Nitrous Oxide Emission Reductions Protocol (NERP) Validation Study Report

Year One

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Submitted by: The Prasino Group

Disclaimer

This document has been produced independently by The Prasino Group at the request of the Climate Change Emissions Management (CCEMC) Corporation as specified under contract for the Protocol Validation Studies. It was produced according to the requirements in the Alberta Offset System's Nitrous Oxide Emissions Reduction in Agriculture Quantification Protocol v 1.0 October 2013[1]. The views expressed in this report are not necessarily the views of the Climate Change Emissions Management (CCEMC) Corporation.

[1] See http://environment.gov.ab.ca/info/library/8294.pdf

Findings to Date:

The purpose of the NERP Protocol Validation Study is to learn about the barriers, gaps, solutions and options for adopting the NERP protocol in the marketplace. More specifically, the objectives of the Study include:

- Validating, through small-scale pilots, how the protocol can be applied in the field;
- Providing guidance to producers, aggregators and verifiers on the implementation of the protocol at a commercial scale;
- Demonstrating how verification to a reasonable level of assurance can be accomplished following the available protocol (NERP v1.0; October 2010); and
- Catalyzing continued aggregation efforts for bringing offsets forward from aggregated agricultural projects.

In order to accomplish the above objectives, the NERP Protocol Validation Study team worked with the aggregation firm of AgriTrend – Agritrend Aggregation Inc. (ATAI). ATAI aggregated 6 farms, under the provision of the Quantification Protocol for Agricultural Nitrous Oxide Emissions Reductions, v 1.0, October 2010. The project year was 2011 with a baseline of 2008, 2009 and 2010. ICF-Marbek completed the mock verification and gap analysis on the aggregated project for the Protocol Validation Study. It should be noted that at the time of the mock verification, the state of ATAI's NERP project was such that the robust development of a 4R Consistent Plan, or the gathering of participating farm records was not complete and compiled in such a way to support a full mock-verification at reasonable level of assurance by ICF Marbek. Further, a formal Offset Project Report was not completed. However, ICF-Marbek did assess ATAI's Agri-Data Solutions platform to test the data management system and NERP quantification algorithms for supporting a correct GHG assertion. ICF-Marbek also completed farm visits to observe how the key data requirements are gathered at the farm level and what data controls were in place at these operations. Issues identified in the mock verification are reported here.

Version 1.0 of the Quantification Protocol for Agricultural Nitrous Oxide Emissions Reductions (NERP) is on AESRD's website based on an older protocol format compared to the current format for agricultural protocols in the Alberta Offset System. As a result, Section 5 has not been updated to meet Reasonable Level of Assurance as currently understood in the Alberta Offset System. Therefore, ICF-Marbek's verification recommendations reflect some of the needed updates for NERP to be consistent with the most current agricultural protocol format. Interpretive guides have been prepared in the past for ARD, with a detailed evidence table, but these are not part of the AESRD licensed version 1.0, which was used in the PVS Study's mock verification.

Key Findings from the PVS study are listed below. Please refer to the Interim Recommendations section for explicit recommendations for moving forward.

Protocol Recommendations for Revisions:

