BASELINE EMISSIONS MANAGEMENT INC.

QUANTIFICATION PROTOCOL FOR WASTE HEAT RECOVERY PROJECTS - STREAMLINED -

Submitted to:

Alberta Environment

and

Alberta Agriculture, Food and Rural Development

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Note To Waste Heat Recover Project Developers:

Two versions of the Waste Heat Recovery Protocol have been developed in recognition of two groupings of projects. The project types covered under this first protocol represent the streamlined projects which typically include only one entity or site. For these projects, waste heat from one operation is used to supplement the heat requirement at another point. As such, there is no impact to the operation of the unit where the waste heat is being utilized. Electricity generation is not included as part of this protocol.

The second protocol covers a broader range of projects that may include multiple entities and multiple sites. Further, more complex heat and power generation configurations from multiple sources are contemplated. Under this scenario, there may be changes to the operation of the unit where the waste heat is being utilized. Electricity generation is contemplated under this protocol.

To illustrate the parallels between the two protocols, numbering and naming of sources and sinks remains constant across the two protocols. As such, it may appear that there are gaps in the numbering of sources and sinks in the streamlined protocol. However, these gaps correspond to sources and sinks considered as part of the broader protocol.

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1.1 Protocol Scope and Description

This quantification protocol is applicable to the quantification of direct and indirect reductions of greenhouse gas (GHG) emissions resulting from the implementation of streamlined waste heat recovery projects. The protocol quantifies the emission reductions from the avoidance of fossil fuel consumption resulting from the capture and utilization of heat and power that is currently being wasted. The waste heat recovery may be transferred into the project site where it is utilized, or may be recovered and used within the project site. **FIGURE 1.1** offers a process flow diagram for a typical project.

The waste heat recovery protocol does not prescribe the configuration of the scheme. Rather, this protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements. The project must achieve some level of fuel savings by capturing and utilizing waste heat and power.

The waste heat recovery protocol quantifies emissions reductions on the basis that the heat demand being offset was being achieved through fossil fuel combustion, either on-site or off-site. Thus, the starting point for all quantification is the heat load of the project and how this is being achieved. **FIGURE 1.2** offers a process flow diagram for a typical baseline configuration.

The boundary of the waste heat recovery protocol encompasses the recovery, distribution and utilization systems, which may cross site boundaries. Further, the utilization systems are defined as those within the impacted unit, i.e. equipment, processes, facilities, etc., whose heat load is partially or wholly impacted by the operation of the waste heat recovery system.

To demonstrate that a project meets the requirements under this protocol, the project proponent must supply sufficient evidence to demonstrate that:

1. The heat and power collected was not being used in either a passive or an active manner, where this load is not accounted for as supplementary power under this protocol, as confirmed by an attestation from the supplier of the waste heat and power;
2. The implementation of the waste heat recovery project must not materially impact on the mechanical, biological or chemical operations of the unit as confirmed by an attestation from the project proponent and relevant system design records;
3. The waste heat recovery project does not include any additional electricity generation that may require additional fossil fuels to be consumed as confirmed by an attestation from the project proponent and relevant system design records; and

