QUANTIFICATION PROTOCOL FOR CONSERVATION CROPPING

Version: 1.0

April 2012

Specified Gas Emitters Regulation

Government of Alberta

Alberta

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

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

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

Alberta Environment and Water
Climate Change Secretariat
12th Floor, 10025 – 106 Street
Edmonton, Alberta, T5J 1G4
E-mail: **AENV.GHG@gov.ab.ca**

Date of Publication: April 2012

ISBN: 978-0-7785-9627-1 (Printed)
ISBN: 978-0-7785-9628-8 (On-line)

Table of Contents

List of Tables

List of Figures

Alberta Environment Related Publications

Climate Change and Emissions Management Act
Specified Gas Emitters Regulation
Specified Gas Reporting Regulation

Alberta's 2008 Climate Change Strategy

Technical Guidance for Completing Annual Compliance Reports
Technical Guidance for Completing Baseline Emissions Intensity Applications
Additional Guidance for Cogeneration Facilities
Technical Guidance for Landfill Operators

Technical Guidance for Offset Project Developers
Technical Guidance for Offset Protocol Developers
Quantification Protocols (http://environment.alberta.ca/02275.html)

Technical Seed Document for Conservation Cropping

Technical Background Sources

This protocol has replaced the Quantification Protocol for Tillage System Management (February 2009, version 1.3). This work is based on the *Tillage System Default Coefficient Technical Background Document* and the Technical Seed Document for Conservation Cropping (version 1). Background research was completed by the national Soil Management Technical Working Group (SMTWG) and represents the culmination of a multi-stakeholder consultation process. The technical background document (Haak, 2006) can be found at: http://carbonoffsetsolutions.climatechangecentral.com/files/microsites/OffsetProtocols/ProtocolReviewProcess/1stCycleProtocolReview/Tillage/14_No_Till_Default_Protocol_SMTWG_Oct2006_mod.pdf.

The scope of the conservation cropping protocol has been expanded to include a flexibility mechanism for quantifying greenhouse gas emissions reductions from reduced summerfallow. The summerfallow reduction mechanism is based on and replaces the draft Quantification Protocol for Summerfallow Reductions. This work represents the culmination of a multi-stakeholder consultation process initiated under the Alberta offset protocol development process. The science discussion document can be found at: http://carbonoffsetsolutions.climatechangecentral.com/offset-protocols/alberta-protocol-development-workshops#two.

Summary of Changes

Below is a summary of key changes from the Quantification Protocol for Tillage System Management, version 1.3 , which has been replaced by the Quantification Protocol for Conservation Cropping version 1.0 (this protocol). Changes included in this protocol are explained further in the Technical Seed Document for Conservation Cropping (Version 1.0).

- This protocol has been adapted to the new Alberta Environment and Water quantification protocol format. This includes expanded evidence records and data management requirements that all project developers must adhere to. Records are discussed in Table 8, Section 5 of this protocol.
- The Quantification Protocol for Tillage System Management and the draft Quantification Protocol for Summerfallow Reduction have been merged into a single Quantification Protocol for Conservation Cropping. Tillage system management is the primary activity addressed in this protocol with a flexibility mechanism to quantify additional emissions reductions from reduced summerfallow across the farm enterprise.

  No till adoptions levels based on 2006 Census of Agriculture data, have increased 20% since 2001. This has resulted in a reduction in the sequestration coefficients based on higher adoption levels. The scope for the tillage system management component of the protocol has also been restricted to farms practicing no till management.

  The summerfallow reduction flexibility mechanism applies only to farms located in the Dry Prairie ecozone. Participating farms are required to establish a 3-year baseline based on farm enterprise operations. Greenhouse gas reductions can be quantified based on a reduction in the total farm area managed with summerfallow. Specific quantification methodologies for this flexibility mechanism are contained in Appendix F.
- All coefficients in this protocol have been revised based on 2006 Census of Agriculture data and up-dated values are available in Appendix A.
- The Parkland and Dry Prairie boundary line has been up-dated as described in Appendix B. An electronic file is available at: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cl11708.
- Both the tillage system management and the summerfallow reduction flexibility mechanism have a 10 year crediting period that expires December 31, 2021. **No additional renewals will exist for this activity after 2021.**
- Sources and sinks have been up-dated to more accurately reflect cropping practices. See Section 3.0 of the Technical Seed Document for Conservation Cropping for more information.
- Section 5.0 Records and Data Requirements has been expanded to address records requirements needed to support project implementation and third party verification to

a reasonable level of assurance for conservation cropping projects. Please note, the field size being claimed must include deductions for non-cropped areas (e.g. roads, gullies, wooded areas, grassed waterways, farm buildings).

Professional Agrologists with relevant expertise can provide an third party check on the records and project documentation be collected to support no till and reduced summerfallow on a farm enterprise. Agrologists do not replace records requirements or third party verification, however they can enhance and support project implementation. Guidance on the role and expectations of Professional Agrologists has been provided in Section 5.1, Table 8, and Table 9.

Please note, Tax Assessments will no longer be accepted as proof of ownership for a farm field. Project developers are required to obtain land titles for the first year in which a field is signed up, and then required to conduct and document an annual check of land titles to confirm ownership for that parcel of land.

- A comprehensive technical seed document is available for the conservation cropping protocol. It contains background and context information on revisions to the protocol, and analysis of the coefficients and additionality. It also contains background information on the discount factors applied to the greenhouse gas emissions reductions, and discretionary tillage allowance included in the sequestration coefficients.

1.0 Offset Project Description

Agricultural activities account for approximately 8 per cent of Alberta's provincial greenhouse gas emissions (Environment Canada, 2010). Greenhouse gas emissions reductions from this sector are not regulated under the *Specified Gas Emitters Regulation*, providing the sector with a significant opportunity to generate offset credits for voluntary greenhouse gas emissions reductions from a variety of activities including improved soil sequestration opportunities covered by this protocol.

Shifting from conventional farming to conservation cropping can increase carbon sequestered in the soil. This results in reduced carbon dioxide (CO_2) emissions to the atmosphere and lower nitrous oxide (N_2O) emissions resulting from less soil disturbance. Fewer passes on a farm field reduces fossil fuel emissions from farm equipment further helping to lower greenhouse gas footprint for the farm.

This protocol specifically quantifies greenhouse gas emissions reductions from the following three activities:

- New carbon stored annually in agricultural soil;
- Lower nitrous oxide emissions from soils under no till management; and
- Associated emission reductions from reduced fossil fuel use from fewer passes per farm field.

Shifting from any type of fallow (chemfallow, tilled fallow or a combination of chemfallow and tilled fallow) to continuous cropping also increases carbon stored in the soil, further reducing the greenhouse gas emissions footprint of the farm.

This quantification protocol is written for project developers and farm operators implementing conservation cropping offset projects in the Dry Prairie and Parkland ecozones. Familiarity with and general understanding of conservation cropping farming practices is required.

1.1 Protocol Scope

This protocol uses a **performance standard baseline** methodology to quantify greenhouse gas emission reductions resulting from conservation cropping management practices. This means that sector level performance based on 2006 Census data was used to establish a sector level baseline for Alberta based on best practices for the sector and known levels of adoption of reduced and no till agriculture within Alberta ecozones.

This performance standard baseline allows farm operators using this protocol to quantify annual emissions reductions based on annual, incremental increases in soil carbon adjusted (discounted) for 2006 sector level adoption. This discounting approach allows all farm operators practicing conservation tillage farming, irrespective of the adoption date of the practice change, to participate in conservation cropping offset projects. It assumes all carbon stored prior to 2001 is discounted from 2006 levels and only the new, incrementally stored carbon is eligible for offset credits. As adoption levels of no till increase, the potential for new carbon sequestration is reduced; the associated emission reduction coefficients and the resulting offset credit opportunities are also reduced. Additional information on adoption levels, emission factor coefficients and corresponding adjustment factors is available in the Technical Seed Document for Conservation Cropping (Version 1).

Further, it takes approximately 20 years for soil reservoirs managed under conservation cropping practices to reach saturation. Saturation is the point where the soils reach equilibrium and no new, incremental carbon will be stored in the soils. **This protocol expires December 31, 2021 based on a 20-year crediting period for conservation cropping using no till management.**

Sequestered carbon is a reversible activity. Tillage and other types of soil disturbances can cause previously sequestered carbon to be re-released to the atmosphere. This protocol manages the risk of reversal through a reserve discount factor (sequestered carbon reserve) applied to sequestered carbon to account for known rates of reversal occurring at a regional scale. This reserve factor discounts sequestered carbon by 7.5 to 12.5 per cent for the Dry Prairie and Parkland regions respectively according to the likelihood of reversals on a sector wide basis.

Reversal events affecting less than 10 per cent of a total field area are considered to be a normal part of farm operations. Examples of these reversals include discretionary tilling to fix ruts or to manage weeds. Reversals under 10 per cent must be documented in the offset project report, but do not affect greenhouse gas emission reduction calculations.

Reversal events that affect more than 10 per cent of a field area are considered beyond business as usual activities for farm operations. Reversals over 10 per cent must be documented in the offset project report, and affect fields must be removed from the project condition for the vintage year affected by the reversal. Examples of reversals may include re-seeding events and manure incorporation.

Greenhouse gas emission reductions quantified using this reserve discount are considered permanently retired against future liabilities. Discounting for future liability ensures that offset credits quantified under this protocol are given to permanently sequestered carbon and not to carbon that may be released to the atmosphere as part of normal farm operations (e.g.: discretionary tillage for weed management). Alberta Environment and Water will do a periodic assessment of reversals against permanent reductions in the sequestered carbon reserve account. More information on the sequestered carbon reserve is available in Section 5.0 of the technical seed document.

This protocol also contains a flexibility mechanism to quantify emissions reductions from reduced fallow activities. Reduced fallow activities must be done in conjunction with no till cropping. More information on this flexibility mechanism is provided in Appendix F.

Emission reductions related to nitrogen (N) fertilizer management (rates, placement and timing of application) are addressed in the Quantification Protocol for Agricultural Nitrous Oxide Emissions Reductions from Farm Operations.

Baseline Condition for Tillage System Management Projects

Tillage system management uses a **performance-standard** baseline using standardized regional quantification methodology and 2006 Census of Agriculture adoption rates for full, reduced, and no till activities to adjust the coefficients. This means that farm operators and project developers do not have to establish individual farm baselines. Instead, they must provide sufficient information to support proof of practice for the tillage system used on the farm.

All projects established under this protocol must use the discount coefficients mandated in this protocol and are eligible to generate credits for new, incremental carbon stored annually in the soil.

More information on baseline quantification is available in section 2.0 below.

Baseline Condition for Summerfallow Reduction Projects

This flexibility mechanism uses a 3-year **project-specific, historic** baseline. The baseline for this flexibility mechanism is established at the individual farm based on farm data and records for individual fallow practices. Farmer operators must be able to demonstrate the proportion of the farm enterprise area in fallow (proportion of total area under fallow to total area in the project condition).

Baseline farming practices may include full, reduced or no till management of summerfallowed land.

More information on baseline quantification is available in Appendix F.

Project Condition for Tillage System Management Projects

Tillage management systems and associated soil disturbance levels applicable to this protocol are defined in Table 1 below. Fallow periods are included in these definitions based on allowed disturbance levels during a fallow period.

NOTE: The practice of leaving fields uncropped or fallowed does not result in a removal of carbon from the atmosphere by a growing crop. Fallow fields result in a net loss of carbon when soils respire. As such, fallow is not considered an eligible 'crop' under the tillage system management component of this protocol.

Emission reduction opportunities exist for farm operators that are able to demonstrate a net reduction in fallow across the farm enterprise.

NOTE: Reduced Till is no longer a creditable activity under this protocol based on 2006 Census of Agriculture adoption levels. See the technical seed document for more information.

Table 1: Definitions of Tillage Systems in the Parkland[1] and Dry Prairie Ecozones

Tillage System Used	Cropped Land Period [2]	Fallow Period [3]
No Till	Up to two passes with low-disturbance openers (up to 38% each) [4, 5] or one pass with a slightly higher disturbance opener (up to 46%) to apply seed, fertilizer or manure [5], discretionary tillage of up to 10% [6], no tillage operations allowed. Manure applications are either injection or broadcast within these disturbance criteria – no incorporation.	No tillage operations (cultivations)
Reduced Till	Soil disturbance to apply seed, fertilizer, or manure exceeds no till definition and/or one tillage operation in fall or spring	One to two tillage operations
Full Till	More than one tillage operation between harvest and subsequent seeding if no fallow in that period, or, more than three tillage operations between harvest to subsequent seeding if fallow.	More than two tillage operations

Notes:

[1] The Peace River Lowland ecoregion is contained within the Parkland ecozone.

[2] Cropped land period applies to the management cycle that terminates at harvest, (e.g. harvest to harvest defines the cropped land period). This includes land preparation for seeding which may occur in the previous fall.

[3] Fallow period extends from harvest for one full year to the next harvest, typically in the fall.

[4] Percentage values associated with openers are based on maximum opener width (e.g. 5 inch openers actually measure 5.5 inches) divided by the spacing between shanks of the implement.

[5] Additional operations with harrows, packers, or similar non-soil disturbing implements are accepted (e.g., rodweeders are not acceptable).

[6] Discretionary tillage operations of up to 10 per cent means that up to 10 per cent of the project area (i.e.: excluding sloughs, grassed waterways, buildings, forested areas, etc) of a single agricultural field may be cultivated to address field- specific management issues (for example, ruts caused by working through wet areas or weed control at field boundaries). These areas are determined on an annual basis, meaning that specific areas may change from year to year. All discretionary tillage must be documented and the area size of the disturbance must be estimated. Discretionary tillage that is equal to or greater than 10% of field area will result in the field being disallowed for the affected year and no offset credits can be generated on the whole field for that year. This information must be disclosed in project documentation (See example field sheet in Appendix E).

<u>Project Condition for Summerfallow Reduction Projects</u>

This flexibility mechanism applies to farms in the **Dry Prairie ecozone**. It represents the reduction in the amount of land area managed under till fallow or chemfallow compared to the total land area managed by the farm enterprise compared to a 3-year farm specific baseline. Farm operators must be able to demonstrate the average proportion of fallow area for the farm enterprise has decreased after switching more area into the conservation cropping practices (continuous cropping under no till).

This component is not a stand-alone project and must be co-implemented with the no till practices describes within the tillage system management component of this protocol.

Farms wishing to qualify for emissions reductions from reduced summerfallow must enroll for a minimum of 8 years (3 years for the baseline and 5 years for the project condition). New lands added to the farm enterprise that are not included in the baseline must be quantified as a separate project with a separate baseline.

More information on summerfallow reduction project quantification is available in Appendix F.

Overview of Records Requirements

Project developers are required to collect and retain farm records to support the greenhouse gas emission reduction assertion being made by each farm operator. Specific evidence must be collected from farms to support the information to the project developer for:

- Tillage equipment type, measurements and purchase date;
- Tillage management practice used;
- Field size being claimed;
- Crop type being claimed;
- Ownership assessment and, if applicable, land owner-tenant agreements;
- Ecozone classification; and
- Irrigation activity, if applicable.

Reduced summerfallow projects must also track:

- Fallow practices on the fields within the farm enterprise area that is included in the project and baseline condition; and
- Tillage management practice used.

Minimum record requirements are provided in Section 5, Table 8.

Table 2: Greenhouse Gases Applicable for the Conservation Cropping Protocol

Specified Gas	Formula	100-year GWP	Applicable to Project
Carbon Dioxide	CO_2	1	Yes
Methane	CH_4	21	Yes
Nitrous Oxide	N_2O	310	Yes
Sulphur Hexafluoride	SF_6	23,900	No
Perfluorocarbons*	PFCs	Variable	No
Hydrofluorocarbons*	HFCs	Variable	No

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

1.2 Protocol Applicability

This protocol is applicable to any farm in Alberta practicing conservation cropping (no till farming) where sufficient records are available to justify the emission reductions being claimed.

Farms located in the Dry Prairie ecozone that previously fallowed fields and can demonstrate a management change to continuous cropping using no till farming practices are also eligible to claim credits for reductions in fallowed area.

This protocol relies on the proper documentation of field practices and requires that dated farm records and similar direct evidence of practices be retained by the farm operator, agrologist (if applicable), and project developer; and be made available to the third party verifier and government auditor upon request. See Section 5 for documentation requirements for conservation cropping projects.

This protocol is applicable to no till management of annual crops including the first year of seeding perennial or biennial crops into annual crop stubble or sod. Coefficients used in this protocol have been specifically developed for annual crops (e.g.: wheat, barley, canola, etc.). While some perennial row crops may involve tillage (e.g. orchards, small fruits, nuts, nurseries, woodlots, etc.), the coefficients used in this protocol are not applicable to reductions in inter-row zone cultivation.

To demonstrate that a project meets the requirements no till farming practices, the project developer must supply sufficient evidence to demonstrate that:

1. Farm fields included in the project are producing annual crops as confirmed by dated farm records according to specifications described in Section 5;

2. Farms/fields in the project under no till systems meet the soil disturbance levels and allowable number of disturbance events specified in Table 1 of this protocol confirmed by the evidence outlined in Table 8 and Section 5;

3. Disturbance events that exceed the allowable amounts specified in Table 1 are considered a reversal event and result in fields being ineligible to generate offset credits for the year in which the reversal occurred. Reversal events[1] by participating farm operators must be tracked and disclosed in the offset project report and the spatial locator templates submitted to the Alberta Emissions Offset Registry[2];

[1] Fields being tilled/disturbed beyond the specifications in Table 1 – in incidences where disturbance is above the 10% discretionary tillage allowed, or when disturbance events exceeds the requirements listed in Table 1.

[2] Spatial locator templates can be obtained through emailing contact@c-3.ca.

4. Clear ownership to the offset credits must be established. A land title certificate must be retained on file for each field being included in the offset project for the first year in which the field is included. In subsequent years, the land titles database must be checked to confirm ownership. If a transaction has occurred on a parcel of land, a new land title search must be done to confirm ownership and the new land title certificate must be retained on file. Any change in land ownership or farm operators in an ongoing project needs to be recorded and disclosed in the offset project report.

5. Additional farm management operations for irrigation, manure incorporation, and/or reseeding events must be documented in the offset project report and may affect the greenhouse gas emission reductions claim for no till or reduced summerfallow management practices.

1.3 Protocol Flexibility

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

1. Project developers operating in the Dry Prairie ecozone that undertake actions to reduce or eliminate summerfallow activities are eligible to generate extra offset credits under this protocol.

   Farm operators wishing to participate in a summerfallow reduction project must supply sufficient evidence to demonstrate that:

   1. Land is located in the Dry Prairie ecozone;

   2. Land converted from summerfallow to continuous cropping is producing annual crops as confirmed by dated farm records consistent with requirements stated in Table 8;

   3. Land converted from summerfallow to continuous cropping is managed using no till management as consistent with disturbance requirements in Table 1 above confirmed by farm records;

   4. Emissions reductions (offset credits) are quantified based on actual measurement and monitoring as indicated in this protocol; and

   5. Clear ownership to the offset credits has been established consistent with applicability requirement 4 for no till management practices.

