Summary and Response to Public Comments

A draft *Methodology for N_2O Emission Reductions through Changes in Fertilizer Management* was developed by Winrock International and Applied Geosolutions, LLC for potential approval by the American Carbon Registry (ACR).

All new methodologies and methodology modifications, whether developed internally or brought to ACR by external parties, undergo a process of public consultation and scientific peer review prior to approval.

The methodology was posted for public comment from July 9 through August 2, 2010. Comments and responses are documented here. Additional public (Project Proponent and stakeholder) comments were received after the formal close of public comments, but were still responded to and considered in the final version of the methodology; those comments are also included here. In addition, ACR presented the draft methodology in three public stakeholder forums, which are noted at the end of this document.

Following public comments, the methodology was submitted to four anonymous scientific peer reviewers, experts in the field of nitrogen management and agricultural GHG mitigation. Two rounds of review comments, responses, and methodology revisions took place. The reviewers' comments and the methodology authors' responses to each are documented in a separate *Response to Peer Review Comments*, posted at www.americancarbonregistry.org.

Comments from Stakeholders and Potential Project Proponents

	Comment	Commenter	Response
1	Please provide Pearson *et al.* 2010a and 2010b reports and the Bouwman *et al.* 2002 paper referenced in the methodology.	MGM Innova	Provided. These papers summarize the background work used in developing the methodology. Pearson, TRH, Grimland, S, and Brown, S. 2010a. *A spatial analysis of greenhouse gas emissions from agricultural fertilizer usage in the US*. Report to Packard Foundation under Award #2008-32689. Summarizes spatial analysis of N_2O emissions from fertilizer across the United States, including 3 main fertilizer types and 3 crops (corn, wheat, cotton). N_2O emissions calculated using a "simplified Bouwman methodology" developed by Winrock based on work of Bouwman and

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			others. Pearson, TRH Grimland, S, and Brown, S. 2010b. *Assessment of potential for development of a simplified methodology for accounting for reduction in N_2O emissions from change in fertilizer usage*. Report to Packard Foundation under Award #2008-32689. Summarizes the "simplified Bouwman methodology" developed by Winrock based on work of Bouwman and others, and used along with field results and DNDC modeling to calculate emission reductions from changes in fertilizer management. This approach led to the decision to develop the current methodology using DNDC.
2	Consider inclusion of indirect emissions from fertilizer manufacture in the methodology.	MGM Innova	See more detailed comments in #6 below. This recommendation was reinforced by the peer reviewers, and emissions from fertilizer manufacture were ultimately incorporated into the methodology.
3	Request general briefing on the methodology approach and potential applications, timeframe for completion, approval process.	FutureCamp Climate GmbH	Briefing provided.
4	Request general briefing on the methodology approach and potential applications, similarities/differences to Alberta protocol approach.	Carbonomics Online	Briefing provided.
5	Request general briefing on the methodology approach and potential applications. Commenter is active in developing offset projects for N_2O emission reductions from nitric acid production, rather than fertilizer application, and also works with The Fertilizer Institute. Both entities are interested in potentially applying the methodology as a means to achieve marketable GHG reductions without reducing agricultural yields.	ClimeCo Corporation	Briefing provided. Comments solicited from The Fertilizer Institute.

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6	We greatly appreciate the opportunity to comment on the proposed Methodology for Emission Reductions through Changes in Fertilizer Management. In order to clarify our understanding of the proposed methodology, we have taken the opportunity to work through a real-world example related to one of our own client projects using the DNDC model. Based on that exercise, our primary observed gap in the methodology, as written, has to do with lack of inclusion of upstream emissions in the baseline BAU condition when considering alternate sources of nutrients for fertilization. In principle, the full life-cycle of GHG upstream emissions would be associated with both the manufacture and transport of synthetic fertilizers—e.g., ammonium nitrate, anhydrous ammonia, diammonium phosphate. Given the energy-intensive nature of fertilizer manufacturing, we have estimated that the GHG emissions associated with synthetic fertilizers is significantly different when compared to fertilization using waste products such as effluent from wastewater treatment plants, biosolids residuals from wastewater treatment plants, industrial residuals containing fertilizer constituents, etc. The use of non synthetic fertilizers as opposed to synthetic fertilizers would therefore constitute	CH2M HILL, Inc.	The methodology authors were initially reluctant to incorporate upstream emissions from the manufacture and transport of fertilizers into the methodology. This was seen as primarily an issue of boundary definition. Adding upstream emissions complicates the methodology; and provided it is conservative to exclude these emission sources from accounting – i.e. excluding them would result in lower credited net GHG emission reductions to the project activity than actually occur – they may be left out of this methodology. They could optionally accounted under separate methodologies addressing fertilizer manufacture and transport. However, there are conceivable scenarios in which ignoring embodied emissions would not be conservative. The type of fertilizer (urea, nitrate, ammonium nitrate, etc) can influence direct emissions from soils. A change in fertilizer type could result in a reduction in field emissions but possibly not a total reduction, due to higher embodied emissions from manufacture and/or transport of the new fertilizer type. The issue of embodied emissions from fertilizer manufacture was also raised by the peer reviewers.[1] Thus, guidance for calculating emissions from fertilizer production using IPCC default values has now been added into the methodology (for baseline emissions in section 5.3 and for project emissions in section 6.3).