FIGURE 1.1: Process Flow Diagram for Project Condition

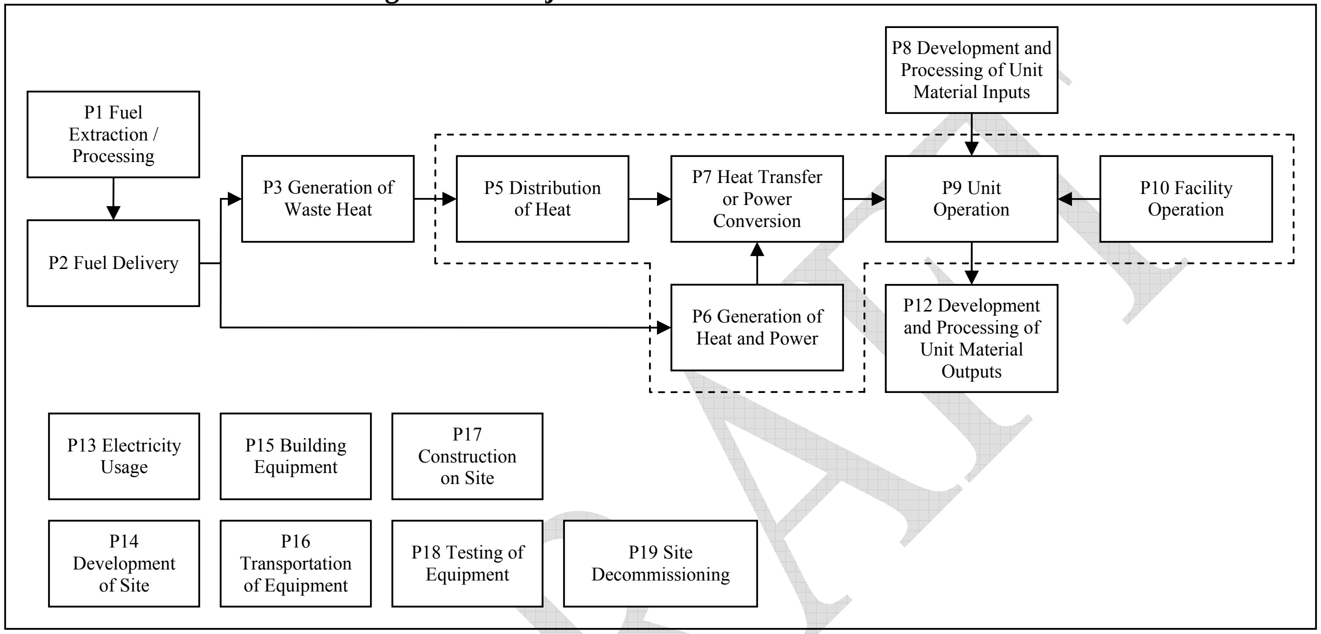
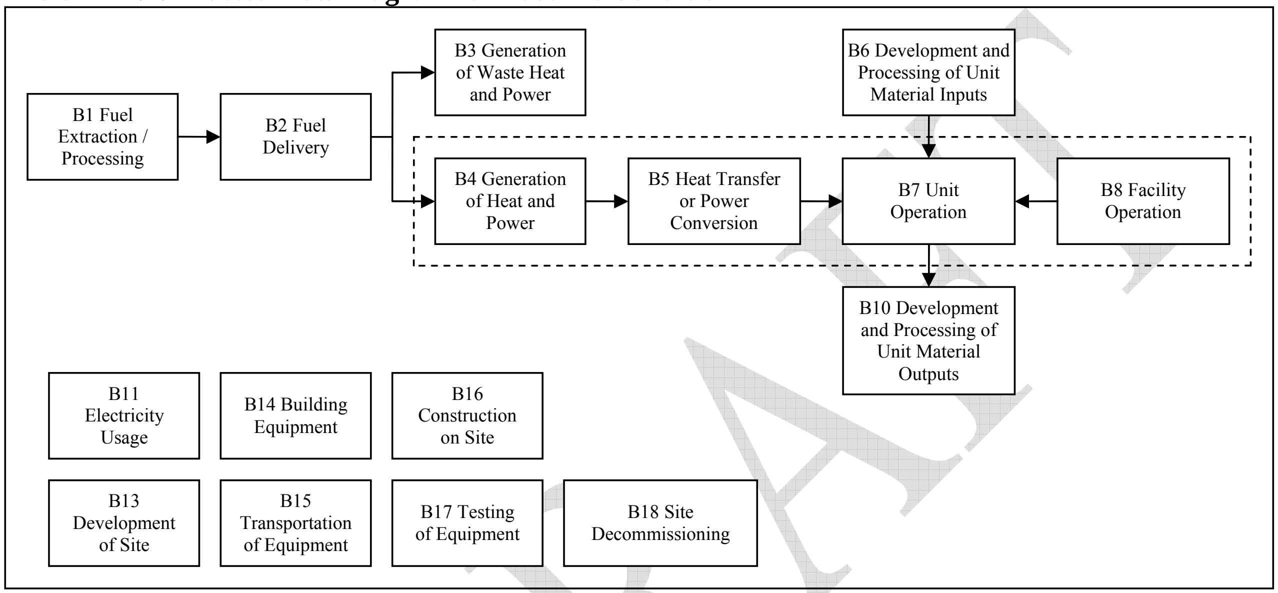


FIGURE 1.2: Process Flow Diagram for Baseline Condition



4. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol.

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

1. The source of the waste heat and power may supplement their heat demand either to replace a component of the heat being transferred or to augment the heat and power exported, however, these emissions must be captured as supplementary heat and power under this protocol;
2. Waste heat recovery projects may occur within a single site or across multiple sites. Further, the defined unit impacted, both on the recovery and utilization of the waste heat and power, may include multiple processes, equipment, etc. Definition of the units impacted is to be justified by the project proponent;
3. Site specific emission factors may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must be sufficiently robust as to ensure reasonable accuracy; and
4. Waste heat recovery projects may provide some or all of the heat and power requirements for the facility. Flexibility is provided in terms of allowing the broadening of the project scope to include existing, new, or retrofit supplementary heating both on and off site to meet the project energy load.

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

This quantification protocol is written for the waste heat recovery project developer or proponent. Some familiarity with, or general understanding of, the operation of these practices is expected.

1.2 Glossary of New Terms

Unit	The project unit is defined as the equipment, processes and facilities who are being serviced and impacted by the waste heat recovery project. The project unit must be clearly defined and justified by the project proponent.

