SPECIFIED GAS EMITTERS REGULATION

QUANTIFICATION PROTOCOL FOR BIOFUEL PRODUCTION AND USAGE

OCTOBER 2007

Version 1

Alberta ENVIRONMENT

ALBERTANS & CLIMATE CHANGE

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.

Acknowledgements

This protocol is largely based on the *Greenhouse Gas Protocol: Biofuels in Transportation Projects* dated April, 2006. This work was completed by The Delphi Group and GHGm.com as part of a Climate Change Technology Early Action Measures (TEAM) under the System of Measurement and Reporting for Technologies (SMART). This document builds on this work, expanding the scope to other project scopes under the heading of biofuel production and usage. The seed document remains as a considerable source of additional detail on any of the technical elements of the protocol.

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

Environmental Monitoring and Evaluation
Alberta Environment
11th Floor, Oxbridge Place
9820 - 106th Street
Edmonton, Alberta, T5K 2J6
E-mail: AENV.GHG@gov.ab.ca

ISBN: 978-0-7785-7220-6 (Printed)
ISBN: 978-0-7785-7221-3 (On-line)

Table of Contents

1.0 Project and Methodology Scope and Description 1
  1.1 Protocol Scope and Description 1
  1.2 Glossary of New Terms 4

2.0 Quantification Development and Justification 6
  2.1 Identification of Sources and Sinks (SS's) for the Project 6
  2.2 Identification of Baseline 12
  2.3 Identification of SS's for the Baseline 12
  2.4 Selection of Relevant Project and Baseline SS's 17
  2.5 Quantification of Reductions, Removals and Reversals of Relevant SS's 21
    2.5.1 Quantification Approaches 21
    2.5.2. Contingent Data Approaches 31
  2.6 Management of Data Quality 31
    2.6.1 Record Keeping 31
    2.6.2 Quality Assurance/Quality Control (QA/QC) 31

List of Figures

FIGURE 1.1 Process Flow Diagram for Project Condition 2
FIGURE 1.2 Process Flow Diagram for Baseline Condition 3

FIGURE 2.1 Project Element Life Cycle Chart 7
FIGURE 2.2 Baseline Element Life Cycle Chart 13

List of Tables

TABLE 2.1 Project SS's 8
TABLE 2.2 Baseline SS's 14
TABLE 2.3 Comparison of SS's 18
TABLE 2.4 Quantification Procedures 22
TABLE 2.5 Contingent Data Collection Procedures 32

1.0 Project and Methodology Scope and Description

This quantification protocol is written for the biofuel production facility or project developer. Some familiarity with, or general understanding of the operation of a biofuel production facility is expected.

The opportunity for generating carbon offsets with this protocol arises mainly from the indirect reductions of greenhouse gas (GHG) emissions from displacing a proportion of fossil fuels with biofuel products in liquid fuel blends. However, some opportunities from reduced feedstock transportation, or onsite heat/power production and other practices are allowed in the flexibility of this protocol

1.1 Protocol Scope and Description

This protocol quantifies the emission reductions from the avoidance of fossil fuel consumption, replaced by biofuels on an equivalent energy potential basis. It also specifically includes reductions in GHG emissions due to any heat/power production and electricity generation related to the process, and from the avoidance of landfilling any materials which may be diverted for conversion to biofuel.

Biofuels can include charcoal, bio-diesel, ethanol, and other similar gas, liquid and solid fuels from renewable sources. These biofuels can be blended with other fuels, including fossil fuels, prior to final use. **FIGURE 1.1** offers a process flow diagram for a typical project.

Protocol Approach:
The Biofuels Protocol is not intended to be prescriptive, but instead serve as a generic 'recipe' for project developers (i.e. biofuel facility owners/operators) to follow in order to meet the measurement, monitoring and GHG quantification requirements. The project must achieve some level of greenhouse gas emission reductions relative to the baseline situation.

The baseline condition includes the use of fossil fuels by downstream users (calculated on an equivalent energy potential basis), the production of heat/power using fossil fuels at facilities that rely on heat/power from the biofuels facility, the generation of electricity by other facilities to cover the net generation capacity of the biofuels facility, and the possible landfilling of any materials which would become feedstocks for the biofuels facility. **FIGURE 1.2** offers a process flow diagram for a typical baseline configuration.

Protocol Applicability:
The boundary of the biofuels protocol encompasses the production of feedstocks, production of biofuels, heat/power and electricity and their end use. To demonstrate that a project meets the requirements under this protocol, the project developer (biofuel facility owner/operator) must provide evidence that:

