QUANTIFICATION PROTOCOL FOR INCLUDING DISTILLERS GRAINS AND EDIBLE OILS IN CATTLE FEEDING REGIMES

Submitted to:

Alberta Environment

and

Alberta Agriculture, Food and Rural Development

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1.1 Protocol Scope and Description

This quantification protocol is applicable to the quantification of direct and indirect reductions of greenhouse gas (GHG) emissions resulting from inclusion of distiller's grains and/or edible oils within the cattle feeding regime during finishing cycle. For this protocol to be applicable, edible oils in the range of 4% to 6% (by dry weight), distiller's grains at greater than 25% (by dry weight), or some equivalent combination of these two components must be included in the cattle feeding regime.

The protocol quantifies the reduction in enteric methane emissions from the cattle as a result of changes in the finishing diet. **FIGURE 1.1** offers a process flow diagram for a typical project.

The Beef Feeding Protocol does not prescribe the feeding regime for beef production. Rather, this protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements. The Beef Feeding Protocol quantifies emissions reductions on the basis of the mass of beef produced. Thus, the starting point for all quantification is the number and weight of cattle produced in the project.

The baseline condition has been identified as a feeding regime that did not include edible oils in the range of 4% to 6% (by dry weight), distiller's grains at greater than 25% (by dry weight), or some equivalent combination of these two components within a three year period prior to project implementation. **FIGURE 1.2** offers a process flow diagram for a typical baseline configuration.

The boundary of the Beef Feeding Protocol encompasses the pasture and feedlot barn where the cattle are raised and fed, the facility where manure is stored, and the land where the manure is spread. The project may include a number of sites, and a variety of enterprises, but all project farms will address the activities within the boundary of the Beef Feeding Protocol.

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

1. The feeding practices used by the farms are materially consistent with those described in **APPENDIX A** as confirmed by an attestation from the project proponent;
2. All farms in the project are currently storing manure and applying manure or custom applying manure to land as confirmed by an attestation from the project proponent;
3. All farms in the project can demonstrate a change in practice in terms of feeding regime for their cattle confirmed by operational records;

