Nitrogen Management Project Protocol

Reducing Nitrous Oxide Emissions through Improved Nitrogen Management in Crop Production

WORKGROUP DRAFT
Version 1.0

April 4, 2012

Acknowledgements

Staff

Teresa Lang
Katie Goldman
Syd Partridge
Rachel Tornek
Derik Broekhoff
Heather Raven
Mark Havel

Workgroup

Wiley Barbour	Camco
Simon Bird	Wildlife Works Carbon
Sara Brodnax	The Clark Group, LLC / Agricultural Carbon Market Working Group
Adam Chambers	United States Department of Agriculture, Natural Resources Conservation Service
Hank Giclas	Western Growers Association
Dana Gunders	Natural Resources Defense Council
Noel Gurwick	Union of Concerned Scientists
Bruce Love	Preferred Carbon Group
Neville Millar	Michigan State University
Belinda Morris	Environmental Defense Fund
Meredith Niles	University of California, Davis
Adam Penque	Scotia Capital, Inc.
Todd Rosenstock	University of California, Davis, Agricultural Sustainability Institute
Richard Scharf	Environmental Services, Inc.
Paul Sousa	Western United Dairymen
Michael Wara	Stanford Law School
Roger Williams	Blue Source
Thomas Wirth	United States Environmental Protection Agency
Christina Tonitto	Ph.D. Ecosystem Modeling

Technical Support

Stephen De Gryze	Terra Global Capital
Charlotte Decock	Terra Global Capital
Johan Six	University of California, Davis
William Salas	Applied Geosolutions
John Kimble	United States Department of Agriculture, Natural Resources Conservation Service

Science Advisory Committee - *to be added*

Credit Stacking Sub-Committee - *to be added*

Aggregation Sub-Committee - *to be added*

Table of Contents

Abbreviations and Acronyms 1
1 Introduction 2
2 The GHG Reduction Project 3
2.1 Background 3
2.2 Project Definition 5
2.2.1 Defining Field Boundaries 6
2.2.2 Defining the Cultivation Cycle 6
2.3 Project Developer 7
2.4 Aggregates 8
2.4.1 Field size limits and other requirements 8
2.4.2 Entering and Leaving an Aggregate 8
2.4.3 Changes in land ownership, management or tenant occupancy 9
3 Eligibility Rules 10
3.1 Location and Crop System 10
3.2 Start Date 11
3.3 Crediting Period 11
3.4 Other Criteria 11
3.5 Additionality 12
3.5.1 The Performance Standard Test 12
3.5.2 The Legal Requirement Test 14
3.5.3 Ecosystem Services Payment Stacking 16
3.6 Regulatory Compliance 18
4 The GHG Assessment Boundary 19
5 Quantifying GHG Emission Reductions 24
5.1 Applicability Conditions for N-Rate Reduction Projects 25
5.2 Determining Fertilizer N-Rates 26
5.3 Determining Baseline N-Rates for Calculating Baseline N_2O Emissions from N-Rate Reduction Projects 28
5.4 Calculating the Primary Effect N_2O Emission Reductions for N-Rate Reduction Projects in Corn Crops in the North Central Region of the United States 32
5.4.1 Calculating Baseline and Project Direct N_2O Emissions from Soils (SSR 1) 32
5.4.2 Calculating Baseline and Project N_2O Emissions from Leaching, Volatilization, and Run-Off (SSR 2) 33
5.4.3 Calculating the Primary Effect Baseline and Project N_2O Emissions 35
5.4.4 Adjusting Primary Effect GHG Reductions for Uncertainty 35
5.5 Quantifying Secondary Effects 38
5.5.1 Calculating GHG Emissions from Cultivation Equipment (SSR 4) 39
5.5.2 GHG Emissions from the Shift of Crop Production Outside of Project Boundaries (Leakage) (SSR 5) 39
6 Project Monitoring 42
6.1 Single-Field Project Monitoring Plan 42
6.2 Monitoring Plans for Aggregates and Participating Fields 43
6.2.1 Aggregate Monitoring Plan 43
6.2.2 Field Monitoring Plan for Project Participants in an Aggregate 43
6.3 Field Data 44
6.3.1 General Field Tracking Data 44
6.3.2 Field Management Data 44
6.3.3 Project Activity Data and Documentation 44

6.3.4 Field Monitoring Parameters 45
7 Reporting and Record Keeping 47
7.1 Project Submittal Documentation 47
7.1.1 Single-Field Project Submittal Documentation 47
7.1.2 Aggregate Submittal Documentation 48
7.2 Annual Reports to be Submitted 48
7.2.1 Single-Field Report 48
7.2.2 Aggregate Report 49
7.3 Record Keeping 49
7.3.1 Record Keeping for Single-Field Projects 49
7.3.1 Record Keeping for Aggregates 50
7.4 Reporting Period and Verification Cycle 51
7.4.1 Additional Reporting and Verification Options for Single-Field Projects 52
8 Verification Guidance 54
8.1 Preparing for Verification 54
8.2 Verification Schedule for Single-Field Projects 55
8.2.1 Option 1: Twelve-Month Maximum Verification Period 55
8.2.2 Option 2: Twelve-Month Verification Period with Desktop Verification 55
8.2.3 Option 3: Twenty-Four Month Maximum Verification Period 56
8.3 Verification Sampling and Schedule for Aggregates 56
8.3.1 Verification Schedule for Small Aggregates 57
8.3.2 Verification Schedule for Large Single-Participant Aggregates 58
8.3.3 Verification Schedule for Large Multi-Participant Aggregates 58
8.4 Standard of Verification 59
8.5 Monitoring Plan 60
8.5.1 Annual Reports 60
8.6 Verifying Eligibility at the Field Level 60
8.7 Core Verification Activities 61
8.8 Project Type Verification Items 62
8.8.1 Project Eligibility and CRT Issuance 62
8.8.2 Quantification 63
8.8.3 Risk Assessment 64
8.9 Successful and Unsuccessful Verifications 64
8.9.1 Field-Level and Project Participant-Level Errors 64
8.9.2 Aggregate-Level Errors 65
8.10 Completing Verification 66
9 Glossary of Terms 67
10 References 70

Appendix A Summary of Performance Standard Development 71
Appendix B Overview of the Science Advisory Committee Process and SAC Recommendations of Nitrogen Management Practices for Inclusion 91
Appendix C Overview of Water Quality Regulations and their Impact on Legal Requirements and Regulatory Compliance for the NMPP 96
Appendix D Criteria Considered for Adoption of New Methodologies and Justification of Approved Quantification Methodologies 104

List of Tables

Table 2.1. Priority list of Nitrogen Management Practices 5
Table 2.2. Definitions for Approved Project Activities 6
Table 2.3. Maximum Field Size, as a Percent of Aggregate Acreage 8
Table 3.1. Eligible Practice: State-Crop Combinations 10
Table 4.1. Description of all Sources, Sinks, and Reservoirs 20
Table 6.1. Field Monitoring Parameters: General Input Parameters 46
Table 8.1. Summary of Eligibility Criteria for a Nitrogen Management Project 60
Table 8.2. Eligibility Verification Items 62
Table 8.3. Quantification Verification Items 63
Table 8.4. Risk Assessment Verification Items 64

Table A.1. Priority List of Practices and Data Availability 72
Table A.2. Default Values for Average N-Content 75
Table A.3. Actual and Recommended N-Rates for Corn in Selected States in the North Central Region 76
Table A.4. Factors Influencing Farmers' N-Rate Decision 77
Table A.10. Trends in Penetration Rate of Fall N Application Over Time 81
Table A.11. Trends in Penetration Rate of Use of N-Inhibitors Over Time 83
Table A.12. Low, Average, and High State- and Crop-Specific RTA Values and Trends Over Time 83
Table A.13. Low, Average, and High State- and Crop-Specific N-Rates and Trends Over Time 87

List of Figures

Figure A.1. Nitrogen Sources, Cycling, and Losses in Agricultural Systems 73
Figure A.7. Penetration Rate of Fall N Application for Corn 81
Figure A.8. Penetration Rate of Use of N-Inhibitors for Corn 82

List of Equations

Equation 3.1. Calculating a Field's Annual RTA 13
Equation 5.1. Calculating GHG Emission Reductions 25
Equation 5.2. Calculating Total Fertilizer N-Rate for Field *f* 26
Equation 5.3. Calculating Synthetic Fertilizer N-Rate for Field *f* 26
Equation 5.4. Calculating Fertilizer N-Rates of Dry N-Containing Synthetic Fertilizer *j* 27
Equation 5.5. Calculating Fertilizer N-Rates for Liquid N-Containing Synthetic Fertilizer *j* 27
Equation 5.6. Calculating Organic Fertilizer N-Rate for Field *f* 27
Equation 5.7. Calculating Fertilizer N-Rates for N-Containing Organic Fertilizer *j* 28
Equation 5.8. Equation to Calculate a Field's Historical RTA 29
Equation 5.9. Equation to Calculate Baseline N Rate if the Historical Average RTA is Greater than or Equal to the Performance Threshold 30
Equation 5.10. Equation to Calculate Baseline N Rate if the Historical Average RTA is Less than or Equal to the Performance Threshold 30
Equation 5.11. Calculating the Range of Acceptable Project Organic-to-Synthetic-N-Ratios 31
Equation 5.12. Direct Baseline N_2O Emissions from Soils for Field *f* 32
Equation 5.13. Direct Project N_2O Emissions from Soils for Field *f* 33
Equation 5.14. Baseline N_2O Emissions from Leaching, Volatilization, and Run-Off (LVRO) for Field *f* 34
Equation 5.15. Project N_2O Emissions from Leaching, Volatilization, and Run-Off (LVRO) for Field *f* [40] 34
Equation 5.16. Calculating the Primary Effect Baseline and Project GHG Emissions 35
Equation 5.17. Total Primary Effect GHG Reductions for the Project 37
Equation 5.18. Structural Uncertainty Deduction 37
Equation 5.19. Total Secondary Effect Emissions from Project Activity for the Project Aggregate 39
Equation 5.20. Project Emissions from Fossil Fuel Combustion 39
Equation 5.21. Calculating the Normalized Yield for Each Year *t* in Case the Project is an Aggregate 40
Equation 5.22. Increased Emissions Outside the Project Boundary 41

Abbreviations and Acronyms

CO_2	Carbon dioxide
CH_4	Methane
CRT	Climate Reserve Tonne
CWA	Clean Water Act
EPA	United States Environmental Protection Agency
GHG	Greenhouse gas
MT	Metric ton (or tonne)
N	Nitrogen
NMP	Nutrient or Nitrogen Management Plan
N_2O	Nitrous oxide
NPS	Nonpoint source
Reserve	Climate Action Reserve
SSR	Source, sink, and reservoir

1 Introduction

The Climate Action Reserve (Reserve) Nitrogen Management Project Protocol provides guidance to account for, report, and verify greenhouse gas (GHG) emission reductions associated with improvements in nitrogen use efficiency in crop production.