FIGURE 1.1: Process Flow Diagram for Project Condition

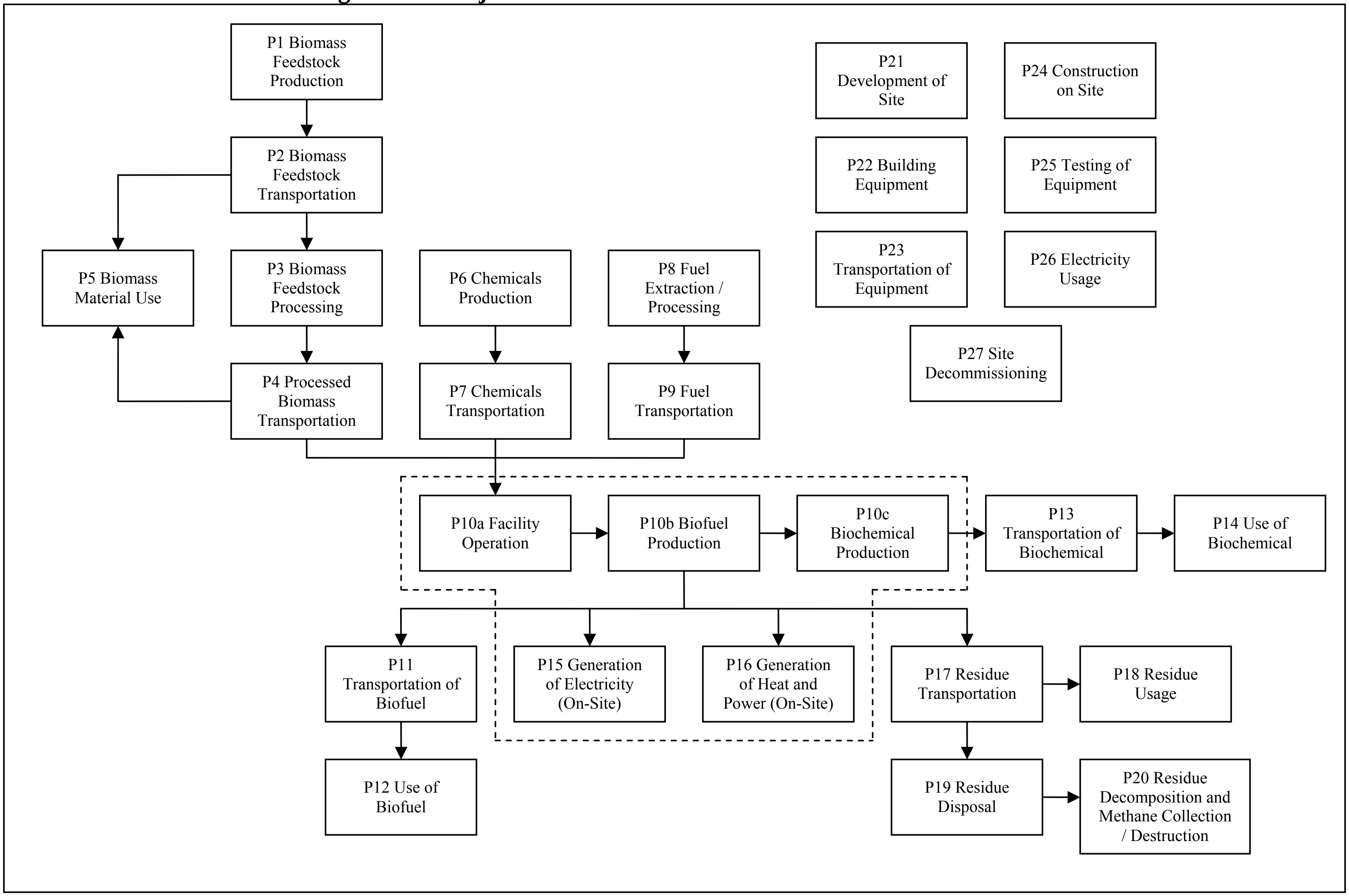
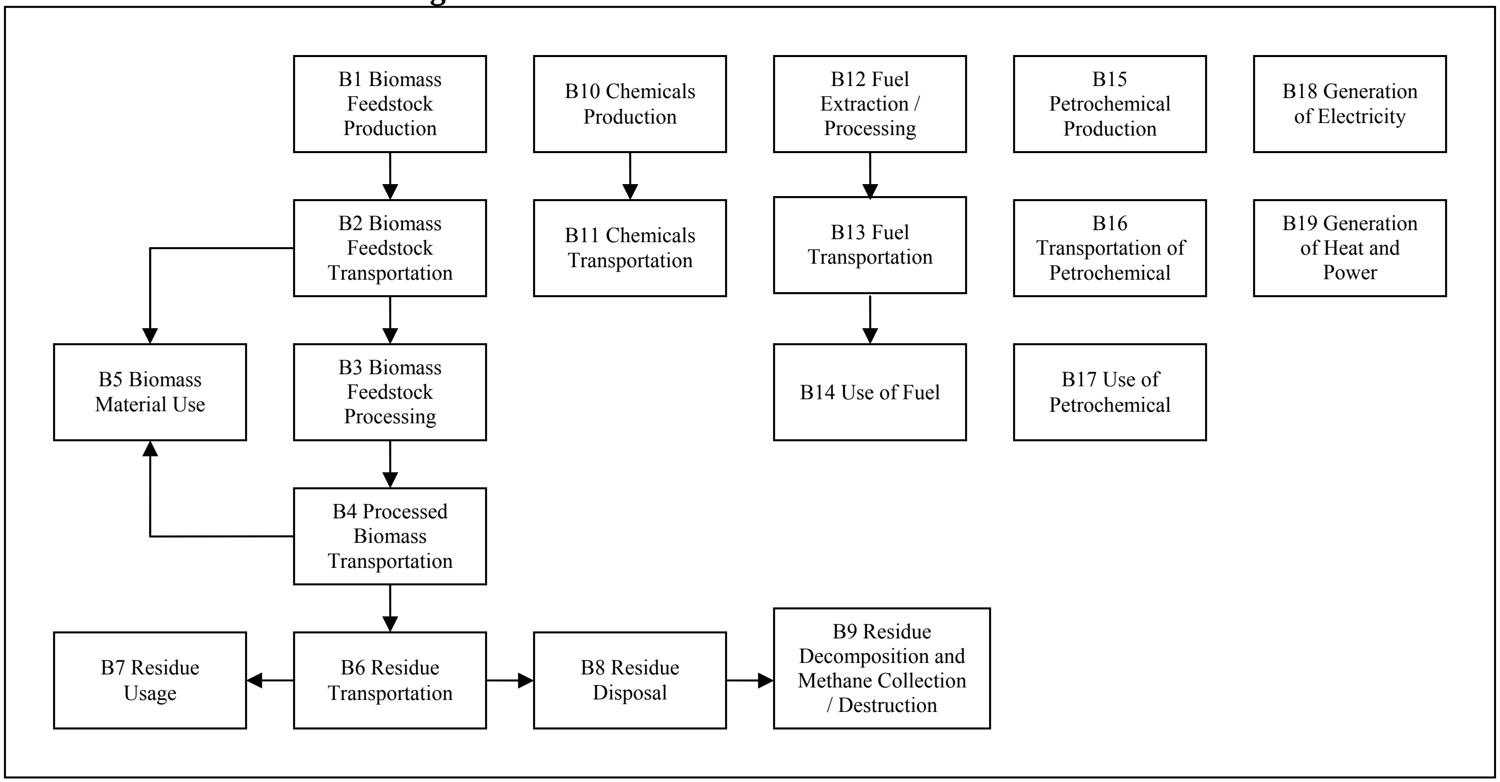


FIGURE 1.2: Process Flow Diagram for Baseline Condition



1. 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;
2. Feedstocks must be sourced from within Canada, as indicated by records, to ensure the sustainability of the source;
3. Process emissions from biofuel production are not material to the emission reduction calculations as indicated by quantitative and/or qualitative analysis; and
4. The project must meet the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System.