   6. Additional farm management practices for irrigation, manure incorporation, and/or reseeding events must be documented.

More information on quantifying emissions reductions from reduced summerfallow is available in Appendix F.

2. This protocol applies cropping system management. Other greenhouse gas quantification protocols are available for farming operations. Multiple projects under one or more protocols can be quantified per farm enterprise to quantify overall greenhouse gas emission reductions from the farming operation. A list of related protocols at the time of publication of this document is available below.

Table 3: Complimentary Agricultural Protocols

Activity	Protocol
Reduced nitrous oxide emissions through improved fertilizer application practices	Quantification Protocol for Nitrous Oxide Emission Reductions in Agriculture
Reducing the age at harvest of beef cattle from birth through finishing	Quantification Protocol for Reducing the Age at Harvest of Beef Cattle
Reducing the number of days on finishing diets for beef cattle	Quantification Protocol for Reducing the Days on Feed for Beef Cattle
Reducing enteric fermentation emissions from beef cattle through use of edible oils in feed regimes	Quantification Protocol for Including Edible Oils in Cattle Feeding Regimes
Reductions in greenhouse gas emissions from changes in dairy cattle management	Quantification Protocol for Emissions Reductions from Dairy Cattle
Reductions in greenhouse gas emissions from changes in swine management	Quantification Protocol for Innovative Feeding of Swine, and Storing and Spreading of Swine Manure
Energy efficiency improvements in farm buildings	Quantification Protocol for Energy Efficiency Projects
Use of anaerobic digesters to handle cattle manure	Quantification Protocol for Anaerobic Decomposition of Agricultural Materials
Processing of some agricultural materials through aerobic composting processes	Quantification Protocol for Aerobic Composting

A full list of approved quantification protocols available for use in the Alberta offset system is available at http://environment.alberta.ca/02275.html.

1.4 Glossary of New Terms

Annual crops	Annual crops are crops that are seeded every year in an annual cropping system excluding fallow years and perennial crops. Annually planted silage crops including barley and oats are also eligible. Under this protocol, the first year of a direct-seeded perennial or bi-annual crops can be included if soil disturbance levels meet the requirements stated in Table 1.
Aggregator	An aggregator is a person or company that, through contractual arrangement, works with suppliers of small volumes of offset credits established under the same protocol to pool these smaller projects into a sufficiently large volume to manage verification and transaction costs. The aggregator is considered to be the project developer for an aggregated project and is responsible for collecting records, developing and managing project documentation, engaging a third party verifier, liaising with the Alberta Emissions Offset Registry and for negotiating credit transactions.
Attestation/Affirmation	These words are used interchangeably and refer to a statement made by a company or individual in the absence of project specific data and third party data needs to support a greenhouse gas emission reduction project.
Bi-annual crops	Bi-annual crops are crop types that are seeded in the first year and terminated in the second year. For the purposes of this protocol, these crops would be eligible for the first year if they are direct seeded using soil disturbance levels that meet the requirements stated in Table 1 confirmed by farm records.
Credit period	The credit period refers to the length of time that a project can generate offset credits. Tillage system management projects were given a 20 year crediting period from January 1, 2002 to December 31, 2021 based on the amount of time required for a soil reservoir to reach saturation.
Cultivation	Cultivation refers to mechanical operations that are performed excluding seeding and fertilizing operations to create soil conditions conducive to improved aeration, infiltration, water conservation, and weed control.
Discretionary tillage	Discretionary tillage occurs when a portion of the field area is cultivated to address specific management issues such as ruts caused by farm equipment or weed control at field boundaries.

Ecozone	An ecozone is a spatial unit in Canada's Ecological Classification System representing a large ecological zone with characteristic landforms and climate[3].
Farm enterprise	Farm enterprise is the total area of a farm that is controlled by a given farm.
Farm operator	The farm operator is the person or entity that controls the operations of a farm and engages with an aggregator (project developer) for the purposes of generating offset credits. The farm operator may or may not be the land owner depending on the farming arrangement.
Farm records	Farm records are records retained by the farm operator and the aggregator that support and confirm farm operations. Record requirements specific for greenhouse gas emission quantifications from conservation cropping are identified in Section 5, Table 8.
GPS track file	A data file from a global positioning system (GPS) that logs the coordinates of a GPS track or route.
Green manure	Green manure refers to legume crops that are a nitrogen fixing crops. Growing a legume crop and working it back into the land can maintain or improve soil fertility without direct costs for external fertilizer.
Land owner	The land owner is the legal land owner confirmed by land titles.
No till	No till is a procedure where seeds are planted directly into the soil with no primary or secondary tillage (cultivation). This practice requires specialized seeders with opener attachments that prepare a narrow, shallow seedbed immediately surrounding the seed being planted. See Table 1 for more information.
Perennial crops	Perennial crops have a lifespan extending over two or more growing seasons. These crops may be reseeded periodically to maintain crop productivity. The first year of seeding a perennial crop into annual crop stubble or sod is eligible go generate offset credits if soil disturbance levels meet the requirements stated in Table 1. Subsequent years are outside the scope of this protocol.

[3] See http://sis.agr.gc.ca/cansis/nsdb/ecostrat/intro.html

Project developer	The project developer is the aggregator (see definition above).
Reduced till	Reduced till cropping uses equipment and farming practices that result in soil disturbance events that exceed allowable limits for no till, but are less than full cultivation. See Table 1 for more information.
Sequestered Carbon Reserve	The sequestered carbon reserve is a discount factor of 12.5 per cent in the Parkland and 7.5 per cent in the Dry Prairie applied to every offset credit created under the conservation cropping protocol. It accounts for the risk and magnitude of carbon sequestration reversals due to tillage events occurring in fields that are otherwise managed under no-till practices.
Soil disturbance	Soil disturbance refers to the amount of soil movement incurred during seedbed preparation, sowing of the seed and/or fertilizer, distributing residues, and incorporating soil amendments (e.g.: manure). Soil disturbance varies depending on the event and type of equipment used. See Table 1 for more information.
Summerfallow	Fallow cropland is land that is intentionally left unseeded during a summer growing season. Plant growth is managed through periodic tillage (tilled summerfallow) or with pesticides and herbicides (chemfallow).
Tillage	Tillage is a mechanical disturbance of the soil profile to modify soil conditions, manage crop residues, control weeds, and/or incorporate chemicals and manure for crop production. Shallow tillage is often called cultivation.

2.0 Baseline Condition

The **tillage management** portion of this protocol uses a **static, performance-standard** to quantify the baseline condition. The performance standard for no-till carbon sequestration is based on scientific research and mathematical modeling methods that have been published in peer reviewed papers (VandenBygaart et al, 2008, Rochette et al, 2008) applied within Canada's National Inventory Report (Environment Canada, 20011) and recognized internationally.

These emission coefficients were adjusted (discounted) based on the adoption levels of the eligible activities using updated adoption levels reported by Statistics Canada in the Census of Agriculture (2006) and the emissions reduction contribution of those practices within an ecozone area (Dry Prairie or Parkland). This discounting has resulted in the emissions reductions achieved to date through the adoption of no till and reduced till practices being removed from the offset project quantification.

Annual, incremental carbon sequestered in the soil through no till farming practices is eligible to generate offset credits starting, January 1, 2012 ending December 31, 2021 based on a sector level discount.

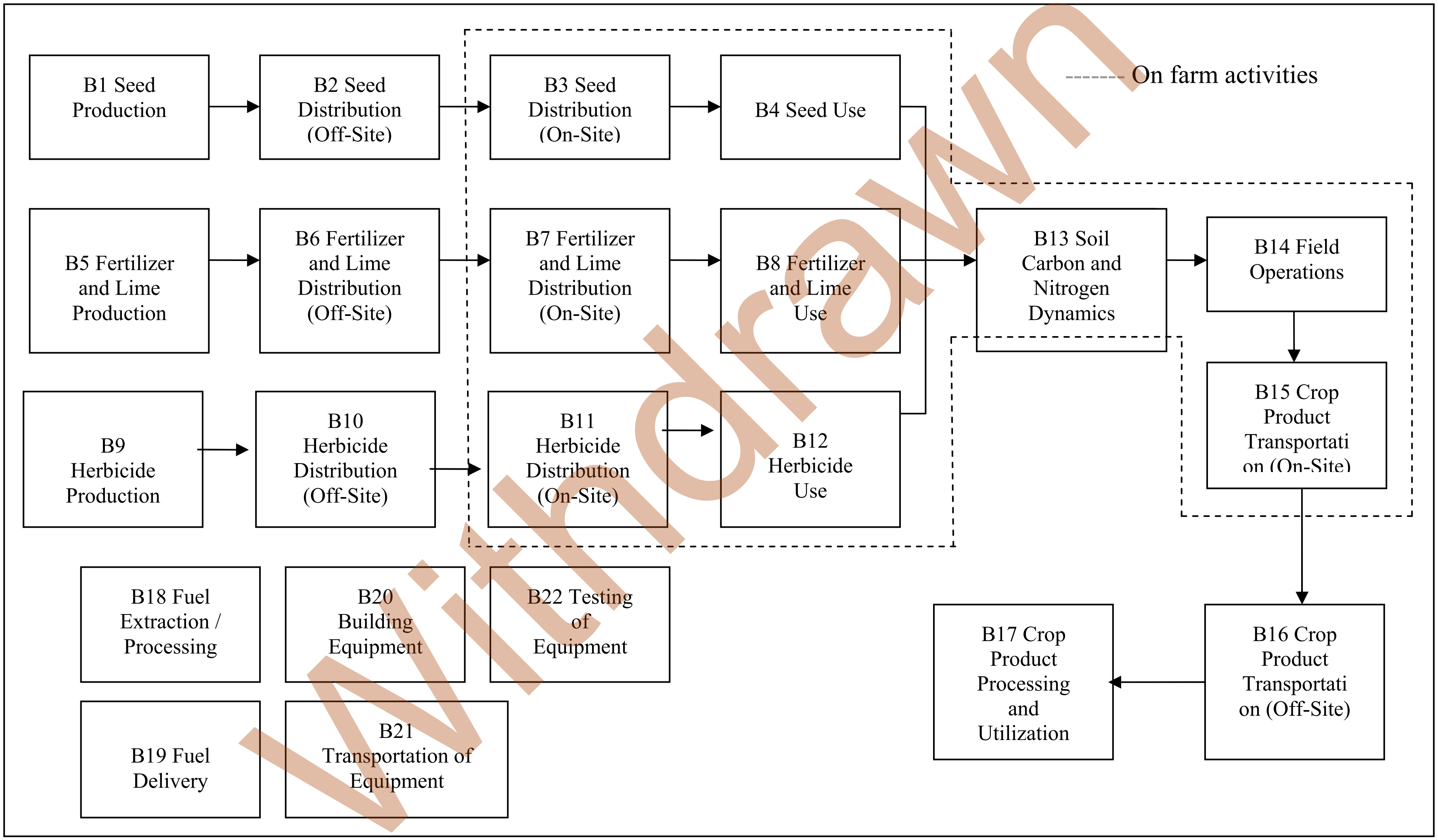
This performance standard baseline is valid for 10 years expiring December 31, 2021, and is subject to review in 2017. More information on establishing the performance standard baseline is available in the Technical Seed Document for Conservation Cropping and the Technical Seed Document for Tillage System Management[4] (Haak, 2006) and in the Technical Seed Document for Conservation Cropping (Version 1).

The **summerfallow reduction** flexibility mechanism uses a **historic, project specific** baseline based on 3 years of farm records to quantify fallow activities for the farm enterprise. It requires that all fields be located in the Dry Prairie ecozone and that the same fields be used in both the baseline and project condition. Each farm must establish a 3-year average proportion, in acres or hectares, of land managed as fallow (chem or till fallow) at the farm enterprise level for the 3 years immediately prior to project implementation. Project implementation is defined as the conversion to continuous cropping. Baseline practices may include full till, reduced till, or no till management practices.

The baseline conditions, including all process flow diagrams, are available in Appendix F.

[4] See http://carbonoffsetsolutions.climatechangecentral.com/files/microsites/OffsetProtocols/ProtocolReviewProcess/1stCycleProtocolReview/Tillage/14_No_Till_Default_Protocol_SMTWG_Oct2006_mod.pdf

Figure 1: Process Flow Diagram for the Baseline Condition Tillage System Management



2.1 Identification of Baseline Sources and Sinks

Sources and sinks for an activity are assessed based on guidance provided by Environment Canada and are classified as follows:

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

Figure 2: Baseline Sources and Sinks for Tillage Systems Management

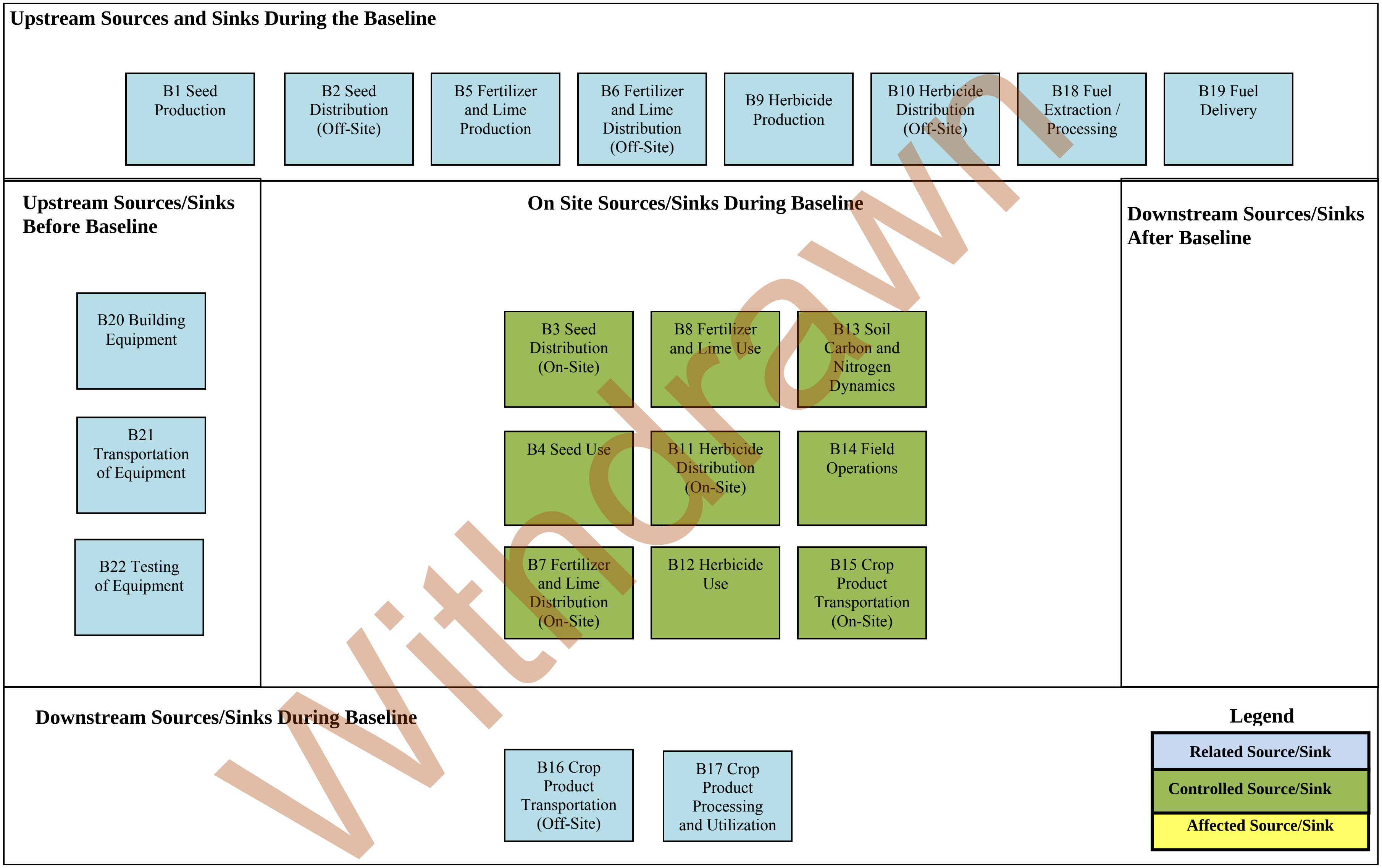


Table 4: Baseline Sources and Sinks for Tillage System Management

Sources/Sinks	Description	Controlled, Related or Affected
Upstream Sources/Sinks during Baseline Operation		
B1 Seed Production	Seed production may include 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
B2 Seed Transportation (Off-Site)	Seeds 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 source/sink, 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
B5 Fertilizer and Lime Production	Fertilizer and lime 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
B6 Fertilizer and Lime Distribution (Off-Site)	Fertilizer and lime 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 source/sink, 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
B9 Herbicide Production	Herbicide 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
B10 Herbicide Distribution (Off-Site)	Herbicide 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 source/sink, 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
P18 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 sources/sinks are considered under this sources/sink. Volumes and types of fuels are the important characteristics to be tracked.	Related

Table 4: Baseline Sources and Sinks for Tillage System Management

Sources/Sinks	Description	Controlled, Related or Affected
B19 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 sources/sinks and there is no other delivery.	Related
Onsite Sources/Sinks during Baseline Operation		
B3 Seed Distribution (On-Site)	Seed would need to be transported from storage to the field. The related energy inputs for fuelling this equipment are captured under this source/sink, 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.	Controlled
B4 Seed Use	Emissions associated with the sowing of the seeds. Inputs of embedded energy and materials would need to be tracked to ensure equivalency with the baseline condition.	Controlled
B7 Fertilizer and Lime Distribution (On-Site)	Fertilizer and lime would need to be transported from storage to the field. The related energy inputs for fuelling this equipment are captured under this source/sink, 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.	Controlled
B8 Fertilizer and Lime Use	Emissions associated with the use of the fertilizer and lime. Timing, composition, concentration and volume of fertilizer need to be tracked.	Controlled
B11 Herbicide Distribution (On-Site)	Herbicide distribution would need to be transported from storage to the field. The related energy inputs for fuelling this equipment are captured under this source/sink, 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.	Controlled
B12 Herbicide Use	Emissions associated with the use of the herbicide. Timing, composition, concentration and volume of fertilizer need to be tracked to ensure equivalency with the baseline condition.	Controlled
B13 Soil Carbon and Nitrogen Dynamics	Flows of materials and energy that comprise the cycling of soil and plant carbon and nitrogen, including deposition in plant tissue, decomposition of crop residues, stabilization in organic matter and emission as carbon dioxide and nitrous oxide.	Controlled
B14 Field Operations	Greenhouse gas emissions from fuel and power use associated with the operation and maintenance of the farm facility and field equipment for sowing, tillage herbicide application, etc.	Controlled
B15 Crop Product Transportation (On-Site)	Crops would need to be harvested and transported from the field to storage. The related energy inputs for fuelling this equipment are captured under this source/sink, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to	Controlled

Table 4: Baseline Sources and Sinks for Tillage System Management

Sources/Sinks	Description	Controlled, Related or Affected
	evaluate functional equivalence with the baseline condition.	
Downstream Sources/Sinks during Baseline Operation		
B16 Crop Product Transportation (Off-Site)	Crops would need to be transported from storage to the market by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this source/sink, 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
B17 Crop Product Processing	Inputs of materials and energy involved in the processing and end product utilization of the crop would need to be tracked to ensure functional equivalence with the baseline condition.	Related
Other Sources/Sinks for the Baseline Operation		
B20 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
B21 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
B22 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related

3.0 Project Condition

For the purposes of quantifying greenhouse gas emissions reductions, tillage is defined as a mechanical disturbance of the soil to modify soil conditions for seeding, managing crop residues, weed control, and/or incorporating chemicals/manure for crop production. Reduced till and no till systems, known as conservation tillage systems, vary in their degree of soil disturbance and number of passes of farm machinery. While both practices are used in farming operations in Alberta, the scope of this component of the protocol is limited to no till cropping systems.

