored in two locations to prevent loss of data.

Note: Attestations will not be considered sufficient proof that an activity took place and will not to meet verification requirements.

5.3 Quality Assurance/Quality Control Considerations

Quality assurance/quality control (QA/QC) can also be applied to add confidence that all measurements and calculations have been made correctly. These include, but are not limited to:

- Ensuring that the changes to operational procedures continue to function as planned and achieve greenhouse gas reductions
- Ensuring that the measurement and calculation system and greenhouse gas reduction reporting remains in place and accurate
- Checking the validity of all data before it is processed, including emission factors, static factors, and acquired data
- Performing recalculations of quantification procedures to reduce the possibility of mathematical errors
- Storing the data in its raw form so it can be retrieved for verification
- Protecting records of data and documentation by keeping both a hard and soft copy of all documents
- Recording and explaining any adjustment made to raw data in the associated report and files.
- A contingency plan for potential data loss.

Contingent means for calculating or estimating the required data for the equations outlined in section 4 are summarized in Table 6 below.

Table 7: Contingent Data Collection Procedures

1.0 Project / Baseline Sources / Sinks	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
Project Sources and Sinks						
P3 Solution Gas Capture	Volume of Each Type of Fuel Used / Vol. $Fuel_i$	L / m^3/ other	Estimated	Reconciliation of volume of fuel used or purchased within a given time period	Monthly	Provides reasonable estimate of the parameter, when more accurate and precise method cannot be used.
P4 Solution Gas Venting	Volume of Solution Gas Vented During Non-Routine Procedures / Vol. $_{\text{Solution Gas Vented}}$	L / m^3 / other	Measured as outlined in D017	Obtained from required reporting records as per ERCB Directive 007 and 017.	Monthly	Provides reasonable estimate of the parameter, when more accurate and precise method cannot be used.
P10 Fuel Extraction / Processing	Volume of Each Type of Fuel Combusted (excluding solution gas) for P5 and P6 / Vol. $Fuel_i$	L / m^3 / other	Estimate	Reconciliation of volume of fuel purchased within a given time period.	Monthly	Provides reasonable estimate of the parameter, when more accurate and precise method cannot be used.
Baseline Sources and Sinks						
B4 Solution Gas Venting	Methane Composition of Solution Gas / % CH_4	%	Estimated	Interpolation of previous and following measurements taken or 90%, whichever is lower.	Annually	Solution gas composition should remain relatively stable during steady-state operation. Interpolating gas composition provides a reasonable estimate when the more accurate and precise method cannot be used.
	Volume of Solution Gas Injected into Pipeline / Vol. $_{\text{Solution Gas Injected}}$	L/ m^3/ other	Measured as outlined in D017	Obtained from required reporting records as per ERCB Directive 007; or, Reconciliation of volume of solution gas	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.

				injected within given time period based on average flow rates.		
	Volume of Solution Gas Used for Extraction / Vol. $_{Solution\ Gas\ Extraction}$	L/ m^3/ other	Measured as outlined in D007	Obtained from required reporting records as per ERCB Directive 007; or, Reconciliation of volume of solution gas injected within given time period based on average flow rates.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
	Volume of Solution Gas Used for Heating / Vol. $_{Solution\ Gas\ Storage}$	L/ m^3/ other	Measured as outlined in D007	Obtained from required reporting records as per ERCB Directive 007; or, Reconciliation of volume of solution gas injected within given time period based on average flow rates.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.

5.4 Liability

Offset projects must be implemented according to the approved protocol and in accordance with government regulations. Alberta Environment reserves the right to audit offset credits and associated projects submitted to Alberta Environment for compliance under the *Specified Gas Emitters Regulation* and may request corrections based on audit findings.

5.5 Registration and Claim to Offsets

It is anticipated that emissions reductions from individual sites will be small and that multiple sites (offset projects) will need to be aggregated to form a single, corporate level project with sufficient volume to support verification and transaction costs.

Aggregated projects will need to track data based on GPS coordinates for the well sites where the solution gas conservation projects are being implemented. This information must be submitted to the Alberta Emissions Offset Registry as part of the required project documentation and will be used to track individual wells being included in the system. Information is kept confidential by the registry and is used to inform double counting checks on like project types registered on the Alberta Emissions Offset Registry.