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

1. The heat and power production component of the process may be dealt with outside the scope of the protocol as part of a *Waste Heat Recovery* protocol. 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;
2. The heat and power production component of the project 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 retrofitted supplementary heating both on and off site to meet the project energy load;
3. In cases where the project developer wishes to quantify the emission reduction from reduced transportation requirements for the biofuel, then the source and sinks for GHGs (P9, P11 and B13) must all be quantified;
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 ensure accuracy; and
5. In cases where the diversion of feedstocks from landfill cannot be verified, the diversion of feedstocks from landfill components of the project may be ignored in both the baseline and project conditions.

1.2 Glossary of New Terms

Functional Equivalence — The Project and the Baseline should provide the same function and quality of products or services. This type of comparison requires a common metric or unit of measurement (such as the mass of beef produced, land area cropped, energy content of fuel consumed) for comparison between the Project and Baseline activity (refer to the Project Guidance Document for the Alberta Offset System for more information).

Biofuel: Any fuel that is derived from biomass. It is a renewable energy source, unlike other natural resources such as petroleum, coal, and nuclear fuels.

Biomass: Previously living organisms or their metabolic by-products (ie. manure from cows). This includes plant material, vegetation, agricultural and agri-food materials that can be used as a fuel or energy source. This may include silage, energy crops, wood materials (construction waste, slash, bark, etc.), oils and fats, etc.

Landfill: A landfill is a site at which materials are stored where they can undergo anaerobic decomposition. This may include the materials being buried, piled, mixed with other waste materials, or otherwise. Landfills classified as either controlled or uncontrolled are included in this definition. The designation of controlled or uncontrolled refers to the level of permitting and technical controls in place at the disposal site. Uncontrolled landfills may exist where although there is no expressly stated goal to leave the materials in place, there is a track record of material residing in that place for extended periods (greater than 10 years) and there are no plans or regulatory requirements for the material to be transferred to another disposal site.

2.0 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 document and relevant process flow diagrams. 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