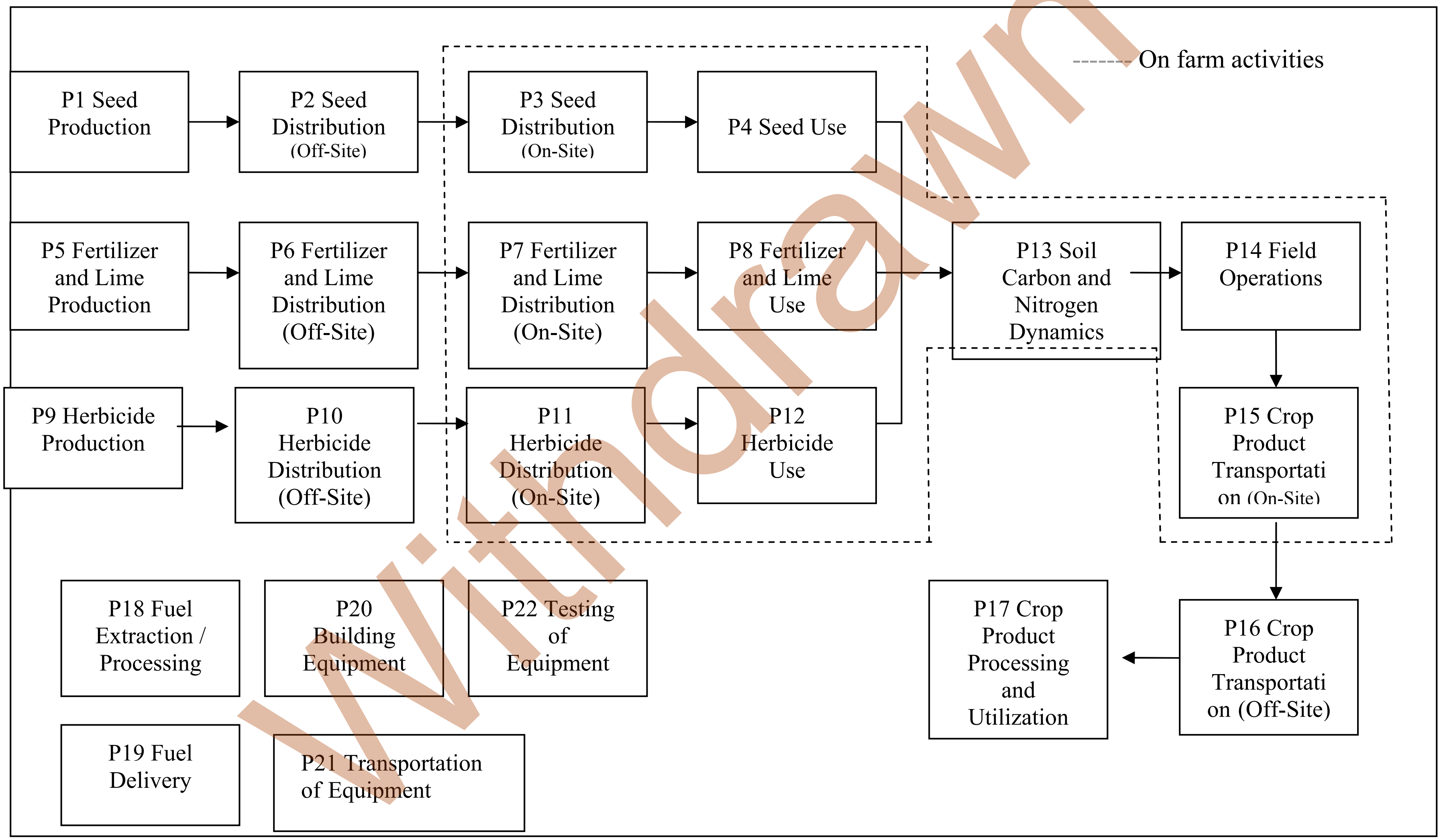
The project condition for the tillage system management is the use of no till systems as defined in Table 1, which results in reduced disturbance of the soil, reduced soil organic carbon decomposition and loss of terrestrial carbon stores relative to conventional tillage systems (i.e.: the baseline condition). No till systems also result in a reduction in the fossil fuel emissions from fuel consumed in conventional, full till farming operations. In the case of the drier soils(i.e. Dry Prairie soils), there is also a reduction in nitrous oxide emissions from agricultural soils under no till relative to full till farming, which have been included in the coefficients provided in this protocol.

Farm operators participating in tillage system management projects must be able to demonstrate each year that they are planting annual crops and managing their fields according to the requirements specified in this protocol. More information on records requirements is available in Section 5 below.

The summerfallow reduction flexibility mechanism requires farm operators to establish a baseline specific to their farming operation and demonstrate a net reduction in the average area fallowed in a year through the adoption of conservation (no till) farming practices. The same fields must be used in the baseline and project. Additional fields would need to establish a unique baseline and demonstrate a practice change from that baseline.

This flexibility mechanism is limited to the Dry Prairie ecozone. More information on summerfallow reduction projects is available in Appendix F.

Figure 3: Process Flow Diagram for the Project Condition of Tillage System Management



3.1 Identification of Project Sources and Sinks

Sources and sinks for tillage system management were identified based on scientific review. This process confirmed that source and sinks in the process flow diagram in Figure 3 above covered the full scope of eligible project activities under this protocol.

These sources and sinks have been further refined according to the lifecycle categories identified in Figure 4 below. These sources and sinks were further classified as controlled, related, or affected as described in Table 5 below.

Figure 4: Project Conditions Sources and Sinks for Tillage System Management

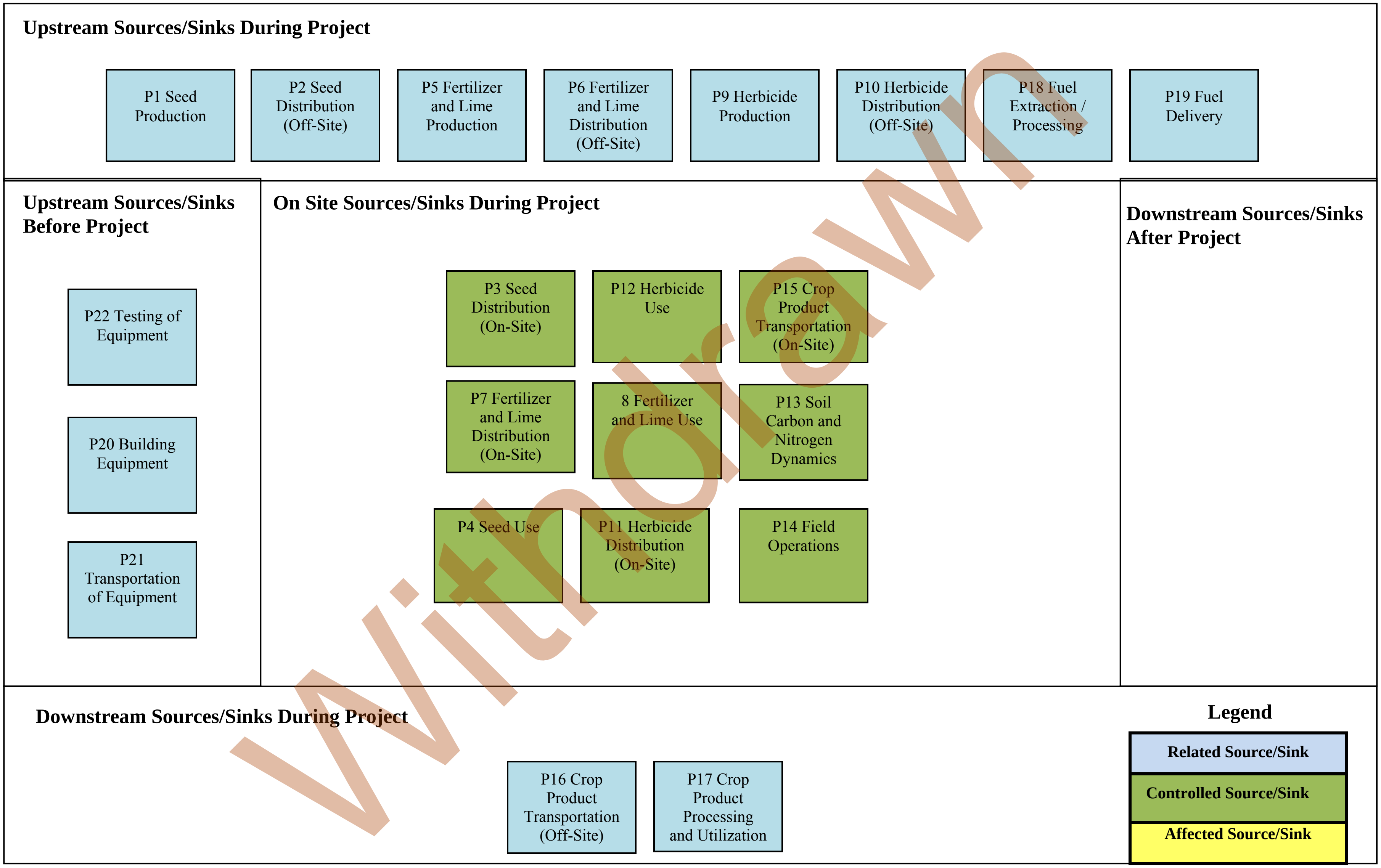


Table 5: Project Condition Sources and Sinks for Tillage System Management

Sources/Sinks	Description	Controlled, Related or Affected
Upstream Sources/Sinks during Project Operation		
P1 Seed Production	Seed production may include 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
P2 Seed Transportation (Off-Site)	Seeds 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 source/sink, 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 Fertilizer and Lime Production	Fertilizer and lime 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
P6 Fertilizer and Lime Distribution (Off-Site)	Fertilizer and lime 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 source/sink, 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
P9 Herbicide Production	Herbicide 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
P10 Herbicide Distribution (Off-Site)	Herbicide 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 source/sink, 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
P18 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 source/sinks are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related

Table 5: Project Condition Sources and Sinks for Tillage System Management

Sources/Sinks	Description	Controlled, Related or Affected
P19 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 sources/sinks and there is no other delivery.	Related
Onsite Sources/Sinks during Project Operation		
P3 Seed Distribution (On-Site)	Seed would need to be transported from storage to the field. The related energy inputs for fuelling this equipment are captured under this source/sink, 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.	Controlled
P4 Seed Use	Emissions associated with the use of the seeds. Inputs of embedded energy and materials would need to be tracked to ensure equivalency with the baseline condition.	Controlled
P7 Fertilizer and Lime Distribution (On-Site)	Fertilizer and lime would need to be transported from storage to the field. The related energy inputs for fuelling this equipment are captured under this source/sink, 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.	Controlled
P8 Fertilizer and Lime Use	Emissions associated with the use of the fertilizer and lime. Timing, composition, concentration and volume of fertilizer need to be tracked.	Controlled
P11 Herbicide Distribution (On-Site)	Herbicide distribution would need to be transported from storage to the field. The related energy inputs for fuelling this equipment are captured under this source/sink, 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.	Controlled
P12 Herbicide Use	Emissions associated with the use of the herbicide. Timing, composition, concentration and volume of fertilizer need to be tracked to ensure equivalency with the baseline condition.	Controlled
P13 Soil Carbon and Nitrogen Dynamics	Flows of materials and energy that comprise the cycling of soil and plant carbon and nitrogen, including deposition in plant tissue, decomposition of crop residues, stabilization in organic matter and emission as carbon dioxide and nitrous oxide.	Controlled
P14 Field Operations	Greenhouse gas emissions from fuel and power use associated with the operation and maintenance of the farm facility and field equipment for sowing, tillage, herbicide application, etc.	Controlled
P15 Crop Product Transportation (On-Site)	Crops would need to be harvested and transported from the field to storage. The related energy inputs for fuelling this equipment are captured under this source/sink, for the purposes of	Controlled

Table 5: Project Condition Sources and Sinks for Tillage System Management

Sources/Sinks	Description	Controlled, Related or Affected
	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.	
Downstream Source and Sinks during Project Operation		
P16 Crop Product Transportation (Off-Site)	Crops would need to be transported from storage to the market by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this source/sink, 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
P17 Crop Product Processing	Inputs of materials and energy involved in the processing and end product utilization of the crop would need to be tracked to ensure functional equivalence with the baseline condition.	Related
Other		
P20 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
P21 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
P22 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related

4.0 Quantification

Baseline and project conditions for tillage system management were assessed against each other to determine the scope for reductions quantified under this protocol. All sources and sinks identified in Table 4 and Table 5 above for tillage system management are listed in Table 6 below. Each source and sink is listed as included or excluded based on how they were impacted by the project condition. Justification for these choices is provided.

Production of herbicides has been added as a source/sink and changes in upstream herbicide production must be quantified. Changes in tillage systems from full till to no till will result in a greater use of herbicides to control weeds. Weed control is one of the primary reasons for tillage so eliminating tillage requires other weed control options including the use of herbicides.

On-site sources and sinks include the application of crop inputs (seed, fertilizer, herbicides, etc.), the production and removal of crop outputs (grain, silage, hay, straw, etc.), and the changes that occur in the soil and surrounding environment as a result of the cropping cycle. The primary impacts of a change in tillage system management from full tillage to no tillage are:

- An increase in soil carbon content or carbon sequestration (ie. greenhouse gas removal from the atmosphere);
- A decrease in fuel/power use in the crop production system overall; and
- A decrease in N_2O emissions related to tillage management (Note that N_2O emissions related to fertilizer management are addressed within the Quantification Protocol for Nitrous Oxide Emissions Reductions from Agriculture).

These are reflected in Table 6 below.

Inclusions and exclusions of sources and sinks for the summerfallow reduction flexibility mechanism are explained in Appendix F.

Table 6: Comparison of Sources and Sinks in Tillage System Management

Identified Sources and Sinks	Baseline (C, R, A)**	Project (C, R, A)**	Include or Exclude from Quantification	Justification for Inclusion/Exclusion
Upstream Sources and Sinks				
P1 Seed Production	N/A	R	Exclude	Excluded as these sources do not change materially from the baseline and project conditions. Further, the baseline and project conditions will be functionally equivalent.
B1 Seed Production	R	N/A	Exclude	
P2 Seed Transportation (Off-Site)	N/A	R	Exclude	Excluded as the emissions from transportation are negligible and likely functionally equivalent to the baseline condition.
B2 Seed Transportation (Off-Site)	R	N/A	Exclude	
P5 Fertilizer and Lime Production	N/A	R	Exclude	Excluded as these sources do not change materially from the baseline and project conditions. Further, the baseline and project conditions will be functionally equivalent.
B5 Fertilizer and Lime Production	R	N/A	Exclude	
P6 Fertilizer and Lime Distribution (Off-Site)	N/A	R	Exclude	Excluded as the emissions from transportation are negligible between baseline and project and likely functionally equivalent to the baseline condition
B6 Fertilizer and Lime Distribution (Off-Site)	R	N/A	Exclude	
P9 Herbicide Production	N/A	R	**Include**	Included due to the switching from tillage use to herbicide use to control weeds in the project condition resulting in higher emissions under the project condition. The increase is integrated into the regional coefficient.
B9 Herbicide Production	R	N/A	**Include**	
P10 Herbicide Distribution (Off-Site)	N/A	R	Exclude	Excluded as the emissions from transportation are negligible and likely functionally equivalent to the baseline scenario.
B10 Herbicide Distribution (Off-Site)	R	N/A	Exclude	
P17 Fuel Extraction and Processing	N/A	R	Exclude	Excluded as the emissions in the baseline are greater than the project condition due to the increased fuel consumption under full till, or higher tillage intensity.
B17 Fuel Extraction and Processing	R	N/A	Exclude	
P18 Fuel Delivery	N/A	R	Exclude	Excluded, as the emissions in the baseline are greater than the project condition due to the increased fuel consumption under full till or higher tillage intensity – a conservative approach.
B18 Fuel Delivery	R	N/A	Exclude	

Table 6: Comparison of Sources and Sinks in Tillage System Management

Identified Sources and Sinks	Baseline (C, R, A)**	Project (C, R, A)**	Include or Exclude from Quantification	Justification for Inclusion/Exclusion
Onsite Source and Sinks				
P3 Seed Distribution (On-Site)	N/A	C	Exclude	Excluded, as these sources do not change materially from the baseline and project conditions. Further, the baseline and project conditions will be functionally equivalent.
B3 Seed Distribution (On-Site)	C	N/A	Exclude	
P4 Seed Use	N/A	C	Exclude	Excluded, as these sources do not change materially from the baseline and project conditions. Further, the baseline and project conditions will be functionally equivalent. Any changes in fuel consumption are captured in Farm Operations (P14 and B14) below.
B4 Seed Use	C	N/A	Exclude	
P7 Fertilizer and Lime Distribution (On-Site)	N/A	C	Exclude	Excluded, as these sources do not change materially from the baseline and project conditions. Further, the baseline and project conditions will be functionally equivalent.
B7 Fertilizer and Lime Distribution (On-Site)	C	N/A	Exclude	
P8 Fertilizer and Lime Use	N/A	C	Exclude	Excluded, as these sources do not change materially from the baseline and project conditions. Further, the baseline and project conditions will be functionally equivalent.
B8 Fertilizer and Lime Use	C	N/A	Exclude	
P11 Herbicide Distribution (On-Site)	N/A	C	Exclude	Excluded as the emissions from increased herbicide use are integrated in the Farm Operations source below (P14 and B14) and emissions due to increased herbicide production in the project condition are captured in the Herbicide Production source above (P9 and B9) above.
B11 Herbicide Distribution (On-Site)	C	N/A	Exclude	
P12 Herbicide Use	N/A	C	Exclude	Excluded as the emissions from increased herbicide use are integrated in the Farm Operations source below (P14 and B14) and emissions due to increased herbicide production in the project condition are captured in the Herbicide Production source above (P9 and B9) above.
B12 Herbicide Use	C	N/A	Exclude	
P13 Soil Carbon and Nitrogen Dynamics	N/A	C	**Include**	Included since the amount of soil carbon sequestered from reduced soil disturbance will increase in the project conditions, and the amount nitrous oxide emitted in the project condition will decrease, relative to baseline.
B13 Soil Carbon and Nitrogen Dynamics	C	N/A	**Include**	
P14 Field Operations	N/A	C	**Include**	Included since the fuel consumption will be decreased in the project condition due to delivery methods of seed and fertilizer under conservation tillage systems (i.e. less power requirements and field passes overall). The net emissions quantification is integrated into the regional coefficient.
B14 Field Operations	C	N/A	**Include**	

Table 6: Comparison of Sources and Sinks in Tillage System Management

Identified Sources and Sinks	Baseline (C, R, A)**	Project (C, R, A)**	Include or Exclude from Quantification	Justification for Inclusion/Exclusion
P15 Crop Product Transportation (On-Site)	N/A	C	Exclude	Excluded as the emissions from crop harvesting and transportation are likely functionally equivalent to the baseline scenario.
B15 Crop Product Transportation (On-Site)	C	N/A	Exclude	
Downstream Sources and Sinks				
P16 Crop Product Transportation (Off-Site)	N/A	R	Exclude	Excluded as the emissions from transportation are negligible and likely functionally equivalent to the baseline scenario.
B16 Crop Product Transportation (Off-Site)	R	N/A	Exclude	
P17 Crop Product Processing	N/A	R	Exclude	Excluded as the emissions from crop product processing are functionally equivalent to the baseline scenario.
B17 Crop Product Processing	R	N/A	Exclude	
Other				
P20 Building Equipment	N/A	R	Exclude	Emissions from building equipment are not material given the long project life, and the minimal building equipment typically required.
B20 Building Equipment	R	N/A	Exclude	Emissions from building equipment are not material for the baseline condition given the minimal building equipment typically required.
P21 Transportation of Equipment	N/A	R	Exclude	Emissions from transportation of equipment are not material given the long project life, and the minimal transportation of equipment typically required.
B21 Transportation of Equipment	R	N/A	Exclude	Emissions from transportation of equipment are not material for the baseline condition given the minimal transportation of equipment typically required.
P22 Testing of Equipment	N/A	R	Exclude	Emissions from testing of equipment are not material given the long project life, and the minimal testing of equipment typically required.
B22 Testing of Equipment	R	N/A	Exclude	Emissions from testing of equipment are not material for the baseline condition given the minimal testing of equipment typically required.