FIGURE 1.1: Process Flow Diagram for Project Condition

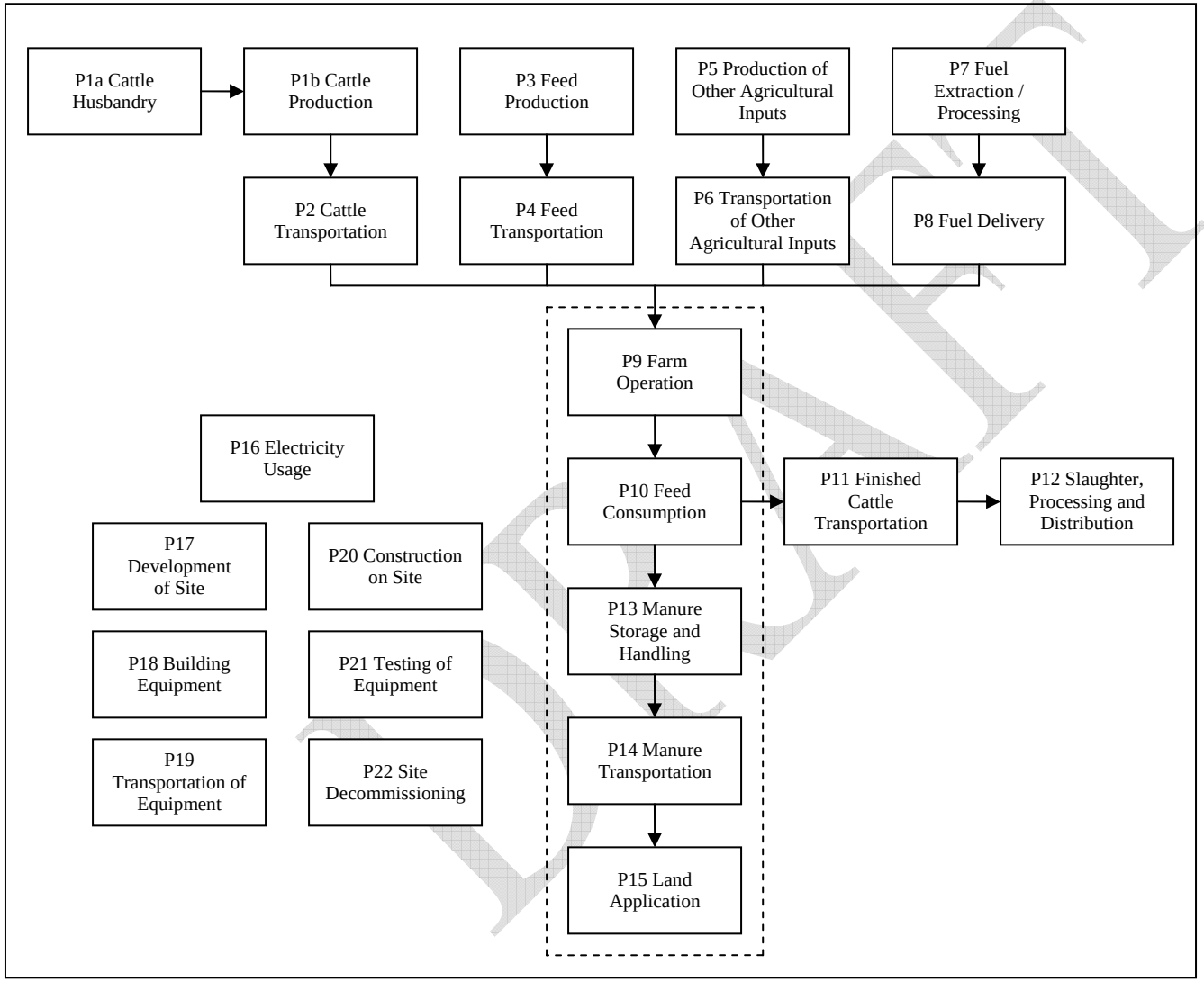
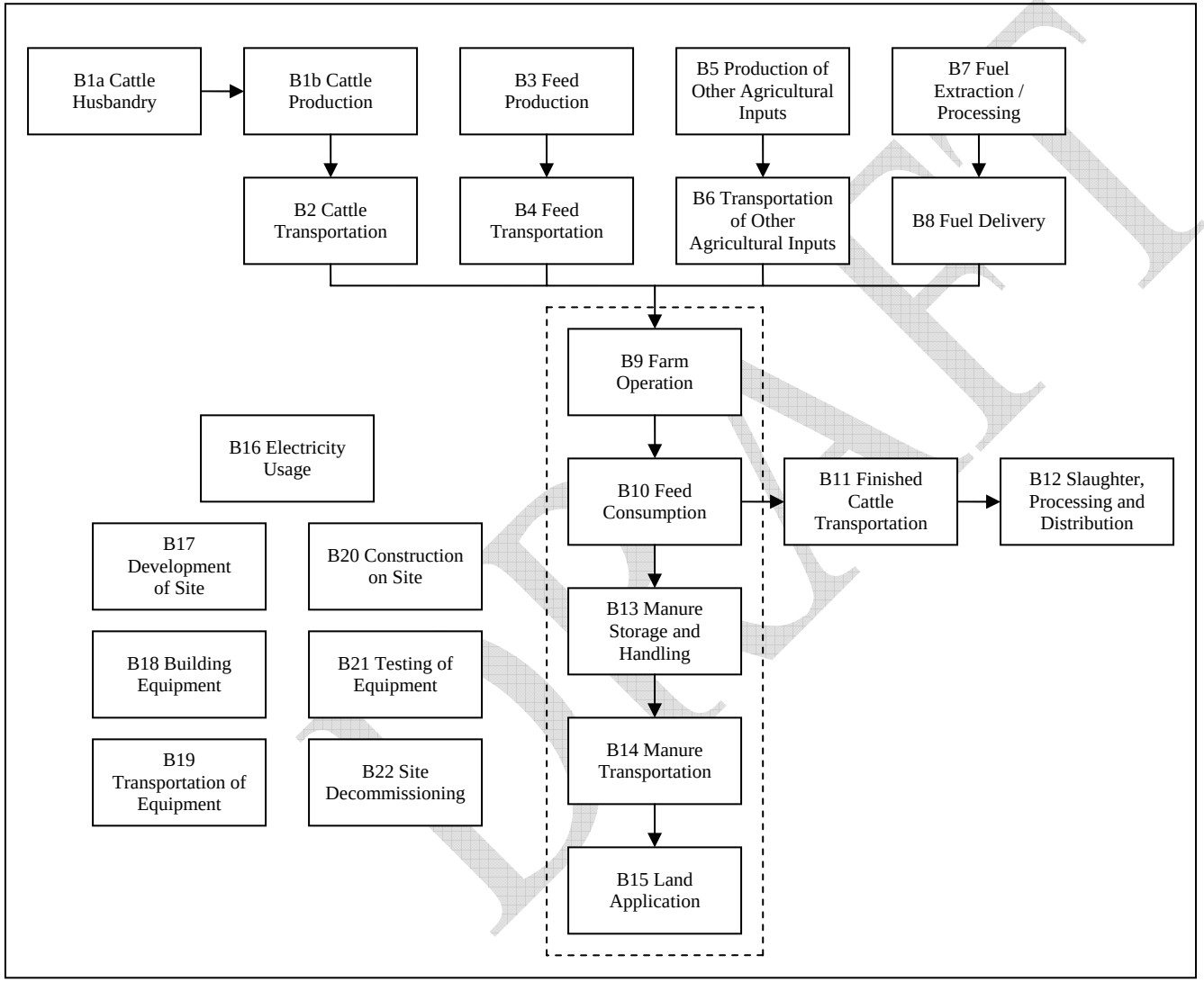


FIGURE 1.2: Process Flow Diagram for Baseline Condition



4. Distiller's grains used in cattle feed are either dried, or are stored for less than 3 days if wet distiller's grains are used as confirmed by an attestation from the project proponent; and
5. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol.