1) The NERP protocol needs to be revised to be consistent with the Conservation Cropping Protocol's Section 5 - Data Management section, particularly the minimum evidence tables.
2) Currently, the quantification methodology uses cropped area (i.e. seeded area) to calculate emission reductions. The protocol can be streamlined by allowing data and calculations to be completed on a mass basis for nitrogen input and yield data, rather on a unit per area basis (e.g. kg/ha) – which is the way the protocol currently quantifies the emissions. This would simplify the data collection process, manage uncertainty of fields having a crop failure by aggregating data at the farm level, and reduce verification costs. Both ICF-Marbek and the Saskatchewan adaptation process have identified this streamlining option. Further, to support these revisions – the following criteria could be applied:
    a. Criteria added along with this revision that specifies that the emission reduction quantification can be completed at the field level (rather than management zone level) if the EF_{ECO}, $FRAC_{renew}$, crop type and performance level are constant across a field. Similarly, the emission reduction quantification can be completed at the farm level for each crop if the EF_{ECO}, $FRAC_{renew}$ and performance level are constant across the farm. (See ICF Mock Verification and Gap Analysis Report – AgriTrend NERP).
3) Further guidance needs to be added to the protocol to clarify a number of items. These items include:
    a. Clarifying and confirming that the crop residue factors provided in Appendix E need to be corrected for a dry matter basis. Currently, it appears that these values have been provided on a standard moisture content basis, rather than a dry matter basis. This needs to be confirmed with Henry Janzen.
    b. Providing additional guidance on how to estimate the fraction of total area that is renewed annually ($FRAC_{renew}$). In the case of annual crops this factor is equal to one; however, for perennial crops it has to be forecasted based on the number of years that the crop will be grown. Additional guidance would make the process of verifying this factor easier.
4) Best management practices published by the Canadian Fertilizer Institute and other organizations indicate that soil testing may not be required on an annual basis. In contrast, the "post-harvest assessment" defined in the NERP protocol seems to indicate that soil testing is required annually after harvest. This requirement should be updated in the protocol to focus on the nitrogen balance assessment. Specifically, the protocol should clarify that the balance assessment can be used based on known nitrogen inputs from the year before and nitrogen consumption values for the yields achieved.
5) A number of changes/additions were made to the NERP protocol when it was being adapted for Saskatchewan. These changes/additions included:
    a. Adding clarity to assure that crop types are the same between the baseline and the project. This was done to ensure accounting equivalency.
    b. Added wording to clarify that if a crop is irrigated in the baseline it must also be irrigated in the project (also to ensure accounting equivalency).
    c. Allowing baling and removal of straw to be eligible activities if it can be shown that 70% of the straw is retained on the soil.
    d. Updating the quantification methodology to clarify that the reduction modifier should not be applied to fallow year emissions since no nitrogen management occurs in that crop year. Under the current AB NERP the reduction modifier is applied resulting in an overestimation of emission reductions.

It is recommended that these changes be considered in the Alberta NERP. These can be discussed at a future meeting.

Deletion from draft report on GHG Calculations[2].

Cost-Benefit Analysis:

1) The Cost-Benefit Analysis for the NERP PVS study was conducted on both a producer basis and an aggregator position basis. For the Aggregator Position, three scenarios were analysed – optimistic, expected and pessimistic (See Aggregator Spreadsheet and "The Benefit Cost Analysis of the Aggregator's Position as it Relates to the Nitrous Oxide Emission Reductions Protocol" documents).
2) The aggregator cost benefit analysis assumed:
    a. An existing aggregator would already have established a robust agronomic reporting framework that could keep track of agricultural practices and performance and that the aggregation functions would be an expansion of current information systems.
    b. Aggregators receive 40% of the market price, while producers receive 60%
    c. A seven year timeframe for the aggregator (over which start-up costs such as modifying the existing agronomic framework would be spread)
    d. Data gathering costs are 10% of the carbon offset price
    e. Verification costs are 3% of the carbon offset price
    f. Start-up costs are the same for each of the three scenarios (optimistic, expected, and pessimistic)

[2] ICF Marbek identified what they thought was an anomaly in the calculation in their mock verification report. After going through the technical expert review conducted December through to February 2014, it was clarified with ICF Marbek that the use of the reduction modifier did not represent double counting.

Aggregator Expected Scenario:

3) The results from the aggregator expected scenario indicate that the net present value of the stream of benefits and costs would be $479,000.00 over seven years. The cost per offset credit generated was $5.73 and the revenue per offset credit was $7.09. The net revenue per credit for the aggregator over the seven years was $1.36 per credit. These results would indicate that under the expected scenario assumptions (that current carbon offset credit prices would continue for 2 years and then increase to $23.00/tonne; 50,000 tonnes of credits were generated/year; and a discount rate of 3%) the aggregator would be expected to make a profit. The results are summarized in the table below.