The Climate Action Reserve is a national offsets program working to ensure integrity, transparency, and financial value in the U.S. carbon market. It does this by establishing regulatory-quality standards for the development, quantification and verification of GHG emission reduction projects in North America; issuing carbon offset credits known as Climate Reserve Tonnes (CRT) generated from such projects; and tracking the transaction of credits over time in a transparent, publicly-accessible system. Adherence to the Reserve's high standards ensures that emission reductions associated with projects are real, permanent and additional, thereby instilling confidence in the environmental benefit, credibility and efficiency of the U.S. carbon market.

Project developers and aggregators that initiate nitrogen management projects use this document to quantify and register GHG reductions with the Reserve. The protocol provides eligibility rules, methods to calculate reductions, performance-monitoring instructions, and procedures for reporting project information to the Reserve. Additionally, all project reports receive independent verification by ISO-accredited and Reserve-approved verification bodies. Guidance for verification bodies to verify reductions is provided in the Reserve Verification Program Manual and Section 8 of this protocol.

This protocol is designed to ensure the complete, consistent, transparent, accurate, and conservative quantification and verification of GHG emission reductions associated with a nitrogen management project.[1]

[1] See the WRI/WBCSD GHG Protocol for Project Accounting (Part I, Chapter 4) for a description of GHG reduction project accounting principles.

2 The GHG Reduction Project

2.1 Background

Nitrous oxide (N_2O), a potent agricultural greenhouse gas (GHG), is emitted as a product or by-product of the naturally occurring microbial processes of nitrification and denitrification. Nitrous oxide emissions from agricultural lands are generally related to the application of inorganic and organic nitrogen (N) fertilizer, or legume-derived N. Any factor or action that impacts N availability in the soil may impact N_2O emissions, due to the fact that higher levels of available mineral N increase the amount of N available for transformation through the nitrification-denitrification cycle.

Nitrous oxide emissions from agricultural lands in the U.S. are estimated at 204.6 Mt CO2e, which make up 69.2% of total U.S. N_2O emissions, or 3.1% of total U.S. emissions. Though annual N_2O emissions from agricultural lands in the U.S. have fluctuated somewhat over the years, they were 3.4% higher in 2009 than they were in 1990. [2]

Nitrogen (N) is an essential nutrient for plants, and agricultural producers have long supplied additional N soil amendments to their crops. During much of history, N was supplied to crops primarily in organic form such as through manure application and N-fixing legumes. However, during the latter part of the 19th century, inorganic N (typically synthetic fertilizer) replaced organic N as the main source of this nutrient, and today, inorganic N has become essential to world food production, contributing significantly to the 18% increase in global atmospheric concentrations of N_2O since 1750.[3] In addition to increased N_2O emissions, the increased use of inorganic N in agriculture has proliferated the N-losses to the environment in the forms of ammonia (NH_3), ammonium (NH_4), nitrogen oxides (NO_x), and nitrate (NO_3), which affect air and water quality and lead to significant disruptions to natural ecosystem functions

Because N available to microbes drives N_2O emissions, any agricultural management practice that reduces the presence of excess mineral N in the soil is a good candidate N_2O emission reduction strategy. Specifically, N_2O emissions can be reduced with the implementation of nitrogen management practices that focus on improving the N use efficiency (NUE)[4] by matching nitrogen supply as exactly as possible with plant nutrient uptake to avoid the presence of excess N in the soil (i.e., less N applied for the same crop productivity). Determining the proper rate and timing of N applications during the year are major management decisions for agricultural producers. Using too little N may result in lower yields, poorer crop quality, and, hence, reduced profits. When too much N is applied, yields and quality are generally not compromised (for most crops), but profit may be reduced and negative environmental effects can occur related to N leaching and nitrous oxide (N_2O) emissions.

The objective of an NM project under this protocol is to reduce N_2O emissions by adopting practices that further improve nitrogen use efficiency beyond what is projected to happen in the future absent a carbon market.

---

[2] U.S. EPA. 2011. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009.* EPA 430-R-11-005. Washington, D.C.: U.S. Environmental Protection Agency. LINK

[3] IPCC 2007

[4] The N-Use Efficiency (NUE) is typically defined as “the proportion of all nitrogen inputs that are removed in harvested crop biomass” (Ribaudo 2011).

This protocol provides eligibility criteria for approved nitrogen management practices and approaches for quantifying N_2O emission reductions that occur as a result of adopting the approved practices.

N_2O emissions are positively correlated with low soil pH, higher ambient temperatures, high water-filled pore space, soil compaction, available C substrate in soils, and available mineral N in soils.[5] These relationships result in significant variability in expected N_2O emissions and reduction potentials associated with different regions and crops across the U.S. They are also responsible for significant differences in the feasibility and efficacy of various nitrogen management practices for reducing N_2O emissions while maintaining or improving crop yield. As a result, this protocol contains region- and crop-specific eligibility criteria, as noted below, and employs system-specific GHG quantification approaches that are applicable to specific circumstances.

Potential Nitrogen Management Practices and N_2O Quantification in this Protocol

Under this version of the Nitrogen Management Project Protocol (NMPP), reducing the N application rate on agricultural fields is the only eligible project activity. Appendix B contains on recommendations from the Reserve's Science Advisory Committee on practices that are likely to reduce N_2O emissions, have shown consistent results in the scientific peer-reviewed literature, and as such, were prioritized for consideration as project activities. These candidate activities are listed in Table 2.1, below, along with the Reserve's current assessment of data availability and existing quantification methods for these activities. Appendix A addresses the steps required for developing performance standards, particularly these data needs on common nitrogen management practice, and Appendix D describes the criteria the Reserve believes are necessary to ensure that quantification methods are sufficiently rigorous and vetted to be included as a project activity in this protocol. The Reserve may add additional eligible project activities to future versions of the protocol if data and analysis support their inclusion and if robust quantification methods can be developed for them.

In addition, this version of the NMPP includes only one method for quantifying N2O emission reductions from reducing N application rates, which is applicable only to N-rate reductions for corn in the Corn Belt, or the North Central Region, as it is called in this protocol.[6] Additional information on where the currently approved project activity is applicable is detailed in Section 5. Additional quantifications methods for N application rate reductions may be added in future versions of the protocol, covering additional regions and crop systems.

[5] Chantigny et al. 2010; Farahbakhshazad et al. 2008; Venterea and Rolston 2000.
[6] See Table 2.2 below for applicability of the approved quantification methodology and for a list of states included in the North Central Region (NCR).

Table 2.1. Priority list of Nitrogen Management Practices

Potential Nitrogen Management Practice	Comprehensive national data are available to develop performance standard?[7]	A standardized quantification methodology for N_2O emissions is currently available that meets Reserve criteria?[8]
Reduce N Applied	Yes	Yes
Use of Nitrification and Urease Inhibitors / Use of Nitrification Inhibitors (only)[9]	Yes	No
Switch from anhydrous to urea	No	No
Switch from Fall to Spring Application	Yes	No
Change to Slow Release Fertilizer	No	No
Change to Fertigation	No	No
Apply N Closer to Roots	No[10]	No
Add N Scavenging Cover Crops	No	No

Project Aggregation

Incorporated into the NMPP is an option for project aggregation, with clear rules for how aggregation must be undertaken, that aims to facilitate participation by farmers. Aggregators may provide appropriate technical expertise and fulfill protocol requirements on behalf of farmers in addition to providing other technical consulting services. In addition, aggregation allows for “economies of scale” within the methodology, allowing streamlined requirements for individual farmers while upholding rigorous quantification and verification standards at an aggregate level. This is primarily accomplished through pooling uncertainty and sampling fields for verification activities.

2.2 Project Definition

For the purpose of this protocol, a GHG reduction project (“project”) is defined as the adoption and maintenance of an approved project activity[11] that reduces nitrous oxide (N_2O) emissions.

[7] This column represents whether or not data is available specifically through the USDA ARMS dataset, which the Reserve identified as the best available to develop performance standards for nitrogen management. Appendix A provides more detail on how the Reserve made this determination.
[8] The Reserve shall only adopt quantification methodologies that are standardized, vetted, and conservative. Appendix D outlines general criteria that the Reserve considered when determining which quantification methodologies were sufficiently vetted to include in this protocol.
[9] Note that while the use of nitrification inhibitors was recommended both with urease inhibitors, and on their own, the use of urease inhibitors (without nitrification inhibitors) is not a priority practice.
[10] Though some N application method data is available, the Reserve does not believe the data is sufficient to develop a performance standard for changing N-placement to apply N closer to the roots.

The approved project activity may be implemented on a single field, known as a "single-field project," or may be implemented on two or more individual fields combined into a single project area, also known as the "aggregate." Specific requirements for aggregates are outlined in Section 2.4. Physical boundaries for individual fields must be defined according to the requirements in Section 2.2.1.

At present, only project activities listed in Table 2.2 below are considered "approved project activities."

Table 2.2. Definitions for Approved Project Activities

Approved Project Activities	Description	Applicable Crop(s)	Applicable Region(s)
Reduce N Applied	Reduction in the annual nitrogen application rate compared to recent historic application rates at the site, without going below N demand	Corn[12]	North Central Region[13]

2.2.1 Defining Field Boundaries

For the purposes of this protocol, an individual field must be defined by the following criteria:

1. The field must be under the direct management control of a single entity.
2. The field must be contiguous.
3. Management within the field boundary must be homogeneous. More specifically, the same crop/crop rotation must be grown (including cover crops) throughout the field, N fertilization dates must be the same (within the same week), and N fertilization composition, rates, and placement must be implemented consistently throughout the field.[14]

2.2.2 Defining the Cultivation Cycle

For the purposes of this protocol, a cultivation cycle is generally defined as the period starting immediately after harvest of one primary crop and ending after the next primary planted crop is harvested the following calendar year. If there are multiple crops in rotation, each type of crop (e.g. corn in a corn-soybean rotation) has a distinct cultivation cycle. As version 1.0 of this protocol is only applicable to annual corn crops, the cultivation cycle in version 1.0 is further defined as approximately 365 days. One complete cultivation cycle for corn in a corn-soy rotation, for example, begins with post-harvest residue management for the soy crop harvested in Fall of year 1, continues with field preparation, seeding, and cultivation of the corn crop, and culminates upon completion of the corn harvest in Fall of year 2.