**Where C is Controlled, R is Related, and A is Affected.

4.1 Quantification Methodology

Reductions and removals of greenhouse gases achieved through conservation cropping must be quantified according to the methodologies outlined in Table 7 below. A listing of relevant emission factors is provided in Appendix A.

Quantification methodologies for the summerfallow reduction flexibility mechanism are provided in Appendix F.

Emission Reduction = Emissions Baseline – Emissions Project Emissions Baseline = Emissions Energy Use + (Emissions Carbon Sequestration X Reserve Discount Factor) + Emissions Nitrogen Emissions Project = 0

Where:

Emissions Baseline = sum of the emissions under the baseline condition

- $\text{Emissions}_{\text{Energy Use}}$ = component of emissions change under source/sink B9 Herbicide Production to source sink P9; and emissions change under source/sink B14 to P14 for Field Operations (Table 11)

- $\text{Emissions}_{\text{Carbon Sequestration}}$ = carbon component of emissions change under source/sink B13 Soil Carbon Dynamics to P13 Soil Carbon Dynamics (Table 11)

  $\text{Sequestered Carbon Reserve}_{\text{discount factor}}$ = Factor to account for reversals of carbon sequestration due to tillage events.
- $\text{Emissions}_{\text{Nitrogen}}$ = component of emissions change under source/sink B13 Soil Nitrogen Dynamics to P13 Soil Nitrogen Dynamics (Table 11)

Emissions Project = sum of the emissions under the project condition

An example method for deriving total coefficients from each type of emission is provided in the Technical Seed Document for Conservation Cropping (Version 1).

Table 7: Quantification Methodology

Project/ Baseline Sources/Sinks	Parameter / Variable	Unit	Measured / Estimated	Method	Frequency	Justify measurement or estimation and frequency
Project Sources/Sinks						
P9 Herbicide Production	Captured in Baseline Emission Factors					
P14 Field Operations						
P13 Soil Carbon and Nitrogen Dynamics						
Baseline Sources/Sinks						
$\text{Emissions}_{\text{Energy Use}} = \sum \text{Area}_{\text{Till Practice y}} * \text{EF}_{\text{Energy Use}}$						
B9 Herbicide Production and B14 Field Operations	Emission Reductions from Carbon Sequestration / Emissions $_{\text{Energy Use}}$	kg CO_2e / yr	N/A	Integrated into Energy Regional Coefficient	N/A	Quantity being calculated.
	Cropped Area of Field under Each Till Practice / Area $_{\text{Till Practice Y}}$	ha	Measured	Remote Sensing or GPS	Initial measurement acceptable, until field dimensions change.	Remote sensing or GPS measurement are most accurate. Legal land locations used for field identification.
B13 Soil Carbon and Nitrogen Dynamics	Reduction Factor For Relevant Till Practice in Relevant Area and Geographic Zone / EF $_{\text{Energy Use}}$	kg CO_2e / ha / yr	Estimated	Integrated into regional coefficient based on project farm location in either Dry Prairie or Parkland ecozone.	Annually	As per Canada's National Emissions Inventory Methodology in Appendix A: Relevant Emission Factors.
B13 Soil Carbon	$\text{Emissions}_{\text{Carbon Sequestration}} = \sum \text{Area}_{\text{Till Practice y}} * \text{EF}_{\text{20 yr Linear SOC Coefficient}}$					

Table 7: Quantification Methodology

Project/ Baseline Sources/Sinks	Parameter / Variable	Unit	Measured / Estimated	Method	Frequency	Justify measurement or estimation and frequency
Project Sources/Sinks						
and Nitrogen Dynamics	Emission Reductions from Carbon Sequestration / Emissions $_{Carbon\ Sequestration}$	kg CO_2e / yr	N/A	Integrated into regional coefficient based on project farm location in either Dry Prairie or Parkland ecozone.	N/A	Quantity being calculated.
	Area of Field under Each Till Practice / Area $_{Till\ Practice\ Y}$	ha	Measured	Remote sensing or GPS	Initial measurement acceptable, until field dimensions change.	Remote sensing or GPS measurement are most accurate. Legal land locations used for field identification.
	Sequestration Factor For Relevant Till Practice in Relevant Area and Geographic Zone / EF $_{10\ yr\ Linear\ SOC\ Coefficient}$	kg CO_2e / ha / yr	Estimated	Integrated into regional coefficient based on project farm location in either Dry Prairie or Parkland ecozone.	Annually	As per Canada's National Emissions Inventory Methodology in Appendix A: Relevant Emission Factors.
	Emissions $_{Nitrogen}$ = $\sum$Area $_{Till\ Practice}$ * EF $_{N2O\ Coefficient}$					
	Emission Reductions from Nitrous Oxide Reduction / Emissions $_{Nitrogen}$	kg CO_2e / yr	N/A	Integrated into regional coefficient based on project farm location in either Dry Prairie or Parkland ecozone.	N/A	Quantity being calculated.
	Area of Field under Each Till Practice / Area $_{Till\ Practice}$	ha	Measured	Remote sensing or GPS	Initial measurement acceptable, until field dimensions change.	Remote sensing or GPS measurement are most accurate. Legal land locations used for field identification.

Table 7: Quantification Methodology

Project/ Baseline Sources/Sinks	Parameter / Variable	Unit	Measured / Estimated	Method	Frequency	Justify measurement or estimation and frequency
Project Sources/Sinks						
	Reduction Factor For Relevant Till Practice in Relevant Area and Geographic Zone / $EF_{N2O\ Coefficient}$	kg CO_2e / ha / yr	Estimated	Integrated into regional coefficient based on project farm location in either Dry Prairie or Parkland ecozone.	Annually	As per Canada's National Emissions Inventory Methodology in Appendix A.

5.0 Data Management

Data types, quality and management systems must be of sufficient quality to support quantification of greenhouse gas emissions and reductions. **In all cases, greenhouse gas emission reductions must be substantiated with records and must meet minimum data requirements specified in Table 8. Alberta Environment and Water cannot accept offset credits for compliance purposes that are not supported by records.**

Farm operators participating in conservation cropping projects must collect and maintain records and proof of practice consistent with the requirements stated in Table 8. Additional evidence other than those collected for other business reasons may be required to substantiate claims of greenhouse gas emission reductions and to provide positive proof to a reasonable level of assurance. Each type of data requirement listed in Table 8 must be supported for each field within the project that is farmed as a unit for each year of the project or the claim cannot be made. **Farm enterprises with incomplete records cannot be included in the conservation cropping project.**

Project developers (aggregators) are required to retain copies of the farm operator's records and any additional records needed to support greenhouse gas assertions consistent with the requirements stated in Table 8 of this protocol.

The project developer must also establish and apply data management procedures to manage data and information within the project. Written procedures must be established for each management task outlining responsibility, timing, quality control and quality assurance checks, records and record location requirements. These procedures must be documented in a procedures manual, and must be made available to third party verifiers and government auditors upon request. More rigorous data management systems can facilitate third party verification and government audit, and help to reduce overall transaction costs for the project.

Third party verifiers are required to assess the data management system, the internal procedures manual, quantification and project records as part of the third party verification. Incomplete adherence to any protocol terms are considered a contravention and will **not be accepted by Alberta Environment and Water.**

5.1 Role of Professional Agrologists

Professional agrologists are third party professionals with technical knowledge in farm operations. Agrologists may work directly for the farm, the project developer, or be an independent third party that is consulted during project development and/or implementation. Agrologists may have familiarity with a farm enterprise and must have specific knowledge on farm cropping systems. They can provide additional support for project implementation; however **sign-off by a professional agrologist cannot be considered a substitute for farm records or third party verification.**

Project developers may elect to have a professional agrologist sign off on their opinion regarding practices being claimed for each field included in the project. This sign-off provides a secondary source of corroborating evidence of the farm management practices.

Sign-off by a professional agrologist does not replace record keeping requirements, but rather, can provide an added level of due diligence on the emission reduction claims. All parties (agrologist, farm operator, and project developer) are required to maintain copies of records needed to support the greenhouse gas assertion. Minimum records are provided in Table 8.

Note: The professional agrologist must collect and keep copies of the records needed to support his/her professional opinion presented in the sign-off statement.

5.2 Project Documentation and Evidence

Minimum data management requirements and examples of acceptable records needed to support a conservation cropping project are outlined in Table 8 below. The project developer is required to obtain and retain copies of records for each field for each year of the project in their data management system and must disclose records to a third party verifier and government auditor upon request. Farm operators must retain records for their files and may be asked to produce records during a site visit conducted by a third party verifier or government auditor. Data collection and retention responsibilities by party are outlined in Table 9.

Alberta Environment and Water will not accept offset credits as a compliance option under the *Specified Gas Emitters Regulation* that do not have sufficient evidence to support the greenhouse gas reductions being claimed. **Records are needed to support each type of data requirement listed for each field farmed for each project year. These documents may be requested to support verification or government audit. See Table 9 for details of data collection responsibilities.**

Table 8: Evidence Required for a Conservation Cropping Project

Data Requirement	Records Needed	Why it is Required
1) Ownership of the farm field	▪ Land title certificate for each field being claimed in the project for the first year the field is included, AND ▪ Confirmation of annual check against land titles to determine if ownership for the property has changed. If ownership has changed, a new land title certificate must be obtained and associated land owner – tenant agreements must be updated.	To confirm land ownership
2) Right to transact on offset credits	▪ Contract between project developer and the farm operator for the assignment of the carbon rights. This must include an agreement to provide access to data needed to quantify the greenhouse gas assertion for the farm enterprise. AND, in the case of rented or crop-shared land: ▪ Signed written lease agreement between land owner(s) and the tenant that clearly states the assignment of the rights to the carbon. The contract must be in place before the farm field can be registered in an offset project.	To confirm the right to transact on offset credits
3) Field size and location being claimed	▪ GPS track file from farm seeding equipment for each year, OR ▪ GPS shape file derived from field inspection, showing deductions for non-cropped areas (e.g. roads, gullies, wooded areas, grassed waterways, farm buildings). OR ▪ Measurement of field size using Google Earth, airphotos or satellite data showing deductions for non-cropped areas (e.g. roads, gullies, wooded areas, grassed waterways, farm buildings, etc).	Only area under conservation cropping is eligible for offset credits.
4)Ecozone protocol area	Location of field compared to the classification boundary layer file available at:	To confirm the ecozone and the

Data Requirement	Records Needed	Why it is Required
classification	http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cl11708	emission coefficients
5) Existence of an annual crop, or first year of seeding of a perennial crop	At least <u>one</u> of the following list of detailed farm records (completed by the farm operator), specifying the crop during the project year: ▪ Detailed farm record sheets (see example in Appendix E), ▪ Crop plan, such as one provided to seed/fertilizer dealers to ensure product is available for spring farming operations, AND <u>one</u> of the following: ▪ Crop insurance records, or ▪ Photo of annual crop with time and date stamp and link to location of field making the claim (e.g. reference point in photo, GPS file), or ▪ Supporting records to verify the accuracy of the items above. This may include sign off by a professional agrologist who has reviewed and collected supporting farm records that confirm the types of crops/field activities for that year. These records must be identified in the report and maintained in a format that is readily available for verifiers to inspect.	To confirm offset credits were generated from an annual or first year perennial crop
6) Occurrences of soil disturbance on each farm field being claimed	▪ Detailed farm record sheets (see example in Appendix E) that specify all land disturbance activities including but not limited to seeding, manure spreading/incorporation and discretionary tillage; ▪ Disclosure of any discretionary tillage events on a field and calculation of area affected by the disturbance confirmed by a farm record sheet (see example in Appendix E) or GPS readings from farm equipment. ▪ If no discretionary tillage is done on a farm field, this must be documented in the farm record sheet. AND <u>one</u> of the following: ▪ The specific equipment used, or ▪ Supporting records to verify the accuracy of the items above. This may include sign off by a professional agrologist who has reviewed and collected supporting farm records that confirm the types of equipment used to meet protocol requirements (e.g. number of passes, shank spacing and opener width) and disturbances per	To assess soil disturbance against requirements stated in Table 1

Data Requirement	Records Needed	Why it is Required
	field. These records must be identified in the report and maintained in a format that is readily available for verifiers to inspect. Failure to disclose discretionary tillage will result in the field being disqualified for the claim year.	
7) Seeding / fertilizer specifications used each year	▪ Calculation of the percentage of soil disturbance based on the width of the opener and shank spacing. AND <u>one</u> of the following: ▪ Photo evidence with time stamp of: equipment used including: • Opener width, • Distance between shanks ▪ Supporting documentation for equipment used by the farm operator including equipment receipt or rental agreement, model number of the tillage equipment. Changes in equipment need to be documented and recorded in the project developer's files. Equipment purchase and sale records or rental records shall be maintained for verification purposes, or ▪ Signed-off report completed by a professional agrologist who has reviewed and collected supporting farm records that confirm the type of equipment used by farm or custom operator meets the protocol requirements.	Equipment specifications affect the amount of soil disturbance incurred during farming operations
8) Reseeding events, if applicable	• One additional low-disturbance pass is allowed for reseeding events if total disturbance remains within allowable maximums, see Appendix D. Equipment specifications must be recorded in the farm record sheet (see example field sheet in Appendix E) indicating dates of initial and reseeding events; OR • Sign-off by a professional agrologist who reviewed and collected supporting farm records that confirm the reseeding events and the types of field operations that meet the protocol requirement	Reseeding events must not exceed the soil disturbance requirements in Table 1

Data Requirement	Records Needed	Why it is Required
9) Use of Irrigation in Dry Prairie Ecozone, if applicable	• Supporting documentation for water usage on the field by farm operator including two of the following: ▪ Water use records ▪ Photo evidence with GPS time stamp showing equipment used including model information ▪ Crop insurance records noting use of irrigation ▪ Air photo or satellite imagery showing pivots ▪ Alberta Irrigation Program documents ▪ Detailed farm maps showing coverage of irrigation networks over project fields including type and model numbers for equipment being used OR • Sign-off by a professional agrologist who reviewed and collected supporting farm records that confirm the irrigation practice and the types of field operations that meet the protocol requirement	Irrigation increases the carbon sequestration potential of Dry Prairie soils to that of Parkland soils. This information is needed to confirm the practice occurred.

Table 9: Additional Evidence for Summerfallow Reduction Projects

Data Requirements	Records Needed	Why Required
1) Location of fields in the Dry Prairie ecozone being included in the baseline and project conditions	Location of fields with respect to the ecozone classifications boundary layer file available at: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cl11708.	Field eligibility is restricted to the Dry Prairie ecozone
2) The crop years used for the baseline	▪ Detailed farm maps showing locations of baseline fields within the farm enterprise for each year for 3 consecutive years immediately prior to project implementation, OR ▪ If a baseline year is not representative of farm operations, the next consecutive year and justification for why the year	Baselines must be established based on 3 years of typical farm operations

Data Requirements	Records Needed	Why Required
	was excluded from the baseline calculations AND • Data to establish the year(s) as typical and thus eligible for inclusion, including detailed farm records of inputs and yields of crops for each field within the farm enterprise (see example in Appendix E). AND one of the following: • Records from crop insurance showing typical yields and whether field was previously summerfallowed, or • Signed-off report that includes all of the above evidence completed by a professional agrologist who has reviewed and collected supporting farm records that confirm the type of equipment used by farm or custom operator meets the protocol requirements	
3) The crop years used if a non-consecutive baseline is used.	▪ Detailed farm maps showing locations of baseline fields within the farm enterprise for each year. AND • Detailed farm records of inputs and yields of crops for each field within the farm enterprise (see example in Appendix E). AND • Data and trending to establish the year(s) as atypical and thus eligible for exclusion. AND one of the following: • Records from crop insurance showing typical yields and whether field was previously summerfallowed, or • Signed-off report that includes all of the above evidence completed by a professional agrologist who has reviewed and collected supporting farm records that	Documents atypical crop years and provides justification for exclusion of that year in favour of the next consecutive year

Data Requirements	Records Needed	Why Required
	confirm the type of equipment used by farm or custom operator meets the protocol requirements	
4) Eligibility of fields during the project condition	▪ Proof as stated above that the crop met the requirements for inclusion in the tillage system management component of this protocol including the evidence required above for tillage system management.	This flexibility mechanism must be co-implemented with no till management practices.

Table 10: Responsibilities for Data Collection and Retention

Entity	Data Collection and Retention Responsibilities
Farm Operator	Provides copies of farm records and documentation to the project developer. The farm operator must retain original records for their files.
Project Developer	The project developer has primary responsibility for record keeping and record coordination to support project implementation and due diligence, and will be the primary information source for third party verification. The project developer is required to collect and manage copies of farm records and supporting documentation outlined in Table 8 above.
Professional Agrologist	The professional agrologist can provide a third party opinion on the project based on project records. Records must be collected and maintained consistent with this protocol, and to support his/her professional opinion of the farm management practices.