[1] See *Response to Peer Review Comments*, posted at www.americancarbonregistry.org.

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	an avoided upstream emission associated with the extraction of natural gas, transport, fertilizer manufacture, and fertilizer transport. In sum, by not accounting for the upstream GHG emissions associated with conventional fertilizers in the baseline BAU conditions, we estimate that significant and real emission reduction opportunities may be missed for project developers using the proposed methodology, as it is written. We therefore recommend that standardized coefficients/lookup tables accounting for GHG emissions associated with the manufacture of conventional types of synthetic fertilizers be developed and included in the methodology itself for use by project proponents. For simplicity, and to minimize costs for estimating upstream emissions, we further recommend that transportation emissions be left out of the BAU conditions as their impact is likely to be *de minimis*.		
7	Please note that the ACR protocol references version 9.4 of the DNDC model, and that version 9.3 is the only one currently available on the DNDC web site. Version 9.3 appears to have some issues that we hope will be resolved in version 9.4, including the propensity for the program to crash rather than give an error message if an output file is open when the run command is given, and input values for some parameters revert to defaults or zeros even if	CH2M Hill, Inc.	Methodology clarified to state that the latest version of DNDC available at http://www.dndc.sr.unh.edu/Models.html must always be used.

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	the inputs have been accepted and saved. A more complete documentation of input values appears to be needed in the outputs from the model.		
8	We had a question on the use of the DNDC model in your reduced N_2O methodology versus the CDM AFOLU model for estimating N_2O emissions from lime and urea application. There are some obvious differences in the scope of the models and the "tier" type of each, but whereas we need to run software simulations using the DNDC model, we can do simple scenario analysis using the CDM model. The latter is much easier to if we make some simplifying assumptions—thus easier to explain the potential value proposition to land owners. Not being a soil scientist, I wanted to ask if these models were at all similar: specifically if they would produce remotely similar results in terms of emission reduction potential of a project depending on the type of fertilizer and fertilizer usage.	SunOne Solutions	Very occasionally these two approaches will produce similar results but the large majority of the time they will not. The Tier 1 approach gives no variation by soil type, by history and above all by weather. The numbers in the great majority of cases will be very greatly removed from reality. In addition, simplistic approaches providing default values for emissions by fertilizer rate would only allow for projects that reduce fertilizer rate (quantity applied), to which there is significant resistance in some segments of the agricultural community. The DNDC-based methodology allows a willing farmer to reduce fertilizer rate, but also provides options for changing type (specific synthetic or organic fertilizers), placement, timing, use of timed-release fertilizers, use of nitrification inhibitors and other factors. The pros and cons of Tier 1, 2 and 3 approaches are addressed in Pearson, TRH Grimland, S, and Brown, S. 2010b. *Assessment of potential for development of a simplified methodology for accounting for reduction in N_2O emissions from change in fertilizer usage*. Report to Packard Foundation under Award #2008-32689.
9	Perhaps I am confused by the description of the Monte Carlo runs, but are there only two runs being conducted in Step 3 of the DNDC process? Monte Carlo runs tend to rely on multiple (i.e. >10) runs to more accurately predict values, as far as I understand them; since they are effects-simulations using randomized conditions from the model	Blue Source Canada	The intent of the methodology was to require 4,096 Monte Carlo runs for both baseline and project simulations. We agree this was not clear in the original wording and it has been clarified.