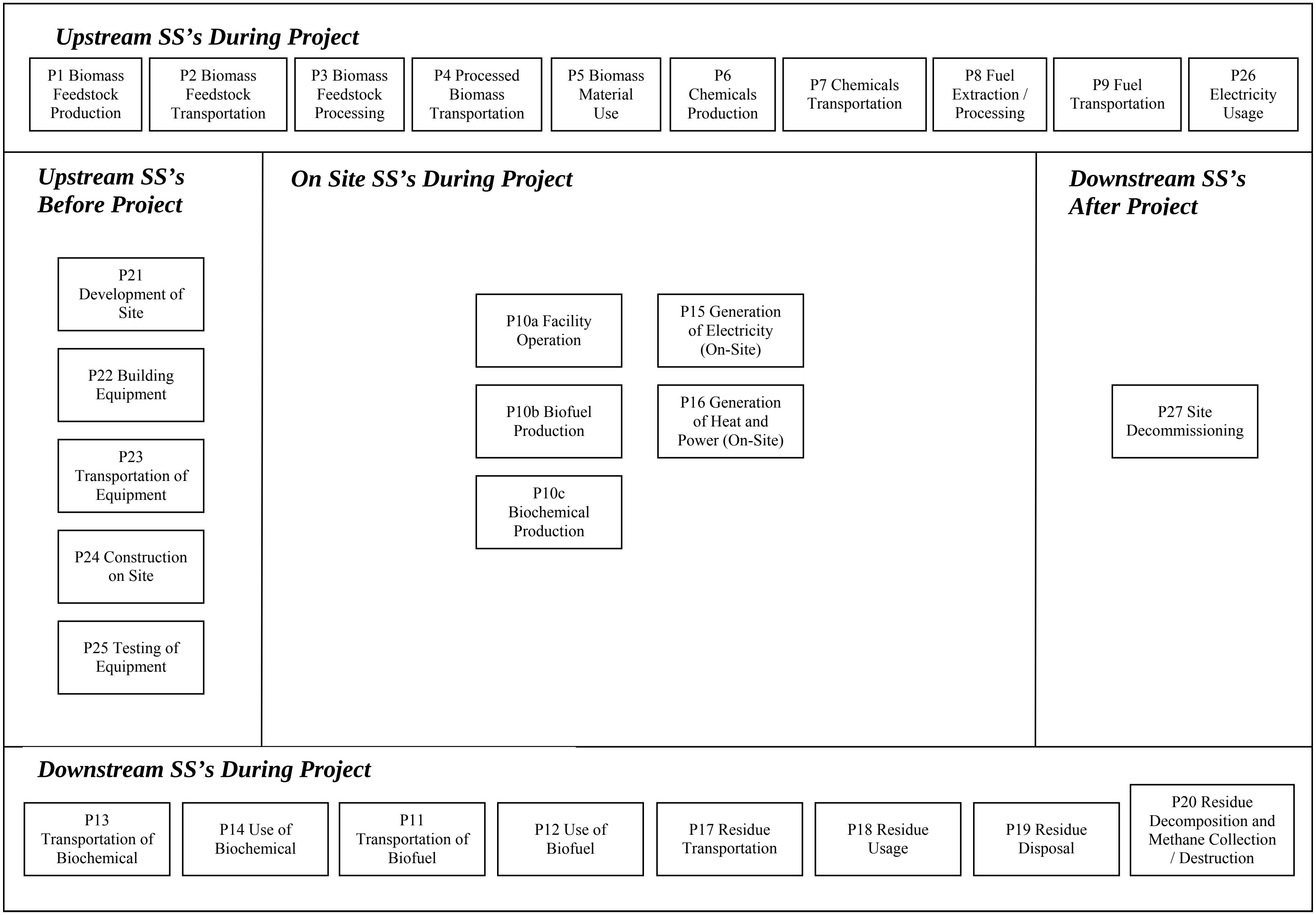


TABLE 2.1: Project SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's during Project Operation		
P1 Biomass Feedstock Production	Biomass feedstock may be created as a result of a number of agricultural and agri-food processes. Quantities for each of the energy inputs for biomass feedstock production would need to be contemplated and tracked.	Related
P2 Biomass Feedstock Transportation	Biomass feedstock may be transported to the processing site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the baseline condition.	Related
P3 Biomass Feedstock Processing	Biomass feedstock may be processed as a result of a number of agricultural and agri-food processes. Quantities for each of the energy inputs for biomass feedstock processing would need to be contemplated and tracked.	Related
P4 Processed Biomass Transportation	Processed biomass feedstock may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the baseline condition.	Related
P5 Biomass Material Use	Portions or components of the biomass feedstock and processed biomass may be diverted for other uses. Any energy inputs (ie. Use of fossil fuels) associated with their downstream use would need to be captured.	Related
P6 Chemicals Production	Chemical production may include several material and energy inputs such as natural gas, diesel and electricity. Quantities and types for each of the energy inputs would be contemplated to evaluate functional equivalence with the baseline condition.	Related
P7 Chemicals Transportation	Chemicals may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the baseline condition.	Related
P8 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

P9 Fuel Transportation	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
P26 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 SS's during Project Operation		
P10a Facility Operation	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the project site. This may require any number of mechanical, chemical or biological processes including those related to processing inputs and generating outputs (including those other than the biofuel) for downstream use. All relevant characteristics of the material inputs would need to be tracked to prove functional equivalence with the baseline scenario.	Controlled
P10b Biofuel Production	This SS encompasses the process emissions for the biofuel production. This may results from chemical, biological and mechanical processes used in the production of biofuel. All relevant characteristics of these processes would need to be tracked.	Controlled
P10c Biochemical Production	Biochemical feedstocks may be generated that would serve to offset petrochemical feedstocks. This may result from chemical, biological and mechanical processes used in the production of the biochemicals. All relevant characteristics of these processes would need to be tracked.	Controlled
P15 Electricity Production (On-Site)	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
P16 Generation of Heat and Power (On-Site)	The generation of heat and power may occur at the project site for sale to other facilities. 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
Downstream SS's during Project Operation		
P11 Transportation of Biofuel	Biofuels may be transported from the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the baseline condition.	Related
P12 Use of Biofuel	Biofuel is used as a fuel source. Although the carbon dioxide emissions are considered biogenic, there are methane and nitrous oxide emissions from its combustion. The quantities of biofuels combusted would need to be tracked.	Related

P13 Biochemical Transportation	Biochemical feedstocks may be transported from the project site by truck, barge and/or train to disposal or re-processing sites. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would need to be tracked.	Related
P14 Use of Biochemical	Biochemical feedstocks from the biofuel process may become inputs to other petrochemical processes. Any energy inputs (i.e. use of fossil fuels) associated with their downstream use would need to be captured.	Related
P17 Residue Transportation	Residues may be transported from the project site by truck, barge and/or train to disposal or re-processing sites. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would need to be tracked.	Related
P18 Residue Usage	Residues from the biofuel process may become inputs to other processes, such as a feed for livestock. Any energy inputs (ie. Use of fossil fuels) associated with their downstream use would need to be captured.	Related
P19 Residue Disposal	Residue may be handled at a disposal site by transferring the waste from the transportation container, spreading, burying, processing, or otherwise dealing with the waste using a combination of loaders, conveyors and other mechanized devices. This equipment would be fuelled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities and types for each of the energy inputs may need to be tracked.	Related
P20 Residue Decomposition and Methane Collection / Destruction	Waste may decompose in the disposal facility (typically a landfill site) resulting in the production of methane. A methane collection and destruction system may be in place at the disposal site. If such a system is active in the area of the landfill where this waste is being disposed, then this methane collection must be accounted for in a reasonable manner. Disposal site characteristics and mass disposed of at each site may need to be tracked as well as the characteristics of the methane collection and destruction system.	Related
Other		
P21 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

P22 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
P23 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 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
P24 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
P25 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test biofuels 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
P27 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 protocol includes the use of fossil fuels by downstream users, the production of heat/power using fossil fuels at facilities that rely on heat/power from the biofuels facility, the generation of electricity by other facilities to cover the net generation capacity of the biofuels facility, and the possible landfilling of any materials which would become feedstocks for the biofuels facility. The baseline condition is defined based on the provision of the equivalent energy load as under the project condition. This is accomplished by applying an energy balance to the systems using the Biofuels, and the heat/power and electrical output from the production facility.

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 energy demands, biofuel supply, as well as other market conditions.

