QUANTIFICATION PROTOCOL FOR GREEN BUILDING PROJECTS – LARGE RESIDENTIAL BUILDINGS

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Alberta Environment

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1. Project and Methodology Scope and Description

This quantification protocol is written for those familiar with Large Residential Building (see section 1.2 for definition of Large Residential Building) construction and retrofit projects. Some familiarity with, or general understanding of, the operation of these practices and processes is expected.

The opportunity for generating carbon offsets with this protocol arises from the direct and indirect reductions of greenhouse gas (GHG) emissions resulting from the implementation of new building methods, and facility retrofits that result in overall efficiencies in energy use per unit of productivity. Process changes may include the mechanical, biological and/or chemical components of the operation and may impact upon on-site heat, electrical and power requirements.

Should a project include a variety of building types e.g. mixed use development, there are a suite of green building protocols (small and large residential building, and commercial/institutional protocols) that can be used in conjunction with this protocol to capture the carbon offsets from the entire project. In addition, other protocols covering renewable energy production (solar, wind, biomass) and energy efficiency may also be used simultaneously, as applicable.

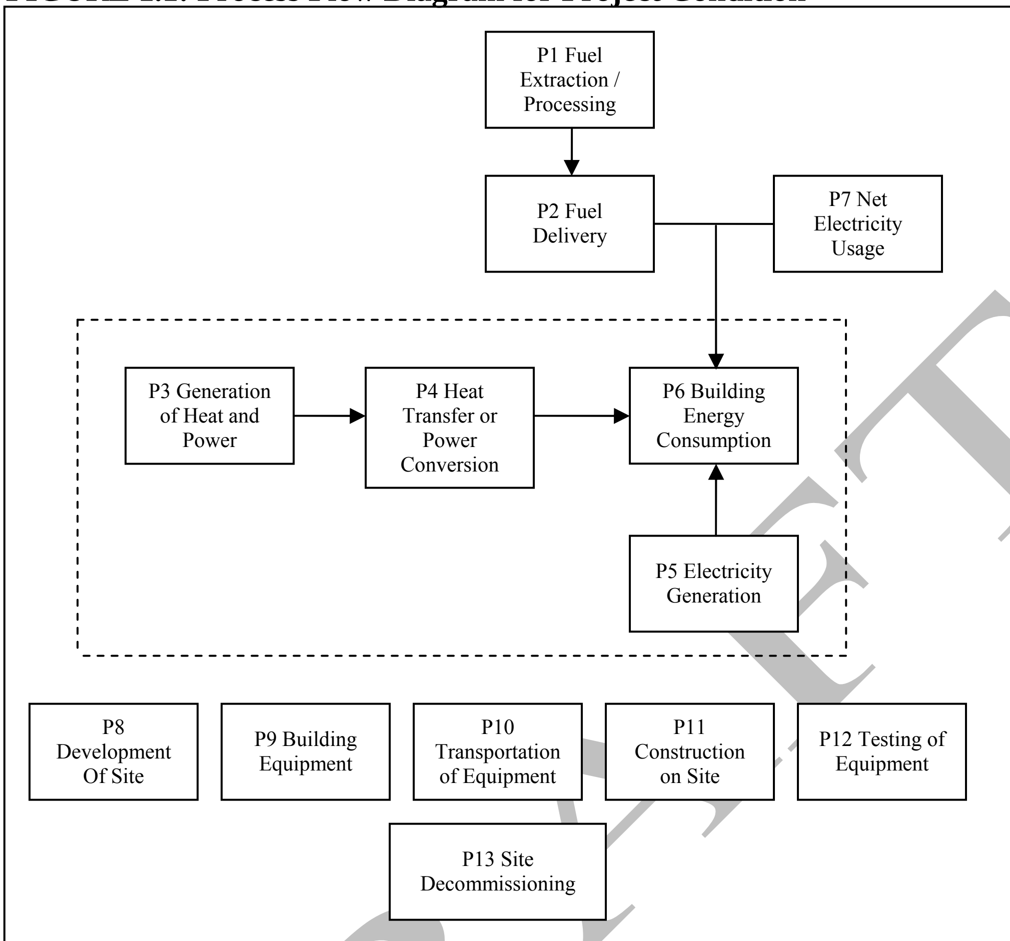
1.1 Protocol Scope and Description

This quantification protocol is applicable to the quantification of direct and indirect reductions of greenhouse gas (GHG) emissions resulting from energy efficiencies in new Large Residential Buildings or the retrofit of existing Large Residential Buildings It includes reductions in GHG emissions due to any heat/power savings and/or production, and electricity generation.