2.0 Quantification Development and Justification

The following sections outline the quantification development and justification.

2.1 Identification of Sources, Sinks and Reservoirs (SSRs) for the Project

SSRs were identified for the project by reviewing the seed protocol document and relevant process flow diagram. This process confirmed that the SSRs in the process flow diagrams covered the full scope of eligible project activities under the protocol.

Based on the process flow diagrams provided in **FIGURE 1.1**, the project SSRs were organized into life cycle categories in **FIGURE 2.1**. Descriptions of each of the SSRs and their classification as controlled, related or affected are provided in **TABLE 2.1.**

FIGURE 2.1: Project Element Life Cycle Chart

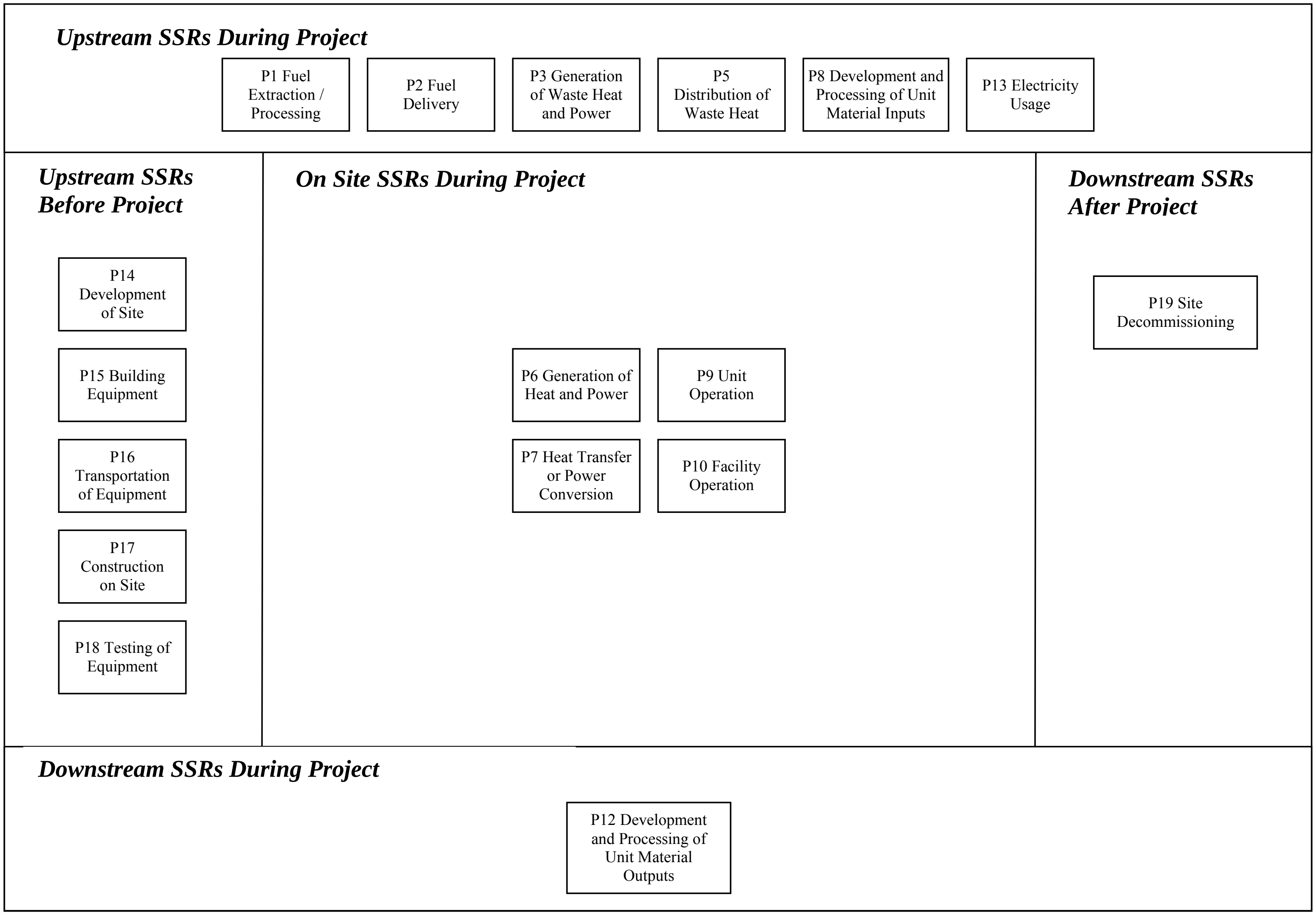


TABLE 2.1: Project SSRs

1. SSR	2. Description	3. Controlled, Related or Affected
Upstream SSRs during Project Operation		
P1 Fuel Extraction and Processing	Each of the fuels used throughout the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the SSRs are considered under this SSR. Volumes and types of fuels are the important characteristics to be tracked.	Related
P2 Fuel Delivery	Each of the fuels used throughout the project will need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. 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 sites is captured under other SSRs and there is no other delivery.	Related
P3 Generation of Waste Heat and Power	The generation of waste heat and power may require the combustion of fossil fuels precipitating greenhouse gas emissions. Volumes and types of fuels are the important characteristics to be tracked.	Related
P5 Distribution of Waste Heat	The waste heat may need to be distributed to the project site. This may require compression or other mechanical processes and includes any recirculation functions. The energy inputs related to this function would need to be tracked.	Related
P8 Development and Processing of Unit Material Inputs	The material inputs to the unit process need to be transported, developed and/or processed prior to the unit process. This may require any number of mechanical, chemical or biological processes. All relevant characteristics of the material inputs would need to be tracked to prove functional equivalence with the baseline scenario.	Related
P13 Electricity Usage	Electricity may be required for operating the facility or to compensate for any net reduction in electricity output from the project facility as compared to the baseline. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions.	Related
Onsite SSRs during Project Operation		
P6 Generation of Heat and Power	The generation of heat and power may be required to supplement the heat delivered to the project site. This generation could require the combustion of fossil fuels precipitating greenhouse gas emissions. Volumes and types of fuels are the important characteristics to be tracked.	Controlled
