Methodology Synthesis to Supplement Cropland Management Protocol Development

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1 Introduction

One important component of the Reserve's protocol development process is consideration of whether there are existing methodologies or protocols which could serve as a starting point, due to the fact that standardized protocols are more easily developed where sound scientific methods already exist to determine baselines and quantify emission reductions. A number of GHG offset protocols exist, in various stages of development, that address some combination of the activities the Reserve is considering for inclusion within the Cropland Management Agricultural Project Protocol.

This "Methodology Synthesis" will supplement the Cropland Management protocol development process by providing a review of two comprehensive and relevant protocols that have been used in practice for both voluntary and regulatory purposes, the respective protocols of the Chicago Climate Exchange (CCX) and Alberta, Canada's Offset Program (Alberta). The purpose of the synthesis is to provide a quick reference for workgroup members and stakeholders to how key protocol criteria are addressed in other protocols and ultimately to inform discussion of similar elements in a Reserve protocol. While other methodologies will also be informative, they have not been synthesized here. For a brief review of some of the other relevant methodologies, please refer to T-AGG's Summary of Existing and Developing Agricultural Offsets Protocols.

Due to the primary focus of this Methodology Synthesis on the CCX and Alberta protocols, a brief overview of each respective program is provided below. The remainder of the paper describes the protocol criteria and methodologies looking separately at the CCX and Alberta programs.

Chicago Climate Exchange (CCX)

CCX launched its trading operations with 13 charter members in 2003. CCX Members, who are largely entities whose emissions would likely be capped under a regulatory program, "make a voluntary but legally binding commitment to meet annual GHG emission reduction targets. Those who reduce below the targets have surplus allowances to sell or bank; those who emit above the targets comply by purchasing CCX Carbon Financial Instruments (CFIs)," which are generated through the implementation of offset projects that sequester, destroy or reduce GHG emissions." The offset program established a number of programmatic rules "to provide easy to understand performance criteria for potential Project Proponents." These general criteria include whether or not a particular category of actions is:

- Rare (e.g. best-in-class actions)
- Voluntary (e.g. not legally required)
- Recent
- Verifiable
- Permanent
- Avoids the creation of perverse incentives that would result in increases in GHG emissions on or off the project site
- Conservative

CCX project protocols are meant to comply with the standards of ISO 14064-2, which establishes the industry standard for quantification, monitoring and reporting for GHG emission reduction projects. For additional information on the CCX program, please refer to the Overview section of their website and their Offset Program Overview page. General criteria for offsets are

established in the "CCX General Offset Program Provisions" document, while the "CCX Offset Program Verification Guidance Document" provides general guidance on verification activities.

Of the ten CCX project protocols currently available, one of those protocols, the "Continuous Conservation Tillage and Conversion to Grassland Soil Carbon Sequestration Offset Project Protocol" is particularly relevant for the Reserve's Cropland Management protocol development. 20 million acres on 12,000 farms have been enrolled under this protocol since it became active in 2004.[1] The full protocol[2] is available for download, and a brief overview of the project type is available on the CCX website.

Alberta Offset System

The Canadian province of Alberta was "the first jurisdiction in North America to impose comprehensive regulations requiring large facilities in various sectors to reduce their greenhouse gas emissions." Under the provincial "Climate Change and Emissions Management Act," Alberta has required annual reporting of air emissions since 2003, and the Specified Gas Emitters Regulation, which went into effect July 1, 2007, established a regulatory framework for the Alberta Offset System through emission reduction targets for regulated entities and guidelines for achieving compliance. Additional information on the Alberta legislation, regulation, and policy development is available on their website, as is more specific information on their Offset System. Similar to the CCX program, Alberta also provides an "Alberta Offset Credit Guidance Document" and an "Alberta Offset Credit Verification Guidance Document."

The Alberta system has approved numerous protocols, the full list of which is available on its website, with many more currently under review and in various stages of development. The "Quantification Protocol for Tillage Systems Management" is particularly relevant to the Reserve's Cropland Management protocol development and will be reviewed here. Resources available on Alberta's website include: version 1.3 of the quantification protocol,[3] an Additional Guidance Document, and a Technical Background Document, which explains much of the quantification approach. The Reserve recently learned that Alberta Environment, the Alberta program's regulatory agency, is currently considering revisions for a version 2.0 protocol update. Though version 2.0 is not yet publicly available, it provides mostly additional clarification to the methodology outlined in earlier versions, as opposed to whole-scale changes. For the most part, this paper reviews protocol version 1.3, but aspects of version 2.0 have been incorporated into this methodology synthesis, as necessary for clarification purposes.