This protocol does not prescribe the configuration or nature of the processes that result in energy efficiencies. Rather, this protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements. **FIGURE 1.1** offers a typical element life cycle chart for a typical project as defined in this protocol.

There are separate baseline conditions for new Large Residential Buildings and retrofits of existing Large Residential Buildings. The baseline for new Large Residential Buildings should be determined using EE4 software provided by Natural Resources Canada. The software is a tool that can model new buildings and determine energy performance relative to the Model National Energy Code for Buildings (MNECB). To assess the performance of the building under the project condition relative to the EE4 model performance, an energy audit will need to be conducted in the second year of building operation, or subsequently.

FIGURE 1.1: Process Flow Diagram for Project Condition



The baseline condition for the retrofits of existing Large Residential Buildings in this protocol is defined as the building energy use prior to any retrofits and/or improvements. The energy and emissions footprint, per square metre, of the baseline configuration is established using EE4 or equivalent energy audit that is completed before any changes have been made to the building. To assess the performance of the building under the project condition relative to the EE4 model performance, an energy audit will need to be conducted in the second year of building operation, or subsequently.

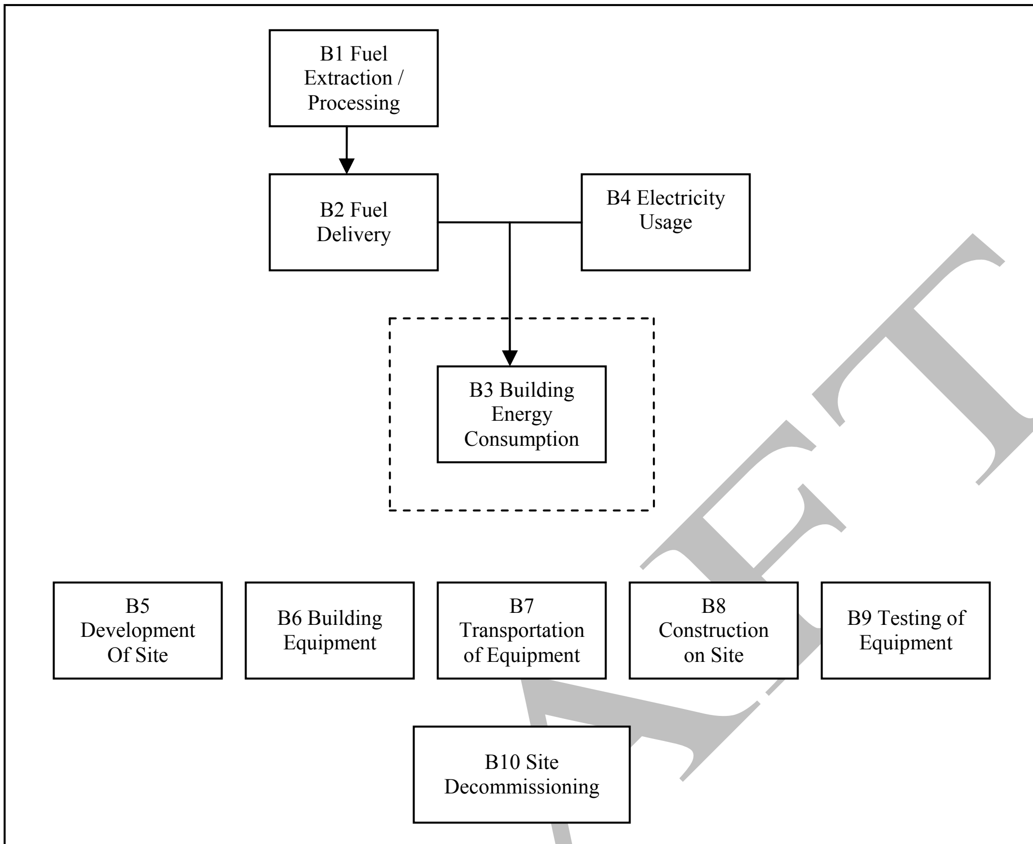
The basis for quantification of the offsets generated is the difference between the baseline assessment using the EE4 model or equivalent energy audit, and the energy audit in the second year (or subsequently) or an average of energy audits from second year to date. Offsets cannot be generated from the beginning of the second year following retrofit or new building construction to allow for operations to achieve a steady state.