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

1. Farms that do not have three years of baseline data as per slaughter age may establish a baseline condition based on a combination of available data and industry practise in their region or operation;
2. For farms where the feed regime varies across groups of animals, these animals can be grouped in discreet units and tracked individually. In this case, the baseline condition may need to be calculated relative to the group(s) not currently being fed edible oils and/or distillers grains;
3. Project proponents may choose to account for the potential reduction in direct and indirect emissions from the reduction in barley and silage production, and direct and indirect emissions from energy use from barely and silage cultivation, harvesting and storage;
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; and
5. Farms using feeding cycles materially different from those outlined in **APPENDIX A** may calculate custom emissions factors based on their particular feeding cycles using a relevant method, such as the IPCC (tier 2) methodology.

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

This quantification protocol is written for the beef farm operator or project proponent. Some familiarity with, or general understanding of, the operation of a beef farm and associated practices is expected.

1.2 Glossary of New Terms

Enteric Emissions	Emissions of methane from the cattle as part of the digestion of the feed materials.

2.0 Quantification Development and Justification

The following sections outline the quantification development and justification.

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

SSRs were identified for the project by reviewing the seed documents and relevant process flow diagrams developed by the Beef Technical Working Group (BTWG) under the National Offset Quantification Team (NOQT). This process confirmed that the SSRs in the process flow diagrams covered the full scope of eligible project activities under the protocol.