P7 Heat Transfer or Power Conversion	Mechanical or other processes may be required to transfer the heat and power delivered to a usable form at the project site. All relevant characteristics of the heat transfer or power conversion would need to be tracked to prove functional equivalence with the baseline scenario.	Controlled
P9 Unit Operation	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the unit at the project site. This may require any number of mechanical, chemical or biological processes. All relevant characteristics of the material inputs would need to be tracked to prove functional equivalence with the baseline scenario.	Controlled

P10 Facility Operation	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the overall facility operations. This may include running vehicles and facilities at the project site. Quantities and types for each of the energy inputs would be tracked.	Controlled
Downstream SSRs during Project Operation		
P12 Development and Processing of Unit Material Outputs	The material inputs to the unit process need to be transported, developed and/or processed subsequent to the unit process. This may require any number of mechanical, chemical or biological processes. All relevant characteristics of the material outputs would need to be tracked to prove functional equivalence with the baseline scenario.	Related
Other		
P14 Development of Site	The site of the facility may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc.	Related
P15 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
P16 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
P17 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
P18 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
P19 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

2.2 Identification of Baseline

The baseline condition for projects applying this streamlined protocol are sites where there is currently waste heat that can have a beneficial use under the project condition, which would offset the fulfillment of the heat load requirements through the combustion of fossil fuels. The baseline condition is defined based on the provision of the equivalent heat load as under the project condition. This is accomplished by applying an energy balance to the generating, distribution and utilization systems.

The approach to quantifying the baseline will be projection based as there are suitable models for the applicable baseline condition that can provide reasonable certainty. The baseline scenario for this protocol is dynamic as the emissions profile for the baseline activities would be expected to change materially relative to fluctuating heat and power supply and demand, as well as other market conditions.

The baseline condition is defined, including the relevant SSRs and processes, as shown in **FIGURE 1.2**. More detail on each of these SSRs is provided in Section 2.3, below.

2.3 Identification of SSRs for the Baseline

Based on the process flow diagrams provided in **FIGURE 1.2**, the project SSRs were organized into life cycle categories in **FIGURE 2.2**. Descriptions of each of the SSRs and their classification as either ‘controlled’, ‘related’ or ‘affected’ is provided in **TABLE 2.2.**