FIGURE 1.2 offers an element life cycle chart for the typical baseline configuration.

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

1. New Large Residential Buildings must or exceed the MNECB by 25% based on the EE4 model results and measured energy use;
2. Retrofits to existing Large Residential Buildings must improve emission performance by 10% as established by the difference between pre- and post-retrofit energy audit;
3. The quantification of reductions achieved by the project is based on the results of an energy audit in the second year (or subsequently). For existing Large Residential Buildings this will include both a pre-construction and post- construction energy audit. New Large Residential Buildings reductions will be established based on a post- construction energy audit and compared to the established EE4 model baseline of the new building;
4. The project is eligible to generate offsets from the second year following construction or retrofit;
5. The occupancy rate has not materially changed, as defined in Appendix B; and
6. The project must meet the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System.

FIGURE 1.2: Process Flow Diagram for Baseline Condition



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

1. The requirement for an energy audit may be waived in situations where the baseline energy use per square meter can be justified using available records. The period for which the records should cover must be justified as suitable to account for seasonal effects in energy demand;
2. Reductions in onsite electricity or fuel use would be dealt with outside the scope of the protocol as part of the energy efficiency protocol and renewable energy protocols. The benefit of including onsite energy production (i.e. solar, small hydro, wind, biomass, etc) would be dealt with under appropriate protocols. However, the project developer must justify the separation of this component of the project to ensure that the emission reductions are properly quantified between the two projects and that double counting does not occur;
3. For the purpose of this protocol, the unit of production will be square meter. Another suitable unit of production can be defined for incorporating functional equivalence within the calculation methodology as indicated by reasoned qualitative and quantitative analysis; and
4. 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.

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

Considering the changes that are occurring in this sector around energy management, a review of the protocol's baseline and rating system selection will be part of each periodic review and update of the protocol. The review is meant as an opportunity to maintain the environmental integrity of the protocol and as such, any changes will reflect a higher standard of measurement.

1.2 Glossary of New Terms

Energy Audit:	Is an assessment of how much energy a building consumes and includes details on efficiency of the building's insulation, heating and cooling systems, and can include recommendations on ways to make the building more energy-efficient
Green Building:	Are buildings that incorporate practices that increase the efficiency of buildings and their use of energy, water, and materials, and reduce building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal.

Unit of Production:	For the purpose of this protocol, the unit of production will be square meter. As mentioned in the flexibility provisions, with thorough justification the project proponent may change the unit of production to a more appropriate unit.
Large Residential Buildings	Any residential building that has 4 Storey or more. These buildings may include mixed commercial space.

2. Quantification Development and Justification

The following sections outline the quantification development and justification.

2.1 Identification of Sources and Sinks (SS's) for the Project

SS's were identified for the project by reviewing the seed protocol document and relevant process flow diagram. This process confirmed that the SS's 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 SS's were organized into life cycle categories in **FIGURE 2.1**. Descriptions of each of the SS's and their classification as controlled, related or affected are provided in **TABLE 2.1.**