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

FIGURE 2.1: Project Element Life Cycle Chart

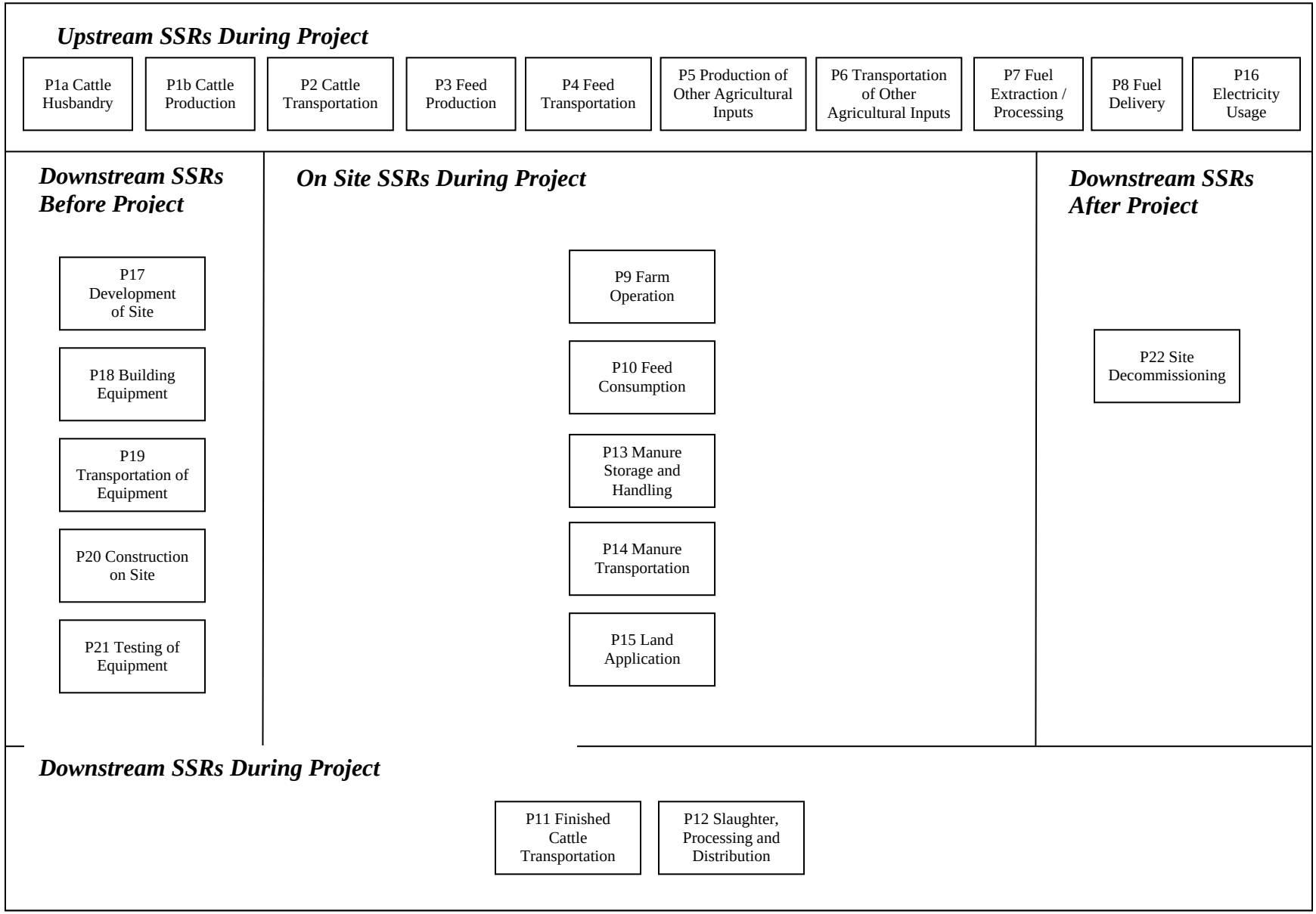


TABLE 2.1: Project SSRs

1. SSR	2. Description	3. Controlled, Related or Affected
Upstream SSRs during Project Operation		
P1a Cattle Husbandry	Cattle husbandry may include insemination and all other practices prior to the birth of the calf. Quantities and types for each of the energy inputs would be contemplated to evaluate functional equivalence with the baseline condition.	Related
P1b Cattle Production	Cattle production may include raising calves, including time in pasture, that are input to the enterprise. Feed consumption includes the enteric emissions from the cattle and related manure production. The feed composition would need to be tracked to ensure functional equivalence with the baseline condition. Length of each type of feeding cycle would need to be tracked.	Related
P2 Cattle Transportation	Cattle 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 SSR, 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 Feed Production	Feed may be produced from agricultural materials and amendments. The processing of the feed may include a number of chemical and mechanical amendment processes. This requires several energy inputs such as natural gas, diesel and electricity. Distiller's grains used in the project condition must be in dry form, or stored for no more than three days if in wet form. Quantities and types for each of the energy inputs would be tracked to evaluate functional equivalence with the baseline condition.	Related
P4 Feed Transportation	Feed 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 SSR, 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 Production of Other Agricultural Inputs	Other agricultural inputs, such as feed supplements, bedding, etc., may be produced from agricultural materials and amendments. The processing of these inputs may include a number of chemical, mechanical and amendment processes. This requires several energy inputs such as natural gas, diesel and electricity. Quantities and types for each of the energy inputs would be tracked to evaluate functional equivalence with the baseline condition.	Related
P6 Transportation of Other Agricultural Inputs	Feed 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 SSR, 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

P7 Fuel Extraction and Processing	Each of the fuels used throughout the on-site component of 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 on-site SSRs are considered under this SSR. Volumes and types of fuels are the important characteristics to be tracked.	Related
P8 Fuel Delivery	Each of the fuels used throughout the on-site component of the project will need to be transported to the site. This may include shipments by tanker 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 site is captured under other SSRs and there is no other delivery.	Related
P16 Electricity Usage	Electricity may be required for operating the facility. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions.	Related
Onsite SSRs during Project Operation		
P9 Farm Operation	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the cattle feeding facility operations. This may include running vehicles and facilities at the project site for the distribution of the various inputs. Quantities and types for each of the energy inputs would be tracked.	Controlled
P10 Feed Consumption	Feed consumption includes the enteric emissions from the cattle and related manure production. The feed composition would need to be tracked to ensure functional equivalence with the baseline condition. Length of each type of feeding cycle would need to be tracked.	Controlled
P13 Manure Storage and Handling	Greenhouse gas emissions can result from the operation of manure storage and handling facilities. This will include emissions from energy use, and from the emissions of methane and nitrous oxide from the manure being stored and processed. Quantities and types for each of the energy inputs would be tracked. Quantities, duration and conditions would also need to be tracked.	Controlled
P14 Manure Transportation	Manure may need to be transported to the field for land application from storage. Transportation equipment would be fuelled by diesel, gas or natural gas. Quantities for each of the energy inputs would be contemplated to evaluate functional equivalence with the baseline condition.	Controlled
P15 Land Application	Manure may then be land applied. This may require the use of heavy equipment and mechanical systems. This equipment would be fuelled by diesel, gas, or natural gas resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities for each of the energy inputs would be contemplated to evaluate functional equivalence with the baseline condition.	Controlled

Downstream SSRs during Project Operation		
P11 Finished Cattle Transportation	Finished cattle 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 SSR, 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
P12 Slaughter, Processing and Distribution	Greenhouse gas emissions may occur that are associated with the slaughter, processing and distribution components downstream of the cattle finishing facility operations. This may include running vehicles and facilities at other sites. Quantities and types for each of the energy inputs would be tracked.	Related
Other		
P17 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
P18 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
P19 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
P20 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
P21 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related

P22 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 is defined as the operating conditions at the project farm prior to the change in feeding practises. The baseline condition would be defined as a feeding regime that does not include edible oils in the range of 4% to 6% (by dry weight), distiller's grains at greater than 25% (by dry weight), or some equivalent combination of these two components within a three year period prior to project implementation.

The approach to quantifying the baseline will be primarily 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 the production of cattle at the project farm, and the baseline condition may vary from project to project.