FIGURE 2.2: Baseline Element Life Cycle Chart

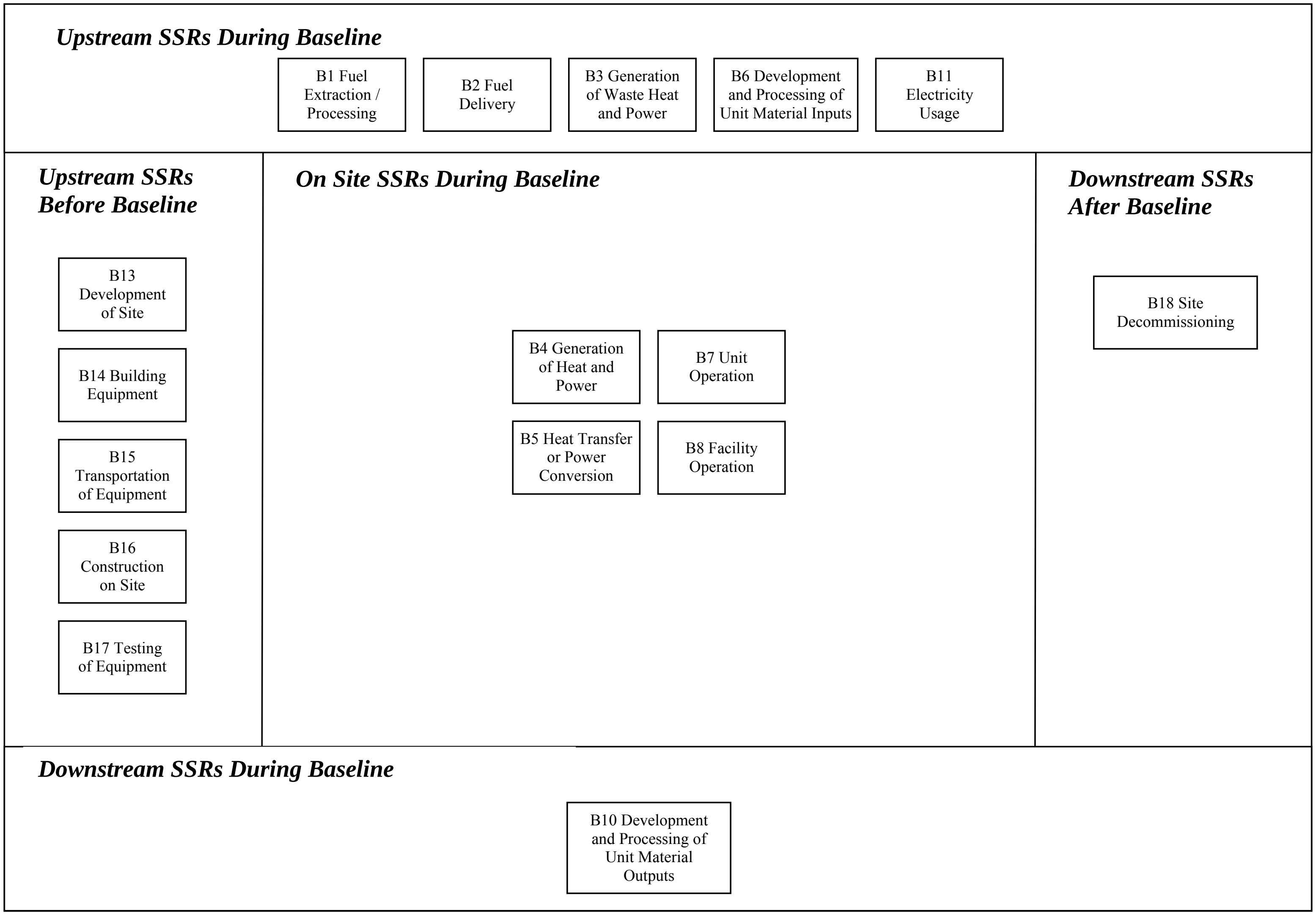


TABLE 2.2: Baseline SSRs

1. SSR	**2. Description**	**3. Controlled, Related or Affected**
Upstream SSRs during Baseline Operation		
B1 Fuel Extraction and Processing	Each of the fuels used throughout the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the SSRs are considered under this SSR. Volumes and types of fuels are the important characteristics to be tracked.	Related
B2 Fuel Delivery	Each of the fuels used throughout the project will need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. 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 sites is captured under other SSRs and there is no other delivery.	Related
B3 Generation of Waste Heat and Power	The generation of waste heat and power may require the combustion of fossil fuels precipitating greenhouse gas emissions. Volumes and types of fuels are the important characteristics to be tracked.	Related
B6 Development and Processing of Unit Material Inputs	The material inputs to the unit process need to be transported, developed and/or processed prior to the unit process. This may require any number of mechanical, chemical or biological processes. All relevant characteristics of the material inputs would need to be tracked to prove functional equivalence with the project scenario.	Related
B11 Electricity Usage	Electricity may be required for operating the facility or to compensate for any electricity output from the project facility as compared to the baseline. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions.	Related
Onsite SSRs during Baseline Operation		
B4 Generation of Heat and Power	The generation of heat and power may be required at the project site. This generation could require the combustion of fossil fuels precipitating greenhouse gas emissions. Volumes and types of fuels are the important characteristics to be tracked.	Controlled
B5 Heat Transfer or Power Conversion	Mechanical or other processes may be required to transfer the heat and power delivered to a usable form under the baseline condition. All relevant characteristics of the heat transfer or power conversion would need to be tracked to prove functional equivalence with the project scenario.	Controlled
B7 Unit Operation	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the unit at the project site. This may require any number of mechanical, chemical or biological processes. All relevant characteristics of the material inputs would need to be tracked to prove functional equivalence with the project scenario.	Controlled
B8 Facility Operation	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the overall facility operations. This may include running vehicles and facilities under the baseline condition. Quantities and types for each of the energy inputs would be tracked.	Controlled