[1] Cooley, David, Lydia Olander, and Lucy Henry, "T-AGG Summary of Existing and Developing Agricultural Offset Protocols," Technical Working Group on Agricultural Greenhouse Gases (T-AGG), Nicholas Institute for Environmental Policy Solutions, Duke University, November 2009, Available at: http://nicholasinstitute.duke.edu/ecosystem/t-agg/T-AGG_protocol_summary.pdf

[2] Chicago Climate Exchange, "Continuous Conservation Tillage and Conversion to Grassland Soil Carbon Sequestration Offset Project Protocol," 30 September 2009, Available at: http://theccx.com/docs/offsets/CCX_Conservation_Tillage_and_Grassland_Conversion_Protocol_Final.pdf

[3] Alberta Environment, "Quantification Protocol for Tillage System Management," version 1.3, February 2009, Specified Gas Emitters Regulation, Available at: http://environment.gov.ab.ca/info/library/7918.pdf

2 Project Eligibility and Other Requirements

CCX

Project Definition and Eligibility Criteria

Eligible project activities are continuous conservation till and conversion from cropland to grasslands, which are defined in the CCX Protocol as:

- **Conservation till:** "managing the amount, orientation and distribution of crop and other plant residue on soil surface year round while limiting soil disturbing activities to only those necessary to place nutrients, condition residue and plant crops."[4] Continuous conservation till refers to maintaining conservation tillage practices for the duration of the crediting period (i.e. 5 years).
    - The protocol also lists a number of "approved implements," which include: "no-till and strip-till planters; certain drills and air seeders; strip-type fertilizer and manure injectors and applicators; in-row chisels; and similar implements that only disturb strips and slots."
    - Though both the conservation till definition and approved implements come directly from the 2006 Natural Resources Conservation Service (NRCS) National Handbook of Conservation Practices, Standard 329, the protocol requires that project developers meet the protocol's definition, not necessarily holding them to all components of the standard. For example, Standard 329 requires that the Soil Tillage Intensity Rating (STIR)[5] be no greater than 30, while the CCX protocol does not require meeting a particular STIR threshold, except in North Dakota, where the more rigorous STIR of 20 or less is required, per Appendix B.
- **Grassland conversion:** "the act of converting land previously used for crop production to grassland cover for the purpose of capturing (sequestering) atmospheric carbon through photosynthesis during growth, and allowing the vegetation to remain on and in the soil, wherein the vegetative matter will decompose to stable organic carbon."
- Certain additional eligibility criteria apply, depending on where a project is located, as will be addressed in the following section.
- Projects on federal and state lands are not eligible. Projects on tribal lands are eligible.
- Projects receiving Conservation Reserve Program (CRP) or other conservation program cost-share payments for conservation till or cropland conversion are eligible.

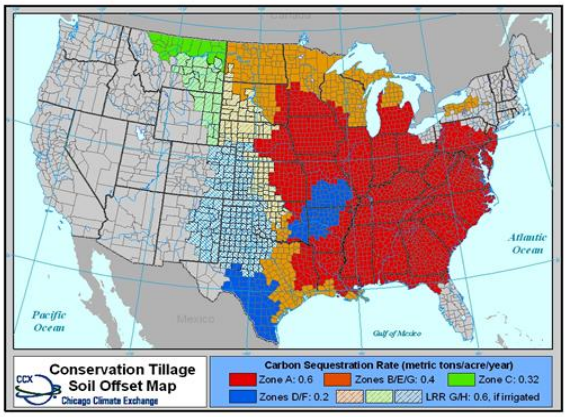
Geographic Eligibility

- Conservation tillage projects are eligible within a select-subset of states, as shown in Map 2 below. Ineligible regions include: the Western states, much of the Northeast, and the Florida panhandle. Grasslands conversion projects, on the other hand, are eligible in all 48 continental states in the US. However, projects of both types generate offsets at different rates depending on their location (See Maps 1 and 2 below).

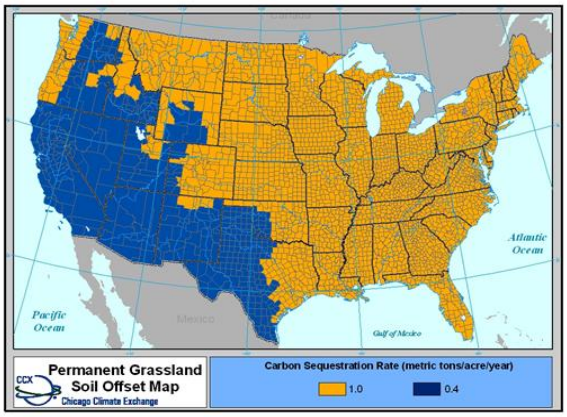
[4] NRCS National Handbook of Conservation Practices (2006), as cited in the CCX Protocol.
[5] STIR is an NRCS-developed and maintained, web-based tool available for most US regions and a large number of crop-types. It is a numerical value calculated using based on factors determined by crop management decisions being implemented for a particular field. For more information, see the NRCS STIR Fact Sheet and the STIR section on the NRCS website.