FIGURE 2.1: Project Element Life Cycle Chart

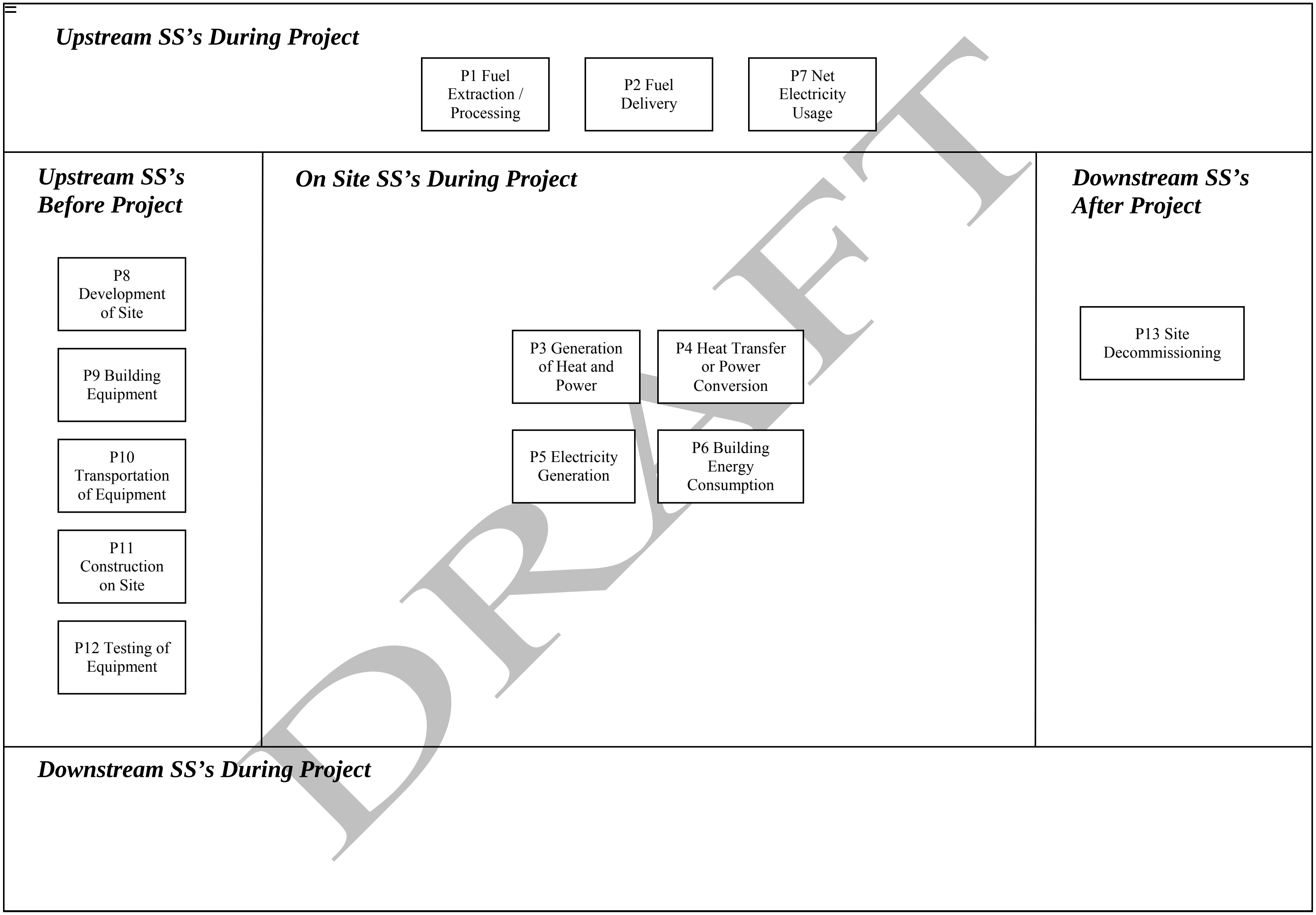


TABLE 2.1: Project SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's 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 SS's are considered under this SS. 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 SS's and there is no other delivery.	Related
P7 Net Electricity Usage	Electricity may be required for operating the Project Unit. 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 SS's during Project Operation		
P3 Generation of Heat and Power	The generation of heat and power may be for 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
P4 Heat Transfer or Power Conversion	Mechanical or other processes may be required to transfer the heat and power to a usable form at the project site. All relevant characteristics of the heat transfer or power conversion would need to be tracked including volumes and types of fuels are the important characteristics to be tracked.	Controlled
P5 Electricity Generation	Electricity may be generated to meet internal project demand or for export from the project site. The generation of this electricity may yield incremental greenhouse gas emissions. Quantities and types for each of the energy inputs would be tracked.	Controlled
P6 Building Energy Consumption	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the overall building. This may include the energy used in the heating and cooling of the building, lighting the building, etc. Quantities and types for each of the energy inputs would be tracked.	Controlled
Downstream SS's during Project Operation		
	None	
Other		
P8 Development of Site	The site of the building 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

P9 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
P10 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
P11 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
P12 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or 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
P13 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

There are separate baseline conditions for new Large Residential Buildings and retrofits of existing Large Residential Buildings. The baseline for new Large Residential Buildings should be determined using EE4 software provided by Natural Resources Canada. The software is a tool that can model new buildings and determine energy performance relative to the Model National Energy Code for Buildings (MNECB). To assess the performance of the building under the project condition relative to the EE4 model performance, an energy audit will need to be conducted in the second year of building operation, or subsequently.