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

2.3 Identification of SSRs for the Baseline

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

FIGURE 2.2: Baseline Element Life Cycle Chart

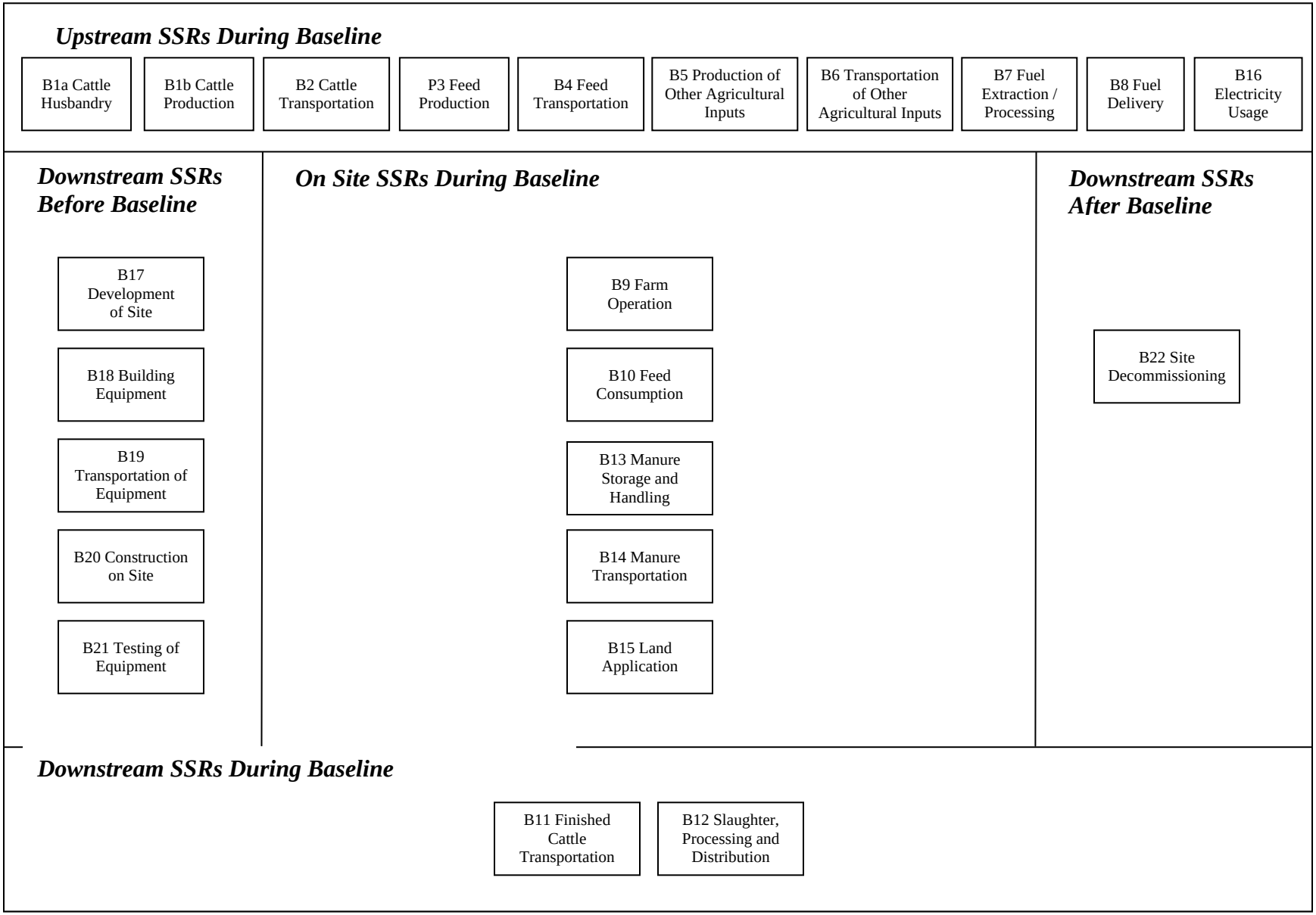


TABLE 2.2: Baseline SSRs

1. SSR	2. Description	3. Controlled, Related or Affected
Upstream SSRs during Baseline Operation		
B1a Cattle Production	Cattle husbandry may include insemination and all other practices prior to the birth of the calf. Quantities and types for each of the energy inputs would be contemplated to evaluate functional equivalence with the project condition.	Related
B1b Cattle Production	Cattle production may include raising calves, including time in pasture, that are input to the enterprise. Feed consumption includes the enteric emissions from the cattle and related manure production. The feed composition would need to be tracked to ensure functional equivalence with the project condition. Length of each type of feeding cycle would need to be tracked.	Related
B2 Cattle Transportation	Cattle 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 SSR, 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 Feed Production	Feed may be produced from agricultural materials and amendments. The processing of the feed may include a number of chemical, mechanical and amendment processes. This requires several 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
B4 Feed Transportation	Feed 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 SSR, 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 Production of Other Agricultural Inputs	Other agricultural inputs, such as feed supplements, bedding, etc., may be produced from agricultural materials and amendments. The processing of the feed may include a number of chemical, mechanical and amendment processes. This requires several 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
B6 Transportation of Other Agricultural Inputs	Feed 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 SSR, 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
B7 Fuel Extraction and Processing	Each of the fuels used throughout the on-site component of 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 on-site SSRs are considered under this SSR. Volumes and types of fuels are the important characteristics to be tracked.	Related