- Eligibility for Conservation Till projects is further limited by a number of additional region-specific eligibility requirements outlined in Appendix B of the Protocol. These regionally-specific requirements include such restrictions as: allowing/disallowing the use of certain implements, caveats for eligibility/ineligibility of some crops and the limited eligibility of others (e.g., certain crops in certain regions are eligible only in conjunction with a cover crop).
- In the case of conversion to Grasslands projects, there are fewer regionally specific eligibility requirements. There are only two carbon sequestration coefficients, one for the western US and another for the rest of the country. In the east, projects are allowed to hay, grain or burn grasses in the project area. The drier Western states receive a lower crediting rate and are eligible only if the projects establish "permanent (i.e. not harvested) grass cover plantings."

Map 1 Conservation Tillage, CCX



Map 2 Conversion to Grassland, CCX



Ownership

- CCX requires enrolled land to be either owned or "controlled by" the Project Developer.
- Leased land is allowable as long as the lessee has decision-making authority over the land's management. Additionally, "a lease agreement need not be for the term of the project, but the Project Owner, and/or Aggregator, assumes responsibility for any loss of control of the land and subsequent debits from the reserve pool for nonconformance."
- The Project Developer is required to provide documentation to the aggregator/verifier, which demonstrates clears ownership over the GHG mitigation rights. The primary documentation required by CCX is the USDA-Farm Service Agency (FSA) 578 for every enrolled parcel. The FSA-578 form demonstrates who has management control over the land, while also providing significant information on the crop land under cultivation.

Start Date

- For Conservation Tillage projects, CCX allows projects to be eligible "regardless of the implementation date of project," noting that C*ontinuous* Conservation Tillage is "a yearly management decision which can easily be altered or reversed." Implicitly, the start date is tied to the date of adoption of continuous as opposed to intermittent conservation till.
- Credits are typically generated beginning with the year in which the project is enrolled, but pre-existing projects may receive credits for the cropping year previous to the year of enrollment, provided that all protocol requirements were met and the previous year's

tillage practices can be verified. The previous cropping year does not count toward the total crediting period allowed.

- The start date policy for Grassland Conversion is more explicitly tied to the date of adoption of the management change, requiring documentation (in the form of a CRP contract, seeding records, etc) which demonstrates the grass seeding date. There is a "look back" policy for Grassland Conversion that allows for projects commenced as early as January 1, 2003 to be enrolled provided they can meet the documentation requirement.

Crediting Period

- The crediting period under the CCX protocol is five years for both project types.
- Pre-existing conservation till projects that register a previous cropping year's offsets are effectively granted a six year crediting period, as CCX does not count that previous year in the five year forward contract commitment.

Legal Requirements

- For both conservation tillage projects and conversion to grassland projects, CCX explicitly states that projects are not eligible where the project activity is required by law, and in the Verification section the protocol goes on to state that "there are currently no such laws in the United States" that require either project activity.
- CCX also notes that USDA/NRCS programs are voluntary and therefore participation should not preclude projects eligibility.

Performance Standards

- Generally, the CCX protocol states that soil carbon projects are ineligible where conservation tillage practices and/or grassland planting can be considered "a standard business practice" (i.e. business as usual or common practice).
- Recognizing that intermittent no-till adoption would likely not meet this condition, the CCX protocol asserts in Section 5.7.3 that "while occasional use of conservation tillage is more widespread, continuous conservation tillage remains rare," which is supplemented by estimates based on expert opinion that 5-10% of US farmland is under continuous conservation tillage. (USDA ARMS survey data released in November 2010 and reported on in a companion Background Paper under preparation by the Reserve suggest that the actual adoption rates of continuous no-till may be much higher.)
- The CCX protocol assumes that that "conversion of cropland to grasslands rarely occurs [i.e. is not common practice]… without significant incentives beyond the value of the grass" and that maintaining grasslands after expiration of a CRP contract and its incentives is also "uncommon practice." Currently enrolled CRP lands as well as expired CRP lands are both eligible under the CCX protocol.
- The implication is that the adoption rates for continuous conservation tillage and conversion of cropland to grassland, being "rare," do not exceed a threshold for common practice; however, a specific threshold defining a rate of adoption that would indicates a level consistent with common practice is not provided by the protocol.
- Once a project is registered with CCX, its eligibility will not be affected by changes to common practice criteria for the remainder of the crediting period.

Aggregation

- CCX explicitly allows for aggregation and outlines extensive processes for aggregation within the protocol itself. While aggregation is an important protocol development issue, details on the CCX aggregation approach will not be further elaborated in this paper and will be a future topic for discussion.