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

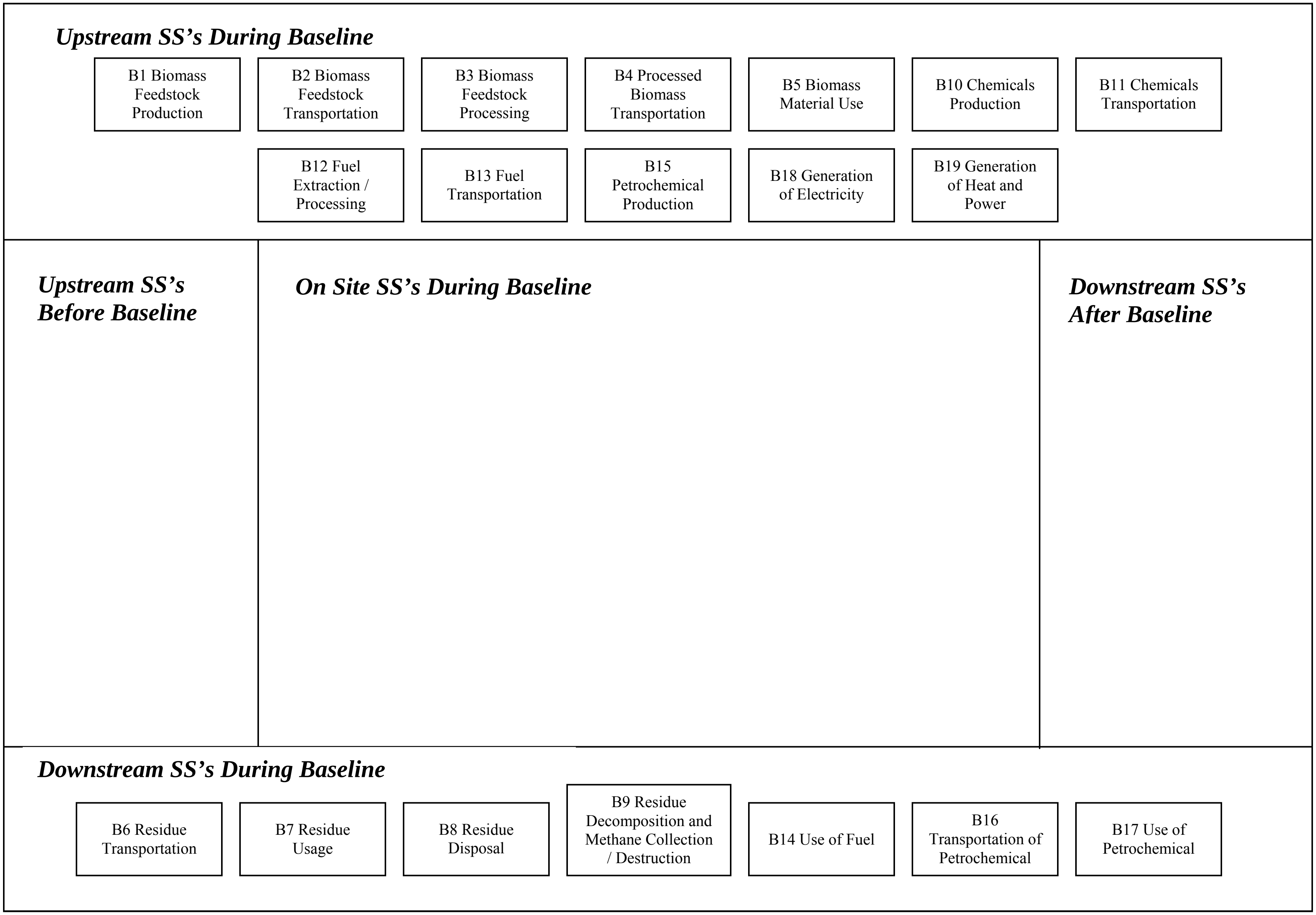


TABLE 2.2: Baseline SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's during Baseline Operation		
B1 Biomass Feedstock Production	Biomass feedstock may be created as a result of a number of agricultural and agri-food processes. Quantities for each of the energy inputs for biomass feedstock production would need to be contemplated and tracked.	Related
B2 Biomass Feedstock Transportation	Biomass feedstock may be transported to the processing site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the project condition.	Related
B3 Biomass Feedstock Processing	Biomass feedstock may be processed as a result of a number of agricultural and agri-food processes. Quantities for each of the energy inputs for biomass feedstock processing would need to be contemplated and tracked.	Related
B4 Processed Biomass Transportation	Processed biomass feedstock may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the project condition.	Related
B5 Biomass Material Use	Portions or components of the biomass feedstock and processed biomass may be diverted for other uses. Any energy inputs (ie. Use of fossil fuels) associated with their downstream use would need to be captured.	Related
B10 Chemicals Production	Chemical production may include several material and energy inputs such as natural gas, diesel and electricity. Quantities and types for each of the energy inputs would be contemplated to evaluate functional equivalence with the project condition.	Related
B11 Chemicals Transportation	Chemicals may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the project condition.	Related
B12 Fuel Extraction and Processing	Each of the fuels used throughout the baseline would 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
B13 Fuel Transportation	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

B15 Petrochemical Production	Petrochemical feedstocks may be generated that would be offset petrochemical feedstocks. This may result from chemical, biological and mechanical processes used in the production of the petrochemicals. All relevant characteristics of these processes would need to be tracked.	
B18 Generation of Electricity	Electricity may be generated to compensate for any electricity output from the project facility as compared to the baseline. 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
B19 Generation of Heat and Power	The generation of heat and power may be required at other facility sites to offset the heat and power provided under the project condition. This generation could require the combustion of fossil fuels resulting in greenhouse gas emissions. Volumes and types of fuels are the important characteristics to be tracked.	Related
Onsite SS's during Baseline Operation		
None		
Downstream SS's during Baseline Operation		
B6 Residue Transportation	Residues may be transported under the baseline condition by truck, barge and/or train to disposal or re-processing sites. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would need to be tracked.	Related
B7 Residue Usage	Residues from processing under the baseline condition may become inputs to other processes, such as a feed for livestock. Any energy inputs associated with their downstream use would need to be captured.	Related
B8 Residue Disposal	Residue may be handled at a disposal site by transferring the material from the transportation container, spreading, burying, processing, otherwise dealing with the waste using a combination of loaders, conveyors and other mechanized devices. This equipment would be fuelled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities and types for each of the energy inputs may need to be tracked.	Related
B9 Residue Decomposition and Methane Collection / Destruction	Residues may decompose in the disposal facility (typically a landfill site) resulting in the production of methane. A methane collection and destruction system may be in place at the disposal site. If such a system is active in the area of the landfill where this material is being disposed, then this methane collection must be accounted for in a reasonable manner. Disposal site characteristics and mass disposed of at each site may need to be tracked as well as the characteristics of the methane collection and destruction system.	Related
B14 Use of Fuel	Equivalent amounts of fossil fuels may be consumed to cover the same energy content as the biofuels consumed. 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.	Related

B16 Transportation of Petrochemical	Petrochemical feedstocks may be transported from the production site by truck, barge and/or train to disposal or re-processing sites. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would need to be tracked.	Related
B17 Use of Petrochemical	Petrochemical feedstocks are used as inputs in the petroleum, chemical manufacturing and other processes. Any energy inputs (i.e. use of fossil fuels) associated with their downstream use would need to be captured.	Related
Other		
None		

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 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 SS's may be excluded is provided in **TABLE 2.3** below. All other SS's listed previously are included.