5.3 Record Keeping

Alberta Environment requires that project developers maintain appropriate supporting information for the project, including all raw data for the project for a period of 7 years **after** the end of the project credit period. Where the project developer is different from the person implementing the activity, as in the case of an aggregated project, the individual farm operator and the project developer (aggregator), must both maintain sufficient records to support the offset project. The project developer, the farmer and the aggregator must keep the information listed below and disclose all information to the verifier and/or government auditor upon request. For more information, see Technical Guidance for Offset Project Developers available at: http://environment.alberta.ca/02275.html

Record Keeping Requirements:

- Records stated in Table 8 above for all applicable years in which offset credits are being claimed;
- A record of all adjustments made to the project data with justifications;
- List of equipment included and any changes that occurred during the crediting period;
- Common practices relating to possible greenhouse gas reduction scenarios discussed in this protocol (tillage system management and summerfallow reduction practices);
- All calculations applying the greenhouse gas assertion and emission factors listed in this protocol; and
- Initial and annual verification records and audit results.

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

- All records must be kept in areas that are easily located;
- All records must be legible, dated and revised as needed;
- All records must be maintained in an orderly manner;
- All documents must be retained for 7 years after the project crediting period has ended;
- Project developers must maintain electronic records; while farm operators must maintain original records, which may include hardcopy records; and
- Files must be backed up and should be stored offsite to reduce the likelihood of file loss.

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

5.4 Quality Assurance/Quality Control Considerations

Project developers are required to ensure sufficient and appropriate quality assurance/quality control procedures are implemented to support the project implementation. Quality Assurance/Quality Control can also be applied to add confidence that all measurements and calculations have been made correctly. These include, but are not limited to:

1. Outlining the process related to data management and record keeping for offset credits;
2. Restriction of user access to offset claim calculations and data;
3. Ensuring that the changes to operational procedures (including manure management, etc.) continue to function as planned and achieve greenhouse gas reductions;
4. Ensuring that the measurement and calculation system and greenhouse gas reduction reporting remains in place and accurate;

5. Checking the validity of all data before it is processed, including emission factors, static factors, and acquired data;
6. Exception reports for identification of duplicate records, incorrect emission factors, or records with values outside of expected ranges;
7. Performing recalculations of quantification procedures to reduce the possibility of mathematical errors;
8. Storing the data in its raw form so it can be retrieved for verification;
9. Protecting records of data and documentation by keeping both a hard and soft copy of all documents;
10. Recording and explaining any adjustment made to raw data in the associated report and files;
11. A contingency plan for potential data loss; and
12. Management review and approval of agreements, records, completeness of field activity information, consistency with underlying data, as well as linkage between base data and claims.

5.5 Liability

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

Notwithstanding any agreement between a project developer (aggregator) and the land owner / farmer, the project developer shall not and can not pass on any regulatory liability for errors in design and/or errors in the project developer's data management system.

5.6 Registration and Claim to Offsets

Project developers must complete and submit a spatial locator template to the Alberta Emission Offsets Registry as part of the required documentation needed for project registration. This template is provided as part of the project registration package and may be requested directly from the registry.

6.0 References

2006 Census of Agriculture. Statistics Canada.

Alberta Land Resource Unit. 1995. Soil Group Map of Alberta. Research Branch, Agriculture and Agri-Food Canada, see: <http://www1.agric.gov.ab.ca/soils/soils.nsf/soilgroupmap?readform>

Brierly, J. A., T.C. Martin and D.J. Spiess. 2001. Agricultural Region of Alberta Soil Inventory Database (AGRASID 3.0). Soil Landscape User's Manual, see: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag6903.

ClimateCHECK, 2008. Science Discussion Document for Summerfallow Reduction Protocol. 31 pp. Available at: http://carbonoffsetsolutions.climatechangecentral.com/files/microsites/OffsetProtocols/ABProtocolDevelopmentWorkshops/Summerfallow08/SCIENCE_Discussion_Document_Summerfallow.pdf

Environment Canada, 2011, National Inventory Report 1990 – 2009. Greenhouse Gas Sources and Sinks in Canada. Part 2. Submission to the United Nations Framework Convention on Climate Change. 387 pp. Available at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5888.php

Haak, D. 2006. *Tillage System Default Coefficient Technical Background Document*. Completed with the national Soil Management Technical Working Group (SMTWG). Available at: http://carbonoffsetsolutions.climatechangecentral.com/files/microsites/OffsetProtocols/ProtocolReviewProcess/1stCycleProtocolReview/Tillage/14_No_Till_Default_Protocol_SMTWG_Oct2006_mod.pdf.

Helgason, B.L. 2005. GHGFarm Version 1.0. An assessment tool for estimating net greenhouse gas emissions from Canadian farms. Agriculture and Agri-Food Canada, Lethbridge 40 pp.

Huffman, T., Yang, J. Y., Drury, C. F., De Jong, R., Yang, X. M. and Liu, Y. C. 2008. Estimation of Canadian manure and fertilizer nitrogen application rates at the crop and soil-landscape polygon level. Can. J. Soil Sci. 88:619-627.

KPMG Advisory. 2011. Scoping Study of Assurance Standards to Verify Agricultural Greenhouse Gas Offset Projects. 57 pp.

Lal, 2004. Soil carbon sequestration impacts on global climate change and food security. Science. Vol 304, no 5677, pp. 1623-1627.

Liebig, M.A., J.A. Morgan, J.D. Reeder, B.H. Ellert, H.T. Gollany, and G.E. Schuman. 2005. Review: Greenhouse gas contributions and mitigation potential of agricultural practices in northwestern USA and western Canada. Soil & Tillage Research. 83:25–52.

Little, S., J. Lindeman, K. Maclean and H.H. Janzen. 2008. Holos. A tool to estimate and reduce greenhouse gases from farms. Methodology and algorithms for version 1.1.x. http://www.agr.gc.ca/nlwis/index_e.cfm?s1=tools_outils&page=intro.

McClinton, Blair. 2008. PERRL Pilot Carbon Trade: What did we learn. Prairie Steward. 3 pp.

McConkey, B., D. Angers, M. Bentham, M. Boehm, T. Brierley, D. Cerkowniak, C. Liang, P. Collas, H. de Gooijer, R. Desjardins, S. Gameda, B. Grant, T. Huffman, J. Hutchinson, L. Hill, P. Krug, C. Monreal, T. Martin, G. Patterson, P. Rochette, W. Smith, B. Vanden Bygaart, X. Vergé, D. Worth. 2007. Canadian Agricultural Greenhouse Gas Monitoring Accounting and Reporting System (CanAG-MARS): Methodology and greenhouse gas estimates for agricultural land in the LULUCF sector for NIR 2006

Parton, W.J., D.S. Schimel, C.V. Cole and D.S. Ojima (1987), Analysis of factors controlling soil organic matter levels in Great Plains grasslands, Soil Science Society of America Journal, 51: 1173–1179.

Parton, W.J., J.W.B. Stewart and C.V. Cole (1988), Dynamics of C, N, P and S in grassland soils: a model, *Biogeochemistry*, 5: 109–131.

Rochette, P., Worth, D. E., Lemke, R. L., McConkey, B. G., Pennock, D. J., Wagner-Riddle, C. and Desjardins, R. L. 2008. Estimation of N2O emissions from agricultural soils in Canada. I. Development of a country-specific methodology. Can. J. Soil. Sci. 88: 641_654.

Saskatchewan Soil Conservation Association, 2005. Agriculture Soil Organic Carbon Sequestration Emission Removal Project. Pilot emission Removals, Reductions and Learnings Initiative. 2005 Claim Report. 6pp.

Saskatchewan Soil Conservation Association, 2006. Agriculture Soil Organic Carbon Sequestration Emission Removal Project. Pilot emission Removals, Reductions and Learnings Initiative. 2006 Claim Report. 8 pp.

Saskatchewan Soil Conservation Association, 2007. Agriculture Soil Organic Carbon Sequestration Emission Removal Project. Pilot emission Removals, Reductions and Learnings Initiative. 2007 Claim Report. 10 pp.

Technical Seed Document for Conservation Cropping, Version 1. 2012. Alberta Environment and Water.

Vanden Bygaart, A. J., B.G. McConkey, D.A. Angers, W. Smith, H. de Gooijer, M. Bentham, and T. Martin, 2008. Soil carbon change factors for the Canadian agriculture national greenhouse gas inventory. Can. J. Soil Sci. 88: 671-680.

APPENDIX A: Coefficients for Conservation Cropping

Coefficients for Tillage System Management

Table 11 provides a summary of raw coefficients associated with tillage change between No Till (NT), Reduced Till (RT) and Full Till (FT) management where positive signs represent emission removals from increased soil organic carbon sequestration and reduced N_20. (adapted from Haak, 2006.).

Table 11: Raw Coefficients for Tillage Practice Change

Ecozone	Tillage Change	Soil Organic Carbon[z] (t CO_2e ha^{-1} yr^{-1})	N_2O (t CO_2e ha^{-1} yr^{-1})	Energy (t CO_2e ha^{-1} yr^{-1})
Parkland	FT to NT	0.59	0.045	0.1091
	FT to RT	0.22	0.045	0.0239
	RT to NT	0.31	0.000	0.0852
	NT to FT	-0.59	-0.045	-0.1091
	RT to FT	-0.22	-0.045	-0.0239
	NT to RT	-0.31	0.000	-0.0852
Dry Prairie	FT to NT	0.41	0.014	0.0589
	FT to RT	0.15	0.014	0.0250
	RT to NT	0.19	0.000	0.0339
	NT to FT	-0.41	-0.014	-0.0589
	RT to FT	-0.15	-0.014	-0.0250
	NT to RT	-0.19	0.000	-0.0339

Source: Haak, 2006
[z] 10 year values represented annually

Below are baseline adjusted emission factors for 2012 through 2021 (inclusive) for No Till (NT) management using 2006 Census adoption levels on cropped land area by region in Alberta (See sample calculations in Appendix C).

Table 12: Baseline Adjusted Emissions Factors

Ecozone	Practice	Baseline Adjusted Emission Factors		
		Sequestration of Soil Organic Carbon (t CO2e ha-1 yr-1)	**N2O Reduction** (t CO2e ha-1 yr-1)	**Energy Reduction** (t CO2e ha-1 yr-1)
Parkland	NT	0.25	0.012	0.054
Dry Prairie	NT	0.13	0.0030	0.021

Coefficients for Summerfallow Reduction Projects

Tables 13 to 16 provide a summary of raw coefficients for conversion from summerfallow to continuous cropping using no till. Positive signs represent emission removals resulting from increased soil organic carbon sequestration. Negative signs represent increases in N_20 and energy emissions from increased land management requirements for seeding a no till crop compared to chemfallow. Using chemfallow in the project baseline represents the most conservative estimate of summerfallow management for the purposes of quantifying greenhouse gas emissions reductions. Sample calculations are provided in Section 3.3 of the Technical Seed Document.

Table 13: Soil Organic Carbon Sequestration Coefficient for Summerfallow Reduction

Ecozone	t C ha^{-1} yr^{-1}	t CO_2e ha^{-1} yr^{-1}
Dry Prairie	0.30	1.1

Source: Vanden Bygaart et al. 2008

Table 14: Energy Emissions Factors

Ecozone	Tillage System	Crop Rotation	Fuel	Herbicide	Total
			GJ ha^{-1} yr^{-1}	GJ ha^{-1} yr^{-1}	t $CO_{2e}ha^{-1}$ yr^{-1}
Dry Prairie	**NT**	Crop	- 1.42	- 0.46	- 0.14
		Chemfallow	- 0.34	- 0.78	- 0.061

Source: Little *et al.* 2008;

Note: Conversion factors are: fuel – 0.081, herbicide – 0.043 t $CO_{2\ \mathrm{equivalent}}$ GJ^{-1} (from Helgason 2005).

Table 15: Net Energy Coefficients for No Till Cropping Compared to Chemfallow

Ecozone	Fallow System		Tillage System		Net Emissions
		t CO_2e ha^{-1} yr^{-1}		t CO_2e ha^{-1} yr^{-1}	t CO_2e ha^{-1} yr^{-1}
Dry Prairie	**Chemfallow**	- 0.061	NT	- 0.14	- 0.079

Table 16: Coefficients for Upstream Fertilizer Production

N Fertilizer Rate [z] (kg N ha-1 yr-1)	**N Fertilizer Production Coefficient** [y] (kg CO2e kg-1N yr-1)	**Emissions** (t CO2e ha-1 yr-1)
45	- 3.59	- 0.16
P205 Fertilizer rate (kg P ha-1 y-1)	**P205 Fertilizer Production Coefficient** [y] (kg CO2e kg-1P y-1)	**Emissions** (t CO2e ha-1 y-1)
27	- 0.5699	- 0.015

[z] Average of estimated N rates used Brown and Dark Brown soil zones (Huffman et al. 2008)
[y] Little et al. 2008

Table 17 lists the discount factors applied to emission reduction calculations for conservation cropping and reduced summerfallow projects. More information is available in Section 5 of the Technical Seed Document for Conservation Cropping.

Table 17: Sequestered Carbon Reserve Discount Factors
a) No till reserve factor for the Parkland and Dry Prairie ecozone

Ecozone	**Factor**	**No Till**
Parkland	Reserve Factor	87.5%
	Chosen Number of Reversals	2.5
	Range of Reversals	Range: 1-4
Dry Prairie	Reserve Factor	92.5%
	Chosen Number of Reversals	1.5
	Range of Reversals	1 – 2

b) Summerfallow reduction reserve factor for the Dry Prairie ecozone

Ecozone	**Factor**	**No Till**
Dry Prairie	Reserve Factor	80%
	Chosen Number of Reversals	20
	Range of Reversals	10 to 20

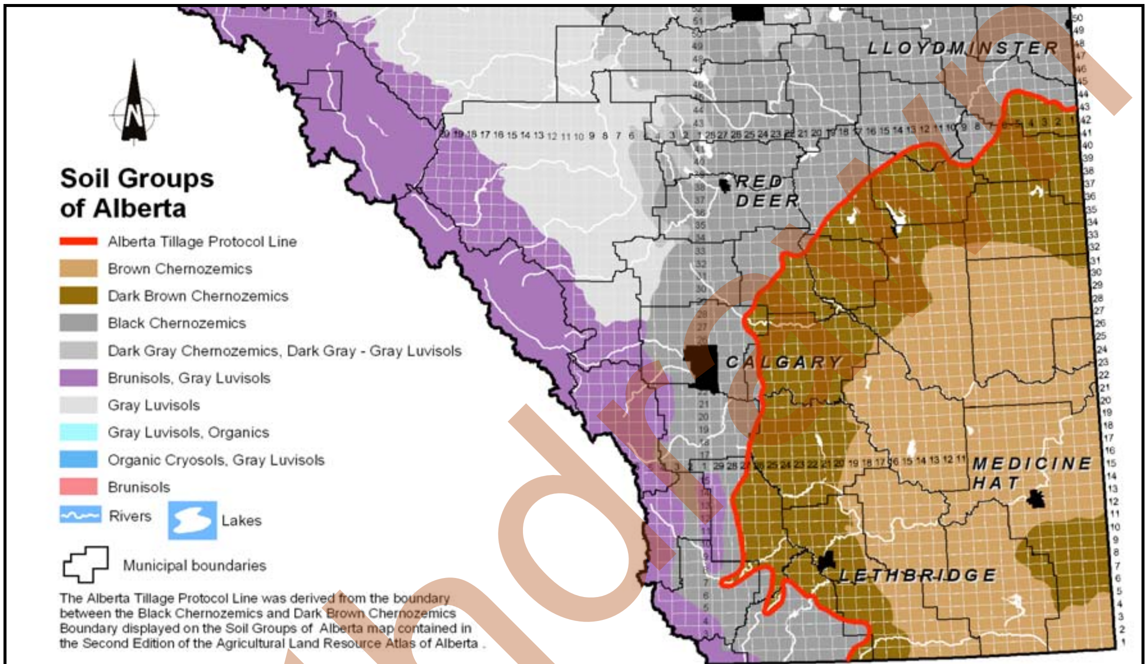
See Appendix C and the Technical Seed Document for Conservation Cropping for more information.

APPENDIX B: Ecozone Boundary Line

Ecozone Boundary Line

Alberta's digital soils database (AGRASID, Brierley et al. 2001) prescribes a precise boundary line for the change from Dry Prairie to Parkland ecozones for the purpose of quantifying greenhouse gas emission reductions. This line is shown in Figure 5 below. For the purposes of this protocol, the boundary is the fence-line on the Dry Prairie side of the quarter sections located on the boundary line.

Figure 5: Ecozone Boundary Line



Source: Alberta Land Resource Unit. 1995

A digital copy of the boundary line is available at:
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cl11708

APPENDIX C: Sample Quantification

The section below demonstrates how total coefficients for an ecozone were derived and outlines the methodology project developers need to use to calculate total coefficients used to quantify net greenhouse gas emissions reductions for no till and summerfallow reduction management practices.

Example Calculation for No Till in the Parkland Ecozone

Step 1: Apply the raw coefficients for tillage practice changes in the Parkland ecozone provided in Table 11 (Appendix A) and adoption levels provided in Table 1 (Technical Seed Document) to calculate the baseline adjusted emissions factors listed in Table 12 (Appendix A).

SOC Net NT Coefficient = [Raw Coeff(FT to NT)*(%Area in FT)/100%+ Raw Coeff(RT to NT)*(%Area in RT)/100%]
= [(0.59*26.55/100) + (0.31*29.64/100)]
= 0.25 tonnes of CO2e/ha

$N_2$0 Net NT Coeff. = [Raw Coeff(FT to NT)*(%Area in FT)/100%+ Raw Coeff(RT to NT)*(%Area in RT)/100%]
= [(0.045*26.55/100) + (0.000*29.64/100)]
= 0.012 tonnes of CO2e/ha

Energy Net NT Coeff = [Raw Coeff(FT to NT)*(%Area in FT)/100%+ Raw Coeff(RT to NT)*(%Area in RT)/100%]
= [(0.1091*26.55/100) + (0.0852*29.64/100)]
= 0.054 tonnes of CO2e/ha

Where:
SOC is the soil organic carbon
NT is no till soil land management
FT is full till land management
RT is reduced till land managment

Step 2: Apply the sequestered carbon reserve discount factor for the Parkland Ecozone from Table 17 (Appendix A), to the baseline adjusted emissions factor for soil organic carbon coefficient in Table 12. Add $N_2$0 and energy coefficients from Table 12 to calculate the total coefficient used to quantify total greenhouse gas emissions reductions for no till in the Parkland ecozone. If necessary, convert area from acres to hectares (2.47 ac = 1 ha) prior to applying the Total Coefficient to the project area.