The baseline condition for the retrofits of existing Large Residential Buildings in this protocol is defined as the building energy use prior to any retrofits and/or improvements. The energy and emissions footprint, per m^2, of the baseline configuration is established using EE4 or equivalent energy audit that is completed before any changes have been made to the building. To assess the performance of the building under the project condition relative to the EE4 model performance, an energy audit will need to be conducted in the second year of building operation, or subsequently.

The approach to quantifying the baseline will be projection based using the results from the EE4 model as the applicable baseline condition that can provide reasonable certainty. The baseline scenario for this protocol is considered static if there is no material change to the occupancy rate as the energy use profile for the baseline and project activities remain relatively constants based on a fixed unit of production (i.e. constant building size).

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

2.3 Identification of SS's for the Baseline

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

FIGURE 2.2: Baseline Element Life Cycle Chart

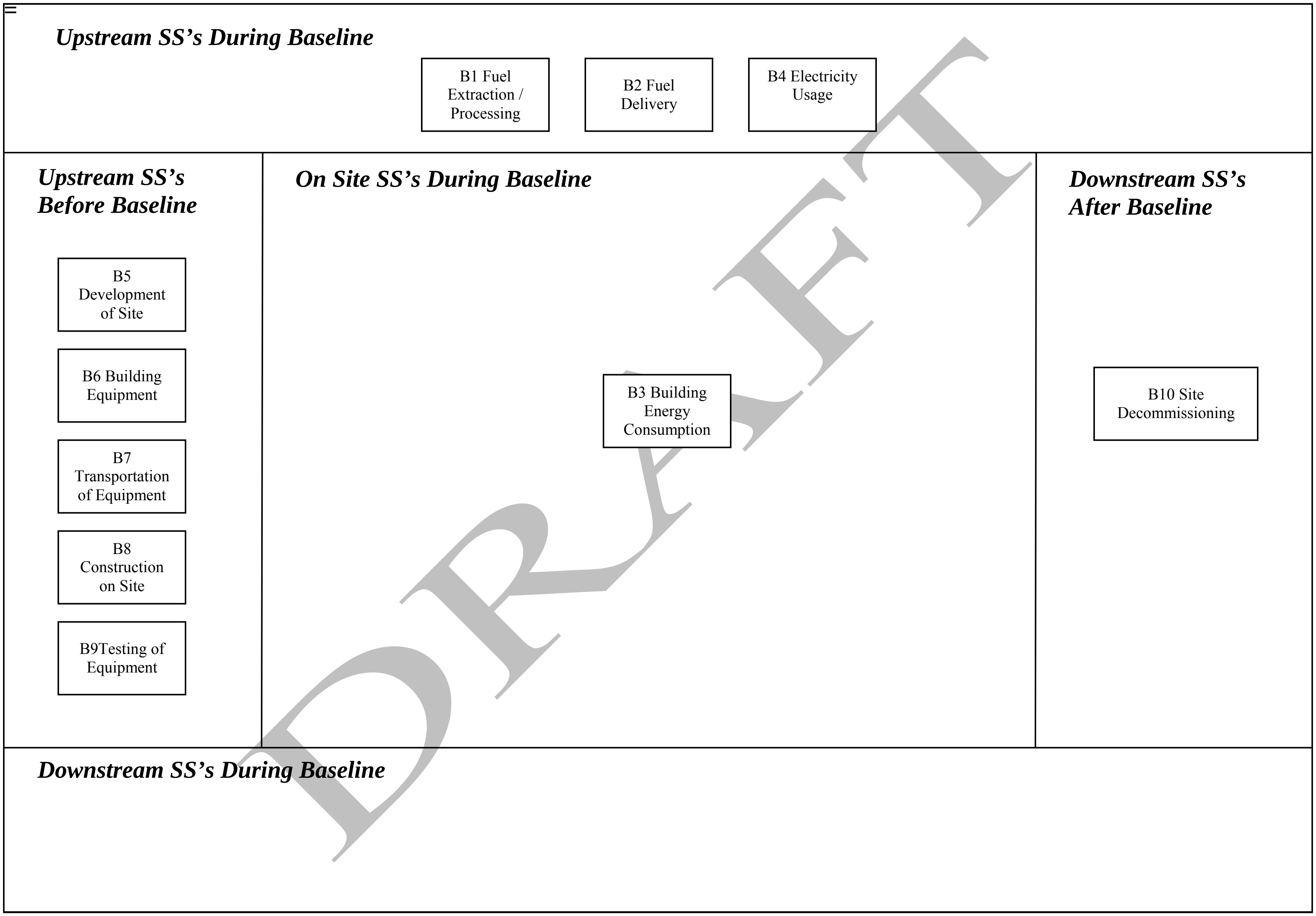


TABLE 2.1: Baseline SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's during Baseline Operation		
B1 Fuel Extraction and Processing	Each of the fuels used throughout the baseline process 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 SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related
B2 Fuel Delivery	Each of the fuels used throughout the baseline process 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 SS's and there is no other delivery.	Related
B4 Electricity Usage	Electricity may be required for operating the baseline process. 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 SS's during Baseline Operation		
B3 Building Energy Consumption	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the overall building. This may include the fossil fuel energy used in the heating and cooling of the building, lighting the building, etc. Quantities and types for each of the energy inputs would be tracked.	Controlled
Downstream SS's during Baseline Operation		
	None	
Other		
B5 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
B6 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, and 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
B7 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

B8 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
B9 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or 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
B10 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 SS's