Downstream SSRs during Baseline Operation		
B10 Development and Processing of Unit Material Outputs	The material inputs to the unit process need to be transported, developed and/or processed subsequent to the unit process. This may require any number of mechanical, chemical or biological processes. All relevant characteristics of the material outputs would need to be tracked to prove functional equivalence with the project scenario.	Related
Other		
B12 Development of Site	The site of the facility may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc.	Related
B13 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
B14 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
B15 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
B16 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
B17 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

2.4 Selection of Relevant Project and Baseline SSRs

Each of the SSRs from the project and baseline condition were compared and evaluated as to their relevancy using the guidance provided in Annex VI of the "Guide to Quantification Methodologies and Protocols: Draft", dated March 2006 (Environment Canada). The justification for the exclusion or conditions upon which SSRs may be excluded is provided in **TABLE 2.3** below. All other SSRs listed previously are included.

TABLE 2.3: Comparison of SSRs

1. Identified SSR	2. Baseline (C, R, A)	3. Project (C, R, A)	4. Include or Exclude from Quantification	5. Justification for Exclusion
Upstream SSRs				
P1 Fuel Extraction and Processing	N/A	Related	Include	N/A
B1 Fuel Extraction and Processing	Related	N/A	Include	
P2 Fuel Delivery	N/A	Related	Exclude	Excluded as the emissions from transportation are likely greater under the baseline condition.
B2 Fuel Delivery	Related	N/A	Exclude	
P3 Generation of Waste Heat and Power	N/A	Related	Exclude	Excluded as by definition, the generation of this component of the heat and power is deemed as a waste produced as part of another process. As such, the project and baseline condition are defined to be functionally equivalent.
B3 Generation of Waste Heat and Power	Related	N/A	Exclude	
P5 Distribution of Waste Heat	Related	N/A	Include	N/A
P8 Development and Processing of Unit Material Inputs	N/A	Related	Exclude	Excluded as by definition, must be functionally equivalent to allow for the application of the protocol.
B6 Development and Processing of Unit Material Inputs	Related	N/A	Exclude	
P13 Electricity Usage	N/A	Related	Exclude	Excluded as these SSRs are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B11 Electricity Usage	Related	N/A	Include	Include only the component of electricity production that is offset by the additional generation of electricity by the project.
Onsite SSRs				
P6 Generation of Heat and Power	N/A	Controlled	Include	N/A
B4 Generation of Heat and Power	Controlled	N/A	Include	
P7 Heat Transfer or Power Conversion	N/A	Controlled	Include	N/A
B5 Heat Transfer or Power Conversion	Controlled	N/A	Include	
P9 Unit Operation	N/A	Controlled	Exclude	Excluded as under the scope of the streamlined waste heat recovery protocol these must be functionally equivalent.
B7 Unit Operation	Controlled	N/A	Exclude	
P10 Facility Operation	N/A	Controlled	Exclude	Excluded as the facility operation is not typically impacted by the implementation of the project and as such the baseline and project conditions will be functionally equivalent.
B8 Facility Operation	Controlled	N/A	Exclude	

Comment [MSOffice1]: Not excluded as these represent incremental emission reductions and are easy to calculate

Downstream SSRs				
P12 Development and Processing of Unit Material Outputs	N/A	Related	Exclude	Excluded as by definition, these components must be functionally equivalent to allow for the application of the protocol.
B10 Development and Processing of Unit Material Outputs	Related	N/A	Exclude	
Other				
P14 Development of Site	N/A	Related	Exclude	Emissions from site development are not material given the long project life, and the minimal site development typically required.
B12 Development of Site	Related	N/A	Exclude	Emissions from site development are not material for the baseline condition given the minimal site development typically required.
P15 Building Equipment	N/A	Related	Exclude	Emissions from building equipment are not material given the long project life, and the minimal building equipment typically required.
B13 Building Equipment	Related	N/A	Exclude	Emissions from building equipment are not material for the baseline condition given the minimal building equipment typically required.
P16 Transportation of Equipment	N/A	Related	Exclude	Emissions from transportation of equipment are not material given the long project life, and the minimal transportation of equipment typically required.
B14 Transportation of Equipment	Related	N/A	Exclude	Emissions from transportation of equipment are not material for the baseline condition given the minimal transportation of equipment typically required.
P17 Construction on Site	N/A	Related	Exclude	Emissions from construction on site are not material given the long project life, and the minimal construction on site typically required.
B15 Construction on Site	Related	N/A	Exclude	Emissions from construction on site are not material for the baseline condition given the minimal construction on site typically required.
P18 Testing of Equipment	N/A	Related	Exclude	Emissions from testing of equipment are not material given the long project life, and the minimal testing of equipment typically required.
B16 Testing of Equipment	Related	N/A	Exclude	Emissions from testing of equipment are not material for the baseline condition given the minimal testing of equipment typically required.
P19 Site Decommissioning	N/A	Related	Exclude	Emissions from decommissioning are not material given the long project life, and the minimal decommissioning typically required.
B17 Site Decommissioning	Related	N/A	Exclude	Emissions from decommissioning are not material for the baseline condition given the minimal decommissioning typically required.