[11] Note that a project is defined by the adoption of practices; however, GHG reductions are quantified based on actual project performance in terms of reduced N_2O emissions.
[12] Multi-year rotations that include other crops (e.g. soy, wheat) are eligible under this protocol; however only emission reductions related to the corn cultivation cycle shall be credited.
[13] As defined in Section 3.1, the North Central Region (NCR) is comprised of the following states: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin.
[14] This definition of field boundaries does not exclude the implementation of variable rate technology.

2.3 Project Developer

The project developer is an entity that has an active account in good standing on the Reserve, submits a project for listing and registration with the Reserve, and is ultimately responsible for all project reporting and verification. Under this protocol, project developers may act as aggregators who represent one or more fields participating in a project. Project developers/aggregators may be a corporation or other legally constituted entity, city, county, state agency, agricultural producer, or a combination thereof. An individual farmer may serve as a project developer of a single-field project, as an aggregator for his/her own fields, or as an aggregator for a group of fields under different ownership or management. Farmers who elect to enroll in an aggregate and not serve as a project developer are referred to as "project participants." Project participants must have authority to make cultivation management decisions on their fields that are enrolled in the aggregate.

Project developers/aggregators act as official agents to the Reserve on behalf of project participants and are ultimately responsible for submitting all required forms and complying with the terms of this protocol. Project developers/aggregators manage the flow of ongoing monitoring and verification reports to the Reserve and may engage in other project development activities such as developing monitoring plans, modeling emission reductions, managing data collection and retention etc., or may hire technical contractors to perform these services on their behalf. The scope of project developer/aggregator services is negotiated between the project participants and the project developer/aggregator and should be reflected in contracts between the project participants and the project developer/aggregator.

Project aggregators have the authority to develop their own internal monitoring, reporting, and other participation requirements for individual fields as they deem necessary, as long as these internal requirements do not conflict with any requirements outlined in this protocol.

Aggregators also have the discretion to exclude individual fields enrolled in their aggregate from participating in verification activities for any given reporting period; however, in such cases there can be no CRTs issued for those fields in the aggregate total.

In all cases, the Project Developer/Aggregator must attest to the Reserve that they have exclusive claim to the GHG reductions resulting from all fields in the project. The Project developer/aggregator must attest to this requirement by submitting a signed Attestation of Title form for single-field projects or Aggregator Attestation of Title[15] form for aggregates, prior to the commencement of verification activities each time the project is verified (see Section 8).

Though the aggregator must have exclusive claim to CRTs for the project to complete verification, this protocol does not dictate the terms for how that exclusive title will be established; allowing the aggregator, project participant and land owner (if separate from the project participant) maximum flexibility for the terms of contracts between the respective parties. In the case of project activities taking place on leased fields (e.g. the project participant is not the land owner, but rather a lessee), the aggregator must notify the land owner with a Letter of Notification of the Intent to Implement a GHG Mitigation Project on the respective field.

[15] The Reserve Aggregator Attestation of Title form is available at: http://www.climateactionreserve.org/how/projects/register/project-submittal-forms/

As part of verification activities, verifiers shall review contracts and letters of notification as a means of confirming exclusive title to the CRTs. The Reserve will not issue CRTs for GHG reductions that are reported or claimed by entities other than the aggregator.

2.4 Aggregates

2.4.1 Field size limits and other requirements

The aggregate does not need to be comprised of contiguous fields, and can encompass fields located on one farming operation or distributed amongst different farms and/or producers.

There is no limit on the total number of acres enrolled in an aggregate, assuming each individual field meets the requirements of Section 2.2.1. There are, however, limits on how large a single field may be, in relation to the total combined acreage in an aggregate, as defined by Table 2.3 below. Field size limitations are in place to minimize the influence a single large field may have on an aggregate's calculations.

Table 2.3. Maximum Field Size, as a Percent of Aggregate Acreage

Number of Fields in Aggregate	Maximum Acreage of a Single Field (% of Aggregate Acreage)
2	70%
3	50%
4	33%
5 or more	25%

2.4.2 Entering and Leaving an Aggregate

2.4.2.1 Entering an Aggregate

Individual fields may join an aggregate by being added to the aggregate's Project Submittal Form (if joining an aggregate at initiation) or by being added through the New Field Enrollment Form (if joining once the aggregate is underway).

Single-field projects that have already been submitted to the Reserve as such may choose to join an existing aggregate by submitting an "Aggregate Transfer Form" to the Reserve. The project aggregator will also need to submit a New Field Enrollment Form, listing that field. Emission reductions occurring on single-fields or new fields entering an aggregate will start counting toward the aggregate CRTs in the reporting period immediately following the transfer. Because project start dates and reporting periods are tied to annual cultivation cycles, fields are encouraged to begin the process of entering an aggregate prior to completion of the cultivation cycle (e.g. prior to harvest) of the year immediately preceding that in which emission reductions will be registered as part of that aggregate.

2.4.2.2 Leaving an Aggregate

Fields must meet the requirements in this section in order to leave or change aggregates and continue reporting emission reductions to the Reserve. In all cases, emission reductions must be attributed to one project for a complete reporting period, as defined in Section 2.2.2, and no CRTs may be claimed by a project for a field that does not participate and report data for a full reporting period.

Project activities on an individual field may be terminated and the field may elect to leave the aggregate at any time.

Individual fields may elect to leave an aggregate and participate as a single-field project for the duration of their crediting period. To leave an aggregate and become a single-field project, the project participant must open a project developer account on the Reserve and submit a "Project Submittal Form" to the Reserve, noting both that it is a "transfer project" and identifying the aggregate from where it transferred.

Fields can switch their participation to another aggregate during a crediting period if and only if:

1. The field changes ownership, tenant occupancy or management control during the crediting period and the new owner, tenant or manager has other fields already enrolled with a different aggregator, or
2. The original aggregate is terminated (e.g. goes out of business)
3. The aggregator breaches its contract with the project participant

Fields seeking to change aggregates during a crediting period under one of the above allowed circumstances must submit an "Aggregate Transfer Form" to the Reserve prior to enrolling in the new aggregate.

2.4.3 Changes in land ownership, management or tenant occupancy

A field in an aggregate may change ownership, tenant occupancy or management control during a crediting period, and remain in the aggregate with uninterrupted crediting, if and only if the following criteria are met:

1. The contract with the aggregator is transferred from the old to the new project participant.
2. The new project participant submits a "Field Management Transfer Form" to the Reserve via their aggregator prior to the beginning of the subsequent reporting period.
3. Implementation of the approved project activity continues without change until the end of the current reporting period.[16]

Where any of these criteria are not met, a field will forfeit the opportunity to generate CRTs for the reporting period during which the ownership, tenant occupancy or management control change occurs. The field may re-enter the aggregate at any time during the remainder of the 5-year crediting period by fulfilling the three requirements above.

[16] See Section 5 for definition of reporting period.

3 Eligibility Rules

Projects must fully satisfy all eligibility rules in order to register with the Reserve. All fields participating in a project must meet the following criteria, as well as the definition of a GHG reduction project (Section 2.2), in order for the project to be eligible.

Eligibility Rule I:	Location and Crop System	⟶	*U.S. and U.S. tribal areas, in areas corresponding to approved quantification approaches (see Table 3.1).*
Eligibility Rule II:	Start Date	⟶	*No more than six months prior to submission**
Eligibility Rule III:	Additionality	⟶	*Meet performance standard*
		⟶	*Exceed regulatory requirements*
Eligibility Rule IV:	Regulatory Compliance	⟶	*Compliance with all applicable laws*

* See Section 3.2 for further detail

3.1 Location and Crop System

Only projects located in the United States and on U.S. tribal lands are eligible to register reductions with the Reserve under this protocol. Fields that make-up the project must be located in regions and employ crop systems for which there is an applicable quantification approach in this protocol. Table 3.1 lists the quantification approaches currently contained in this protocol along with their applicable geographic regions and crop systems. Not all fields within a project are required to be located in the same region,

Table 3.1. Eligible Practice: State-Crop Combinations

Approved Practice	Eligible State-Crop Combinations[17]	
Reducing Amount of N Applied	Illinois	Corn
	Indiana	Corn
	Iowa	Corn
	Kansas	Corn
	Michigan	Corn
	Minnesota	Corn
	Missouri	Corn
	Nebraska	Corn
	North Dakota	Corn
	Ohio	Corn
	South Dakota	Corn
	Wisconsin	Corn

[17] Multi-year rotations that include other crops than those listed here are eligible under this protocol; however, only emission reductions related to the corn cultivation cycle shall be credited.

3.2 Start Date

Each field has a unique start date, defined as the first day of a new cultivation cycle during which an approved project activity is implemented. The first day of a new cultivation cycle is defined as the day after the field's previous harvest was completed. The start date may be chosen as any date on or after June 27, 2010 that coincides with the start of a cultivation cycle during which a project activity is implemented.

To be eligible, a field must be submitted as a single-field project or join an aggregate before the end of the first cultivation cycle after the start date, unless the field is submitted during the first 12 months following the date of adoption of this protocol by the Reserve board (the Effective Date). For a period of 12 months from the Effective Date of this protocol (Version 1.0), fields with start dates on or after June 27, 2010 are eligible to register with the Reserve if submitted by June 27, 2013. Fields with start dates prior to June 27, 2010 are not eligible under this protocol. Fields may always be submitted for listing by the Reserve prior to their start date.

3.3 Crediting Period

The crediting period for fields under this protocol is defined as seven eligible crop years, which may occur over a period of up to fourteen years. Crediting periods may not be renewed. An eligible crop year is defined as a year in which an eligible crop (see Table 3.1) is grown on the field.[18] Eligible crop years do not have to be consecutive, but project reporting for each field must be continuous during a crediting period, with no gaps between reporting periods. This means that multi-year rotations that alternate between eligible and non-eligible crops must report project data for all time periods, including ineligible crop years, to maintain continuous reporting between reporting periods (see Section 7 for reporting requirements). The reporting period under this protocol is one complete cultivation cycle of an annual crop, approximately 365 days. Reporting periods in which a field does not meet the performance standard (see Section 3.5), or a field is withdrawn from participation in verification activities (see Section 2.3), still count towards the crediting period and reporting requirements for fields.

Crediting periods do not apply to aggregates, only to individual fields within an aggregate and to single-field projects.

If, at any point in the future, any one of the approved project activities adopted on a field becomes legally required, the Reserve will cease to issue CRTs for GHG reductions for the legally required N-rate reduction, but may allow continued crediting, if the project can be demonstrated to go above and beyond the legal requirement, as defined by the terms of the Legal Requirement Test (see Section 3.5.2).