Alberta

Project Definition and Eligibility Criteria

- Many eligibility requirements (i.e. start date, crediting period, ownership requirements) are addressed in Alberta's program-wide "Offset Credit Project Guidance Document," and are outlined in the respective sections below. Specific eligibility requirements for a given project type, such as the project definition itself and exceptions to the general program rules, are provided within each protocol.
- The Tillage Management protocol is applicable to all annual crops.
- Perennial crops are "not within the scope of the protocol," as the associated tillage practices are typically not comparable with annual crops (i.e. tillage of only the inter-row zone is necessary for perennials). However, they are not entirely ineligible. The Additional Guidance Document and version 2.0 update outline certain circumstances when the inclusion of perennials can receive some credit (e.g. when perennials are rotated back into annual crops, when a perennial crop is terminated and immediately reseeded with an annual crop). (See Additional Guidance Document for full explanation.)
- Fallow lands are also ineligible for this protocol.
- Alberta distinguishes between no-till, reduced till, and full-till management practices, as a component of the project definitions, outlined in the table below, which includes clarifying revisions from version 2.0. These tillage definitions, including the 10% discretionary tillage, are aligned with the process-based modeling quantification approach discussed later in this paper. Project developers must prove to the verifier that these definitions are met.

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

- Though carbon accumulation is considered on a calendar-year basis, tillage definitions (i.e. number of allowable passes, number of cultivations, length of fallow period) apply to the normal harvest year for the crop.

- Manure application is permissible under the protocol, but does not receive any additional credit. Any resulting change in tillage practices due to the manure application, however, must be quantified.
- It is also worth noting that Alberta's protocols were designed to be "layered." Even though this project type is specific to conservation tillage in annual crops, protocol developers considered linkages to other potential project types during development. This approach allows the possibility, for example, of a no-till project and a nutrient management project to be implemented simultaneously on the same piece of cropland. Alberta's "modular" approach is discussed further in the Section of this Paper on "GHG Emissions Boundary."

Geographic Eligibility

- The methodology was developed for annual crops throughout Canada.
- However, under Alberta's Offset Program, only offset projects implemented within the province of Alberta will be considered for compliance purposes.
- In addition, the methodology is readily applicable to the Parkland and Dry-Prairie regions, effectively limiting eligibility to the two agricultural regions of Alberta unless further work is undertaken. The "Assurance factors" used by Alberta as a tool to address "permanence" (see section on Permanence for more discussion on derivation and purpose of Assurance factors) were estimated for all regions. However, only those developed for the agricultural regions of Alberta (Parkland and Dry Prairie), have been fully vetted by regional experts. Additional work would need to be done on the assurance factors of other regions if the methodology were to be applied to other Canadian provinces. Similarly, definitions of tillage systems within the protocol are defined specifically for the Parkland and Dry Prairie regions.
- Projects on irrigated land within the Dry Prairie and Parkland regions are both eligible, however, only projects on irrigated land in the Dry Prairie region are credited at a higher rate due to irrigation (e.g. irrigated Dry Prairie projects apply the higher Parkland carbon sequestration coefficient).

Ownership

- Before undertaking a project, "legal ownership of the GHG reductions and removals must be established by contract or other legal agreement."
- A project may be "implemented by the land lessee and not the land owner," assuming such a contract exists.
- Similarly, a project may be implemented on "crown land" (i.e. analogous to federally owned land in the US), assuming the proper GHG ownership contracts are in place.

Start Date

- Generally, the project start date for all Alberta protocols is "the first day of operation of the facility or project," which must occur on or after January 1, 2002.
- The start date policy is further clarified in version 2.0 of the Tillage Management Protocol. A project implementing no-till or reduced till starting in 2002 could register at anytime and receive credits starting from the 2002 start date, if the management practices can be verified.

Crediting Period

- The project crediting period is set at a period of 10 years, and "an extension for another 10 years may be granted by Alberta Environment" for a total of 20 years.
- The intent of the 20-year (total) crediting period appears to be related to maintaining stored carbon for a period of time consistent with the time it would take for carbon sequestration to reach a saturation point (i.e. when net soil carbon flux approaches zero).
- Coefficients may be updated during that crediting period, if a new version of the protocol is adopted. New coefficients must be applied for the remainder of the crediting period. However, the protocol guarantees that coefficients for the 2002 to 2012 crediting period will remain constant.

Legal Requirements

- The Tillage Management Protocol does not address existing legal requirements, which might pertain to this project type.
- However, the general Offset Guidance Document requires that project activities not be required by law.

Performance Standards

- The Alberta protocol applies what it calls an "adjusted baseline approach," which uses proportional additionality to "adjust" or "discount" carbon sequestration coefficients to account for current adoption levels of reduced and no till practices, as reflected by the most recent Agricultural Census. The methodology for applying the adjusted baseline approach is discussed further in the Quantification Section of this paper.
- If the project meets the eligibility criteria of the protocol, it is eligible regardless of historical practices or actual carbon stock levels at the project location, as a discount is applied to each participating project.