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 Biomass Feedstock Production	N/A	Related	Exclude	Excluded as the emissions from feedstock production are likely greater under the baseline condition. Discussion of this point is provided in **Appendix A**. This assumption should be revisited as part of the periodic protocol review and revision cycle.
B1 Biomass Feedstock Production	Related	N/A	Exclude	
P2 Biomass Feedstock Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely greater under the baseline condition.
B2 Biomass Feedstock Transportation	Related	N/A	Exclude	
P3 Biomass Feedstock Processing	N/A	Related	Exclude	Excluded as the emissions from feedstock processing are likely greater under the baseline condition.
B3 Biomass Feedstock Processing	Related	N/A	Exclude	
P4 Processed Biomass Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely greater under the baseline condition.
B4 Processed Biomass Transportation	Related	N/A	Exclude	
P5 Biomass Material Use	N/A	Related	Exclude	Excluded as the emissions from transportation are likely greater under the baseline condition.
B5 Biomass Material Use	Related	N/A	Exclude	
P6 Chemicals Production	N/A	Related	Exclude	Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B10 Chemicals Production	Related	N/A	Exclude	
P7 Chemicals Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely greater under the baseline condition.
B11 Chemicals Transportation	Related	N/A	Exclude	

P8 Fuel Extraction and Processing	N/A	Related	Include	N/A
B12 Fuel Extraction and Processing	Related	N/A	Include	
P9 Fuel Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation (combination of P9 and P11) are likely greater under the baseline condition (B13).
B13 Fuel Transportation	Related	N/A	Exclude	
B15 Petrochemical Production	Related	N/A	Exclude	Excluded as the scope of the protocol is limited to sites where biochemical production is not included.
B18 Generation of Electricity	Related	N/A	Include	N/A
B19 Generation of Heat and Power	Related	N/A	Include	N/A
P26 Electricity Usage	N/A	Related	Exclude	Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
Onsite SS's				
P10a Facility Operation	N/A	Related	Include	N/A
P10b Biofuel Production	N/A	Related	Exclude	Excluded as the emissions are likely negligible.
P10c Biochemical Production	N/A	Related	Exclude	Excluded as the scope of the protocol is limited to sites where biochemical production is not included.
P15 Electricity Production (On-Site)	N/A	Related	Include	N/A
P16 Generation of Heat and Power (On-Site)	N/A	Related	Include	N/A
Downstream SS's				
P11 Transportation of Biofuel	N/A	Related	Exclude	Excluded as the emissions from transportation are negligible and likely greater under the baseline condition (comparing SS P9 and P11 with SS B13).
P12 Use of Biofuel	N/A	Related	Include	N/A
P13 Biochemical Transportation	N/A	Related	Exclude	Excluded as the scope of the protocol is limited to sites where biochemical production is not included.
P14 Use of Biochemical	N/A	Related	Exclude	Excluded as the scope of the protocol is limited to sites where biochemical production is not included.
P17 Residue Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely greater under the

B6 Residue Transportation	Related	N/A	Exclude	baseline condition.
P18 Residue Usage	N/A	Related	Exclude	Excluded as the emissions from transportation are likely greater under the baseline condition.
B7 Residue Usage	Related	N/A	Exclude	
P19 Residue Disposal	N/A	Related	Exclude	Excluded as the emissions from residue disposal operations are likely functionally equivalent to the baseline condition.
B8 Residue Disposal	Related	N/A	Exclude	
P20 Residue Decomposition and Methane Collection / Destruction	N/A	Related	Include	N/A
B9 Residue Decomposition and Methane Collection / Destruction	Related	N/A	Include	
B14 Use of Fuel	Related	N/A	Include	N/A
B16 Transportation of Petrochemical	Related	N/A	Exclude	Excluded as the scope of the protocol is limited to sites where biochemical production is not included.
B17 Use of Petrochemical	Related	N/A	Exclude	Excluded as the scope of the protocol is limited to sites where biochemical production is not included.
Other				
P21 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.
P22 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.
P23 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.
P24 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.
P25 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.
P27 Site Decommissioning	N/A	Related	Exclude	Emissions from decommissioning are not material given the long project life, and the minimal decommissioning typically required.

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 B**. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

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

$$\begin{aligned}\text{Emissions}_{\text{Baseline}} = {} & \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Use of Fuel}} \\ & + \text{Emissions}_{\text{Electricity Generation}} + \text{Emissions}_{\text{Gen Heat and Power}} \\ & + \text{Emissions}_{\text{Decomposition, Collection and Destruction}}\end{aligned}$$

$$\begin{aligned}\text{Emissions}_{\text{Project}} = {} & \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Facility Operation}} \\ & + \text{Emissions}_{\text{Use of Biofuel}} \\ & + \text{Emissions}_{\text{Distribute Heat and Power}} + \text{Emissions}_{\text{Gen Heat and Power}} \\ & + \text{Emissions}_{\text{Transfer / Conversion}}\end{aligned}$$

Where:

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

- $\text{Emissions}_{\text{Fuel Extraction / Processing}}$ = emissions under SS B12 Fuel Extraction and Processing
- $\text{Emissions}_{\text{Use of Fuel}}$ = emissions under SS B14 Use of Fuel
- $\text{Emissions}_{\text{Electricity Generation}}$ = emissions under SS B18 Electricity Generation
- $\text{Emissions}_{\text{Gen Heat and Power}}$ = emissions under SS B19 Generation of Heat and Power
- $\text{Emissions}_{\text{Decomposition, Collection and Destruction}}$ = emissions under SS B9 Residue Decomposition and Methane Collection / Destruction

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

- $\text{Emissions}_{\text{Fuel Extraction / Processing}}$ = emissions under SS P8 Fuel Extraction and Processing
- $\text{Emissions}_{\text{Facility Operation}}$ = emissions under SS P10a Facility Operation
- $\text{Emissions}_{\text{Use of Biofuel}}$ = emissions under SS P12 Use of Biofuel
- $\text{Emissions}_{\text{Elec Gen}}$ = emissions under SS P15 Generation of Electricity (On-Site)
- $\text{Emissions}_{\text{Gen Heat and Power}}$ = emissions under SS P16 Generation of Heat and Power (On-Site)
- $\text{Emissions}_{\text{Decomposition, Collection and Destruction}}$ = emissions under SS P20 Residue Decomposition and Methane Collection / Destruction

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 SS's						
P8 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 SS's.
	Volume of Fuel Combusted for P10a, P13, and P14 / 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 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/ 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.