B8 Fuel Delivery	Each of the fuels used throughout the on-site component of the project will need to be transported to the site. This may include shipments by tanker 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 site is captured under other SSRs and there is no other delivery.	Related
B16 Electricity Usage	Electricity may be required for operating the facility. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions.	Related
Onsite SSRs during Project Operation		
B9 Farm Operation	Greenhouse gas emissions may occur that are associated with the operation and maintenance of the beef production facility operations. This may include running vehicles and facilities at the project site for the distribution of the various inputs. Quantities and types for each of the energy inputs would be tracked.	Controlled
B10 Feed Consumption	Feed consumption includes the enteric emissions from the cattle and related manure production. The feed composition would need to be tracked to ensure functional equivalence with the project condition. Length of feeding cycle would need to be tracked.	Controlled
B13 Manure Storage and Handling	Greenhouse gas emissions can result from the operation of manure storage and handling facilities. This will include emissions from energy use, and from the emissions of methane and nitrous oxide from the manure being stored and processed. Quantities and types for each of the energy inputs would be tracked. Quantities, duration and conditions would also need to be tracked.	Controlled
B14 Manure Transportation	Manure may need to be transported to the field for land application from storage. Transportation equipment would be fuelled by diesel, gas or natural gas. Quantities for each of the energy inputs would be tracked to evaluate functional equivalence with the project condition.	Controlled
B15 Land Application	Manure may then be land applied. This may require the use of heavy equipment and mechanical systems. This equipment would be fuelled by diesel, gas, or natural gas resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities for each of the energy inputs would be tracked to evaluate functional equivalence with the project condition.	Controlled
Downstream SSRs during Project Operation		
B11 Finished Cattle Transportation	Finished cattle 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 SSR, 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
B12 Slaughter, Processing and Distribution	Greenhouse gas emissions may occur that are associated with the slaughter, processing and distribution components downstream of the cattle finishing facility operations. This may include running vehicles and facilities at other sites. Quantities and types for each of the energy inputs would be tracked.	Related

Other		
B17 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
B18 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
B19 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 train, truck, by some combination, or even by courier. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
B20 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
B21 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related
B22 Site Decommissioning	Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site.	Related

2.4 Selection of Relevant Project and Baseline SSRs

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

TABLE 2.3: Comparison of SSRs

1. Identified SSR	2. Baseline (C, R, A)	3. Project (C, R, A)	4. Include or Exclude from Quantification	5. Justification for Exclusion
Upstream SSRs				
P1a Cattle Husbandry	N/A	Related	Exclude	Excluded as animal husbandry is functionally equivalent to the baseline scenario.
B1a Cattle Husbandry	Related	N/A	Exclude	
P1b Cattle Production	N/A	Related	Include	N/A
B1b Cattle Production	Related	N/A	Include	
P2 Cattle Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario.
B2 Cattle Transportation	Related	N/A	Exclude	
P3 Feed Production	N/A	Related	Include	N/A
B3 Feed Production	Related	N/A	Include	
P4 Feed Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario.
B4 Feed Transportation	Related	N/A	Exclude	
P5 Production of Other Agricultural Inputs	N/A	Related	Exclude	Excluded as upstream production of other agricultural inputs are not impacted by the implementation of the project and as such the baseline and project conditions will be functionally equivalent.
B5 Production of Other Agricultural Inputs	Related	N/A	Exclude	
P6 Transportation of Other Agricultural Inputs	N/A	Related	Exclude	Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario.
B6 Transportation of Other Agricultural Inputs	Related	N/A	Exclude	
P7 Fuel Extraction and Processing	N/A	Related	Exclude	Excluded as these SSRs are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B7 Fuel Extraction and Processing	Related	N/A	Exclude	
P8 Fuel Delivery	N/A	Related	Exclude	Excluded as these SSRs are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B8 Fuel Delivery	Related	N/A	Exclude	
P16 Electricity Usage	N/A	Related	Exclude	Excluded as these SSRs are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B16 Electricity Usage	Related	N/A	Exclude	
Onsite SSRs				
P9 Farm Operation	N/A	Controlled	Exclude	Excluded as beef production is not impacted by the implementation of the project and as such the baseline and project conditions will be functionally equivalent.
B9 Farm Operation	Controlled	N/A	Exclude	