Aggregation

- While it was unclear from earlier protocol versions whether the Alberta protocol allows for aggregation, version 2.0 clarifies that aggregated projects are eligible. However, extensive details on how aggregation would work in the context of the Tillage Management Protocol are not provided. While aggregation is an important protocol development issue, details on the Alberta aggregation approach will not be further elaborated in this paper and will be a future topic for discussion.

3 Project and GHG Assessment Boundaries

CCX

GHG Assessment Boundaries

CCX states that a "clearly defined boundary is vital to accurately assessing emissions reductions due to… [project] activities," and notes the ISO 14064-2 requirement that the project's GHG Sources and Sinks be categorized as controlled by, related to, or affected by the project. The CCX protocol goes on to discuss each of these categories, but does not distinguish separate GHG assessment boundaries for continuous conservation till and conversion to grasslands in the protocol explicitly. In practice, the two project types may vary in their GHG assessment boundaries.

The controlled GHG sources under the CCX Protocol refer to those that are "part of the harvesting and planting process but are directly attributable to the conversion" to the new management practice, whether it be a conversion from conventional or intermittent conservation till to continuous conservation till, or a conversion from cropland to grassland.

CCX assumes that there are no "related" GHG sources or sinks (i.e. upstream material or energy flows) associated with either type of project. Additionally, CCX assumes leakage (also called "affected" sources/sinks or "secondary project impacts") to be zero for both continuous conservation tillage and grassland conversion projects, and as such, does not require a project specific leakage assessment.

CCX is somewhat conservative in its treatment of project emissions. Though continuous conservation tillage typically lowers on-farm fuel-use (and subsequently emissions), the CCX protocol does not allow for any of these associated reductions to be credited. The protocol assumes that it is extremely rare for there to be an increase in emissions due to the project, but if there is reason to suspect project emissions increased, the verifier should require quantification of these project emissions. That said, no methodology is provided for quantifying these emissions.

Project Boundaries

The boundary for the project is "the farmland under consideration for Offsets on which the sequestration activity is taking place."

Alberta

GHG Assessment Boundaries

The Alberta protocol has a fairly comprehensive and complete list of definitions for sources and sinks within the protocol, as well as numerous process flow diagrams and information on the rationale for including/excluding the sources and sinks (See Tables 2.1, 2.2, 2.3). The GHG assessment boundary considered by the Alberta Protocol is relatively broad, with the protocol identifying a host of upstream and downstream "related" sources and sinks, such as seed production and fuel delivery, many of which are ultimately excluded from project quantification. The rationale for those sources/sinks ultimately excluded from quantification is two-fold: emissions from seed production, for example, are likely to be equivalent to the baseline

condition, while sources such as fuel delivery are "not relevant to the project," as they are likely to be capped under proposed GHG regulations.

Of the 17 related or controlled sources and sinks identified for baseline and project conditions, only 4 pairs (e.g. baseline and project source counted as one "pair") of sources/sinks are included in Alberta's quantification methodology. These sources/sinks include:

- Pesticide production (off-site)
- Fertilizer and lime distribution (on-site)
- Pesticide distribution (on-site)
- Soil crop dynamics (on-site)

Though the first three sources must be quantified, the protocol notes that the quantification methodology for each will evaluate whether project emissions from these sources are equivalent to the baseline condition. The fourth source/sink, "soil crop dynamics" is most directly linked to the project activity, and is characterized as a summary category encompassing numerous sources and sinks. "Soil crop dynamics" is defined as: "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." Though this category primarily considers carbon dioxide emissions and carbon sequestration, it also includes nitrous oxide (N_2O) emissions from the project. Notably, the protocol's default coefficients assume that no-till and reduced tillage will consistently reduce N_2O emissions in the drier "prairie" soils of Canada. Assuming directional certainty of N_2O emissions, however, may not be an option in the US, due to potential N_2O increases in wetter regions.[6] Version 2.0 of Alberta's protocol notes this potential emissions increase in wetter regions and has quantified these emissions for Central and Eastern regions of Canada.

The Alberta protocol specifically addresses "modularity" in agriculture protocol development. Explicitly recognizing the interdependent nature of cropland management practices, this tillage management protocol was developed in such a way that it could be "layered" or "stacked" with other protocols across a number of project areas, as they are developed. The protocol notes that Alberta Environment will consider these types of "protocol linkages" moving forward, with the newest recently adopted Nitrogen Management Protocol (adopted in October 2010) in particular.

Project Boundaries

The project boundary is farmland under no and reduced till.