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	specifications. One randomized/ Monte Carlo run (or two) isn't going to be enough to accurately account for uncertainty; nor give an effective confidence interval. Will there be two separate sets of Monte Carlo runs conducted: one for baseline values and one for project values? I understand that a lot of the details reside in DNDC, but a basic explanation of the components might be beneficial within the protocol as well.		
10	Equations 1 and 2, which calculate the BASELINE and PROJECT emissions, respectively, use the exact same data for calculations. How will this create different values? These equations need further differentiation and/or explanation unless they are intended to produce the exact same values. Equations 3 and 4 are, verbatim, the same equation. This may only be a typo, but something needs to be addressed, or equation 4 can be removed. And, if the only change is to alter the $GHG_{BSL, N2O, E, I}$ to $GHG_{P, N2O, E, I}$, then it falls into the same problem as equations 1 and 2. This either needs further explanation within the methodology, or the subscripts need to change on some of the other values to represent different values for calculating the baseline versus the project emissions.	Blue Source Canada	Equations (1) and (2) are correct as written; the same data is used for baseline and project, but with the change in fertilizer practices will have different direct and indirect emissions. Commenter is correct on typo in equation (4). This has been corrected to read $GHG_{P,N2O,E,i}$.

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11	Request general briefing on the methodology approach and potential applications, particularly as regards issues of costs, change in practice, and carbon yield.	CE2 Capital Partners	Briefing provided.
12	We've recently stumbled on to a tool developed by Michigan State to estimate baseline N_2O emissions for field crops (link). We realize that it likely won't produce results as detailed as the DNDC model, but it is so much more user friendly when we need to quickly estimate the potential for a project.	SunOne Solutions	Multiple comments, both public and peer review, focused on the issue of DNDC model complexity and data input requirements. This is a challenging issue, addressed at length in the responses to peer review comments.[2] In short, the choice of a DNDC-based methodology is the result of first testing simplified approaches and, while finding them powerful for coarse emissions estimates at a broad spatial scale, finding them inadequate for rigorous project-level crediting. The use of a simplified methodology for spatial analysis of N_2O emissions at a county scale of resolution, across 31 states, 3 main fertilizer types and 3 main crops is summarized in Pearson, TRH, Grimland, S, and Brown, S. 2010a. *A spatial analysis of greenhouse gas emissions from agricultural fertilizer usage in the US*. Here a simplified methodology with relatively few input parameters produced excellent results. Background work on developing and testing a simplified methodology is summarized in Pearson, TRH Grimland, S, and Brown, S. 2010b. *Assessment of potential for development of a simplified methodology for accounting for reduction in N_2O emissions from change in fertilizer usage*. This report summarizes the decision process in which, for rigorous project-level crediting, the simplified methodology was found to be inadequate and replaced with the DNDC modeling approach

[2] See *Response to Peer Review Comments*, posted at www.americancarbonregistry.org.

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			used in the current methodology. The implicit trade-off for the Michigan State tool is similar: the user interface is impressively straightforward and data requirements are relatively light, but does the tool yield rigorous estimates accounting for the multiple site-specific and seasonal variables that affect N_2O emissions? The tool relies on IPCC Tier 1 or Tier 2 approaches, depending on location and crop type selected. These may not accurately capture the emissions impacts of a change in fertilizer management at a specific site through a specific project activity.
13	The protocol asks us to evaluate the “adoption of precision agriculture” as one of the non-project scenarios. There are two things about this: a. “Precision agriculture” is a very general term, and could mean implementing a variety techniques/technologies to field & crop management. Moreover, having a field evaluated for adoption of the myriad of options could cost thousands. b. Inclusion in this list implies that adopting precision agriculture is excluded from the list of possible project activities. Do we have that right?	SunOne Solutions	“Precision agriculture” does encompass a variety of practices but the intent is not to exclude these as possible project activities. The methodology is designed to be as broadly applicable as possible. Therefore any change in fertilizer management can be implemented as long as it leads to a net reduction in emissions relative to the baseline. The Project Proponent must demonstrate that the baseline he/she is calculating is real and then monitor what happens in the project case in order to model emissions.
14	On the next page “the application of an additionality tool is recommended”, and the CDM tool for additionality is footnoted. Why the extra additionality step, and why not use the ACR guidance on additionality?	SunOne Solutions	The methodology does require that ACR guidance on additionality be followed. Any project brought to ACR for registration must apply an approved methodology and also meet all requirements of the applicable standard – here the *ACR Standard v2.1*, which includes guidance on additionality. An additionality tool such as the CDM Tool for the Demonstration and