Total Coefficient = (Net SOC Coefficient * (Reserve Factor/100) + (Net $N_2$0 Coefficient) + (Net Energy Coefficient)
= (0.25*0.875) + (0.012) + (0.054)
= 0.28 tonnes of CO_2e/ha for Parkland ecozone under no till.

Note: Although significant digits are defined by the raw coefficients throughout the calculations, final results must be rounded to two significant digits consistent with the soil organic carbon coefficients.

APPENDIX D: Guidance on Specific Management Scenarios

Guidance on Specific Management Scenarios

This section replaces the "Additional Guidance for Tillage Management Systems (February 2008)".

Additional guidance is provided below for the variety of management scenarios that occur in Alberta. This section draws on the good practice guidance of the Tillage System Default Coefficient Protocol based on Canada's Offset System for Greenhouse Gases prepared by the Soil Management Technical Working Group (Haak et al. 2006).

Minimum record keeping requirements for conservation cropping and reduced summerfallow projects is provided in Section 5, Table 8 above.

Key considerations are:

1) Nitrogen fertilizer management is not quantified in this protocol. Applying fertilizer in the fall may qualify for no till if both the fertilization and subsequent seeding operation both involved low disturbance openers. Reductions in greenhouse gas emissions from improved fertilizer use are quantified under the Quantification Protocol for Agricultural Nitrous Oxide Emissions Reductions.

2) Fall seeding qualifies for no till if it occurs after the cropped land period for the management cycle of the previous crop and meets soil disturbance requirements on for a harvest to harvest time period (See Table 1 for an example). All types of land preparation prior to fall seeding (e.g.: fertilizer application) must be documented.

3) Most sweeps do not qualify as no till because there is normally greater than 46 per cent soil disturbance.

4) Tillage definitions apply to the cropped land period of the harvest to harvest management cycle for a normal harvest year for the crop. This would apply to fall seeded crops or situations when weather delays harvest to the following spring.

5) Carbon accumulation is deemed to be on a calendar year basis for the normal harvest year in which the crop is harvested or the land is fallowed even though tillage definitions relate to the cropped land period.

6) The carbon sequestration potential of perennial or bi-annual crops is not quantified within this protocol **except for the first year of seeding**. Tillage practices associated with seeding perennials into annual crop stubble in the spring or fall will qualify if disturbance is within the constraints of the tillage definitions (Table 1). Tillage definitions also apply when perennials are rotated back into annual crops. If the perennial crop is terminated and seeded to an annual crop in fall or spring, apply the coefficient for the year in which the crop is harvested. If the perennial crop is terminated in the spring, fallowed and then seeded in the fall

or the next spring, apply coefficients for one year – the first as a fallow year and the second as a seeding year. If the perennial crop is terminated between June 15 and August 1 and the next crop is seeded the following spring, apply coefficients for 1.5 years – the first as a partial fallow year with the coefficient reduced by one half, and the second year as a seeding year.

7) Since some research supports the fact that irrigation will increase soil organic carbon levels in drier regions (Liebig et al. 2005), the Parkland ecozone coefficient will be used for irrigated land within the Dry Prairie ecozone. However, the use of irrigation within the Parkland ecozone will not affect the coefficient since there are no data to support increased soil organic carbon due to irrigation within this region.

8) If a crop must be reseeded, or if a cover or green manure crop is seeded, the no till coefficient applies only if the total cumulative disturbance does not exceed the maximums specified in Table 1. For low disturbance openers (less than 38 per cent disturbance by measuring implement), the total allowable disturbance may include:

   - Two separate passes to apply fertilizer, then seed the first crop. This assumes some overlap between passes. A third reseeding pass may be added to the disturbance of the first two passes, but the total allowable may not exceed the maximum for two passes (76 per cent).

   - If only one low disturbance pass is used to both seed and fertilize the first crop, a second reseeding pass may be added, provided that the total disturbance from the both passes does not exceed 76 per cent.

   Reseeding with higher disturbance openers is not eligible for inclusion in greenhouse gas emission reduction calculations (i:e.: offset credits). If tillage is used to incorporate a cover crop or green manure, the definitions provided in Table 1 must be applied and may result in a reduced till or full till designation.

9) The addition of soil carbon through the application of manure is not quantified within this protocol. Although manure applications are permitted, they must adhere to the definitions of soil disturbance that are outlined in Table 1in order to qualify as no till. All manure application events must be documented in the farm records.

The occurrence of inter-row tillage to control weeds during the growing season in annual row crops such as corn results in a full till practice.

APPENDIX E: Example Field Record Sheet

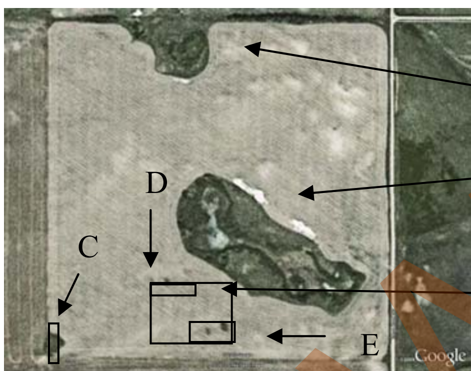
The following sample field record sheet is provided to illustrate the types of information tools needed to support a carbon offset claim under this protocol. Requirements provided in this sample Field Record Sheet are consistent with the minimum records requirements stated in Section 5, Table 8 of the Quantification Protocol for Conservation Cropping.

Farm management practices are highly variable between farm operations. Individual farms may have additional field management operations and practices not included in this sample. Field Records Sheets must address the items identified in Section 5, Table 8 and may require additional categories based on specific farm operations.

Table 18 below is an example only. It has been partially completed to provide further clarifications on the level of detail acceptable for tracking greenhouse gas emission reduction claims resulting from no till agricultural practices.

Table 18: Sample Field Record Sheet

Landowner(s) Name:	**Year land was purchased**
Tenant (Farm Operator) Name:	**Start date of tenancy**
Legal Land Description of Field:	
Land Title Certificate: **Date of annual ownership check:**	
Date(s) of contract between Project Developer and Farm Operator regarding terms of offset transaction agreement:	
For rented lands, Date(s) of contract assigning carbon rights between Landowner and Tenant*:	
Size of field in Project (hectares): <u>42.0 ha (103.8 acres)</u> Provide a map of the field showing the measurement of field size based on one of: GPS track file from farm equipment, GPS shape file from field inspections, Google Earth, airphoto, or satellite data. Indicate the extent of cropped area in the field within the land description. Label locations of areas where cropping did not occur, such as wet depressions, woodlots, grassed waterways, farm buildings, etc.	



Quarter section field area is 64.8 ha (160 acres)
Uncropped area:
A Slough - 4.9 ha (12 acres)
B Unseeded - 17.9 ha (44.2 acres)
Cropped area:
64.8 ha - 12ha - 17.9 ha = 42 ha (103.8 acres)

Delayed Seeding in Subarea F = D + E + 3 ha

Tilled subareas
C - 1 ha
D - 1 ha
E - 2 ha
F - 6 ha

Field Equipment:	
Record all types of field equipment and operations that involve mechanical contact with soil, other than wheel traffic (ie. tillage, seeding, fertilizer/manure/lime injection/incorporation, harrowing, rolling etc.). Record date of purchase of equipment, date of review, shank/row spacing, opener width (portion that penetrates soil explained in footnote 4, Table 1), and area to which	

management was applied in hectares. Note: units need to be consistently reported throughout the project, and must be converted to metric for final greenhouse gas emission reduction quantification.

If a specific operation involved only a portion of the field, identify this portion on the map above, and label the sub area on both the map and this form. Indicate the reason for doing the operation on only a portion of the field.

If photo evidence is used, label location that photo was taken on field map.

Photo #:

Was there discretionary tillage of the field? Yes:	No:	If yes, record details below.	
Implement #1 – Fertilizer Injection		Make:	Model #:
Shank spacing: 16 in	Opener width: 4 in	% Disturbance: 25	Photo #:
Implement #2 – Cultivator		Make:	Model #:
Shank spacing: 12 in	Opener width: 16 in	% Disturbance: 100	Photo #:
Implement #3 – Air Drill		Make:	Model #:
Shank spacing: 9 in	Opener width: 2 in	% Disturbance: 22	Photo #:
Were any portions of the field reseeded? Yes:	No:	If yes, record details below.	
Was the field irrigated? Yes:	No:	If yes, record details below	

Field Operations:							
Date	**Operation Type**	**Notes**	**Shank/ Row Spacing**	**Opener Width**	**Area (ha)**	**Map Sub Areas**	**Supporting Evidence ****
09/28/09	Harvest	Canola crop					
10/3/09	Fertilizer Injection	Omitted sub area F - too wet (see accompanying map)	16 in.	4 in.	40		GPS track file
5/10/10	Tillage of Weed Patch	Foxtail barley seedlings from blown in seed from neighbour's land, see map	12 in.	16 in.	1	C	Photo
5/15/10	Air Drill	Seeded barley crop, sub area #2 and #3 too wet to seed	9 in.	2 in.	36	D, E	GPS track file
5/26/10	Tillage of depressional wet areas	Weed control after soil dried up	12 in.	16 in.	3	D, E	Photo, notes with calculations showing 10 % discretionary tillage of cropped area was not exceeded
5/31/10	Air Drill	Delayed seeding of barley due to wetness	9 in.	2 in.	6	F	Crop insurance report # , or, GPS track file
10/07/10	Harvest	Barley crop					
Notes: Total area tilled for weed control on Subareas C, D and E = 1 ha + 1 ha + 2 ha = 4 ha (see map). Percent of cropped (seeded) area = Tilled area / total cropped area = 4 / 42 * 100 = 9 %							

* Contract must be in place after harvest of the previous crop and before field operations commence.

** Claims must be supported by farm records, including but not limited to: crop insurance forms, seed/fertilizer purchase receipts, seed sales receipts, equipment purchase receipts, custom seeding agreements, crop plans, etc. These records must be identified in the report and maintained in a format that is readily available for verifiers to inspect.

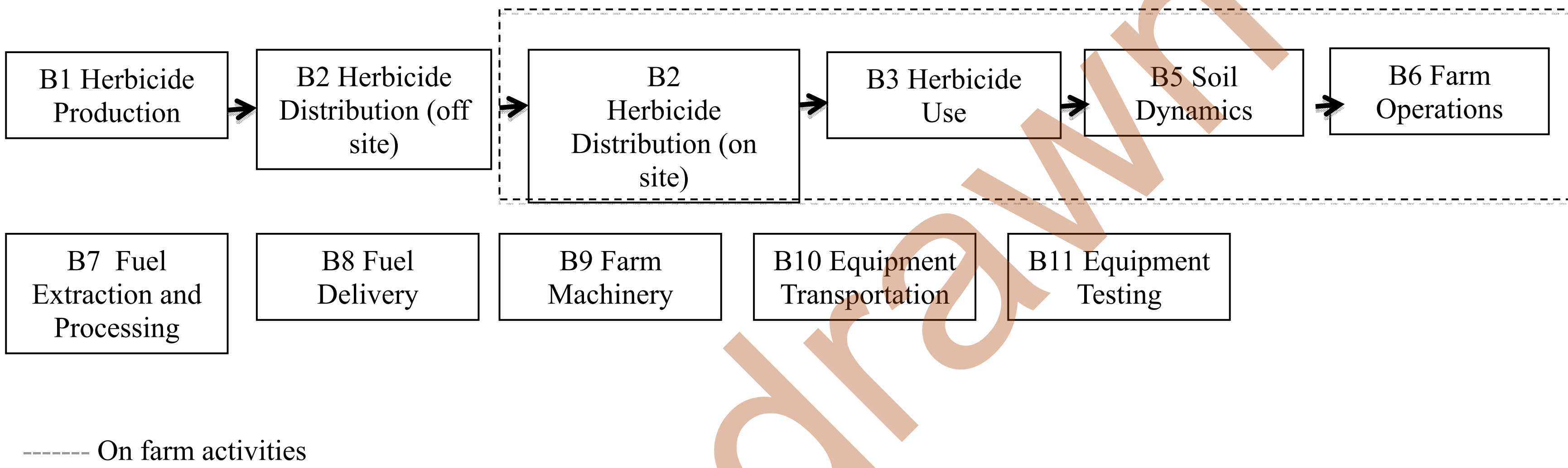
APPENDIX F: Flexibility Mechanism for Reduced Summerfallow in Dry Prairie

The summerfallow reduction flexibility mechanism is available for farm operations in the Dry Prairie ecozone that can demonstrate a reduction in the proportion of area in summerfallow per year based on a 3-year, farm specific baseline. To be eligible, farms enterprises must demonstrate a practice change from summerfallow (chemfallow, till fallow, or combination of both) to a continuous cropping system using conservation cropping (no till) farming practices described above.

This section provides the sources and sinks, process flow diagram and quantification methodology for this flexibility mechanism.

Figure 6 provides a process flow diagram for a typical baseline configuration.

Figure 6: Process Flow Diagram for Baseline Condition Summerfallow Reduction



<u>**Flexibility Mechanism Approach**</u>

The Flexibility Mechanism approach is based on increasing the proportion of land area within the total managed area of the farm enterprise that is converted from summerfallow in the baseline to continuous, no-till cropping management in the project condition.

Participating farm enterprises must establish a 3-year, farm specific baseline representing the average proportional area in fallow compared to total area farmed over the 3-year period. The project condition must result in a reduction of the area in summerfallow compared to total area farmed across the farm enterprise for the total managed area for each year over a 5-year period (See sample calculation in the Technical Seed Document for Conservation Cropping, Section 3.3). **Note the same fields must be included in both the baseline and project condition.**

A minimum project duration of 5 consecutive years is required to capture sufficient data to demonstrate the transition from summerfallow to continuous cropping (i.e.: to decrease the average area of land that is fallowed),. This means the project must compile annual reports documenting reductions in summerfallow area, but can only register offset credits on the Alberta Emissions Offset Registry at the end of the 5-year project period for reductions achieved over that time. This requirement is to ensure that offset credits are given for permanent reductions achieved based on a 5-year average performance at the farm enterprise. Annual variations in areas managed as fallow and as continuous no-till cropping must be documented and retained consistent with the requirements in Table 8.. Note: Credits from no-till management are added to summerfallow reduction credits to obtain total project reductions for farm field enterprise.

Please note, the same farm fields must be used in both the baseline and project condition and must be clearly stated in the offset project plan. The project developer and farm operator must determine which lands will be considered for the baseline and the duration of the project. Only lands that are managed for the entire eight year period (3 years for the baseline and 5 years project condition) will be eligible to generate offset credits.

Farm operators can claim one additional, 5-year renewal for a summerfallow reduction project. This means summerfallow reduction projects have a maximum crediting period of 10 years. Note although the 5 year project period (crediting period) can start at any time during the 10 year crediting period, a maximum of two full 5 year periods can occur within the 10 year time span available prior to December 31, 2021. Any additional lands added to the farm enterprise, but not stated in the baseline will have to be registered as a separate project with a project-specific baseline.

The credit duration period for this flexibility mechanism is 10 years terminating December 31, 2021.

*Note**:** Summerfallow reduction projects must have established a baseline and be registered in the system on or before January 1, 2017 to qualify. Project registered later will not have* *sufficient time to complete a 5-year implementation phase needed to generate offset credits and will therefore, not be eligible under this protocol.*

This project type is reversible. Returning to summerfallow, chemfallow or other discretionary tillage activities may cause previously sequestered carbon to be re-released to the atmosphere. To manage the risk of reversal, summerfallow reduction projects are assigned a 20 per cent discount on verified offset credits generated by the project (See Appendix A). These discounted credits are held in a government owned Sequestered Carbon Reserve account and will be considered permanently retired against possible future reversals. All projects must disclose reversals to provide a basis for assessing the amounts of carbon in the reserve account.

See Section 5.0 of the Technical Seed Document for Conservation Cropping for more information on the Sequestered Carbon Reserve.

Baseline and Project Condition for Flexibility Mechanism

The baseline condition for this protocol is defined as the continued use of summerfallow as a land management technique. The baseline greenhouse gas emissions are quantified based on the business as usual use of summerfallow determined on a project by project basis.

The baseline condition uses an average percentage of fields in summerfallow of the total land controlled by a given farm enterprise in that year. The baseline average is based on 3 years of data prior to the project implementation. Records requirements for the summerfallow reduction flexibility mechanism are provided in Table 8.

The flexibility mechanism requires that the baseline be calculated from data from the three consecutive years prior to project implementation. If the project developer determines that one or more of the baseline years was atypical in terms of summerfallow frequency due to extreme weather or other conditions, the next consecutive year(s) back may be used in its place. The project developer must provide the necessary data and trending to establish the year(s) as atypical and thus eligible for exclusion.

In order to ensure consistency between the baseline and project condition, the farm operator must include the same land area (fields) in both the baseline and project condition.

Based on the process flow diagrams provided in Figure 6, the project sources/sinks were organized into lifecycle categories in Figure 7. Descriptions of each of the source/sink and its classification as either ‘controlled’, ‘related’ or ‘affected’ is provided Table 19.