Present Value of the Costs and Revenue, Cost per Credit, Revenue Per Credit and Net Present Value for the Expected Scenario	
Indicator	**Present Value**
Present Value of the Costs	$2,004,054.78
Present Value of the Revenue	$2,483,236.22
Cost Per Offset Credit Generated	$5.73
Revenue Per Offset Credit Generated	$7.09
Net Present Value	$479,181.44

4) Sensitivity analysis of the expected scenario revealed that:
   a. Fixed costs could increase by 10 or 20 percent and still result in a positive net present value for the aggregator (the break-even increase in annual fixed costs was found to be approximately 27.32%)
   b. The price of carbon could decrease to approximately $14.77 in year's three to seven to break-even if all other parameters remained the same.
   c. The quantity of offset credits could decrease to approximately 35,705 credits from the assumed 50,000 offset credits per year before a loss would be observed

Aggregator Optimistic Scenario

5) In the case of the optimistic scenario, as expected, both the aggregator's annual costs and annual revenues increased. Under this scenario, the net present value after seven years was $1.7 million. Furthermore, the cost per carbon offset tonne decreased from $5.73 in the expected scenario to $5.17 in the optimistic scenario; and the present value of the revenue increased from $2.4 million in the expected scenario to $4.4 million with the optimistic scenario. The optimistic scenario assumed that the carbon price remained the same for the first two years and then increased to $27.00 per tonne in year 3 to year 7; the number of carbon offset tonnes generated increased to 75,000 tonnes/year and a discount rate of two percent. The results are summarized in the table below.

Present Value of the Costs and Revenue, Cost Per Credit, Revenue Per Credit and Net Present Value for the Optimistic Scenario	
Indicator	**Present Value**
Present Value of the Costs	$2,712,547.05
Present Value of the Revenue	$4,426,857.17
Cost Per Offset Credit Generated	$5.17
Revenue Per Offset Credit Generated	$8.43
Net Present Value	$1,714,310.12

6) Sensitivity analysis of the optimistic scenario revealed that:
    a. The break-even increase in annual fixed costs was approximately 69.9%
    b. The price of carbon could decrease to approximately $9.13 in year's two to seven to break-even if all other parameters remained the same.
    c. The quantity of offset credits could decrease to approximately 39,170 credits from the assumed 75,000 offset credits per year before a loss would be observed

<u>Aggregator Pessimistic Scenario</u>

7) For the pessimistic scenario, the price of carbon was assumed to remain constant at $13.00 per tonne over the seven year period, the volume of offset credits was decreased to 25,000 tonnes and the discount rate increased to 5 percent. Under this scenario annual costs were higher than annual revenue, indicating that it would not be profitable for aggregators. Specifically, based on present costs and benefits over the seven years, the net present value for the aggregator would be negative $621,000. Furthermore, the cost to the aggregator of generating the offset was $7.84/tonne while revenue was only $4.30/tonne.

Present Value of the Costs and Revenue, Cost Per Credit, Revenue Per Credit and Net Present Value for the Pessimistic Scenario.	
Indicator	**Present Value**
Present Value of the Costs	$1,374,003.03
Present Value of the Revenue	$752,228.54
Cost Per Offset Credit Generated	$7.85
Revenue Per Offset Credit Generated	$4.30
Net Present Value	-$621,774.49

8) Sensitivity analysis of the pessimistic scenario revealed that:
    a. Annual fixed costs would have to decrease by approximately 55.3% in order to break-even
    b. Approximately 55,600 tonnes of carbon offsets would be needed in each of the seven years to break-even
    c. The price of carbon would have to increase to approximately $32.05/tonne in order to break-even (note: this price is higher than the price in the optimistic scenario do the differences in the underlying assumptions described above)