3.4 Other Criteria

Management records and/or data must be available on the history of crop production practices for at least the past five years prior to the field's start date. In case less than 3 eligible crop years were planted in the 5 years prior to the field's start date, the period shall be extended so

[18] The time period over which a crediting period of seven eligible crop years must be completed is based on a variable period of time (seven to fourteen years), depending on how many eligible crop years are planted. For example, in the case of a corn-corn monoculture, the crediting period must be seven consecutive years, while a corn-soy rotation may have a seven year crediting period that extends over fourteen years, if corn is planted every other year. A more complex multi-crop rotation, however, in which the eligible crop is grown only every fourth year will likely be limited specifically by the fourteen year maximum crediting period, as opposed to limited by the seven eligible crop years.

that at least 3 eligible crop years are included. Further, the crop production system on a project field must be consistent with the past five years of management data for that field.

Increases or decreases in yields compared to pre-project yields are allowable. However, yield reductions may result in leakage effects that must be estimated and accounted for (see Section 5.5.2 for further guidance on accounting for leakage).

While all projects must meet all eligibility criteria in Section 3, Section 5 includes additional "applicability conditions," specific to each approved project activity, that must be met by each field implementing that respective project activity. Currently, Section 5.1 includes only applicability conditions for implementing the approved project activity, reducing N-rate.

Workgroup:

- Historic look back / Management Records: We have required 5 years of data for monocultures, or at least 3 eligible crop years of data for more complex rotations. In theory, multi-crop rotations may have to look far back for those 3 years. Is more guidance/thinking needed for those complex situations?
- Crop production system during the project must be "consistent" with past management. We are trying to be flexible for producers in complex rotations who want to make minor changes, as long as the crop system is generally "consistent." Did we leave this too vague/open to interpretation?
- The ACR methodology includes an eligibility condition that guards against "within farm leakage," or more specifically, they require that: "Fertilizer use must not be increased on all crops on owned or managed lands that are not part of the project." Though the Reserve considered a similar provision, we believe this would requirement would require significant effort and farm records from non-project fields to report and verify. As a second, less cumbersome option, we considered requiring an attestation from farmers that they have not increased N-use elsewhere. We are interested in how big a risk the WG thinks it is (that a farmer would increase N-use on non-project fields, specifically to guard against project-induced yield-loss), and if it is a big enough risk, how do you propose we manage this risk?

3.5 Additionality

The Reserve strives to register only projects that yield surplus GHG reductions that are additional to what would have occurred in the absence of a carbon offset market.

Projects must satisfy the following tests to be considered additional:

1. The Performance Standard Test
2. The Legal Requirement Test

3.5.1 The Performance Standard Test

Projects pass the Performance Standard Test by meeting a performance threshold, i.e. a standard of performance applicable to all nitrogen management projects, established by this protocol. Performance standards are specified below according to the type of project activity being implemented.

The performance standard research and rationale for the specific performance standards outlined below are summarized in Appendix A.

3.5.1.1 Performance Standard for Reduction in N Application Rate

The performance standard for this project activity is based on a nitrogen use efficiency metric, calculated as a ratio of the amount of N removed by crop biomass to the amount of N available to the crop as a function of how much total nitrogen was applied to the crop. This ratio is referred to as the "RTA" value (ratio of **R**emoved **T**o **A**pplied N). The RTA can be interpreted as a general measure of the N use efficiency.

A field passes the performance standard test when its annual RTA, calculated for each eligible crop year of the project, exceeds the applicable performance standard RTA threshold in Table A.8. A field must pass the performance standard test in a reporting period (e.g. annually) in order to be awarded CRTs for that reporting period. If a field does not pass the performance standard in an eligible crop year, it does not necessarily forfeit eligibility for the remainder of the crediting period. Rather, the field loses one of the seven eligible crop years of its crediting period but maintains eligibility for the remainder of the crediting period, so long as the field maintains continuous reporting to the Reserve and is able to pass the performance standard in a future reporting period. A field growing both eligible and non-eligible crops does not need to pass the performance standard in its non-eligible crop years to maintain eligibility.

The calculation to demonstrate that a field passes the performance standard occurs ex-post (e.g. after completion of the reporting period) using Equation 3.1 below.[19]

Equation 3.1. Calculating a Field's Annual RTA

$$\boldsymbol{RTA_{f,c,t}} = \frac{(\boldsymbol{Y_{f,c,t}} \times \boldsymbol{NC_c})}{\boldsymbol{NR_{f,c,t}}}$$

Where,

			<u>Units</u>
$RTA_{f,c,t}$	=	RTA calculated for field *f* and crop *c* over time *t*	
$Y_{f,c,t}$	=	annual yield for field *f* and crop *c* over time *t*	unit*/ha
NC_c	=	Default N content for crop *c* based on the look-up table, Table A.2	kg N/unit
$NR_{f,c,t}$	=	annual nitrogen application rate (including organic and synthetic forms of N) for field *f* and crop *c* over time *t*	kg N/ha

* Unit may be bushels or other measure of crop biomass. To convert from unit/acre to unit/ha, divide by 0.405. Additional guidance on determining this equation's input parameters is provided in Section 5.1.

The annual RTA, calculated for years prior to the field's start date, is also used as a basis for determining a field's baseline when calculating GHG reductions, as prescribed in Section 5.

[19] Though the actual performance standard test occurs ex-post using data from the reporting period, for planning purposes, project developers are encouraged to use a field's historic yields and the target RTA threshold for that field (in Table A.8), to estimate the N-rate necessary for a given field to pass the Performance Standard Test.

3.5.2 The Legal Requirement Test

All fields enrolled in a project or aggregate are subject to a Legal Requirement Test to ensure that the GHG reductions achieved by approved project activities on those fields would not otherwise have occurred due to federal, state or local regulations, or other legally binding mandates. A field passes the Legal Requirement Test when there are no laws, statutes, regulations, court orders, environmental mitigation agreements, permitting conditions, binding contractual obligations,[20] or other legally binding mandates (including, but not limited to, legally mandated nutrient management plans,[21] conservation management plans, and deed restrictions) that require adoption or continued use of approved nitrogen management project activities on the field

Workgroup:

Please provide us your feedback on whether you believe the above paragraph (and Footnote 20) is so overly broad that it may preclude some of the ecosystem services credit/payment stacking that is allowed, as per 3.5.2 below.

To satisfy the Legal Requirement Test, project developers of single-field projects must submit a signed Attestation of Voluntary Implementation form, while aggregators must submit a signed Attestation of Voluntary Implementation form on behalf of all project participants in the aggregate.[22] Attestations of Voluntary Implementation must be signed and submitted to the Reserve prior to the commencement of verification activities each time the project or aggregate is verified (see Section 8). Individual project participants who are part of an aggregate will not be required to attest to the voluntary nature of project activities to the Reserve. However, supporting documentation should be made available to the verifier during verification, if requested. In addition, the Aggregate Monitoring Plan (Section 6.2) must include procedures that the aggregator will follow to ascertain and demonstrate that all fields in the aggregate at all times pass the Legal Requirement Test. Similarly, the Single-Field Monitoring Plan (Section 6.1) must include procedures that the project developer will follow to ascertain and demonstrate that the project field at all times passes the Legal Requirement Test.

A complete summary of research performed on federal, state, and local legal requirements is provided in Appendix C. This summary includes extensive background on the Clean Water Act and other important water quality laws, as well as other regulations related to synthetic N fertilizer, manure N, and their uses.

As of the Effective Date of this protocol, the Reserve could identify no existing federal regulations that explicitly obligate agricultural producers to adopt the nitrogen management practices approved under this protocol. When watersheds are successfully meeting the Clean Water Act (CWA)'s water quality standards, agriculture sources are generally unregulated. However, the Reserve has identified circumstances, particularly where watersheds are not in

[20] Contracts with NRCS that must be signed by a grower in order to receive EQIP funds are not considered "legally binding mandates" if the only repercussion of violating the contract is not receiving the aforementioned financial incentive (e.g. there is no fine, notice of violation, or other legal penalty levied).

[21] If Nutrient Management Plans are legally required, but do not require N-rate reductions or specify N-rate targets that would require reductions, the field passes the Legal Requirement Test. Verifiers shall evaluate such NMPs and use their professional judgment to make a determination.

[22] Form available at http://www.climateactionreserve.org/how/projects/register/project-submittal-forms/.

compliance with CWA water quality standards, in which state- and local-level regulations enacted to implement the federal Clean Water Act (CWA) may require nutrient management plans (NMPs) and/or require implementation of some of the nitrogen management practices approved as project activities. More specifically, once a watershed is identified as "impaired,"[23] if any agriculture non-point source (NPS)[24] is identified as contributing to a watershed's impairment (e.g. nitrate levels exceeding XX), agricultural non-point sources in that watershed may become limited by an NPS source pollution obligation (e.g. a field or region-specific obligation to help meet a Total Maximum Daily Load (TMDL).

Due to localized implementation of the CWA and TMDL strategies, the extent to which nutrient management plans become effectively required by law may vary greatly in terms of flexibility and what is explicitly required (e.g. a project participant may be allowed to self-select practices to include in an NMP for their field, while elsewhere an explicit N-rate reduction may be required). Once a practice is required or is self-selected by a project participant as part of an NPS pollution obligation, the Reserve considers that practice a non-voluntary legally binding mandate, as continued implementation of that practice is required by law, and that practice will not be considered an eligible project activity for that farm.

Fields that are located in impaired watersheds where agriculture is identified as a source of impairment shall not pass the Legal Requirement Test *unless* the field (and/or appropriate non-point source under which discharges from the field would be categorized) has specifically been identified as *not* contributing to the watershed's impairment. If no point- or non-point source of discharge has been identified as the causing the watershed's impairment (e.g. the source of impairment is "unknown") the Reserve will assume that all agricultural sources may be contributing to the watershed's impairment and no fields in that watershed shall pass the Legal Requirement Test.

The calculation of a project field's baseline must reflect all legal constraints in effect at the time of the project field's start date, as required in Section 5.1 of this protocol. If the approved project activity (N-rate reduction) of an eligible field later becomes legally required, emission reductions may be reported to the Reserve for that field up until the date that the practice is required by law to be adopted. Upon the effective date of the new legal requirement, a field may no longer report emission reductions, unless it can demonstrate that the approved project activity goes above and beyond the legal requirement and that "above and beyond" action can be quantified. The legal requirement test is applied to each field, so if one field in an aggregate becomes legally required, it shall not affect the other fields in the aggregate.