Figure 7: Baseline Sources and Sinks for Summer Fallow Flexibility Mechanism

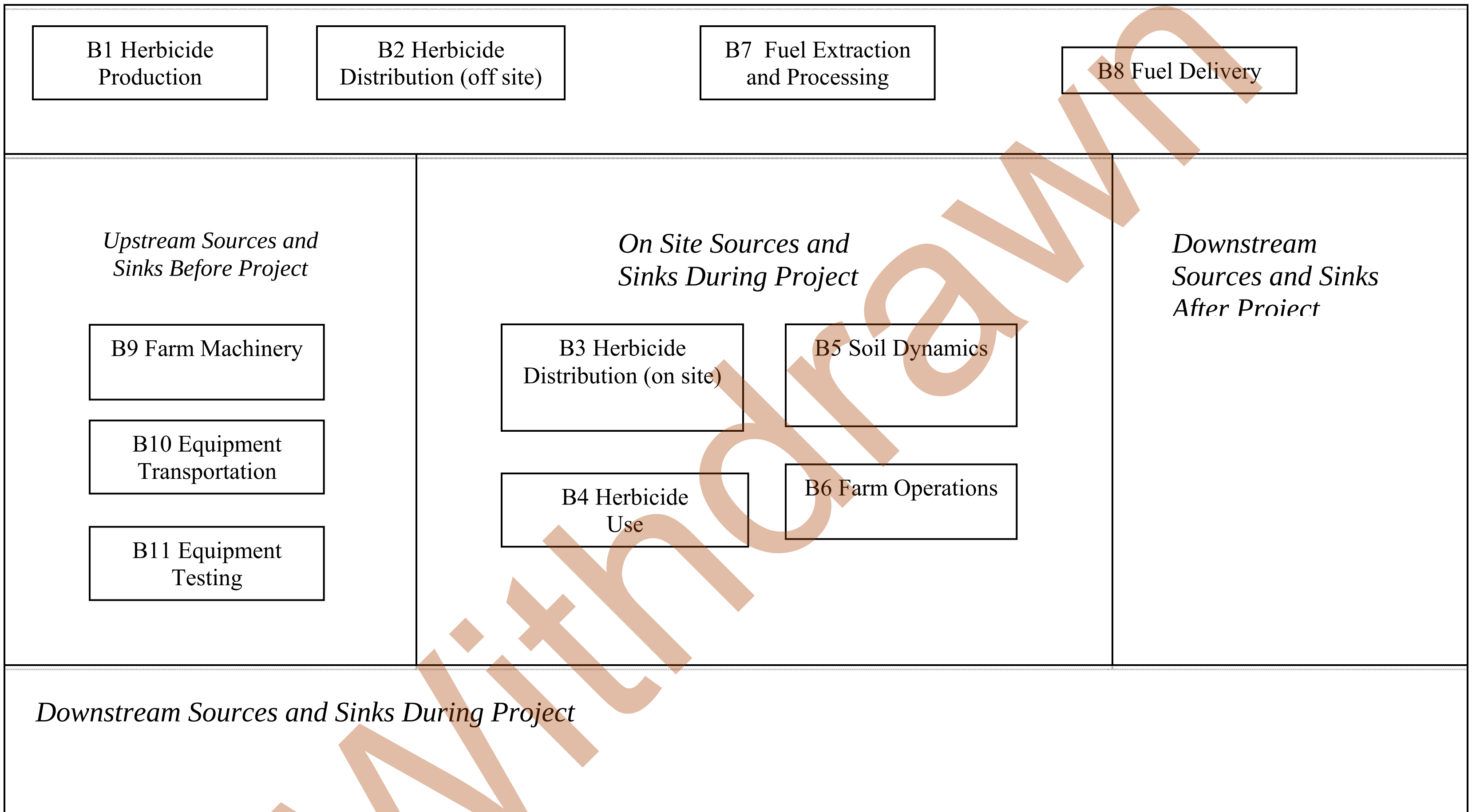
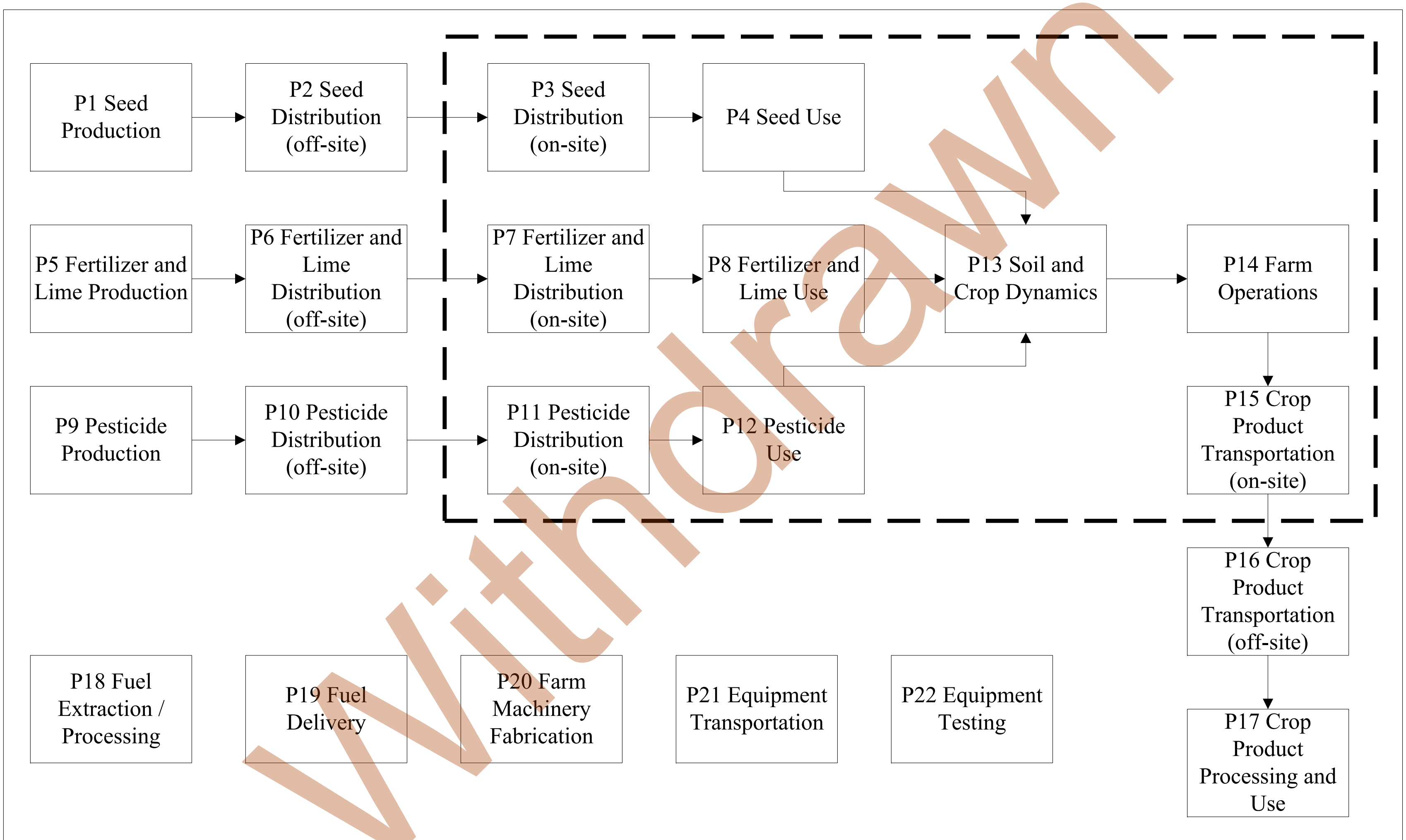


Table 19: Baseline Condition Sources and Sinks for Summerfallow Reduction Flexibility Mechanism

Source/Sink	Description	Controlled, Related or Affected
Upstream sources/sinks during Baseline Operation		
B1 Herbicide Production	Herbicide production may include several material and energy inputs such as natural gas, diesel and electricity. The emissions resulting from the energy inputs required to run the production processes are captured under this source/sink. Coefficients representing the change in Herbicide use from the baseline condition would be used to evaluate equivalence with the project condition.	Related
B2 Herbicide Distribution (off-site)	Herbicide may be transported to the project site by truck, barge and/or train. The emissions resulting from the energy inputs for fuelling this equipment are captured under this source/sink. Type of equipment, number of loads and distance travelled would be tracked to evaluate equivalence with the project condition.	Related
B7 Fuel Extraction / Processing	Each of the fuels used throughout the on-site component of the project will need to be sourced and processed. The emissions resulting from the energy inputs for various processes involved in the production, refinement and storage of the fuels are captured under this source/sink Total volumes and types of fuels used on-site would be tracked to evaluate equivalence with the project condition.	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 by tanker or by pipeline. The emissions resulting from the transportation of fuels are captured under this source/sink. 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 source/sinks and there is no other delivery. Total volumes and types of fuels transported to the site would be tracked to evaluate equivalence with the project condition.	Related
Onsite sources/sinks during Baseline Operation		
B3 Herbicide Distribution (on-site)	Herbicide would need to be transported from storage to the field. The emissions resulting from the energy inputs for fuelling this equipment are captured under this source/sink. Type of equipment, number of loads, and distance travelled would be tracked to evaluate equivalence with the project condition.	Controlled
B4 Herbicide Use	Herbicide used on the farm has inputs of materials and energy embedded in it. The emissions resulting from these inputs are captured under this source/sink. Total volumes and types of seed used would be tracked to evaluate equivalence with the baseline condition.	Controlled

Source/Sink	Description	Controlled, Related or Affected
B5 Soil Dynamics	The cycling of soil and plant carbon and nitrogen involves flows of materials and energy that include deposition in plant tissue, decomposition of crop residues, stabilization in organic matter and emission as carbon dioxide and nitrous oxide. The cycle can be affected by changes in tillage practices. The change in N_2O emissions resulting from a change in tillage practices is captured under this source/sink. The change in carbon sequestration resulting from a change in tillage practices is captured under source/sink P13. Coefficients representing the change in N_2O emissions from the baseline condition would be used to evaluate equivalence with the project condition.	Controlled
B6 Farm Operations	The operation of the farm will require running farm facilities, field equipment and related equipment, not including tillage equipment. This may include running vehicles and facilities at the project site. The emissions resulting from the energy inputs for fuelling these facilities and related equipment are captured under this source/sink. Quantities and types for each of the energy inputs would be tracked to evaluate equivalence with the baseline condition.	Controlled
Downstream sources/sinks during Baseline Operation		
None.		
Other		
B9 Farm Machinery Fabrication	In the baseline condition the type of machinery associated with conventional till is tillage equipment. These may be sourced as pre-made standard equipment or custom built to specification. Tillage equipment is substantially heavier than Pesticide sprayers. The emissions resulting from the material and energy inputs to fabricate this equipment are captured under this source/sink. Coefficients representing the change in emissions from the baseline condition would be used to evaluate equivalence with the project condition.	Related
B10 Equipment Transportation	Equipment built off-site and the materials to build equipment on-site, will need to be delivered to the site by train, truck, or some combination. The emissions resulting from the energy inputs to fuel this equipment are captured under this source/sink. Type of equipment, number of loads, and distance travelled would be tracked to evaluate equivalence with the project condition.	Related
B11 Equipment Testing	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test fuels or fossil fuels in order to ensure that the equipment runs properly. The emissions resulting from the energy inputs to run these tests are captured under this source/sink. Total volumes and types of fuels used during testing would be tracked to evaluate equivalence with the project condition.	Related

Figure 8: Process Flow Diagram for Project Condition Summerfallow Reduction Flexibility Mechanism:



Identification of Project Sources and Sinks

Sources/sinks were identified for the project by reviewing the relevant process flow diagrams, consulting with stakeholders (i.e. project developers) and reviewing good practice guidance and other relevant greenhouse gas quantification protocols. This iterative process confirmed that the source/sink 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 7 and 8 above, the project sources/sinks were organized into lifecycle categories in Figure 9. Descriptions of each sources/sinks and its classification as controlled, related or affected are provided in Table 19.

Figure 9: Project Condition Sources and Sinks for Summerfallow Reduction Flexibility Mechanism

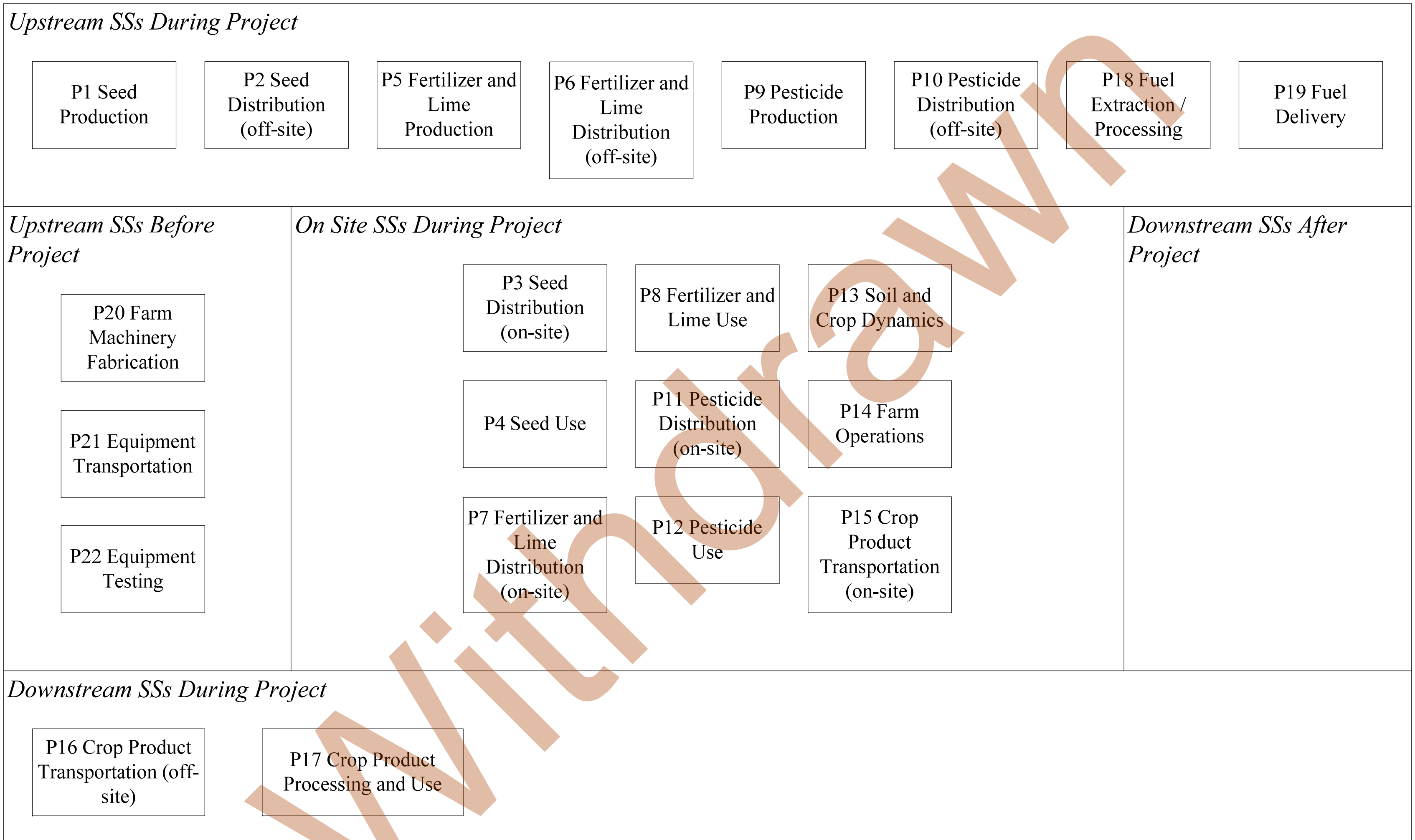


Table 17: Project Condition Sources and Sinks for Summerfallow Reduction Flexibility Mechanism

Sources/Sinks	Description	Controlled, Related or Affected
Upstream sources/sinks during Project Operation		
P1 Seed Production	Seed production may include several energy inputs such as natural gas, diesel and electricity. The emissions resulting from the energy inputs required to run the production processes are captured under this source/sink. Quantities and types for each of the energy inputs would be tracked to evaluate equivalence with the baseline condition.	Related
P2 Seed Transportation (off-site)	Seeds may be transported to the project site by truck, barge and/or train. The emissions resulting from the energy inputs for fuelling this equipment are captured under this source/sink. Type of equipment, number of loads, and distance travelled would be tracked to evaluate equivalence with the baseline condition.	Related
P5 Fertilizer and Lime Production	Fertilizer and lime production may include several material and energy inputs such as natural gas, diesel and electricity. The emissions resulting from the inputs required to run the production processes are captured under this source/sink. Quantities and types for each of the energy inputs would be tracked to evaluate equivalence with the baseline condition.	Related
P6 Fertilizer and Lime Distribution (off-site)	Fertilizer and lime may be transported to the project site by truck, barge and/or train. The emissions resulting from the energy inputs for fuelling this equipment are captured under this source/sink. Type of equipment, number of loads, and distance travelled would be tracked to evaluate equivalence with the baseline condition.	Related
P9 Herbicide Production	Herbicide production may include several material and energy inputs such as natural gas, diesel and electricity. The emissions resulting from the energy inputs required to run the production processes are captured under this source/sink. Coefficients representing the change in Herbicide use in the project condition would be used to evaluate equivalence with the baseline condition.	Related
P10 Herbicide Distribution (off-site)	Herbicide may be transported to the project site by truck, barge and/or train. The emissions resulting from the energy inputs for fuelling this equipment are captured under this source/sink. Type of equipment, number of loads and distance travelled would be tracked to evaluate equivalence with the baseline condition.	Related
P18 Fuel Extraction / Processing	Each of the fuels used throughout the on-site component of the project will need to be sourced and processed. The emissions resulting from the energy inputs for various processes involved in the production, refinement and storage of the fuels are captured under this source/sink. Total volumes and types of fuels used on-site would be tracked to evaluate equivalence with the baseline condition.	Related

Sources/Sinks	Description	Controlled, Related or Affected
P19 Fuel Delivery	Each of the fuels used throughout the on-site component of the project will need to be transported to the site by tanker or by pipeline. The emissions resulting from the transportation of fuels are captured under this source/sink. 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 source/sink s and there is no other delivery. Total volumes and types of fuels transported to the site would be tracked to evaluate equivalence with the baseline condition.	Related
Onsite Sources/sinks during Project Operation		
P3 Seed Distribution (on-site)	Seed will need to be transported from storage to the field and the fields will have to be prepared for planting. The emissions resulting from the energy inputs for fuelling this equipment are captured under this source/sink. Coefficients representing the seed distribution and field preparation practices in the project condition will be used to evaluate equivalence with the baseline condition.	Controlled
P4 Seed Use	Seed planted on the farm has inputs of materials and energy embedded in it. The emissions resulting from these inputs are captured under this source/sink. Total volumes and types of seed used would be tracked to evaluate equivalence with the baseline condition.	Controlled
P7 Fertilizer and Lime Distribution (on-site)	Fertilizer and lime will need to be transported from storage to the field. The emissions resulting from the energy inputs for fuelling this equipment are captured under this source/sink. Type of equipment, number of loads and distance travelled would be used to evaluate equivalence with the baseline condition.	Controlled
P8 Fertilizer and Lime Use	The application of fertilizer and lime can result in N_2O emissions. The emissions resulting from the application of fertilizer and lime are captured under this source/sink. The emissions resulting from the interaction between the fertilizer, the crop, and the soil are captured under source/sink B13. Timing, composition, concentration and volume of fertilizer would be tracked to evaluate equivalence with the baseline condition.	Controlled
P11 Herbicide Distribution (on-site)	Herbicide would need to be transported from storage to the field. The emissions resulting from the energy inputs for fuelling this equipment are captured under this source/sink. Type of equipment, number of loads, and distance travelled would be used to evaluate equivalence with the baseline condition.	Controlled
P12 Herbicide Use	Pesticide used on the farm has inputs of materials and energy embedded in it. The emissions resulting from these inputs are captured under this source/sink. Total volumes and types of seed used would be tracked to evaluate equivalence with the baseline condition.	Controlled

Sources/Sinks	Description	Controlled, Related or Affected
P13 Soil Dynamics	The cycling of soil and plant carbon and nitrogen involves flows of materials and energy that include deposition in plant tissue, decomposition of crop residues, stabilization in organic matter and emission as carbon dioxide and nitrous oxide. The cycle will be affected by changes in tillage practices. The change in carbon sequestration resulting from a change in tillage practices is captured under this source/sink, as quantified in the Tillage System Management component of this protocol. The change in N_2O emissions resulting from a change in tillage practices is addressed in this source/sink. Coefficients representing the change in carbon sequestration in the project condition would be used to evaluate equivalence with the baseline condition.	Controlled
P14 Farm Operations	The operation of the farm will require running farm facilities, field operations and related equipment, not including tillage equipment. This may include running vehicles and facilities at the project site. The emissions resulting from the energy inputs for fuelling these facilities and related equipment are captured under this source/sink. Quantities and types for each of the energy inputs would be tracked to evaluate equivalence with the baseline condition.	Controlled
P15 Crop Product Transportation (on-site)	Crops will need to be harvested and transported from the field to storage. The emissions resulting from the energy inputs to fuel this equipment are captured under this source/sink. Type of equipment, number of loads, and distance travelled would be tracked to evaluate equivalence with the baseline condition.	Controlled
Downstream Sources/sinks during Project Operation		
P16 Crop Product Transportation (off-site)	Crop products will need to be transported from storage to the processing facility by truck, barge and/or train. The emissions resulting from the energy inputs to fuel this equipment are captured under this source/sink. Type of equipment, number of loads, and distance travelled would be tracked to evaluate equivalence with the baseline condition.	Related
P17 Crop Product Processing and Use	Crop products will need to be processed and eventually used. The emissions resulting from the energy and material inputs to process and use of the crop product are captured under this source/sink. The amount of crop product, type of processing, and final use would be tracked to evaluate equivalence with the baseline condition.	Related
Other		
P20 Farm Machinery Fabrication	In the project condition the type of machinery associated with no till is Herbicide sprayers. These may be sourced as pre-made standard equipment or custom built to specification. Herbicide sprayers are substantially lighter than tillage equipment. The emissions resulting from the material and energy inputs to fabricate this equipment are captured under this source/sink. Coefficients representing the change in emissions in the project condition would be used to evaluate equivalence with the baseline condition.	Related

Sources/Sinks	Description	Controlled, Related or Affected
P21 Equipment Transportation	Equipment built off-site and the materials to build equipment on-site, will need to be delivered to the site by train, truck, or some combination. The emissions resulting from the energy inputs to fuel this equipment are captured under this source/sink. Type of equipment, number of loads, and distance travelled would be tracked to evaluate equivalence with the baseline condition.	Related
P22 Equipment Testing	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test fuels or fossil fuels in order to ensure that the equipment runs properly. The emissions resulting from the energy inputs to run these tests are captured under this source/sink. Total volumes and types of fuels used during testing would be tracked to evaluate equivalence with the baseline condition.	Related

Quantification

Baseline and project conditions for the summerfallow reduction flexibility mechanism were assessed against each other to determine the scope for reductions quantified under this protocol.