9) The producer cost-benefit analysis was conducted for three farms of similar size (3,000 ha) in three different soils zones (dark brown, brown and black) with three different crops (canola, spring wheat and feed barley). The analysis assumed:

a. The amount of nitrogen being applied increased slightly by 2 to 4 kg per acre with the change in management
b. Agricultural professionals would cost $7.50/acre for advice and administrative work
c. $1,000 would be needed for additional soil samples on the farm
d. Yield increased on average by 20% with implementation of the NERP and increased N Use Efficiency
e. An initial carbon price of $13/tCO$_2$e, of which 70% or $9.10 goes to the producer
f. The crops had the following moisture contents:

Moisture Content (%)	Canola	Spring Wheat	Feed Barley
Off the field	12.5%	18%	18%
Delivered to the elevator	10%	13.5%	14.5%

10) In the dark brown soil zone, adopting the NERP provided an increase in net farm income of $106.10/acre for canola, $72.73/acre for feed barley and $75.01/acre for spring wheat. The greatest increase in economic benefit came from the increased yield of the crops. For example, additional revenue from cropping for canola was $117.00/acre; whereas the additional revenue from carbon credits was $0.64/acre. Therefore, the revenue from selling the carbon offset credits is small relative to the revenue generated from better crop management. Based on the assumptions of the model, the cost of adopting the NERP ranged from $10.24 to $11.54 per acre for reed barley and canola, respectively. The table below summarizes the results.

Cost and benefits of NERP on Dark Brown Soil Zone			
	Canola	**Spring Wheat**	**Feed Barley**
Additional Costs for 4R Program on a Per Acre Basis (positive values are increased costs while negative values are decreased costs from the baseline).	$11.54	$10.24	$10.24
Additional Revenue from 4R program from cropping on a Per Acre Basis (positive values are increased revenue while negative values are decreased values)	$117.00	$84.70	$82.50
Additional Revenue from Carbon Credits (per Acre Basis)	$0.64	$0.55	$0.47
Net Change in Revenue per Acre	**$106.10**	**$75.01**	**$72.73**

11) A sensitivity analysis was undertaken on the price of carbon. With an increase in price to $23.00 per tonne, in the dark brown soil zone, the carbon revenue from the canola crop was $1.13 per acre, which was approximately $0.49 more per acre than the original situation. At $37.00 per tonne, the carbon revenue from the canola crop was $1.82, which was more than double the initial situation. The same type of relationship was found for barley and spring wheat.
12) Similar results were found in the brown soil zone. The increase in net revenue for canola was $106 per acre, followed by spring wheat at $75 per acre and then by feed barley at $73 per acre. Costs could increase substantially before the change in management would break-even. Once again the greatest increase in revenue was from the increased output from areas cropped. However,

the revenue from the carbon market was larger in the brown soil zone than in the dark brown zone. For example, the carbon revenue for canola was $0.95/acre (at a price of $13/tonne). The carbon revenue for spring wheat and feed barley was higher than when grown in the dark brown zone; however, the increases were not as large as with canola. The results are summarized in the table below.

Costs and benefits of NERP in the Brown Soil Zone			
	Canola	**Spring Wheat**	**Feed Barley**
Additional Costs for 4R Program on a Per Acre Basis (positive values are increased costs while negative values are decreased costs from the baseline).	$11.54	$10.24	$10.24
Additional Revenue from 4R program from cropping on a Per Acre Basis (positive values are increased revenue while negative values are decreased values)	$117.00	$84.70	$82.50
Additional Revenue from Carbon Credits (per Acre Basis)	$0.95	$0.69	$0.68
Net Change in Revenue per Acre	**$106.41**	**$75.15**	**$72.94**

13) In the black soil zone the costs of implementing the change in management to better utilize fertilizer were also small relative to the potential benefits from increased revenue from crop sales and carbon sales. The results are summarized in the below table.