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

TABLE 2.3: Comparison of SS's

1. Identified SS	2. Baseline (C, R, A)	3. Project (C, R, A)	4. Include or Exclude from Quantification	5. Justification for Exclusion
Upstream SS's				
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	
P7 Net Electricity Usage	N/A	Related	Include	N/A
B4 Electricity Usage	Related	N/A	Include	
Onsite SS's				
P3 Generation of Heat and Power	N/A	Controlled	Include	N/A
P4 Heat Transfer or Power Conversion	N/A	Controlled	Include	N/A
P5 Electricity Generation	N/A	Controlled	Include	N/A
P6 Building Energy Consumption	N/A	Controlled	Include	N/A
B3 Building Energy Consumption	Controlled	N/A	Include	
Downstream SS's				
None				
Other				
P8 Development of Site	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.
B5 Development of Site	Related	N/A	Exclude	
P9 Building 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.
B6 Building Equipment	Related	N/A	Exclude	
P10 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.
B7 Transportation of Equipment	Related	N/A	Exclude	

P11 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.
B8 Construction on Site	Related	N/A	Exclude	
P12 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.
B9 Testing of Equipment	Related	N/A	Exclude	
P13 Site Decommissioning	N/A	Related	Exclude	Emissions from decommissioning are not material given the long project life, and the minimal decommissioning typically required.
B10 Site Decommissioning	Related	N/A	Exclude	

2.5 Quantification of Reductions, Removals and Reversals of Relevant SS's

2.5.1 Quantification Approaches

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

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

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Electricity Usage}} + \text{Emissions}_{\text{Building Energy Consumption}}$$

$$\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Total Onsite Energy Use}} + \text{Emissions Net}_{\text{Net Electricity Usage}}$$

Where:

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

- Emissions $_{\text{Fuel Extraction / Processing}}$ = emissions under SS B1 Fuel Extraction and Processing
- Emissions $_{\text{Building Energy Consumption}}$ = emissions under SS B3 Building Energy Consumption
- Emissions $_{\text{Electricity Usage}}$ = emissions under SS B4 Electricity Usage

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

- Emissions $_{\text{Fuel Extraction / Processing}}$ = emissions under SS P1 Fuel Extraction and Processing
- Emissions $_{\text{Total Onsite Energy Use}}$ = emissions under SS P3 Generation of Heat And Power; SS P4 Heat Transfer or Power Conversion; SS P5 Electricity Generation; SS P6 Building Energy Consumption
- Emissions $_{\text{Net Electricity Usage}}$ = emissions under SS P7 Electricity Usage