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			Assessment of Additionality at http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf, amplifies but in no way conflicts with the ACR three-prong test. Use of such tools is recommended to help Project Proponents demonstrate to ACR and the verifier that the ACR additionality requirement has been met.
15	Training on DNDC would be very appreciated. In addition to training, it would be great if there were "ACR-standard/recommended" values that we could input into DNDC to reduce the amount of landowner supplied information needed during the initial phases of project development. I realize this could be a non-starter, but wanted to check if you were considering this.	SunOne Solutions	ACR at present has no plans to develop "ACR standard/recommended" values for the various DNDC inputs – for many of which there are "look-up" tables and literature values already. However, ACR does hope (contingent on funding) to be able to offer in-practice DNDC training in various locations and for various crop types following publication of the methodology.
16	We had sort of an internal debate about the crediting period / project term for N_2O projects. The non-AFOLU term is 7 years according to version 2.1 of the ACR Standard which Fertilizer Management must comply with. I have not seen a sector standard for ALM that could specify a different time period. Would you mind offering a quick clarification? If the 7 year crediting period stands, then would the Minimum Project Term also be 7 years? I definitely understand the difference between the two periods (i.e. how long MRV continues to occur vs. how often common practice/additionality/ baseline needs to be reevaluated)—but with N_2O emissions avoidance, would a longer Project Term be	SunOne Solutions	ACR agrees with the commenter that there is no required minimum term. There is also no concern about permanence. We generally emphasize that minimum term is not a mechanism for permanence; but at any rate here there is no issue of permanence because the avoided emissions cannot be reversed. The project duration could be as short as one year. On crediting period: ACR defines this as the period of baseline validity, or the length of time a project can be credited against its baseline before being required to reevaluate that baseline in order to renew for another crediting period. In general terms, the crediting period is 7 years unless otherwise specified in an ACR sector standard or approved methodology. This methodology is a special case because both baseline and project are modeled in DNDC, and some aspects of both change year by year as weather etc. changes. The methodology requires the Project Proponent to define a baseline scenario *ex ante*, representing fertilizer

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	necessary because they are by their nature permanent?		management practices in the absence of the project activity. However in this case the baseline is only defined in abstract terms. Each reporting period (say each year, but could be longer depending how often the Project Proponent wants to verify and issue ERTs), the Proponent must simultaneously model the baseline and project scenarios for each year since the previous verification using site-specific data, climate inputs, yields, fertilizer application rates and so on – all the input parameters that go into DNDC. In other words while baseline assumptions are defined *ex ante*, the Proponent is just modeling the baseline and project *ex post* for each reporting year, taking into account the climatic and other conditions in that reporting year. The Proponent could do this every year, if credit issuance is desired and thus verification occurs every year. If verification and credit issuance occur less frequently (e.g. five years), the Proponent would take all the input data from each of the previous years since last verification and model a baseline scenario and a project scenario and get a benefit for that year. They would then sum the years and that is the emission reduction that would be verified.

Additional Stakeholder Consultations

While the methodology remained in development and during the public comment and peer review process, ACR presented on the methodology and received stakeholder feedback in three high-level forums for agricultural GHG mitigation policy, science, and market mechanisms.

1. **Agriculture and Carbon Markets: Making Carbon Count, Davis, California, June 10, 2010**

The Market Mechanisms for Agricultural Greenhouse Gases (M-AGG) is one of three initiatives, along with C-AGG and T-AGG (see below), funded by the David and Lucile Packard Foundation. M-AGG is designed to bring particular focus to the carbon market infrastructure required for the agriculture sector to participate within emerging carbon policy and market frameworks. M-AGG is focused on identifying the current tools for quantifying greenhouse gas emission reductions and sequestration across a broad range of agricultural sectors. The M-AGG process will result in benchmarking a sub-set of these tools, namely quantification protocols, that fit a defined set of offset quality criteria common to most emerging carbon markets today. See http://sustainablefoodlab.org/index.php?option=com_content&view=article&id=104:ag-carbon-markets&catid=9&Itemid=27.

M-AGG hosted a workshop entitled “Agriculture and Carbon Markets: Making Carbon Count” in Davis, California on June 10, 2010. ACR presented on the draft *Methodology for N_2O Emission Reductions through Changes in Fertilizer Management* and received preliminary feedback from M-AGG participants and California agricultural stakeholders.