[23] A watershed is identified as impaired when it is not in compliance with Clean Water Act's water quality standards. Once identified as "impaired," a watershed is added the "Impaired or Threatened Waters List," also known as the CWA's "303(d) List." As this list is updated frequently, project developers and verifiers should refer to the U.S. EPA website for the most up-to-date list of impaired watersheds: http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T

[24] A "nonpoint source" is defined by the Clean Water act as any source of water pollution not meeting the legal CWA definition of "point source." The term "point source" is defined by the CWA Section 502(14) as "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged." The CWA point source definition goes on to explicitly state that agricultural storm water discharges and return flows from irrigated agriculture are not considered point sources.

3.5.3 Ecosystem Services Payment Stacking

When multiple ecosystem services credits or payments are sought for a single activity on a single field, it is referred to as "credit stacking" or "payment stacking," respectively.[25] Under this protocol, credit stacking is defined as issuing more than one mitigation credit for the same activity on spatially overlapping areas (i.e. in the same acre). Payment stacking is defined as issuing mitigation credits for a best management or conservation practice that is funded by the government or other parties via grants, subsidies, payment, etc. Mitigation credits are used to offset the environmental impacts of another entity, be it emissions of GHGs, removal of wetlands, or discharge of pollutants into waterways, to name a few.

3.5.3.1 Credit Stacking

Based on a review of mitigation credit markets in the U.S., water quality trading is the only other ecosystem service market that would credit nutrient-reducing activities. Water quality trading programs (WQTP) are being developed across the country as an optional tool for compliance with the Clean Water Act. While there are many water quality trading programs under development, there were no active WQT markets identified that had issued nutrient reduction credits to agricultural sources for the approved practice (N-rate reduction) in eligible project locations under this protocol (see Table 3.1).[26] As such, credit stacking is not addressed by the protocol at this time.

Research on WQTP to date suggests that these programs are highly variable due to the localized nature of program development and enforcement as allowed under the Clean Water Act. The Reserve will continue to track the development of relevant WQTP and will update this section as relevant programs are implemented.

3.5.3.2 Payment Stacking

The Reserve has identified three USDA Natural Resource Conservation Service (NRCS) programs that provide payments nationwide to support the implementation of agricultural BMPs. Authorized by the 2008 Farm Bill, the Environment Quality Initiative Program, the Agricultural Water Enhancement Program and the Conservation Stewardship Program are national programs that are implemented at the state- and county-level. NRCS expressly allows the sale of environmental credits from enrolled lands,[27] but does not provide any additional guidance on ensuring the environmental benefit of any PES stacked with an NRCS payment.

All NRCS programs share a common set of conservation practice standards that contain information on why and where the practice is to be applied, and set forth the minimum quality criteria that must be met during the application of that practice in order for it to achieve its intended purpose(s).

NRCS Conservation Practice Standard 590 – *Nutrient Management* (CPS 590) provides assistance to farmers to manage the amount (rate), source, placement (method of application),

---

[25] Cooley, David, and Lydia Olander (September 2011). "Stacking Ecosystem Services Payments: Risk and Solutions," Nicholas Institute for Environmental Policy Solutions, Duke University. NI WP 11-04. Available at: http://nicholasinstitute.duke.edu/ecosystem/land/stacking-ecosystem-services-payments/.

[26] The following WQT programs that allow nutrient trading between point sources and agricultural non-point sources were assessed: The Great Miami River Watershed Water Quality Credit Trading Pilot (OH), Red Cedar River Nutrient Trading Pilot Program (WI), Southern Minnesota Beet Sugar Cooperative Program, Alpine Cheese Phosphorus Nutrient Trading Plan (OH), Kalamazoo River Demonstration (MI), and Rahr Malting Company NPDES Permit (MN). None of these programs have issued water quality credits to cropland for fertilizer reduction activities.

[27] EQIP, 7 CFR §1466.36; CSP, 7 CFR §1470.37.

and timing of plant nutrients and soil amendments on lands where plant nutrients and soil amendments are applied.[28]

Data obtained from NRCS show that no state eligible under this protocol has more than 3% of cropland acres receiving NRCS funding under CPS 590, suggesting that existing payments are not adequate to further incentivize nitrogen application reductions.[29] Analyses also show that farmers base their fertilizer application rate decisions on routine practice and there is significant opportunity for farmers to reduce fertilizer application without affecting yields (see Appendix A).

Because of these reasons, the use of NRCS payments to help support reductions in nitrogen application under this protocol is allowed, except as specified below.

Stacking NRCS payments under CPS 590 with CRTs under this protocol is not allowed if the nutrient management plan required by CPS 590 was under a signed agreement with NRCS prior to the project field being submitted to the Reserve and the plan included a reduction in fertilizer application.

Note that if a field is under an agreement with NRCS to receive payments for activities that do not include reduced fertilizer application under CPS 590 (or NRCS payments under any other CPS), those payments do not affect field eligibility, as the payments were awarded for different activities than those credited by this protocol and thus are not considered “stacked.”

Furthermore, other fields owned by the farmer are eligible if they are not under agreement to receive NRCS funding for CPS 590 activities that include reduced fertilizer application. Fields that have received CPS 590 payments in the past but are no longer receiving payments are also eligible.

For informational purposes, any other type of ecosystem service payment or credit received for activities on a project field must be disclosed by the project developer/aggregator to the verification body and the Reserve.

Workgroup:

The Reserve’s proposal to allow payment stacking is inconsistent with the policies of some active and developing water quality trading programs. These WQTPs are not allowing stacking of public funds with water quality credits. For example, in the Willamette Partnership program, if a project receives public conservation funds for 50% of its costs, the project would only be eligible to receive credits from the portion of the project not funded by public dollars (e.g. available credits to be sold would be reduced from 100 credits to 50 credits). The Ohio River Trading Program is developing a similar policy where federal cost share dollars or other federal grant funding can be used to set baseline conditions, but cannot be used to generate credits.

These WQTPs believe public programs (like EQIP) that provide funds for voluntary natural resource protection and/or restoration should not be used to finance mitigation projects undertaken to satisfy regulatory requirements (i.e. a NPDES permit or to offset a power plant’s

[28] Natural Resources Conservation Service *Conservation Practice Standard Nutrient Management, Code 590*, December 2011. State-specific conservation practice standards can be downloaded from http://efotg.sc.egov.usda.gov//efotg_locator.aspx.
[29] Based on NRCS funding for Contract Fiscal Years 2010 and 2011 obtained from NRCS Protracts database, accessed October 2011.

CO_2 emissions in a cap-and-trade system). They believe to do so would be inconsistent with the mandated and/or intended purposes and limitations of these public conservation programs.

We are interested to hear if the workgroup feels public dollars should be used to finance project activities that will be issued carbon credits, or if we should consider discounting credits based on the proportion of public funds received by the project.

3.6 Regulatory Compliance

As a final eligibility requirement, project developers must attest that the project is in material compliance with all applicable laws relevant to the project activity (e.g. air, water quality, water discharge,[30] safety, labor, endangered species protection, etc.) prior to verification activities commencing each time a project is verified. Project developers are required to disclose in writing to the verifier any and all instances of non-compliance of the project with any law. If a verifier finds that a field is in a state of recurrent non-compliance or non-compliance that is the result of negligence or intent, then CRTs will not be issued for GHG reductions that occurred on that field during the period of non-compliance. Non-compliance solely due to administrative or reporting issues, or due to “acts of nature,” will not affect CRT crediting.

Additional information on legal requirements potentially relevant to a project’s status of regulatory compliance is included in Appendix C.

[30] See Appendix C for an overview of water quality rules and regulations that may impact a farm’s legal requirements or regulatory compliance.

4 The GHG Assessment Boundary

The GHG Assessment Boundary delineates the GHG sources, sinks, and reservoirs (SSRs) that must be assessed by project developers in order to determine the net change in emissions caused by a nitrogen management (NM) project.[31]

The GHG Assessment Boundary encompasses all the GHG sources, sinks, and reservoirs that may be significantly affected by project activities, including sources of nitrous oxide and methane emissions from the soil, biological CO_2 emissions and soil carbon sinks, and fossil fuel combustion GHG emissions. For accounting purposes, the sources, sinks, and reservoirs included in the GHG Assessment Boundary are organized according to whether they are predominantly associated with an NM project's "primary effect" (i.e. the NM project's intended N_2O reduction), or its "secondary effects" (i.e. unintended changes in carbon stocks, CH_4 emissions, or other GHG emissions).[32] Secondary effects may include increases in mobile combustion CO_2 emissions associated with site preparation, as well as increased GHG emissions caused by the shifting of cultivation activities from the project area to other agricultural lands (often referred to as "leakage"). Projects are required to account for all SSRs that are included in the GHG Assessment Boundary regardless of whether the particular SSR is designated as a "primary" or "secondary" effect.

Workgroup:

For most Reserve protocols, we provide a general illustration of the GHG Assessment Boundary, indicating which SSRs are included or excluded from the boundary, here. The Reserve did not include such a diagram in the Rice Protocol, and we do not think including one for this protocol will be particularly helpful either. However, we are interested in hearing your comments. Do you think a GHG boundary diagram would be helpful here?

Table 4.1 provides a comprehensive list of the GHG sources, sinks, and reservoirs (SSRs) that may be affected by an NM project, and indicates which SSRs must be included in the GHG Assessment Boundary.

[31] The definition and assessment of sources, sinks, and reservoirs (SSRs) is consistent with ISO 14064-2 guidance.
[32] The terms "Primary Effect" and "Secondary Effect" come from WRI/WBCSD, 2005. *The Greenhouse Gas Protocol for Project Accounting*, World Resources Institute, Washington, DC. Available at http://www.ghgprotocol.org.

Table 4.1. Description of all Sources, Sinks, and Reservoirs

SSR	Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
Primary Effect Sources, Sinks, and Reservoirs					
1. Soil Dynamics	Biogeochemical interactions occurring in the soil that produce emissions of nitrous oxide, as well as carbon dioxide (biogenic), and possibly methane.	N_2O	I	A method for quantifying direct N2O emissions from an approved project activity, as provided in Section 5.4.1	The primary effect of an NM project is a reduction in nitrous oxide emissions from soil. [33]
		CO_2	E	N/A	Changes in soil carbon stocks may result from implementation of a NM project activity; however, the effect is likely to be small and/or result in a net increase in carbon sequestration. This SSR includes soil carbon stock changes resulting from applying organic forms of nitrogen to soils.
		CH_4	E	N/A	Methane production and oxidation is insignificant for non-flooded soils.
2. Leaching, Volatilization, and Run-Off	Leaching, volatilization, and run-off of applied nitrogen, followed by denitrification into N_2O. [34]	N2O	I	IPCC emission factor methodology, as provided in Section 5.4.2	Also a primary effect of NM projects, this may be a significant portion of overall N_2O emission reductions, due to the project's reduction in losses of total N from the project field.
Secondary Effect Sources, Sinks, and Reservoirs					
3. Manure Incorporation, Storage, and Handling	Indirect emissions from storing and handling of manure.	N_2O	E	N/A	Adoption of the approved project activities listed in Table 2.2 is not likely to cause major changes in the way manure is handled and stored prior to application, particularly with the applicability condition that requires maintenance of a consistent organic-to-synthetic-N ratio (see Section 5.1). Therefore, there is no expected change in emissions from this SSR due to NM projects.
		CH_4	E	N/A	
		CO_2	E	N/A	

[33] These N_2O emissions are referred to as "direct N_2O emissions from soils" by the IPCC National Inventory Guidelines.