If offset credits are being claimed for wells owned or operated by a different company, contractual arrangements must be made between all parties that may have an claim to the offset credits. Alberta Environment will not accept any offset credits for compliance that have unresolved ownership claims.

6.0 References

ERCB Directive 007: Volumetric and Infrastructure Requirements, September 2011

ERCB Directive 017: Measurement Requirements for Oil and Gas Operations (April 2011)

ERCB Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting (November 2011)

International Standards Organization ISO 14064 -2:2006 Specification with Guidance at the 21 Project Level for Quantification, Monitoring and Reporting of GHG Emission Reductions or 22 Removal Enhancements

APPENDIX A: Relevant Emission Factors

Table A1: Emission Intensity of Fuel Extraction and Production (Diesel, Natural Gas, and Gasoline)[3]

Diesel		
Production		
Emissions Factor (CO_2)	0.138	kg CO_2 per Litre
Emissions Factor (CH_4)	0.0109	kg CH_4 per Litre
Emissions Factor (N_2O)	0.000004	kg N_2O per Litre
Natural Gas		
Extraction		
Emissions Factor (CO_2)	0.043	kg CO_2 per m^3
Emissions Factor (CH_4)	0.0023	kg CH_4 per m^3
Emissions Factor (N_2O)	0.000004	kg N_2O per m^3
Processing		
Emissions Factor (CO_2)	0.090	kg CO_2 per m^3
Emissions Factor (CH_4)	0.0003	kg CH_4 per m^3
Emissions Factor (N_2O)	0.000003	kg N_2O per m^3
Gasoline		
Production		
Emissions Factor (CO_2)	0.138	kg CO_2 per Litre
Emissions Factor (CH_4)	0.0109	kg CH_4 per Litre
Emissions Factor (N_2O)	0.000004	kg N_2O per Litre

Table A2: Emission Factors for Natural Gas and NGL's[4]

Source	Emission Factors		
	CO_2	CH_4	N_2O
	g/m^3	g/m^3	g/m^3
Natural Gas			
Electric Utilities	1891	0.49	0.049
Industrial	1891	0.037	0.033
Producer Consumption	2389	6.5	0.06
Pipelines	1891	1.9	0.05
Cement	1891	0.037	0.034
Manufacturing Industries	1891	0.037	0.033
Residential, Construction, Commercial/Institutional, Agriculture	1891	0.037	0.035
	g/L	g/L	g/L
Propane			
Residential	1510	0.027	0.108
All Other Uses	1510	0.024	0.108
Ethane	976	N/A	N/A
Butane	1730	0.024	0.108

[3] Source: Quantification Protocol for Acid Gas Injection, v.1, May 2008. Alberta Environment.
[4] Source: Annex 12, Table A12-1 of the National Inventory Report: Greenhouse Gas Sources and Sinks in Canada, 1990 – 2006.

Table A3: Emission Factors for Refined Petroleum Products[5]

Source	Emission Factors (g/L)		
	CO_2	CH_4	N_2O
Light Fuel Oil			
Electric Utilities	2725	0.18	0.031
Industrial	2725	0.006	0.031
Producer Consumption	2643	0.006	0.031
Residential	2725	0.026	0.006
Forestry, Construction, Public Administration, and Commercial/Institutional	2830	0.026	0.031
Heavy Fuel Oil			
Electric Utilities	3124	0.034	0.064
Industrial	3124	0.12	0.064
Producer Consumption	3158	0.12	0.064
Residential, Forestry, Construction, Public Administration, and Commercial/Institutional	3124	0.057	0.064
Kerosene			
Electric Utilities	2534	0.006	0.031
Industrial	2534	0.006	0.031
Producer Consumption	2534	0.006	0.031
Residential	2534	0.026	0.006
Forestry, Construction, Public Administration, and Commercial/ Institutional	2534	0.026	0.031
Diesel	2663	0.133	0.4

Please refer to - http://www.glossary.oilfield.slb.com/MainIndex.cfm?ID=1

[5] Source: Annex 12, Table A12-2 of the National Inventory Report: Greenhouse Gas Sources and Sinks in Canada, 1990 – 2006.