[6] Eagle, Alison et al. "Greenhouse Gas Mitigation Potential of Agricultural Land Management in the United States: A Synthesis of the Literature," Technical Working Group on Agricultural Greenhouse Gases (T-AGG) Report, Nicholas Institute, Duke University, October 2010, Available at: http://nicholasinstitute.duke.edu/ecosystem/land/TAGGDLitRev

4 Permanence

CCX

The CCX Protocol addresses permanence with two tools: a Permanence Reserve and a Soil Carbon Reserve Pool. The Permanence Reserve is used to address reversals occurring after the end of the project's contract period, using discounted crediting throughout the crediting period. During protocol development, outside experts estimated average sequestration rates by region, which CCX "then discounted by 10-20% in order to account for the potential loss of carbon should project participants reverse practices by returning to conventional tillage." The Permanence Reserve represents a program-wide pool of "actual offsets that have occurred but have never been issued to the Project Owner." The discount applied to account for permanence, is also explicitly noted to serve as a mechanism of "conservativeness" in quantification of sequestration rates, elsewhere in the protocol, as well.

To address reversals occurring during the contract period, for continuous conservation till projects, the CCX Protocol uses the Soil Carbon Reserve Pool. Each continuous conservation till project must place 20% of the offsets it generates into that Reserve Pool. These offsets remain the property of the Project Owner and are "released to the Project Owners upon satisfaction of the long term commitment" (i.e. completion of the project's 5-year crediting period with no reversals / tillage events). In the case of non-compliance with the CCX Protocol (e.g. a reversal event occurs during the project crediting period), offsets held in the Reserve Pool will be canceled in an amount and vintage equal to the quantity of offsets issued to the Project. Where reversals exceed the offsets available in the Reserve Pool, Project Owners will be required to make up the difference by purchasing offsets. Offsets remaining in the Soil Carbon Reserve Pool are released back to a project for sale after the 5-year contract period ends.

Reversals from conversion to grasslands projects are addressed somewhat less explicitly in the Protocol. The Permanence Reserve discussed above does address reversals occurring after the end of the project's contract period in the same way as reversals are addressed for continuous conservation till projects. Though treatment of reversals during the contract period specifically for conversion to grassland projects is not explicitly addressed in the protocol, it can be inferred that reversals for conservation tillage projects are applicable for conversion to grassland projects as well.

Alberta

The Alberta protocol addresses permanence through the use of an "Assurance Factor," which is a "risk-based discounting factor" that accounts for the "risk and magnitude of carbon sequestration reversal due to tilling events occurring in fields that would otherwise be under reduced and no-till practices." More specifically, it accounts for "the average number of tillage events anticipated over a 20 year period" across all farms within a given region.

To develop these assurance factors, Alberta consulted with six contributing prairie-based technical experts, who were asked "to conservatively estimate the number of tillage reversal events for each of the regions and practice types" for a twenty year period. From a range of reversal estimates, an average number of reversals were determined then converted to an inverse percentage representing the chances that a reversal will not occur during the 20 year crediting period. For the Parkland and Dry Prairie regions (those within Alberta whose

Assurance Factors have been fully vetted), the Assurance Factors range from 87.5 to 92.5% (e.g. 92.5% of sequestered carbon is assured not to be reversed).

As will be discussed in more detail in the "Quantification Options" section of this paper, the assurance factor is multiplied by the "Net Soil Organic Carbon Coefficient," effectively adjusting the sequestration coefficient downward such that the adjusted factor represents the amount of sequestration that is assured to remain stored permanently, according to program assumptions.

Early versions of the Alberta protocol discuss permanence mechanisms without reference to a "Buffer Reserve Approach." However, Alberta Environment is poised to release a significant protocol update (version 2.0) in early 2011, in which the objective of the Assurance Factor mechanism is further clarified. In version 2.0, it explicitly clarifies that the Assurance Factors effectively contribute to a "buffer reserve."

5 Quantification Options

CCX

The protocol uses standardized offset issuance rates (e.g. sequestration rate or default factor). During protocol development, default factors were developed by a technical advisory team of leading U.S. soil scientists from average regionally-specific sequestration rates published in peer-reviewed academic literature. For conservativeness, these sequestration rates were then discounted by 20%. As noted above, this same 20% discount factor is also intended to address post-crediting reversal risks. Technical details on the derivation of the rates are not provided in the protocol. The protocol provides region-specific rates for both continuous conservation till and conversion to grassland. The protocol's Appendix B is organized by region and includes region-specific crediting rates, while clarifying which crops, practices, and soils in each region are eligible. The effects of irrigation are factored into default factors as well. Specifically, irrigated cropland in certain regions has a higher default factor than non-irrigated cropland in the same region.

The quantification methodology under CCX is relatively straightforward. Once a project developer determines the appropriate default sequestration factor and eligibility constraints for the region, quantification entails simple multiplication of the qualifying acreage by the sequestration rate and subtracting out project emissions (if any).