[34] The IPCC refers to the N_2O emissions from leaching, volatilization, and run-off (LVRO) as "indirect N_2O emissions" because these emissions typically occur offsite due to denitrification of the N lost from the project site due to LVRO. Reductions in "indirect N_2O emissions" are still considered reductions in "primary effect" emissions because reducing N-losses from the project site is one of the primary goals of the approved project activity "reducing N-rate." Reductions of these "indirect" N_2O emissions are not to be confused with "indirect emission reductions" or "secondary effect emission reductions," (e.g. emission reductions occurring outside the control of the project participant). To avoid confusion, this protocol refers to emissions from leaching, volatilization, and run-off as emissions from "LVRO," instead of "indirect N_2O emissions."

SSR	Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
4. Cultivation Equipment	Fossil fuel emissions from equipment used for field preparation, seeding, fertilizer/pesticide/herbicide application, and harvest.	CO_2	I	Method in Section 5.5.1	Emissions may be significant if management requires an increase in the use of cultivation equipment (e.g., increased number of fertilizer applications). Increased emissions due to project activity must be accounted for. Decreased emissions due to project activity are not accounted for, to be conservative and to avoid double counting under a cap (e.g. in regions such as CA where emissions from transportation fuels will be capped).
		CH_4	E	N/A	Excluded, as this emission source is assumed to be very small.
		N_2O	E	N/A	Excluded, as this emission source is assumed to be very small.
5. GHG Emissions from Shifted Production (Leakage)	Increases in production outside the project area, sometimes referred to as Indirect Land Use Change, may occur if yields are significantly and negatively affected by a project activity.	CO_2	I	Method in Section 5.5.2	If aggregate level yields are found to have statistically decreased due to project activities, there is an assumed increase in GHG emissions from shifted production that must be estimated and included.
		CH_4	I	Method in Section 5.5.2	
		N_2O	I	Method in Section 5.5.2	
6. GHG Emissions from Fertilizer Production	Decreases in fertilizer use on fields may affect the amount of fertilizer produced and indirectly cause reduction of GHGs associated with fertilizer production.	CO_2	E	N/A	It is conservative to exclude this category because in all cases, emissions from this SSR will decrease. Also, the source is "indirect," meaning that reductions take place offsite and are difficult to link directly to project activities of single farm. Finally, in some regions emissions from fertilizer production will be directly regulated by being a capped industry and including this source would lead to double counting.
		N_2O	E	N/A	
		CH_4	E	N/A	
7. GHG Emissions from Production and Use of Chemical Inputs	Changes in nutrient management practices may impact how much lime or herbicides are used on fields	CO_2	E	N/A	Excluded, as approved project activities are unlikely to materially increase the use of lime or herbicides used on fields. The very small changes in herbicide and/or lime demand due to NM projects are unlikely to have an effect on herbicide and/or lime production.
		N_2O	E		
		CH_4	E		
8. GHG Emissions from Irrigation	Changes to nutrient management practices may require changes to the field's irrigation system. As	CO_2	E	N/A	Excluded, as currently approved project activities are not expected to result with an increase in water usage or changes to the irrigation
		N_2O	E		

SSR	Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
	irrigation water pumping and transport requires energy, certain nutrient management changes may increase energy use for irrigation and lead energy-related GHG emissions.	CH_4	E		system.

Workgroup:

We are seeking your comments on whether it is appropriate to exclude the following sources, based on the narrow scope of project activities in version 1.0.

- SSR 7 (Emissions from Production and Use of Chemical Inputs) – As far as we know, reducing N-rate shouldn't result in an increased need for herbicides, pesticides, lime, etc. Do you agree with this assumption?
- SSR 8 (Emissions from Irrigation) -- we do not believe N-rate reduction projects under this protocol will drive farmers to change irrigation practices, e.g. implementing fertigation. Do you agree with this assumption?

SSR 3 – Manure Incorporation, Storage, and Handling.

The decision to exclude manure was slightly more complicated. The approved project activity is unlikely to incent *switching* from synthetic to organic, and vice versa. Assuming the same composition of N in the baseline and project, SSR 3 is unlikely to change, due to the project. However, if the project participant switches from synthetic to organic, there may be changes in emissions due to transporting and storing the manure. Changing from organic to synthetic would likely increase emissions from fertilizer production, as well as lead to a situation in which manure previously applied to the project field is now applied (possibly over-applied) elsewhere, possibly increasing emissions.

Other concerns include:

- The fact that unprocessed manures (as well as other unprocessed organics, such as non-commercial compost) have highly variable N-contents (making a robust default N-content somewhat challenging)
- The quantification methodology developed by MSU-EPRI is based on data from reduction in synthetic N-rates. [We will discuss this with the workgroup, but based on published field studies, such as Jarecki et al. (2009), which conclude that the primary factor influencing N_2O emissions is a reduction in N-rate, we think this is not a problem. However, regardless, this methodology is not meant to capture N_2O reductions stemming specifically from a change in N source)

To manage these manure (and other organic) concerns, the Reserve introduced the requirement that the field must maintain a consistent organic to synthetic N ratio (OSN) in both project and baseline (e.g.as total N-rate is reduced, both organic and synthetic N must be reduced, to maintain consistent proportions, within a small range).

See Section 5.1 for additional information on the OSN. Please share with us your comments about this proposal, as well as any additional requirements we may want to consider for monitoring, reporting, and verification.

5 Quantifying GHG Emission Reductions

GHG emission reductions from a nitrogen management project are quantified by comparing actual project emissions to baseline emissions related to nitrogen management. Baseline emissions are an estimate of the GHG emissions from sources within the GHG Assessment Boundary (see Section 4) that would have occurred in the absence of the nitrogen management project. Project emissions are actual GHG emissions that occur from sources within the GHG Assessment Boundary. Project emissions must be subtracted from the baseline emissions to quantify the project's total net GHG emission reductions. GHG emission reductions are calculated separately for each individual field, and in the case of an aggregate, summed together over the entire aggregate. The calculation approach in this section is applicable to single-field projects and aggregates.

Project emission reductions must be quantified and verified on an annual basis, reflecting a reduction in annual N-rate over a complete cultivation cycle. The length of time over which GHG emission reductions are quantified and verified is called the "reporting period. The reporting period must be uniformly defined for the aggregate. Thus, for reporting purposes, the aggregate reporting period shall always be defined as starting on October 1 and ending on September 31 of the next year. Individual fields within an aggregate may have cultivation cycles that start on different dates, however the cultivation cycles for all fields within an aggregate must be complete before the aggregate is able to undergo verification. To ensure that only emission reductions occurring during an aggregate's fixed reporting period is credited during that reporting period, emission reductions from each field shall be prorated, according to the methodology in Section 7.4. For single field projects, the reporting period shall be defined using the exact dates corresponding to the beginning and the end of the cultivation cycle for the particular field.

Workgroup:

We added this uniform reporting requirement (above) due to concerns about overlapping reporting periods. However, there may be reporting period and verification issues associated with pro-rating. Please see the additional green box in Section 7.4.

The primary effect of a nitrogen management project is the total reduction in direct N_2O emissions from soil (SSR 1) and in N_2O emissions from leaching, volatilization and runoff (LVRO, SSR 2), due to implementation of an approved project activity (e.g. a reduction in N application rate).

In addition to the primary effect (SSR 1 and 2), nitrogen management projects may result in unintended increases of GHG emissions from other SSRs. Section 0 provides requirements for calculating these secondary effect GHG emissions resulting from the project activity.

Total emission reductions from a project are equal to the combined primary emission reductions from SSR 1 and 2 for all fields in the project area, minus the increase in emissions from all other SSRs due to the project activity. Total net GHG reductions for a reporting period are calculated by subtracting baseline emissions from actual emissions for all SSRs over the reporting period, as prescribed in Sections 5.4 to 0. Equation 5.1 below provides the general GHG reduction calculation.

Equation 5.1. Calculating GHG Emission Reductions

$$ER = PER - SE$$

Where, Units

ER	=	The total emission reductions from the project area for the reporting period	Mg CO_2e
PER	=	primary effect GHG emissions reductions over the entire project area, see Section 5.3	Mg CO_2e
SE	=	The total secondary effect GHG emissions caused by project activity during the reporting period for the entire project aggregate, see Section 0 to 5.5.2	

5.1 Applicability Conditions for N-Rate Reduction Projects

The following applicability conditions must be met for all fields implementing the approved project activity "reducing N-rate:"

1. The project area shall not contain any organic soils (e.g. histosols).

2. N_2O emissions reductions from reducing N rates of all synthetic and organic fertilizer N sources must be accounted for. Synthetic fertilizers[35] may be applied in dry form (e.g. granular urea, ammonium nitrate) or liquid form (e.g. urea ammonium nitrate - UAN). Eligible organic fertilizers include unprocessed manure (e.g. beef cattle manure, hog manure), other unprocessed organics (e.g. compost) and processed commercial organic fertilizers. On any particular field, a number of different fertilizer types can be applied.

3. Project participants are not permitted to implement significant changes from their historic baseline N composition, in terms of proportions of organic and synthetic N. More specifically, a field that received only organic N or only synthetic N in its baseline must continue to receive only organic N or synthetic N, respectively, throughout the project, while a field that received a combination of organic and synthetic N in its baseline must continue to receive a consistent ratio of organic N to synthetic N throughout the project. Section 5.3, step 5, provides specific guidelines on how to calculate the average historic baseline organic-to-synthetic-N-ratio (OSN), and its permissible range (OSNR).

Workgroup:

Condition 2: We would like to include compost as an "eligible N" so as to include organic growers in this protocol. The variability in N contents is quite high for composts, however, so the Reserve believes it may be challenging to rely on standard N content tables. Do we think that farmers using compost would know (roughly) the N content of compost they are applying? Could we consider requiring an N content measurement for compost? Possibly require a measurement in year 1 with relaxed requirements in subsequent years (if can be demonstrated that N-content will be roughly the same)?

[35] Even though urea is technically an "organic" fertilizer, it is considered a "synthetic" fertilizer for the purposes of this protocol.