Cost and benefits of NERP in the Black Soil Zone			
	Canola	**Spring Wheat**	**Feed Barley**
Additional Costs for 4R Program on a Per Acre Basis (positive values are increased costs while negative values are decreased costs from the baseline).	$11.54	$10.24	$10.24
Additional Revenue from 4R program from cropping on a Per Acre Basis (positive values are increased revenue while negative values are decreased values)	$117.00	$84.70	$82.50
Additional Revenue from Carbon Credits (per Acre Basis)	$1.49	$1.24	$0.94
Net Change in Revenue per Acre	**$106.95**	**$75.70**	**$73.20**

14) Overall, the results of the producer analysis revealed that the 4R program could provide an increase in net revenue per acre. Furthermore, the costs associated with implementing the protocol are small relative to the potential revenue that can be gained. Of the three crops analyzed, canola had the largest economic potential.

Documentation and Records[3]:

In general, the state of development of the ATAI NERP project could not support a robust assessment of documentation and records due to the level of development in the NERP v1.0; December 2010 Data Management section. The state of development of the ATAI project is likely indicative of most others scoping the NERP protocol at this time.

1) It's recommended that project developers have a concrete 4R Plan for each farm, as described in the NERP, and according to the Canadian Fertilizer Institute's training program for Accredited Professional Advisors. Field level practices and field sheets/electronic records need to be linked to the BMPs described in the 4R Plan at the appropriate performance level Basic, Intermediate or Advanced). Also, plans need to be traced to goals at the farm enterprise level.
2) Evidence needs to support the 4Rs – this includes rates of N applied, timing (including soil testing dates); placement (including linking the equipment used for seeding/fertilizing) and source for the field in question.
3) Methods for determining yield need to be sufficient to meet the requirements of the protocol. Current methods present a significant measurement risk for verification purposes.
4) A consistent template for 4R Plans would reduce verification risk.
5) A best practice guide to verification for NERP projects is needed to clarify documentation requirements and support reasonable level of assurance;
6) Clarification is needed in the protocol regarding whether soil testing is required on every field, every year. Queries from project developers and verifiers indicate that clarity is needed. Best practices by the CFI and IPNI indicate that soil testing may not be required on an annual basis, and nitrogen balances based on N applied, crop yield and crop N uptake tables. This includes approaches for post-harvest assessments.

Interim Recommendations:

Capacity of the Sector to Implement the NERP:

At this stage of the study, it is difficult to speak to the capacity of the sector to implement and adopt the NERP. Certainly, the study has found a number of barriers that would inhibit broad scale uptake. In general, those firms that have agronomists on the ground working with growers are in the best position to implement the NERP. Further, those growers who have electronic data collection linked to GPS - assisted application and yield equipment are also going to be in the best position to implement the NERP. In the next year of this study, the opportunity for ATAI to address these gaps and implement the NERP in a more comprehensive way will reveal the size of the opportunity. Given the complexity of the NERP, the state of technology implementation in the agricultural sector to date, and the strong grain and oilseed prices, the current value of carbon ($15/tonne) will make it difficult to attract growers in implementing the NERP beyond this PVS study.

[3] This section has been edited into general recommendations based on the NERP protocol validation study. Sensitive information related to ATAI's data management system have been removed.

However, there are some modifications to the protocol that will remove barriers, streamline implementation and hopefully improve uptake.

Recommendations to Address Major Challenges with Implementation of the NERP:

Due to inconsistencies in the way that farmers are measuring yield, and the level of accuracy of those yield measurements, The Prasino Group is working with a technical expert committee to identify acceptable yield methods for inclusion in a revision to the protocol. These will be incorporated as flexibility mechanisms within a revised protocol[4].

Secondly, a significant challenge with the NERP protocol is the need to establish a 'project or farm-level' historic benchmark baseline, based on 3 years of crop data. Given the issues with accurate yield estimates, the 3-year average baseline means that the NERP can't be implemented until at least 4 years for a particular crop on a farm, once the yield estimation methods are approved and incorporated into the protocol. Therefore, the Prasino Group, in conjunction with the technical expert review committee has established 2 dynamic baselines that can be used as alternatives and pre-cursors to a conventional historic baseline until 3 years of acceptable yields have been established. These will be included as flexibility mechanisms in the revised NERP protocol[3].