All sources and sinks identified in Table 18 and Table 19 above are listed in Table 20 below. Each source and sink is listed as included or excluded. Justification for these choices is provided. Most upstream sources and sinks can be excluded or deemed as not relevant for both the baseline and project, because all activities are not controlled by the project developer and there is negligible change in the quantity of sources and sinks between project and baseline.

Unlike tillage system management, a shift to continuous cropping is unlikely to increase the use of herbicides. Chemfallow, which is a common sector practice, already relies on the use of herbicides to control weeds during fallow years. On average, these have similar inputs to herbicide use during the no till that is required in this protocol. As such, herbicide production is similar between the baseline and project conditions.

Further, the increase in fuel processing and extraction is likely to be insignificant since fuel consumption differences between no- till and chemfallow are unlikely to result in significant impacts upstream at fuel extraction and processing plants.

The conversion of non-cropped fallowed land to more continuous cropping will require increased fertilizer use, which will result in more upstream fertilizer production; however, field scale differences in emissions of nitrous oxide between summerfallowed and cropped conditions are excluded because background flux levels are considerably higher than fluxes from fertilizer. See Section 3 of the technical seed document for more information. Direct reductions in nitrogen fertilizer through improved fertilizer management may be quantified under the Quantification Protocol for Nitrous Oxide Emissions Reductions for Agriculture.

These points are reflected in the comparison table below.

Table 20: Comparison of Sources and Sinks for the Summerfallow Reduction Flexibility Mechanism

Identified Sources/Sinks	Baseline (C, R, A)	Project (C, R, A)	Include or Exclude from Quantification	Justification for Exclusion/Inclusion
Upstream Sources/Sinks				
P1 Seed Production	N/A	R	Exclude	Can be excluded from further consideration as per other relevant criteria: The sources/sink is beyond the on-farm project boundaries.
P2 Seed Distribution (off-site)	N/A	R	Exclude	Can be excluded from further consideration as per other relevant criteria: The sources/sink is greater in the project condition than in the baseline condition because the amount of seed used is increased. However, the emissions from transportation are likely negligible. The sources/sinks is therefore not relevant for quantification.
P5 Fertilizer and Lime Production	N/A	R	**Include**	Although this source/sink is beyond the on-farm project boundaries, this is included to meet the conservativeness criterion. The emissions in this source/sink are included in the net energy coefficient used to derive the net sequestration coefficients
P6 Fertilizer and Lime Distribution (off-site)	N/A	R	Exclude	Can be excluded from further consideration as per other relevant criteria: This source/sink is likely to be negligible between baseline and project condition due to the small contribution of emissions from transportation. The sources/sink is therefore not relevant for quantification.
P9 Herbicide Production	N/A	R	Exclude	Can be excluded from further consideration as per other relevant criteria: The source/sink is expected to be functionally equivalent in the project condition and in the baseline condition because average amounts of herbicide use is similar.
B1 Herbicide Production	R	N/A	Exclude	
P10 Herbicide Distribution (off-site)	N/A	R	Exclude	Can be excluded from further consideration as per other relevant criteria: The source/sink is expected to be functionally equivalent in the project condition and in the baseline condition because average amounts of herbicide used is similar.
B2 Herbicide Distribution (off-site)	R	N/A	Exclude	
P18 Fuel Extraction / Processing	N/A	R	Exclude	The source/sink is similar in the project condition and in the baseline condition since fuel is used for field operations to control weeds in summerfallow and for seeding and fertilizer use in no till systems. The emissions in this source/sink are included in the on-site net energy coefficients.
B7 Fuel Extraction / Processing	R	N/A	Exclude	

Identified Sources/Sinks	Baseline (C, R, A)	Project (C, R, A)	Include or Exclude from Quantification	Justification for Exclusion/Inclusion
P19 Fuel Delivery	N/A	R	Exclude	The source/sink is greater in the project condition than in the baseline condition because the amount of fertilizer used is increased, however differences between no till and chemfallow are unlikely to result in significant impacts upstream at extraction and processing plants. The on-site emissions in this source/sink are included in the net energy coefficient used to derive the net sequestration coefficients.
B8 Fuel Delivery	R	N/A	Exclude	
Onsite Sources/Sinks				
P3 Seed Distribution (on-site)	N/A	C	Exclude	Can be excluded from further consideration as per other relevant criteria: The source/sink is greater in the project condition than in the baseline condition because the amount of seed used is increased. The emissions from transportation are likely negligible. The source/sink is therefore not relevant for quantification.
P4 Seed Use	N/A	C	**Include**	Included in net energy coefficient since this sink/source differs between baseline and project.
P7 Fertilizer and Lime Distribution (on-site)	N/A	C	**Include**	The source/sink is greater in the project condition than in the baseline condition because the amount of fertilizer used is increased. The emissions in this source/sink are included in the net energy coefficient used to derive the net sequestration coefficients.
P8 Fertilizer and Lime Use	N/A	C	Exclude	The source/sink is similar between the project and the baseline condition. Although amounts of nitrogen (N) fertilizer use is increased in the project condition, similar amounts of N_20 are emitted from soils due to denitrification of soil organic N in (noncropped) summerfallow conditions (Rochette *et al*. 2008, Table 6)
P11 Herbicide Distribution (on-site)	N/A	C	Exclude	Can be excluded from further consideration as per other relevant criteria: The source/sink is expected to be similar in the project condition and in the baseline condition
B3 Herbicide Distribution (on-site)	C	N/A	Exclude	
P12 Herbicide Use	N/A	C	Exclude	Can be excluded from further consideration as per other relevant criteria: The source/sink is expected to be similar in the project condition than in the baseline condition.
B4 Herbicide Use	C	N/A	Exclude	
P13 Soil Dynamics	N/A	C	**Include**	The quantification of this source/sink is achieved using the net sequestration coefficients. It should be noted that N_2O emissions are excluded, because emissions from summerfallow fields do not differ from those of crop fields.
B5 Soil Dynamics	C	N/A	**Include**	

Identified Sources/Sinks	Baseline (C, R, A)	Project (C, R, A)	Include or Exclude from Quantification	Justification for Exclusion/Inclusion
P14 Farm Operations	N/A	C	**Include**	The source/sink is greater in the project condition than in the baseline condition because the level of equipment operation has increased. The emissions in this source/sink are included in the net energy coefficient used to derive the net sequestration coefficients.
B6 Farm Operations	C	N/A	**Include**	
P15 Crop Product Transportation (on-site)	N/A	C	**Include**	The source/sink is greater in the project condition than in the baseline condition because the amount of crop produced is increased. The emissions in this source/sink are included in the net energy coefficient used to derive the net sequestration coefficients..
Downstream Sources/Sinks				
P16 Crop Product Transportation (off-site)	N/A	R	Exclude	Can be excluded from further consideration as per other relevant criteria: The source/sink is greater in the project condition than in the baseline condition because the amount of crop produced is increased. The emissions from transportation are likely negligible. The S source/sink s are therefore not relevant for quantification.
P17 Crop Product Processing and Use	N/A	R	Exclude	Can be excluded from further consideration as per other relevant criteria: The source/sink is beyond the on-farm project boundaries.
Other				
P20 Farm Machinery Fabrication	N/A	R	Exclude	Can be excluded from further consideration as per other relevant criteria: The source/sink is beyond the on-farm project boundaries.
B9 Farm Machinery Fabrication	R	N/A	Exclude	
P21 Equipment Transportation	N/A	R	Exclude	Can be excluded from further consideration as per the decision tree: The source/sink is lower in the project condition than in the baseline condition because the equipment being transported is lighter. The change in these source/sinks is therefore conservative to exclude from further consideration.
B10 Equipment Transportation	R	N/A	Exclude	
P22 Equipment Testing	N/A	R	Exclude	Can be excluded from further consideration as per the decision tree: The source/sink is lower in the project condition than in the baseline condition because the equipment being tested is lighter. The change in this source/sinks is therefore conservative to exclude from further consideration.
B11 Equipment Testing	R	N/A	Exclude	

Quantification Methodology

Greenhouse gas emissions reductions and removals from reduced summerfallow must be quantified according to the methodology provided below. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

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

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Summerfallow}}$$

$$\text{Emissions}_{\text{Project}} = (\text{Emissions}_{\text{Carbon Sequestration}} \text{ x } 1 - \text{Sequestered Carbon Reserve Factor}) + \text{Emissions}_{\text{Energy}} + \text{Emissions}_{\text{Upstream Fertilizer Production}}$$

Where:

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

Emissions $_{\text{Summerfallow (B5 and B6)}}$

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

Emissions $_{\text{Soil and Crop Dynamics (P13)}}$

Sequestered Carbon Reserve factor = accounts for probability of reversals (return to higher proportion of summerfallow).
(Sequestered Carbon Reserve factors are provided Appendix A).

Emissions Energy (P13, P14 and P15)

Emissions Upstream Fertilizer Production (P5)

Appendix A specifies the relevant emission factors for use in this portion of the protocol.

Table 21: Quantification Procedures

1. Project/ Baseline Sources/sinks	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
Project Sources/Sinks						
	$Emissions_{Carbon\ Sequestration} = Area_{Converted} * EF_{SOC\ Coefficient} * (-1)$					
P13 Soil Dynamics	$Area_{Converted} = [Portion\ Cropped_{Project} - Portion\ Cropped_{Baseline}] * Total\ Area$					
	$Portion\ Cropped_{Project} = \sum_{i=1}^{5} Cropped\ Area_{Project\ Year\ i} / [Total\ Area * 5]$					5 Year Minimum Reporting Period
	$Portion\ Cropped_{Baseline} = \sum_{i=1}^{3} Cropped\ Area_{Baseline\ Year\ i} / [Total\ Area * 3]$					3 Year average baseline
	Emission Reductions from Increased Carbon Sequestration / $Emissions_{Carbon\ Sequestration}$	t CO_2e / project	N/A	N/A	N/A	Quantity being calculated.
	Converted Cropped Area Additional to the Baseline / $Area_{Converted}$	ha	Calculated	As above.	N/A	Quantity being calculated.
	Sequestration Factor for Reduction of Summerfallow in Dry Prairie/ $EF_{SOC\ Coefficient}$	t CO_2e / ha / yr	Estimated	Default factor in Table 14, Appendix A.	Annual	Based on CanAG-MARS National Inventory methodology
	Average Portion of Land Seeded of the Total Area in the Project Condition / $Portion\ Cropped_{Project}$	ha / ha	Calculated	As above.	N/A	Quantity being calculated.
	Average Portion of Land Seeded of the Total Area in the Baseline Condition / $Portion\ Cropped_{Baseline}$	ha / ha	Calculated	As above.	N/A	Quantity being calculated.

1. Project/ Baseline Sources/sinks	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
	Total Area of Land Considered for Inclusion in All Baseline and Project Years / Total Area	ha	Measured	Measurement (GPS).		Satellite imagery or GPS measurement are most accurate. Legal land locations used for field identification.
	Area of Cropped Fields under NT and RT tillage Practices in the 5 Project Years / Cropped Area $_{\text{Project Year i}}$	ha	Measured	Measurement (GPS).	Continuous	Satellite imagery or GPS measurement are most accurate.
	Area of Cropped Fields under any tillage practice in the 3 Baseline Years / Cropped Area $_{\text{Baseline Year i}}$	ha	Measured	Measurement (GPS).	Continuous	Satellite imagery or GPS measurement are most accurate.
P3 Seed Distribution (on-site) P7 Fertilizer and Lime Distribution (on-site) P11 Pesticide Distribution (on-site)	Emissions $_{\text{Energy}}$ = ∑ [Area $_{\text{Converted}}$ * Energy EF]					
	Emissions $_{\text{Energy}}$	t CO_2e / yr	N/A	N/A	N/A	Quantity being calculated.
	Converted Cropped Area Additional to the Baseline / Area $_{\text{Converted}}$	ha	Calculated	As above.	N/A	Quantity being calculated.
	Net energy coefficient for no till system management / Energy EF	t CO_2e / ha / yr	Estimated	Default factors presented in Table 16 Appendix A.	Annual	Conservative factor is chosen as 0.08 t CO_2e / ha / yr.
P5 Fertilizer and Lime Production (upstream)	Emissions $_{\text{Upstream Fertilizer Production}}$ = ∑ [Area $_{\text{Converted}}$ * N Fertilizer Production] + ∑ [Area $_{\text{Converted}}$ * P_20_5 Fertilizer Production]					
	Emissions $_{\text{Upstream N Fertilizer Production}}$	t CO_2e / yr	N/A	N/A	N/A	Quantity being calculated.

1. Project/ Baseline Sources/sinks	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
	Converted Cropped Area Additional to the Baseline / $Area_{Converted}$	ha	Calculated	As above.	N/A	Quantity being calculated.
	N fertilizer production coefficient / N Fertilizer Production	t CO_2e / ha / yr	Estimated	Default factors presented in Table 15 Appendix A.	Annual	Calculated according to Technical Seed Document
	P_2O_5 fertilizer production coefficient / P2)5 Fertilizer Production	t CO_2e / ha / yr	Estimated	Default factors presented Table 15; Appendix A.	Annual	Calculated according to Technical Seed Document
Baseline Sources/sinks						
B5 Soil Dynamics	Captured in the Project Carbon Sequestration Coefficients.					
B3 Pesticide Distribution (on-site)	Captured in the Project Energy Coefficients.					

APPENDIX G: Additional Guidance for Verifiers

Note: Verifiers must still meet all other Government of Alberta template requirements for verification

This protocol relies on a combination of practice-based evidence (dated field records, field investigations and farm implement measurements) to prove a practice occurred. Detailed record requirements are provided in Table 8. Verifiers are required to:

1. Ensure the project developer has adhered to the protocol and gathered the necessary farm operational records for the relevant years, such as: annual or first year perennial or bi-annual crops as defined by this protocol, planted on which fields by no till, for which years and the size of the fields. This evidence should be recorded on a dated farm field record sheet that indicated numbers of passes to meet disturbance levels (see: Appendix F**:** Example Field Record Sheet). Farm implement measurements must be on file to ensure adherence to soil disturbance levels;

2. Enquire whether a qualified Professional Agrologist (P.Ag.) has signed off or holds the farm data. A P.Ag. must have records on file to substantiate professional opinions;

3. Ensure that clear ownership exists for the project land being asserted. The verifier should ask to see the land title certificate for a sample of field areas included in the project, and if the farmer is not the land owner for that area, an ownership agreement between land owner and land lessee to prove ownership to the credits.

4. Verifiers can provide additional assurance to corroborate evidence for farm records. This includes:
   - Due diligence by conducting land titles searches themselves;
   - Contacting Agriculture Financial Services Corporation (AFSC) a crown corporation that provides hail and crop insurance for farmers for corroborating evidence of farm practices such as crop type or previous summerfallow activity (uncropped area) (See example in Section 7 of Technical Seed Document);
   - Use the Alberta Soil Information Viewer on http://www.agric.gov.ab.ca/app21/rtw/index.jsp to corroborate field size and 2002 visual inspection. This shows the Alberta Township Survey (ATS) system and coordinates of the cursor are also displayed in UTM and Lat/Long coordinates. The soil viewer has aerial colour orthophotos for the whole of the white zone in Alberta circa 2002 - the baseline year. Spatial annotation tools can create polygons on top of the soils/air photo and document the area of the polygon. Thus if a field is a 90 ac field within a quarter, one could see it and measure it on the soil viewer. Visual inspection of the air photo would show if some of the area is non-cropland and a visual estimate of the area or use of the polygon tool can delineate the cropped acres in the baseline year.
   - Historical air photo images are available from the Alberta Air Photo Distribution Centre or the Department of Sustainable Resources;

- http://www.srd.alberta.ca/MapsFormsPublications/Maps/MapDistributionCentre/Default.aspx
- http://www.srd.alberta.ca/MapsFormsPublications/AirPhotoDistributionOffice/Default.aspx

- Google Earth contains satellite imagery with historical photos (Historical imagery on the View menu). Approximate date is stamped on the bottom left hand side of the screen. Number and dates of historical images will vary.
- Purchase Satellite Imagery/remote sensing from reputable suppliers;
- Any changes in the field area, such as removals of woodlots, or additions of buildings must be documented thoroughly by the project developer and assessed during verification.
- Verification can be enhanced by field investigations - for no till activity, field assessments should be done during the growing season, (either before the crop canopy closes, or in the fall with standing crop stubble) to confirm the row spacing and plant spread within the row are consistent with the row spacing and opener type observed on the seeding implement and recorded in the field record sheet. To differentiate between no till and reduced till, dated field records will be required for go-forward tonnes. A second field visit may have to occur in late fall and/ or early spring to determine field passes for distinguishing reduced till from no till, particularly as these pertain to fertilizer application or tillage operations for weed control.