P10 Feed Consumption	N/A	Controlled	Include	N/A
B10 Feed Consumption	Controlled	N/A	Include	
P13 Manure Storage and Handling	N/A	Controlled	Exclude	Excluded as manure production and composition, and thus storage and handling, will be functionally equivalent, if not slightly higher under the baseline condition.
B13 Manure Storage and Handling	Controlled	N/A	Exclude	
P14 Manure Transportation	N/A	Controlled	Exclude	Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario.
B14 Manure Transportation	Controlled	N/A	Exclude	
P15 Land Application	N/A	Controlled	Exclude	Excluded as manure production and composition, and thus land application, will be functionally equivalent.
B15 Land Application	Controlled	N/A	Exclude	
Downstream SSRs				
P11 Finished Cattle Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario.
B11 Finished Cattle Transportation	Related	N/A	Exclude	
P12 Slaughter, Processing and Distribution	N/A	Related	Exclude	Excluded as the emissions from slaughter, processing and distribution are likely functionally equivalent to the baseline scenario.
B12 Slaughter, Processing and Distribution	Related	N/A	Exclude	
Other				
P17 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.
B17 Development of Site	Related	N/A	Exclude	Emissions from site development are not material for the baseline condition given the minimal site development typically required.
P18 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.
B18 Building Equipment	Related	N/A	Exclude	Emissions from building equipment are not material for the baseline condition given the minimal building equipment typically required.
P19 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.
B19 Transportation of Equipment	Related	N/A	Exclude	Emissions from transportation of equipment are not material for the baseline condition given the minimal transportation of equipment typically required.
P20 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.
B20 Construction on Site	Related	N/A	Exclude	Emissions from construction on site are not material for the baseline condition given the minimal construction on site typically required.

P21 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.
B21 Testing of Equipment	Related	N/A	Exclude	Emissions from testing of equipment are not material for the baseline condition given the minimal testing of equipment typically required.
P22 Site Decommissioning	N/A	Related	Exclude	Emissions from decommissioning are not material given the long project life, and the minimal decommissioning typically required.
B22 Site Decommissioning	Related	N/A	Exclude	Emissions from decommissioning are not material for the baseline condition given the minimal decommissioning typically required.

2.5 Quantification of Reductions, Removals and Reversals of Relevant SSRs

2.5.1 Quantification Approaches

Quantification of the reductions, removals and reversals of relevant SSRs for each of the greenhouse gases will be completed using the methodologies outlined in **TABLE 2.4**, below. 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.

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

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Cattle}} + \text{Emissions}_{\text{Feed Production}}$$

$$\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Cattle}} + \text{Emissions}_{\text{Feed Production}}$$

Where:

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

$\text{Emissions}_{\text{Cattle}}$ = emissions under SSR B1b Cattle Production and B10 Feed Consumption

$\text{Emissions}_{\text{Feed Production}}$ = emissions under SSR B3 Feed Production

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

$\text{Emissions}_{\text{Cattle}}$ = emissions under SSR P1b Cattle Production and P10 Feed Consumption

$\text{Emissions}_{\text{Feed Production}}$ = emissions under SSR P3 Feed Production

TABLE 2.4: Quantification Procedures

1.0 Project/ Baseline SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SSRs						
P1b Cattle Production and P10 Feed Consumption	$Emissions_{Cattle} = EF_{Enteric} * Mass_{Production}$					
	Enteric Emissions from Cattle / $Emissions_{Cattle}$	kg CH_4	N/A	N/A	N/A	Quantity being calculated.
	Mass of Cattle Produced / $Mass_{Production}$	kg beef	Measured	Direct measurement of kg of beef produced.	Monthly	Direct measurement is the highest level possible.
	Enteric Emission Factor / $EF_{Enteric}$	kg CH_4 / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.
P3 Feed Production	$Emissions_{Feed}$ = (EF Crop Growth $_{CO2E}$ *$Mass_{Production}$); (EF Fertilizer Production $_{CO2E}$ * $Mass_{Production}$); (EF Fertilizer Usage $_{N2O}$ * $Mass_{Production}$); (EF Soil Carbon $_{CH4}$ * $Mass_{Production}$)					
	Emissions from Feed Production / $Emissions_{Feed}$	kg CH_4; kg N_2O; kg CO_{2E}	N/A	N/A	N/A	Quantity being calculated.
	Mass of Cattle Produced / $Mass_{Production}$	kg beef	Measured	Direct measurement of kg of beef produced.	Monthly	Direct measurement is the highest level possible.
	Emissions Factor for Crop Production / EF Crop Growth $_{CO2E}$	kg CO_{2E} / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.
	Emission Factor for Fertilizer Production / EF Fertilizer Production $_{CO2E}$	kg CO_{2E} / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.
	Emission Factor for Fertilizer Usage / EF Fertilizer Usage $_{N2O}$	kg N_2O / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.
	Emission Factor for Soil Carbon Flux / EF Soil Carbon $_{CH4}$	kg CH_4 / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.