Both of these key pieces should enhance uptake of the NERP in Alberta, and will be completed by February 2013.

Recommendations for Immediate Revisions to the Protocol:

1. Update Section 5 - Data Management Section. This is already completed in the Interpretive Guide submitted to ARD under KHK Consulting contract and will be in the revised version of the NERP protocol.
2. Adopt the modifications to the NERP from Saskatchewan's version of the Protocol, in conjunction with the technical expert committee, which includes[5]:
    a. Add in the streamlining option allowing for data and calculations to be complete on a mass basis for nitrogen inputs and yield, with accompanying criteria listed above)
    b. Add applicability conditions for crop types to ensure accounting equivalency between baseline and project (this includes irrigated crops applied in baseline and project to ensure "like" comparisons)
    c. Allow baling and removal of straw to be eligible activities if it can be shown that 70% of the straw is retained in the field
    d. Fix the accounting glitch with summerfallow fields and the reduction modifier
3. Clarify requirements around annual soil testing vs nitrogen balance assessments
4. Potentially fix the problem with the application of the reduction modifier, by multiplying the modifier by the delta between the baseline emissions/kg of crop and the project emissions/kg of crop). The Prasino Group will prove the veracity of this potential modification by modeling a number of scenarios.

[4] This section edited from the original draft to reflect the status of protocol revisions as of June 2014.
[5] See Appendix A for an excerpt of SK NERP modifications

Further, the findings of this PVS study, including the mock verification, will be incorporated into the Best Practice Guide to Implementing and Verifying NERP projects. This guide will be prepared by The Prasino Group and reviewed by ICF-Marbek. The Guide represents a document that is appropriate to share with stakeholders after Year 2 of the PVS.

Appendix A: Relevant Documents

ICF Marbek's Mock Verification and Gap Analysis Report

Quantification Protocol for Agricultural Nitrous Oxide Emissions Reductions, Version 1.0, October 2010

Interpretive Guide to Applying the Nitrous Oxide Emissions Reductions Protocol, March 2012

Draft Saskatchewan NERP Protocol – excerpt from the Protocol Applicability section shown below:

To apply this protocol, the Project Developer must prove the following requirements:

1. *The 4R Consistent Plan, including clear identification of the baseline and project condition has been accredited and signed by an Accredited Professional Advisor;*
2. *All farms being included in the project are being implemented according to the 4R Consistent Plan and has received annual sign-off by the Accredited Professional Advisor;*
3. *New crops and land being added to the participating farms have correctly established three years of baseline data on crop events prior to including the crop in the farm/project;*
4. *Crop types, according to the list below, are the same in the baseline and project to ensure equivalency in straw/residue N accounting.*
    - *Wheat (all spring planted types)*
    - *Winter Wheat*
    - *Fall Rye*
    - *Barley*
    - *Barley silage*
    - *Corn*
    - *Corn silage*
    - *Pulses*
    - *Canola*
    - *Oats*
    - *Flax*
    - *Tame Hay*
    - *Alfalfa/clovers*
    - *Others;*
5. *Crops produced under irrigation in the 3 year average baseline are also under irrigation in the project for the duration of the project;*
6. *Baling and removal of straw is an eligible activity under this protocol; however, it must be demonstrated that 70% or more of the straw remains on the field to assure against declines in soil organic carbon[6];*
7. *In order to provide consistency and completeness to the greenhouse gas accounting under this protocol, all fields for a farm enrolled in an aggregation program, need to be part of the project and baseline greenhouse gas accounting;*

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[6] According to findings in Malhi et al., 2001 http://www.agriculture.gov.sk.ca/apps/adf/ADFAdminReport/19990026.pdf; Lafond et al., 2009; Lemke et al., 2010. Note normal baling activities result in less than 30% straw removal; on average it's 22% (Lafond et al., 2009.