2. **M-AGG N_2O Protocol Webinar, September 8, 2010**

With three N_2O reduction protocols going through the protocol approval process, M-AGG hosted a webinar and a live panel featuring, comparing and contrasting these three approaches:

- Electric Power Research Institute-Michigan State University - N_2O Reduction Methodology and Annexes – submitted to the Voluntary Carbon Standard process.
- Winrock International - Methodology for Emission Reductions through Changes in Fertilizer Management - under review in the American Carbon Registry's process.
- Canadian Fertilizer Institute-The Fertilizer Institute - Nitrous Oxide Emissions Reduction Protocol - final stages of approval in the regulatory-based Alberta Offset System.

The three-hour webinar was designed to help prepare protocol developers for the N_2O panel during the joint C/T/M-AGG October event in Chicago (see below). One of the outputs of this exercise is a summary table showing a side-by-side comparison of these three protocols, available at http://sustainablefood.org/images/stories/pdf/N20_Protocol_Webinar_Synopsis.pdf.

3. **Joint C-AGG / T-AGG / M-AGG Meeting, Chicago, IL, October 4-5, 2010**

The Coalition on Agricultural Greenhouse Gases (C-AGG) seeks to mitigate climate change and benefit farmers by advancing the development and adoption of science-based policies, methodologies, protocols, and projects for GHG emissions reductions and carbon sequestration within the agricultural sector. C-AGG members are agricultural producers, scientists, GHG quantification experts, carbon investors, policy experts, and GHG project developers. C-AGG’s report, *“Carbon and Agriculture: Getting Measurable Results*”, released in April, 2010, represents contributions from participants in C-AGG, and was developed in consideration of the diversity of opinions within the Coalition. See http://www.c-agg.org/.

The Technical working group on Agricultural Greenhouse Gases (T-AGG) brings together technical expertise to assess and assemble the scientific and analytical foundation for developing high-quality agricultural protocols. T-AGG hopes to expand the opportunities for agricultural practices that can mitigate climate change and benefit farmers. T-AGG involves academic experts in agriculture and related fields from across the United States in dialogue with federal agencies, carbon registries, agricultural producers, project developers, and policy experts. T-AGG will produce a series of reports on key GHG mitigation activities for U.S. agriculture during 2010: a survey and comparison of a wide range of agricultural practices that can provide a road map for future protocol and policy development; and in depth reports to guide protocol development for two promising agricultural activities – soil carbon management and nitrous oxide emissions reduction on cropland. See http://nicholasinstitute.duke.edu/ecosystem/t-agg/.

The Market Mechanisms for Agricultural Greenhouse Gases (M-AGG) initiative is summarized above.

As part of a October 4-5 joint meeting of all three initiatives, ACR presented on the draft methodology in a panel entitled "Nitrous Oxide Protocols: What is Needed to Move Protocols into Practice for Agriculture?" The panel summarized three draft N_2O protocols, focusing on commonalities and differences, identified research needs, and next steps. The three protocols were:

- *Quantification Protocol for Nitrous Oxide Emissions Reductions from Farm Operations*. Developed by the Canadian Fertilizer Institute as a draft offset quantification protocol under the Province of Alberta's Specified Gas Emitters Regulation. Projects that are implemented according to this protocol generate carbon offsets by switching to an integrated set of Beneficial Nitrogen (N) Management Practices (BMPs) for annual and perennial cropping. These BMPs manage applied nitrogen sources in to reduce nitrous oxide emissions associated with nitrogen fertilizer application. These BMPs are integrated into a new technology called a Consistent 4R (Right Source @ the Right Rate, the Right Time and the Right Place) Nitrogen Stewardship Plan.
- *Proposed Methodology: Quantifying N_2O Emissions Reductions in US Agricultural Crops through N Fertilizer Rate Reduction*. Developed by Michigan State University and the Electric Power Research Institute. The methodology is currently under public comment and pending validation through the Voluntary Carbon Standard process, and may also be submitted to ACR for approval through public consultation and scientific peer review. The protocol is applicable under Sectoral Scope 14 of the Voluntary Carbon Standard – Agriculture, Forestry and Other Land Use (AFOLU), and is specific to Agricultural Land Management (ALM) project activities for Improved Cropland Management (ICM) that reduce net nitrous oxide (N_2O) emissions from agricultural cropping systems by reducing nitrogen (N) fertilizer rate.
- ACR *Methodology for N_2O Emission Reductions through Changes in Fertilizer Management.*