Baseline SSRs						
B1b Cattle Production and B10 Feed Consumption	$Emissions_{Cattle} = EF_{Enteric} * Mass_{Production}$					
	Enteric Emissions from Cattle / $Emissions_{Cattle}$	kg CH_4	N/A	N/A	N/A	Quantity being calculated.
	Mass of Cattle Produced / $Mass_{Production}$	kg beef	Measured	Direct measurement of kg of beef produced.	Monthly	Direct measurement is the highest level possible.
	Enteric Emission Factor / $EF_{Enteric}$	kg CH_4 / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.
B3 Feed Production	$Emissions_{Feed} = (EF\ Crop\ Growth_{CO2E} * Mass_{Production}); (EF\ Fertilizer\ Production_{CO2E} * Mass_{Production}); (EF\ Fertilizer\ Usage_{N2O} * Mass_{Production}); (EF\ Soil\ Carbon_{CH4} * Mass_{Production})$					
	Emissions from Feed Production / $Emissions_{Feed}$	kg CH_4; kg N_2O; kg CO_{2E}	N/A	N/A	N/A	Quantity being calculated.
	Mass of Cattle Produced / $Mass_{Production}$	kg beef	Measured	Direct measurement of kg of beef produced.	Monthly	Direct measurement is the highest level possible.
	Emissions Factor for Crop Production / EF Crop Growth $_{CO2E}$	kg CO_{2E} / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.
	Emission Factor for Fertilizer Production / EF Fertilizer Production $_{CO2E}$	kg CO_{2E} / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.
	Emission Factor for Fertilizer Usage / EF Fertilizer Usage $_{N2O}$	kg N_2O / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.
	Emission Factor for Soil Carbon Flux / EF Soil Carbon $_{CH4}$	kg CH_4 / kg beef	Estimated	From data tables provided in Appendix A or other applicable source.	N/A	Reference values may be adjusted periodically based on availability of updated data.

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

1.0 Project / Baseline SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Contingency Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SSRs						
P1b Cattle Production and P10 Feed Consumption	Mass of Cattle Produced / Mass Production	kg beef	Estimated	Estimation based on number of head of cattle brought to slaughter and average weight for most recent period.	Monthly	Provides a reasonable estimate for the given period.
P3 Feed Production	Mass of Cattle Produced / Mass Production	kg beef	Estimated	Estimation based on number of head of cattle brought to slaughter and average weight for most recent period.	Monthly	Provides a reasonable estimate for the given period.
Baseline SSRs						
P1b Cattle Production and P10 Feed Consumption	Mass of Cattle Produced / Mass Production	kg beef	Estimated	Estimation based on number of head of cattle brought to slaughter and average weight for most recent period.	Monthly	Provides a reasonable estimate for the given period.
P3 Feed Production	Mass of Cattle Produced / Mass Production	kg beef	Estimated	Estimation based on number of head of cattle brought to slaughter and average weight for most recent period.	Monthly	Provides a reasonable estimate for the given period.

APPENDIX A:

Relevant Emission Factors

TABLE A1: Emissions Factors Based on Slaughter Age

Emissions Factor	Slaughter Age (Months)				Equation(s) [2,3]	R^2
	12 [1]	14 [1]	18 [1]	21 [1]		
EF Enteric $_{CH4}$	0.34	0.38	0.54	0.68	$y = 0.1296\ e^{0.079\ x}$	0.9931
EF Fertilizer Application $_{N2O}$	0.0013	0.0015	0.0020	0.0017	$y = -0.00002\ x^2 + 0.0007\ x - 0.0042$	0.9345
EF Fertilizer Production $_{CO2\text{-}eq}$	0.3868	0.4584	0.6093	0.5295	$y = -0.0057\ x^2 + 0.2076\ x - 1.2952$	0.9345
EF Crop Growth $_{CO2\text{-}eq}$	-3.55	-3.77	-4.75	-6.29	$y = -0.0328\ x^2 + 0.7824\ x - 8.2486$	0.9990
EF Soil Carbon $_{CH4}$	0.00042	0.00050	0.00067	0.00058	$y = -0.000006\ x^2 + 0.0002\ x - 0.0014$	0.9345

[1] Emission factors developed for each of these slaughter age scenarios as part of the work completed by the BTWG. The calculation of these emission factors follows the guidance from IPCC (tier 2) and is based on the feeding regimes provided in TABLE A.2.
[2] Equations represent best fits with the data from the analysis ensuring that the interpolation by the use of equations represented a conservative approach and reflected the likely variances around the data points.
[3] For the equations, x represents the average age of cattle at slaughter in months.

TABLE A2: Number of Days per Feeding Regime based on Slaughter Age

Feeding Regime	Baseline: Slaughter Age				Project: Slaughter Age			
	12	14	18	21	12	14	18	21
100% milk	91	91	91	91	91	91	91	91
56.6:43.0% forage : milk	31	92	92	92	31	92	92	92
40:60% silage : concentrate (DM basis)	31	31	0	0	31	31	0	0
100% barley silage (DM basis)	0	0	212	212	0	0	212	212
Grass : legume pasture	0	0	0	153	0	0	0	153
17:80:3% silage : barley : suppl (DM basis)	212	212	153	92	0	0	0	0
Adjusted (17:80:3) silage: barley : suppl (DM basis) : min. 4% Edible Oils and/or 25% Distiller's Grain	0	0	0	0	212	212	153	92

[1] DM represents dry matter basis.