2.5 Quantification of Reductions, Removals and Reversals of Relevant SSRs

2.5.1 Quantification Approaches

Quantification of the reductions, removals and reversals of relevant SSRs for each of the greenhouse gases will be completed using the methodologies outlined in **TABLE 2.4**, below. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

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

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Gen Heat and Power}} + \text{Emissions}_{\text{Transfer / Conversion}}$$

$$\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Distribute Heat}} + \text{Emissions}_{\text{Gen Heat and Power}} + \text{Emissions}_{\text{Transfer / Conversion}}$$

Where:

$\text{Emissions}_{\text{Baseline}}$ = sum of the emissions under the baseline condition.

- $\text{Emissions}_{\text{Fuel Extraction / Processing}}$ = emissions under SSR B1 Fuel Extraction and Processing
- $\text{Emissions}_{\text{Gen Heat and Power}}$ = emissions under SSR B4 Generation of Heat and Power
- $\text{Emissions}_{\text{Transfer / Conversion}}$ = emissions under SSR B5 Heat Transfer or Power Conversion

$\text{Emissions}_{\text{Project}}$ = sum of the emissions under the project condition.

- $\text{Emissions}_{\text{Fuel Extraction / Processing}}$ = emissions under SSR P1 Fuel Extraction and Processing
- $\text{Emissions}_{\text{Distribute Heat}}$ = emissions under SSR P5 Distribution of Waste Heat
- $\text{Emissions}_{\text{Gen Heat and Power}}$ = emissions under SSR P6 Generation of Heat and Power
- $\text{Emissions}_{\text{Transfer / Conversion}}$ = emissions under SSR P7 Heat Transfer or Power Conversion

TABLE 2.4: Quantification Procedures

1. Project/Baseline SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SSRs						
P1 Fuel Extraction and Processing	$Emissions_{Fuel\ Extraction\ /\ Processing} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2})\ ;\ \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4})\ ;\ \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N2O})$					
	$Emissions_{Fuel\ Extraction\ /\ Processing}$	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 SSRs.
	Volume of Fuel Combusted for P4 and P6 / Vol. Fuel	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 Fuel Including Production and Processing / $EF\ Fuel_{CO2}$	kg CO_2 per L, m^3 or other	Estimated	From Environment Canada or CAPP reference documents.	Annual	Reference values.
	CH_4 Emissions Factor for Fuel Including Production and Processing / $EF\ Fuel_{CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada or CAPP reference documents.	Annual	Reference values.
	N_20 Emissions Factor for Fuel Including Production and Processing / $EF\ Fuel_{N2O}$	kg N2O per L, m^3 or other	Estimated	From Environment Canada or CAPP reference documents.	Annual	Reference values.
P5 Distribution of Waste Heat and Power	$Emissions_{Distribute\ Heat\ and\ Power} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2});\ \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4})\ ;\ \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$					
	$Emissions_{Distribute\ Heat\ and\ Power}$	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 SSRs.

	Volume of Each Type of Fuel Combusted for the Distribution of Waste Heat and Power / 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 Combustion of 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 Combustion of 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 Combustion of 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.
P6 Generation of Heat and Power	Emissions $_{Gen\ Heat\ and\ Power}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)					
	Emissions $_{Gen\ Heat\ and\ Power}$	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 SSRs.
	Volume of Each Type of Fuel Consumed to Generate Heat and Power / 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 Combustion of 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 Combustion of 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 Combustion of 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.
P7 Heat Transfer or Power Conversion	Emissions $_{Transfer / Conversion}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)					
	Emissions $_{Transfer / Conversion}$	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 SSRs.
	Volume of Each Type of Fuel Consumed for Heat Transfer or Power Conversion / 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 Combustion of 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 Combustion of 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 Combustion of 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 SSRs						
B1 Fuel Extraction and Processing	Emissions $_{Fuel\ Extraction / Processing}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (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 SSRs.