P10a Facility Operation	$Emissions_{Facility\ Operation} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$					
	Emissions $_{Facility\ Operation}$	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 SS's.
	Volume of Each Type of Fuel for Unit Operation / 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 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/ 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/ 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/ other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P12 Use of Biofuel	$Emissions_{Use\ of\ Biofuel} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$					
	Emissions $_{Use\ of\ Biofuel}$	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 Biofuel Consumed / Vol Fuel $_i$	L/ m^3/ other	Measured	Direct metering or reconciliation of volume produced.	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.

	CH_4 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CH4}$	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 Combustion of Each Type of Fuel / EF Fuel $_{i\ N2O}$	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.
P15 Electricity Generation	Emissions $_{Elec\ Gen}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)					
	Emissions $_{Elec\ Gen}$	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 for Electricity Generation / 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 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/ 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/ 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/ other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.

P16 Generation of Heat and Power	$Emissions_{Gen\ Heat\ and\ Power} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$					
	Emissions $_{Gen\ Heat\ and\ Power}$	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 SS's.
	Volume of Each Type of Fuel Consumed to Generate Heat and Power / 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 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/ 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/ 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/ other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P20 Residue Decomposition and Methane Collection / Destruction	$Emissions_{Decomposition,\ Collection\ and\ Destruction} = (Mass_{Residue\ Disposed} * MCF * DOC * DOC_F * F * 16/12 - R) * (1 - OX)$					
	Emissions $_{Decomposition,\ Collection\ and\ Destruction}$	kg of CH_4	N/A	N/A	N/A	Quantity being calculated.
	Mass of Residue Material Sent for Disposal (wet) / Mass $_{Residue\ Disposed}$	kg	Measured	Direct measurement of mass of residue sent for disposal.	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.

	Methane Correction Factor / MCF	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix B and C.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Degradable Organic Carbon / DOC	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix B and C.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Fraction of Degradable Organic Carbon Dissimilated / DOC_F	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix B and C.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Fraction of CH_4 in Landfill Gas / F	-	Estimated	From IPCC guidelines.	Annual	Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Recovered CH_4 at Landfill / R	kg of CH4	Measured	Direct metering.	Annual	Mass of methane collected and destroyed.
	Oxidation Factor / OX	-	Estimated	From IPCC guidelines.	Annual	Reference values adjusted periodically as part of internal IPCC review of its methodologies.
Baseline SS's						
B9 Residue Decomposition and Methane Collection / Destruction	$Emissions_{Decomposition, Collection and Destruction} = (Mass_{Residue Disposed} * MCF * DOC * DOC_F * F * 16/12 - R) * (1 - OX)$					
	$Emissions_{Decomposition, Collection and Destruction}$	kg of CH_4	N/A	N/A	N/A	Quantity being calculated.
	Mass of Residue Material Sent for Disposal (wet) / $Mass_{Residue Disposed}$	kg	Measured	Direct measurement of mass of residue sent for disposal.	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.

	Methane Correction Factor / MCF	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix B and C.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Degradable Organic Carbon / DOC	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix B and C.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Fraction of Degradable Organic Carbon Dissimilated / DOC_F	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix B and C.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Fraction of CH_4 in Landfill Gas / F	-	Estimated	From IPCC guidelines.	Annual	Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Recovered CH_4 at Landfill / R	kg of CH4	Measured	Direct metering.	Annual	Mass of methane collected and destroyed.
	Oxidation Factor / OX	-	Estimated	From IPCC guidelines.	Annual	Reference values adjusted periodically as part of internal IPCC review of its methodologies.
B12 Fuel Extraction and Processing	$\text{Emissions}_{\text{Fuel Extraction / Processing}} = \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CO2})$; $\sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CH4})$; $\sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,N2O})$					
	$\text{Emissions}_{\text{Fuel Extraction / Processing}}$	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 B14 and B16 / Vol. Fuel	L/ m^3/ other	Measured	Based on equivalent heat and power demand with the most likely fuel.	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/ 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.
B14 Use of Fuel	$\text{Emissions}_{\text{Use of Fuel}} = \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CO2}); \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CH4}) ; \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,N20})$					
	Emissions $_{\text{Use of Fuel}}$	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 offset with Biofuel / Vol. Fuel $_i$	L/ m^3/ other	Measured	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/ 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/ 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/ other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
B18 Electricity Generation	Emissions $_{Electricity}$ = Electricity * EF $_{Elec}$					
	Emissions $_{Electricity}$	kg of CO2e	N/A	N/A	N/A	Quantity being calculated.
	Incremental Electricity Exported from the Project 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 reference documents.	Annual	Reference values adjusted as appropriate by Alberta Environment.
B19 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 SS's.
	Volume of Each Type of Fuel Consumed to Generate Equivalent Heat and Power Load / Vol. Fuel $_i$	L/ m^3/ other	Measured	Based on equivalent heat and power demand with the most likely fuel.	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/ 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/ 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/ 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 SS	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Contingency Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SS's						
P8 Fuel Extraction and Processing	Volume of Fuel Combusted for P10a, P13, and P14 / Vol. Fuel	L/ m^3/ 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.
P10a Facility Operation	Volume of Each Type of Fuel for Unit Operation / Vol. $Fuel_i$	L/ m^3/ 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.
P12 Use of Biofuel	Volume of Each Type of Biofuel Consumed / Vol $Fuel_i$	L/ m^3/ other	Measured	Reconciliation of volume of fuel sold within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P15 Electricity Generation	Volume of Each Type of Fuel for Electricity Generation / Vol. $Fuel_i$	L/ m^3/ 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.
P16 Generation of Heat and Power	Volume of Each Type of Fuel Consumed to Generate Heat and Power / Vol. $Fuel_i$	L/ m^3/ 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.
P20 Residue Decomposition and Methane Collection / Destruction	Mass of Residue Material Sent for Disposal (wet) / $Mass_{Residue\ Disposed}$	kg	Estimated	Reconciliation with mass of material disposed of at disposal sites.	Continuous metering or monthly reconciliation.	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.