TABLE 2.4: Quantification Procedures

1. Project / Baseline SS	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SSs						
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 SSs.
	Volume of Fuel Combusted for P4 and P6 / Vol. Fuel	L, m^3 or other	Estimated	Based on values provided from energy audit	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	Values provided in Appendix A.	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 or other	Estimated	Values provided in Appendix A.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_2O Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{N2O}$	kg N_2O per L, m^3 or other	Estimated	Values provided in Appendix A.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

P3 Generation of Heat and Power P4 Heat Transfer or Power Conversion P5 Electricity Generation P6 Building Energy Consumption	$Emissions_{Total\ Onsite\ Energy\ Use} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20});$					
	Emissions $_{Total\ Onsite\ Energy\ Use}$	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 SSs.
	Volume of Each Type of Fuel Consumed to Generate Heat and Power / Vol. Fuel $_i$	L, m^3 or other	Estimated	Based on values provided from energy audit	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 N_2O 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 Net Electricity Usage	$Emissions_{Electricity} = Electricity * EF_{Elec}$					
	Emissions $_{Electricity}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated.
	Incremental Electricity Used at the Site for Unit Operation / Electricity	kWh	Measured	Direct metering.	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	Estimated	From Alberta Environment Offset Project Guidance Document	Annual	Reference values adjusted periodically

Baseline SSs						
B1 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 SSs.
	Volume of Fuel Combusted for B4 / Vol. Fuel	L, m^3 or other	Estimated	Based on values provided from energy audit	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 Natural Gas / $EF\ Fuel_{CO2}$	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 Natural Gas / $EF\ Fuel_{CH4}$	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 Natural Gas / $EF\ Fuel_{N2O}$	kg N_2O 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.
B3 Building Energy Consumption	$Emissions_{Unit\ Operation} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2})$; $\sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4})$; $\sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$					
	$Emissions_{Unit\ Operation}$	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 SSs.
	Volume of Each Type of Fuel for Unit Operation / $Vol.\ Fuel_i$	L, m^3 or other	Estimated	Based on values provided from energy audit	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 N_2O 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.
B4 Electricity Usage	$Emissions_{Electricity} = Electricity * EF_{Elec}$					
	Emissions $_{Electricity}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated.
	Incremental Electricity Exported from the Site / Electricity	kWh	Measured	Direct metering.	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	Estimated	From Alberta Environment Offset Project Guidance Document	Annual	Reference values adjusted periodically

2.5.2 Contingent Data Approaches

No contingent means for calculating or estimating the required data were considered in this protocol as using an energy audit was considered to be the only appropriate data collection method.

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.

A best practice that may used for projects that will have multiple tenants, and/or relatively frequent changes in tenant types, is the inclusion of sub-metering capability. The sub-metering capacity can potential add rigor to the quantity and quality of the data collection and annual verification analysis process, and assist in the assessment of material change in occupancy type.

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.

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 Intensity of Fuel Extraction and Production (Diesel, Natural Gas, and Gasoline)

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

APPENDIX B:

Material Change of Occupancy Definition and Discussion

Definition of Material Change of Occupancy

A material change provision for occupancy is included to address any significant impacts to the comparability between baseline and project performance due to changes in the building occupancy rate. Material change in this context is defined as likely to have a significant impact on the greenhouse gas emissions profile across the baseline and project conditions.

For the purposes of this protocol, material change in occupancy is determined through a multi-stage process. First, the project proponent must assess and document how much building area was unoccupied and for what length of time.

Second, the proponent must calculate and assess whether the total building area affected by both occupancy rate, relative to the baseline condition, is greater than 5% of the total available building area as defined by this formula:

$$\% \text{ Impacted} = \frac{\Sigma \text{ (Building Area Vacant * Number of Days Vacant)}}{\text{Total Building Area}}$$

If the percent impacted is less than 5%, then the change would not be considered material. Should the percentage increase past 5%, the proponent must assess and justify whether the change in occupancy will have a significant impact on the greenhouse gas emissions from the building. This should include a detailed qualitative and/or quantitative assessment of the changes in occupancy.

Should the change be deemed as material and is likely to result in an overestimation of the emission reduction offsets, then a revision to the baseline modeling would be required to justify a new baseline for the year in which the material change occurred, going forward.