	Volume of Fuel Combusted for B4 / Vol. Fuel	L, m^3 or other	Estimated	Based on equivalent heat and power demand with the most likely fuel.	Monthly	Represents most reasonable means of estimation.
	CO_2 Emissions Factor for Natural Gas / EF Fuel $_{CO2}$	kg CO_2 per L, m^3 or other	Estimated	From Environment Canada or CAPP reference documents.	Annual	Reference values.
	CH_4 Emissions Factor for Natural Gas / EF Fuel $_{CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada or CAPP reference documents.	Annual	Reference values.
	N_20 Emissions Factor for Natural Gas / EF Fuel $_{N2O}$	kg N2O per L, m^3 or other	Estimated	From Environment Canada or CAPP reference documents.	Annual	Reference values.
B4 Generation of Heat and Power	Emissions $_{Gen\ Heat\ and\ Power}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)					
	Emissions $_{Gen\ Heat\ and\ Power}$	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 SSRs.
	Volume of Each Type of Fuel Consumed to Generate Heat and Power / Vol. Fuel $_i$	L, m^3 or other	Estimated	Based on equivalent heat and power demand with the most likely fuel.	Monthly	Represents most reasonable means of estimation.
	CO_2 Emissions Factor for Combustion of 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 Combustion of 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 Combustion of 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.

	$Emissions_{Transfer / Conversion} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$					
	$Emissions_{Transfer / Conversion}$	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 SSRs.
	Volume of Each Type of Fuel Consumed for Heat Transfer or Power Conversion / $Vol.\ Fuel_i$	L, m^3 or other	Estimated	Based on equivalent heat and power demand with the most likely fuel.	Monthly	Represents most reasonable means of estimation.
B5 Heat Transfer or Power Conversion	CO_2 Emissions Factor for Combustion of 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 Combustion of 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 Combustion of 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.

2.5.2. Contingent Data Approaches

Contingent means for calculating or estimating the required data for the equations outlined in section 2.5.1 are summarized in **TABLE 2.5**, below.

2.6 Management of Data Quality

In general, data quality management must include sufficient data capture such that the mass and energy balances may be easily performed with the need for minimal assumptions and use of contingency procedures. The data should be of sufficient quality to fulfill the quantification requirements and be substantiated by company records for the purpose of verification.

The project proponent shall establish and apply quality management procedures to manage data and information. Written procedures should 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 an audit will be to conduct for the project.

2.6.1 Record Keeping

Record keeping practises should include:

a. Electronic recording of values of logged primary parameters for each measurement interval;
b. Printing of monthly back-up hard copies of all logged data;
c. Written logs of operations and maintenance of the project system including notation of all shut-downs, start-ups and process adjustments;
d. Retention of copies of logs and all logged data for a period of 7 years; and
e. Keeping all records available for review by a verification body.

2.6.2 Quality Assurance/Quality Control (QA/QC)

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:

a Protecting monitoring equipment (sealed meters and data loggers);
b Protecting records of monitored data (hard copy and electronic storage);
c Checking data integrity on a regular and periodic basis (manual assessment, comparing redundant metered data, and detection of outstanding data/records);
d Comparing current estimates with previous estimates as a ‘reality check’;
e Provide sufficient training to operators to perform maintenance and calibration of monitoring devices;
f Establish minimum experience and requirements for operators in charge of project and monitoring; and
g Performing recalculations to make sure no mathematical errors have been made.

TABLE 2.5: Contingent Data Collection Procedures

1. Project/Baseline SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Contingency Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SSRs						
P1 Fuel Extraction and Processing	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P5 Distribution of Waste Heat and Power	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P6 Generation of Heat and Power	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P7 Heat Transfer or Power Conversion	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
Baseline SSRs						
B1 Fuel Extraction and Processing	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
B4 Generation of Heat and Power	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Estimated	Based on equivalent heat and power demand forecast based on typical output.	Monthly	Represents another reasonable means of estimation.
B5 Heat Transfer or Power Conversion	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Estimated	Based on equivalent heat and power demand forecast based on typical output.	Monthly	Represents another reasonable means of estimation.

APPENDIX A:

Emission Factors for Fuel Production and Processing

Emission Factors for Fuel Production and Processing

All values interpreted from volume 1 of the technical report: A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry dated September 2004 completed by Clearstone Engineering Ltd. on behalf of the Canadian Association of Petroleum Producers (CAPP).

Table A1: Emission Factors for Gasoline and Diesel Production

	Approximate Proportionate Amount in Year of Emission Factor Generation		**Emission Factors**			
			CO_2	**CH_4**	**N_2O**	**Units**
Light / Medium Crude Oil Production	55,588	10^3 m^3 / yr	86.3	4.41	0.0038	t / 10^3 m^3
Heavy Crude Oil Cold Production	30,924	10^3 m^3 / yr	75	25.1	0.0033	t / 10^3 m^3
Heavy Crude Oil Thermal Production	10,589	10^3 m^3 / yr	594.2	3.75	0.009	t / 10^3 m^3
Weighted Average			0.1381	0.0109	4.208E-6	kg / L

Table A2: Emission Factors for Natural Gas Production and Processing

	Emission Factors			
	CO_2	**CH_4**	**N_2O**	**Units**
Natural Gas Production	0.0427	0.00234	0.000004	kg / m^3
Natural Gas Processing	0.0904	0.00029	3.2E-06	kg / m^3