Baseline SS's						
B9 Residue Decomposition and Methane Collection / Destruction	Mass of Residue Material Sent for Disposal (wet) / $Mass_{Residue\ Disposed}$	kg	Estimated	Reconciliation with mass of material disposed of at disposal sites.	Continuous metering or monthly reconciliation.	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
B12 Fuel Extraction and Processing	Volume of Fuel Combusted for B14 and B16 / Vol. Fuel	L/ m^3/ other	Measured	Reconciliation as per B14 and B16 contingency methods.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
B14 Use of Fuel	Volume of Each Type of Fuel offset with Biofuel / Vol. $Fuel_i$	L/ m^3/ other	Measured	Reconciliation of volume of biofuels sold within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
B18 Generation of Electricity	Incremental Electricity Exported from the Project Site / Electricity	kWh	Measured	Reconciliation of power requirements for facility as per equipment output ratings.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
B19 Generation of Heat and Power	Volume of Each Type of Fuel Consumed to Generate Equivalent Heat and Power Load / Vol. $Fuel_i$	L/ m^3/ other	Measured	Reconciliation of volume of biofuels sold within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.

APPENDIX A:

Discussion of Exclusion of Sources and Sinks Associated with Biomass Production

The following provides a brief synopsis of the discussion with stakeholders on the justification for excluding upstream biomass production emissions on the basis that they are equivalent between the baseline and project condition. Based on the sum of these discussions, the equivalence was supported in the short-term and re-evaluated in the future once there is more biofuels development, to test if and when this condition no longer remains defensible (i.e. macroeconomic shifts in crop production types across the prairies, or crop production volumes, as a result of biofuel plants).

Under both the baseline and project conditions, productive agricultural lands will be cropped. Under the baseline condition, these crops will be input as they are now into the food, fibre and agri-food chain. Under the project condition, some of these materials will be diverted to biofuels facilities. The material diverted to biofuels will primarily be canola and wheat.

During the early period of biofuels development in Alberta, only small volumes of agricultural materials will be diverted to biofuels (ie. to meet the proposed federal Renewable Fuels mandate of 5% Ethanol, and 2% biodeiusel in liquid fuel blends, a reallocation of approximately 5% of Canadian total production would be impacted in the short term). The impacts of biofuels production in the United States can be ignored as they are a function of projects in another jurisdiction, which must, itself, deal with the impacts of biofuels development, and would occur under both the baseline and project condition for Alberta projects.

The types of crop that are grown varies year over year with respect to forecast supply/demand, pricing, soil conditions and several other factors. As such, small changes over the first few years of biofuels development would likely be difficult to predict and or definitively attribute to the biofuels industry at a macro-economic level. In other words, while there are only a limited number of biofuel facilities developed, the impact of the biofuel industry in Canada is not likely to be material to volumes of crops produced for consumption as food or livestock rations. Further, as the agricultural sector is highly sophisticated and integrated, localized effects would likely be buffered across the province.

The protocol requires that the biomass feedstock must come from Canada. As such, this should discourage the imports of biomass feedstocks from non-sustainable sources. As agricultural and agri-forestry in Canada is largely managed for sustainability, land-use changes and other practises associated with non-sustainable biomass development in developing nations is not likely.

Given the complex agricultural systems and the forecast for minor impacts therein, it would be difficult to identify and quantify the incremental impact (if any) in upstream biomass production for biofuels production. As such, it is reasonable to assume that the emissions from upstream biomass production would be equivalent between the baseline and project conditions. This assumption is not likely to hold over the long-term and should be reviewed upon subsequent protocol review cycles.

APPENDIX B:

Calculation of DOC

The following calculations were conducted according to the information outlined in the "National Inventory Report – Greenhouse Gas Sources and Sinks in Canada, 1990-2004", Environment Canada, April 2006.

Estimates of the degradable organic carbon (DOC) present in a waste stream can be calculated using the following equation:

$$L_0 = MCF * DOC * DOC_F * F * 16/12 * 1000 \text{ kg } CH_4/\text{t } CH_4$$

Where:
L_O = CH_4 generation potential (kg CH_4/ t waste)
MCF = CH_4 correction factor (fraction)
DOC = degradable organic carbon (t C/t waste)
DOC_F = fraction DOC dissimilated
F = fraction CH_4 in landfill gas
16/12 = stoichiometric factor

According to the IPCC Guidelines, the MCF for managed landfill sites has a value of 1.0. The fraction of CH_4 (F) emitted from a landfill ranges from 0.4 to 0.6 and was assumed to be 0.5. The IPCC default DOC_F value of 0.77 was used. The DOC values in the following table were calculated using average Lo values for each province published by Environment Canada (2006).

TABLE A.1: Estimates of DOC by Province

Province	Lo (value after 1990)	DOC (calculated)
British Columbia	108.8	0.21
Alberta	100.0	0.19
Saskatchewan	106.8	0.21
Manitoba	92.4	0.18
Ontario	90.3	0.18
Quebec	127.8	0.25
New Brunswick	117.0	0.23
Prince Edward Island	117.0	0.23
Nova Scotia	89.8	0.17
Newfoundland and Labrador	102.2	0.20
Northwest Territories and Nunavut	117.0	0.23
Yukon	117.0	0.23

APPENDIX C:

Parameters for Use in Calculations Based on Diversion from Landfills by Landfill Type

TABLE B.1: Landfill Type-Based Factors

	Mixed-Waste Landfills				**Wood Waste Landfills**
Parameter	**Managed**	**Unmanaged – Deep (>= 5m waste)**	**Unmanaged – Shallow (< 5m waste)**	**Uncategorized**	
Methane Correction Factor (MCF)	1.0	0.8	0.4	0.6	0.8[a]
Fraction of CH_4 in landfill gas (F)	0.5				
Fraction of degradable organic carbon dissimilated (DOC_F)	0.77				0.5
Fraction of degradable organic carbon (DOC)	See Appendix A				0.3

a - the default condition for a wood waste landfill is an unmanaged, deep landfill (Environment Canada, 2006). This parameter may be changed if the emissions are being calculated for an alternate type of wood waste landfill.