Emissions Reductions = (Qualifying Acres)*(Sequestration Rate) – (Project Emissions, if any)

Though no methodology is provided for quantifying on-farm or project emissions, the verifier is asked to ensure that these emissions are properly accounted for, if the verifier has reason to believe that emissions have increased relative to the baseline scenario. Finally, as noted in the Permanence Section of this paper, 20% of emissions reductions are transferred to the Soil Carbon Reserve Pool, to be released back to the Project Developer upon completion of the crediting period without any reversals.

Alberta

Quantification Performed by Project Developer

Alberta's quantification methodology is also based on standardized sequestration factors ("coefficients"). Though the protocol provides a full explanation of how to derive these factors (See Appendices A, B, C, as well as the subsequent section of this paper), project developers typically do not need to perform the derivation themselves. The protocol (in Appendix A, Table A.3) provides all necessary "Net Coefficients," also called "Baseline adjusted emission factors," derived by region for each tillage practice.

As mentioned above under Permanence, the Net SOC Coefficient (SOC refers to soil organic content) is multiplied by the appropriate region's Assurance Factor, available in Appendix B. The Assurance Factor is applied only to the Net SOC Coefficient because this is the only SSR that is potentially reversible. After applying the assurance factor to Net SOC, the adjusted coefficient is added to the Net N_2O and Net Energy coefficients to derive a "Total Coefficient," specific to each practice change, which encompasses all included SSRs.

The project developer must simply multiply the "Total Coefficient" by land area under that tillage practice to calculate the total emissions reductions. If more than one tillage practice is in place in one project, the calculation must be repeated for each practice change, and total emissions reductions summed. A summary of the necessary equations are provided below.

Total Coefficient = (Net SOC Coefficient * Assurance factor) + (Net N20 Coefficient) + (Net Energy Coefficient)

Total Offsets Generated = (Total NT Coefficient) * (Area of No-Till land in Project) + (Total RT Coefficient) * (Area of RT land in Project)

Deriving Sequestration Coefficients

As mentioned, project developers typically do not need to derive the "Net Coefficients," as they are provided in the protocol. However, an explanation of how these coefficients were derived is provided here, followed by additional information on Alberta's "Flexibility Approach" which might require a project developer to perform their own derivation.

Alberta's carbon sequestration factors (or "*raw* SOC coefficients") were derived from the Century 4.0 biogeochemical process model and applied to three tillage system practice changes for five regions across Canada. The three practice changes for which "raw SOC coefficients" were derived are:

- Full Till to No-till (FT to NT)
- Full Till to Reduced Till (FT to RT)
- Reduced Till to No-Till (RT to NT)

Next, the adjustment to ensure proportional additionality per the "adjusted baseline approach" must be made. The raw SOC coefficients, for each given practice, are multiplied by the proportion of land in a given region that is potentially available for that respective practice change and summed, which results in a Net SOC Coefficient for each practice. More specifically, the equations for deriving the Net SOC Coefficient for No-Till and Reduced Till, respectively, are as follows:

> Net SOC NT Coefficient = [Raw Coeff(FT to NT)*(%Area in FT)/100%] + [Raw Coeff(RT to NT)*(%Area in RT)/100%]
>
> Net SOC RT Coefficient = [Raw Coeff(FT to RT)*(%Area in FT)/100%] + [Raw Coeff(NT to RT)*(%Area in NT)/100%]

Described another way, the proportion of carbon gained due to current adoption is calculated and subtracted from the sequestration coefficient, allowing for only new, incremental carbon to be credited. It should be noted that the proportions of land under a given tillage practice are based on 2001 Census data and are meant to be static. The protocol notes that they will be updated every ten years, with adoption rates next due to be updated in 2012.

The same methodology is applied to derive a Net N_2O Coefficient and a Net Energy Coefficient for each tillage practice, using the respective raw coefficients. Similar to the raw SOC

coefficients, raw N_2O coefficients were derived from the Century model, while the raw energy coefficients were derived from the GHG Farm tool developed by Bobbi Helgason for Canada.[7]

At that point, as discussed above, the Net SOC Coefficient is multiplied by the appropriate Assurance Factor, added to the Net Coefficients for N_2O and Energy to derive a "Total Coefficient." The final quantification step is to multiply the resulting "Total Coefficient" by the total land under a given tillage practice, which should result in the total tonnes of CO_2e sequestered.

Appendix C of the Alberta Protocol provides a sample derivation of these formulas for application to no-till projects in the Parkland region of Alberta.