Condition 3: Do you think it is problematic that this OSN range is being included as an applicability condition? This means that if the OSN isn't consistent, the field is not eligible that year. Should we be trying to find a way to allow for that field to participate, while still being conservative, perhaps by making them take a large (e.g. 50%) deduction? The deduction would have to be quite large, due to the fact that we aren't quantifying a number of SSRs that may change if the OSN is not kept consistent. (Please also see the box in Section 5.3 where the OSN is calculated).

5.2 Determining Fertilizer N-Rates

The total N-rate for field *f* is the sum of N-rates of synthetic and organic fertilizer N, calculated as follows:

Equation 5.2. Calculating Total Fertilizer N-Rate for Field *f*

$$NR_f = NR_{S,f} + NR_{O,f}$$

Where,

			Units
NR_f	=	Total fertilizer N-rate for field *f*	kg N/ha
$NR_{S,f}$	=	N-rate of total synthetic fertilizer for field *f*, see Equation 5.3	kg N/ha
$NR_{O,f}$	=	N-rate of total organic fertilizer for field *f*, see Equation 5.6	kg N/ha

The total synthetic fertilizer N-rate for a particular field is calculated as the sum of N-rates of all dry and liquid synthetic N sources and calculated as follows:

Equation 5.3. Calculating Synthetic Fertilizer N-Rate for Field *f*

$$NR_{S,f} = \sum_j NR_{DS,j,f} + \sum_j NR_{LS,j,f}$$

Where,

			Units
$NR_{S,f}$	=	N-rate of total synthetic fertilizer for field *f*	kg N/ha
$NR_{DS,,j,f}$	=	N-rate of dry synthetic fertilizer type *j* on field *f*, see Equation 5.4	kg N/ha
$NR_{LS,j,f}$	=	N-rate of liquid synthetic fertilizer type *j* on field *f*, see Equation 5.5	kg N/ha

Fertilizer N-rates used in the equations throughout in this protocol are in [kg N/ha]. This section provides guidance on how to convert project participants' reported synthetic and organic fertilizer N-rates to kg N/ha, yielding values for $NR_{DS,j,f}$, $NR_{LS,j,f}$, and $NR_{O,f}$. In general, the amount of N-containing fertilizer is multiplied by the N-content (NC_j) of the fertilizer, and relevant conversions to SI-units are applied. Equation 5.4, Equation 5.5 and Equation 5.7 show calculations for fertilizer N-rates for dry N-containing synthetic fertilizers, liquid N-containing synthetic fertilizers, and N-containing organic fertilizers, respectively. Default information on N contents and weights of various N-containing fertilizers is provided in Appendix A, Table A.2, although farm management records, commercial fertilizer labels, and N-soil tests are preferable, when available, as discussed further in Section 6.

Equation 5.4. Calculating Fertilizer N-Rates of Dry N-Containing Synthetic Fertilizer *j*

$$NR_{DS,j,f} = \frac{MF_{DS,j,f} \times NC_j \times 0.454}{0.405}$$

Where,			Units
$NR_{DS,j,f}$	=	N-rate of dry synthetic fertilizer *j* for field *f*	kg N/ha
$MF_{DS,j,f}$	=	The mass of dry synthetic N-containing fertilizer *j* applied to field *f*	lbs fertilizer/acre
NC_j	=	The N-content of fertilizer *j*, see Table A.2[36]	lbs N/(lbs fertilizer)
0.454	=	Factor to convert lbs to kg	
0.405	=	Factor to convert acre to ha	

Equation 5.5. Calculating Fertilizer N-Rates for Liquid N-Containing Synthetic Fertilizer *j*

$$NR_{LS,j,f} = \frac{VF_{LS,j,f} \times MF_{LS,j} \times NC_j \times 0.454}{0.405}$$

Where,			Units
$NR_{LS,j,f}$	=	N rate of liquid synthetic fertilizer *j* for field *f*	kg N/ha
$VF_{LS,j,f}$	=	The volume of liquid synthetic N-containing fertilizer *j* applied to field *f*	gallons/acre
$MF_{LS,j}$	=	Mass of liquid synthetic fertilizer *j* per gallon of fertilizer[37]	lbs fertilizer/gallon
NC_j	=	N content of fertilizer *j*, see Table A.2	lbs N/(lbs fertilizer)
0.454	=	Factor to convert lbs to kg	
0.405	=	Factor to convert acre to ha	

Similarly, the total organic fertilizer N-rate for a particular field is calculated as the sum of N-rates of all organic N sources and calculated as follows:

Equation 5.6. Calculating Organic Fertilizer N-Rate for Field *f*

$$NR_{O,f} = \sum_j \left(NR_{O,j,f}\right)$$

Where,			Units
$NR_{O,f}$	=	N rate of total organic fertilizer for field *f*	kg N/ha
$NR_{O,j,f}$	=	N rate of organic fertilizer *j* on field *f,* see Equation 5.7	kg N/ha

[36]Fertilizer N contents, fertilizer weights and unit conversion factors are adopted from: www.mn.nrcs.usda.gov/technical/ecs/nutrient/planning/conversion%20factors/conversionfactors3.pdf

[37] Fertilizer N contents, fertilizer weights and unit conversion factors are adopted from: www.mn.nrcs.usda.gov/technical/ecs/nutrient/planning/conversion%20factors/conversionfactors3.pdf

Equation 5.7. Calculating Fertilizer N-Rates for N-Containing Organic Fertilizer *j*

$$NR_{O,j,f} = \frac{MF_{O,j,f} \times NC_j \times 0.454}{0.405}$$

Where, Units

$NR_{O,j,f}$	=	N-rate of organic fertilizer *j* for field *f*	kg N/ha
$MF_{O,j,f}$	=	The mass of organic N-containing fertilizer j applied to field *f*	tons fertilizer/acre
NC_j	=	The N-content of organic fertilizer *j*, see Table A.2[38]	lbs N/(ton fertilizer)
0.454	=	Factor to convert lbs to kg	
0.405	=	Factor to convert acre to ha	

5.3 Determining Baseline N-Rates for Calculating Baseline N_2O Emissions from N-Rate Reduction Projects

A baseline N-rate to calculate N_2O emissions from N-rate reduction projects shall be calculated separately for each individual field in an aggregate. The following step-wise approach shall be followed.

Workgroup:

Please comment on the methodology for setting the baseline, as it applies to the eligible crop corn, both as a monoculture and in more complicated rotations. We are trying to allow for flexibility with complex rotations, and are concerned the look-back requirements for these complex rotations may be burdensome (e.g. require old records that growers no longer have).

Step 1: Determine the historical look-back period and collect historical yield and N-rate data. A historic average RTA value must be calculated for each individual field in a project using data from all eligible crop years during a period of at least 5 years prior to the field's start date. In case less than 3 eligible crop years were planted in the 5 years prior to the field's start date, the historical look-back period shall be extended until at least 3 eligible crop years are included.[39] From the historical look-back period, and for each of the eligible crop years, identify the total N rate, including mineral and organic fertilizer as well as the historical cropping yields.

Step 2: Calculate the historical average RTA. Using the historical yield and N-rate data, calculate the RTA value for each of the eligible crop years in the historical look-back period using equation 3.1 in Section 3.5.1.1, and average the RTA values to determine the "historical average RTA" for that field using Equation 5.8. For ease of use, equation 3.1 from Section 3.5.1.1 is repeated within Equation 5.8.

[38] For processed commercial organic fertilizer, N contents following manufacturers specification can be used. For unprocessed manure, default manure N contents are shown in Table A.2 in Appendix A and are consistent with Edmonds et al. (2003) cited in U.S. EPA. 2011. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009.* EPA 430-R-11-005. Washington, D.C.: U.S. Environmental Protection Agency.

[39] For example, if the cropping sequence prior to the project start is Corn-Soybean-Corn-Soybean-Corn, and all corn cropping years are eligible, a look-back period of 5 years suffices. However, if the cropping sequence prior to the project start is Soybean-Corn-Soybean-Corn-Soybean, the look-back period shall be extended until one more corn cropping year is included.

Equation 5.8. Equation to Calculate a Field's Historical RTA
(Calculation for Annual RTA is identical to Equation 3.1.)

$$RTA_{Hist,f,c} = \frac{\sum_{t=1}^{n} RTA_{f,c,t}}{n}$$

$$RTA_{f,c,t} = \frac{Y_{f,c,t} \times NC_c}{NR_{f,c,t}}$$ **(Equation 3.1)**

Where,			Units
$RTA_{Hist,f,c}$	=	Historical RTA calculated for field *f* and crop *c*[40]	
N	=	Number of eligible crop years available in the historical look-back period	
$RTA_{f,c,t}$	=	Annual RTA calculated for field *f*, crop *c*, and over time *t*. This equation was repeated from Equation 3.1	
$Y_{f,c,t}$	=	Annual yield on field *f* and crop *c* over time *t*	unit*/ha
NC_c	=	N content for crop *c* based on default look-up Appendix A	kg N/unit
$NR_{f,c,t}$	=	Annual total nitrogen application rate (including organic and synthetic forms of N) on field *f* and crop *c* over time *t*	kg N/ha

* Unit could be bushels or other measure of crop biomass. To convert from unit/acre to unit/ha, divide by 0.405

Step 3: Determine historical baseline N-rate. Look up the relevant state- and crop-specific performance threshold in Table A.8 in Appendix A ($RTA_{c,s}$) and compare the threshold to the historic average RTA.

If the historic average RTA, $RTA_{Hist,f,c}$, determined in step 2, is greater than or equal to the relevant state- and crop-specific performance threshold $RTA_{c,s}$ then the historic baseline N-rate for the field shall be used to calculate baseline N_2O emissions (i.e. $NR_{B,f}$ from Equation 5.9).

[40] Crop *c* refers to the specific crop being grown on the field *f*. In the current version of the NMPP protocol, crop *c* essentially differentiates between corn for grain or silage. For the calculation of the RTA, it is important to distinguish between corn for grain versus corn for silage because the amount of N removed by harvest differs between the two crops. In contrast, the quantification of N_2O emissions and emission reductions is the same for corn for grain and corn for silage, and as such, no subscript *c* is used in the equations in Sections 5.4 to 5.5.2.

Equation 5.9. Equation to Calculate Baseline N Rate if the Historical Average RTA is Greater than or Equal to the Performance Threshold

$$NR_{B,f,c} = \frac{\sum_{t=1}^{n} NR_{f,c,t}}{n}$$

Where,			Units
$NR_{B,f,c}$	=	Baseline N rate for field *f*, crop *c*	kg N/ha
n	=	Number of eligible crop years available in the historical look-back period.	
$NR_{f,c,t}$	=	Annual total nitrogen application rate (including organic and synthetic forms of N) on field *f* and crop *c* over time *t*	kg N/ha

If the historic average RTA, $RTA_{Hist,f,c}$, determined in step 2, is less than the relevant state- and crop-specific performance threshold $RTA_{c,s}$ then a default N-Rate shall be used to calculate baseline N_2O emissions. The default baseline N-rate shall be derived from the relevant state- and crop-specific performance threshold $RTA_{c,s}$ and the field's historic average yield.