All "raw coefficients" are derived from Canada's National Carbon and Greenhouse Gas Accounting and Verification System (NCGAVS) for reporting annual Canadian agricultural emissions and removals under the UNFCCC. Measured data from long term cropping experiments across Canada was used to calibrate the Century 4.0 model to derive the sequestration factors for SOC and N_2O. Crop rotations typical of each respective region were considered, while crops and practices representing 5% or less of the agricultural land area in that region were excluded. Thus, on the project-level, the methodology assumes that all annual crops sequester carbon at the same rate, regardless of the inherent variability in sequestration. Though this would lead to overestimation of reductions in some projects, and underestimation in others, these effects in principle cancel each other out, achieving "accuracy in aggregation," when the program is considered as a whole. A different tool, the GHG Farm Tool, was used by Alberta Environment to derive the energy coefficient used in this protocol.

Flexibility Approach

Alberta's quantification methodology also incorporates a flexibility provision that allows for the application of "custom coefficients" in the case that a project developer can demonstrate more appropriate emission factors than those applied in the protocol. There are extensive requirements for approving custom coefficients, which are fully outlined in a separate "Soil Carbon Custom Coefficient/Protocols Guidance Document." Any well-documented, peer-reviewed model with a reasonable "track record" may be used, as long as model assumptions are well documented and validated and a third party assesses the model's accuracy and sensitivity. Once validated, model data must be scaled up from site-specific data to a regional scale appropriate for use within the protocol. The evaluation results must be published in scientific literature by a third-party, and the Alberta government must approve the model and coefficients at various points throughout the process. Once a custom coefficient is adopted, it may be applied to any relevant project retroactively.

[7] Helgason, B.L., Smith, E., 2005. GHGFarm: An assessment tool for estimating net greenhouse gas emissions from Canadian farms. AAFC. As cited in Haak, Dennis "Tillage System Default Coefficient Technical Background Document," Soil Management Technical Working Group, October 2006, available at: http://carbonoffsetsolutions.climatechangecentral.com/files/microsites/OffsetProtocols/ProtocolReviewProcess/1stCycleProtocolReview/Tillage/14_No_Till_Default_Protocol_SMTWG_Oct2006_mod.pdf

6 Verification and Reporting

CCX

CCX has specific verification and reporting requirements. Project Proponents are responsible for monitoring and recordkeeping that ensures there is sufficient evidence to demonstrate compliance during verification, which must take place at least once annually for an aggregation of projects. Project documentation must be kept for a minimum of 2 years beyond project completion.

Third-party verifiers are required to become accredited or approved as a CCX Verifier. To do so, the verifier must submit a formal application, demonstrate a detailed understanding of the CCX Protocols they are wishing to verify, and be ISO-14065 accredited. Verification bodies which are approved as Designated Operational Entities under the Clean Development Mechanism (CDM) or approved as Verifiers by the Reserve may submit documentation from those programs as part of the application process. Verifiers are required to submit a statement on any existing conflicts of interest, prior to commencing verification activities for a given project.

A minimum of ten percent of project and ten percent of acres in an aggregate of projects is verified each year. For each verified project, the acreage is checked by the verifier and it must be within 3% of the "contracted claim." In addition, the non-compliance rate for all verified projects in an aggregate is calculated and must be below 3%; otherwise, non-verified projects will undergo corrections as well as the verified projects.

The CCX protocol provides detailed guidance on the ideal timing for field verification. The CCX protocol recommends that in the Midwest and Great Plains, the most desirable time for verification is Spring (April-June), ideally taking place at or within 2-3 weeks of planting to "provide the highest confidence regarding tillage practices (or lack thereof)" by allowing the verifier to "examine the maximum acreage of a field from the fewest observation points." The second most desirable time is fall, after harvest, typically October-November, though this is more challenging, as "old residue is more decomposed than in the spring and is often buried under the current year's harvested residue." Field verification is not recommended once snow has fallen.

Alberta

The Alberta protocol does not address verification issues specific to tillage management, but rather, addresses verification requirements more generally in its Program-wide "Alberta Offset Credit Verification Guidance Document" and the Specified Gas Emitters Regulation. The Alberta program establishes a set of qualifications which must be met by the verifier ("third party auditors").

The verifier's conflict-of-interest must be reviewed prior to entering into a contract, and a "Conflict-of-Interest Checklist" must be included in the Verification Statement.

Further information specific to verification procedures for conservation tillage projects is limited. The Alberta Protocol does indicate an Offset Project Plan is required, which must include Quantification, Monitoring and QA/QC Plans, but details are not provided on what parameters and activities shall specifically be monitored.

The materiality threshold is 5%, and the Alberta government requires that a “review” or “limited” level of assurance be provided for offset submissions.

Under the Alberta Offset Program, according to the “Specified Gas Emitters Regulation, a “compliance report” must be submitted by each regulated facility or Project on March 31, annually, reporting on the previous calendar year’s emissions, offsets, etc. As the regulation requires that these annual compliance reports be verified, therefore, it is assumed that verification must also take place annually.