Equation 5.10. Equation to Calculate Baseline N Rate if the Historical Average RTA is Less than or Equal to the Performance Threshold

$$NR_{B,f,c} = \frac{\sum_{t=1}^{n} Y_{f,c,t}}{n} \times \frac{NC_c}{RTA_{c,s}}$$

Where,			Units
$NR_{B,f,c}$	=	Baseline N rate for field *f*, crop *c*	kg N/ha
n	=	Number of eligible crop years available in the historical look-back period	
$Y_{f,c,t}$	=	annual yield for field *f* and crop *c* grown over year *t*.	unit*/ha
NC_c	=	N content for crop *c* based on default look-up Appendix A	kg N/unit
$RTA_{c,s}$		State- and crop-specific RTA performance threshold. Available from Table A.8 in Appendix A	

* Unit could be bushels or other measure of crop biomass. To convert from unit/acre to unit/ha, divide by 0.405

Step 4: Adjust baseline for legal constraints. To ensure additionality and that a field is going above and beyond what it is legally required, the field's baseline N rate ($NR_{B,f,c}$) shall be adjusted to reflect all legal constraints in effect at the time of the field's start date, regardless of when that legal constraint went into effect. More specifically, if a legally binding N application rate is required for the field, and that legally required N rate is less than the calculated baseline N rate ($NR_{B,f,c}$), the baseline N rate shall be set at the legal limit. Similarly, if a Nutrient or Nitrogen Management Plan (NMP) is in place prior to the start date, regardless of whether it is voluntary or legally required, the field's baseline shall reflect the N-rate included in that NMP, even if that NMP has not been in place for five years.

Step 5: Check proportions of organic and synthetic N. As explained in Section 5.1, project participants must maintain consistent proportions of organic and synthetic N in the baseline and project. More specifically, the organic-to-synthetic-N-ratio (OSN) of the field must be within the range of acceptable OSNs (OSNR) throughout the project. The OSNR is calculated in Equation 5.11 based on historical OSNs determined for the historical look-back period as defined in step 1. The historical OSNs as well as the OSN of the project year are calculated as $OSN_{f,t}$ in Equation 5.11.

Equation 5.11. Calculating the Range of Acceptable Project Organic-to-Synthetic-N-Ratios

$$\boldsymbol{OSNR_f = 1 \pm 0.10 \times average(OSN_{f,t})}$$

$$\boldsymbol{OSN_{f,t} = \frac{NR_{O,f,t}}{NR_{S,f,t} + NR_{O,f,t}}}$$

Where,

			Units
$\mathrm{OSNR_f}$	=	Range of acceptable project organic-to-synthetic-N-ratios for field *f*	
$\mathrm{OSN_{f,t}}$	=	Organic-to-synthetic-N-ratio for field *f* in year *t*	
$\mathrm{average(OSN_{f,t})}$	=	Average $OSN_{f,t}$ over the historical look back period, for all eligible cropping years.	
$\mathrm{NR_{O,f,t}}$	=	N-rate of total organic fertilizer for field *f* in year *t*	kg N/ha
$\mathrm{NR_{S,i}}$	=	N-rate of total synthetic fertilizer for field *f* in year *t*	kg N/ha

Workgroup:

See Section 4 for another box which goes further into depth on our concerns on organics. This maintenance of a consistent OSN is an attempt to prevent a switch of N composition.

(Also see green box in 5.1) Does the “consistent OSN” requirement seem workable? Currently, it is implemented at the field level. We have considered allowing this requirement to be met at the aggregate. However, we are concerned that applying the OSN at the aggregate level might make this requirements less conservative (e.g. Applying the test at the aggregate would likely make it easier to meet the requirement)

How should we handle project participants who use manure as a soil amendment somewhat infrequently, e.g. once every five years? These growers would fail the current test. We have considered just explicitly allowing that soil amendment in similar quantities in the project and baseline, as long the “every five year” pattern can be demonstrated/verified.” Thoughts?

5.4 Calculating the Primary Effect N_2O Emission Reductions for N-Rate Reduction Projects in Corn Crops in the North Central Region of the United States

5.4.1 Calculating Baseline and Project Direct N_2O Emissions from Soils[41] (SSR 1)

The baseline direct N_2O emissions are calculated based on the baseline N-rate and the MSU-EPRI Tier 2 emissions factor developed for the project activity "N-rate reduction" in corn cropping systems in the North Central Region of the U.S.[42] See Equation 5.12 below:

Equation 5.12. Direct Baseline N_2O Emissions from Soils for Field *f*

$$N_2O_{Dir,B,f} = NR_{B,f} \times EF_{Dir,B,f} \times \frac{44}{28} \times \frac{310}{1000}$$

$$EF_{Dir,B,f} = \frac{0.67 \times e^{(0.0067 \times NR_{B,f} - 1)}}{NR_{B,f}}$$

Where,[43]

			Units
$N_2O_{Dir,B,f}$	=	Annual baseline direct N_2O emissions from field *f*	Mg CO_2e/ha
$NR_{B,f}$	=	Baseline total N-rate determined for field f, see section 0	kg N/ha
$EF_{Dir,B,f}$	=	Emission factor for baseline direct N_2O emissions from baseline N inputs	kg N_2O-N/(kg N input)
310	=	Global Warming Potential of N_2O	
1000	=	Converts kg CO_2e/ha to Mg CO_2e/ha	

Similarly, the project direct N_2O emissions are calculated based on the project total N-rate applied during the cultivation cycle and the MSU-EPRI Tier 2 emissions factor. See Equation 5.13 below.

[41] As noted in Section 4, SSR 1 refers to the N_2O emissions from soil dynamics, or, to follow IPCC nomenclature, refers to the "direct N_2O emissions from soils."
[42] Millar, Neville, et al, "Quantifying N_2O Emissions Reductions in U.S. Agricultural Crops through Nitrogen Fertilizer Rate Reduction," Version 1.4.6, 25 Jan 2012, Developed by Michigan State University and Electric Power Research Institute, Undergoing 2nd Assessment with Verified Carbon Standard.
[43] Throughout the protocol, the factor 44/28 is a unit conversion from kg N_2O-N to kg N_2O, where 44 is the molecular weight of N_2O and 28 the atomic weight of N.

Equation 5.13. Direct Project N_2O Emissions from Soils for Field *f*

$$N_2O_{Dir,P,f} = NR_{P,i} \times EF_{Dir,P,f} \times \frac{44}{28} \times \frac{310}{1000}$$

$$EF_{Dir,P,f} = \frac{0.67 \times e^{(0.0067 \times NR_{P,f} - 1)}}{NR_{P,f}}$$

Where,

			Units
$N_2O_{Dir,P,f}$	=	Annual project direct N_2O emissions from field *f*	Mg CO_2e/ha
$NR_{P,f}$	=	Project total N-rate for field *f,* calculated following section 0	kg N/ha
$EF_{Dir,P}$	=	Emission factor for project direct N_2O emissions from project N inputs	Mg N_2O-N/(Mg N input)
310	=	Global Warming Potential of N_2O	
1000	=	Converts kg CO_2e/ha to Mg CO_2e/ha	

5.4.2 Calculating Baseline and Project N_2O Emissions from Leaching, Volatilization, and Run-Off (SSR 2)

N_2O emissions from leaching, volatilization, and run-off (LVRO)[44] of N must be accounted for in determining primary effect GHG reductions. Baseline N_2O emissions from LVRO are determined according to Equation 5.14 below.

[44] As noted in Section 4, the IPCC refers to these emissions as "indirect N_2O emissions."

Equation 5.14. Baseline N_2O Emissions from Leaching, Volatilization, and Run-Off (LVRO) for Field *f* [45]

$$N_2O_{LVRO,B,f} = \left(\left(\left(NR_{B,S,f} \times 0.10 + NB_{B,O,f} \times 0.20\right) \times 0.01\right) + \left(NR_{B,f} \times Frac_{LEACH} \times 0.0075\right)\right) \times \frac{44}{28} \times 310 \div 1000$$

Where,

			Units
$N_2O_{LVRO,B,f}$	=	Annual baseline N_2O emissions from leaching, volatilization, and run-off (LVRO) from field *f*	Mg CO_2e/ha
$NR_{B,S,f}$	=	N rate of total synthetic fertilizer for field *f*	kg N/ha
$NR_{B,O,f}$	=	N rate of total organic fertilizer for field *f*	kg N/ha
0.10	=	$Frac_{GASF}$, IPCC Default Factor, representing the fraction of all synthetic fertilizer N inputs that volatilizes as NH_3 and NO_x	
0.20	=	$Frac_{GASM}$, IPCC Default Factor, representing the fraction of all organic fertilizer N inputs that volatilizes as NH_3 and NO_x	
0.01	=	EF_4, IPCC Default Emission Factor for N_2O emissions from atmospheric deposition of N on soil and water surfaces and subsequent volatilization	kg N_2O-N/(kg NH_3-N + kg NO_x-N)
$NR_{B,f}$	=	Baseline total N-rate determined for field *f*, see Section 0	kg N/ha
$Frac_{LEACH}$	=	Fraction of N inputs (equal to 0.30) that is lost through leaching and runoff, in regions where leaching and runoff occurs, defined as where [Σ(rain in rainy season) - Σ (potential evaporation in same period)] > soil water holding capacity, or where irrigation (except drip irrigation) is employed	
0.0075	=	EF_5, IPCC Default Emission Factor for N_2O emissions from N leaching and runoff	kg N_2O-N/(kg NO_3^-N)
310	=	Global Warming Potential of N_2O	

Project N_2O emissions during the cultivation cycle from leached and volatilized N must be accounted for according to Equation 5.15 below:

Equation 5.15. Project N_2O Emissions from Leaching, Volatilization, and Run-Off (LVRO) for Field *f* [45]

$$N_2O_{LVRO,P,f} = \left(\left(\left(NR_{P,S,f} \times 0.10 + NR_{P,O,f} \times 0.20\right) \times 0.01\right) + \left(NR_{P,f} \times Frac_{LEACH} \times 0.0075\right)\right) \times \frac{44}{28} \times 310 \div 1000$$

Where,

			Units
$N_2O_{LVRO,P,f}$	=	Annual project indirect N_2O emissions from field *f*	Mg CO_2e/ha
$NR_{P,f}$	=	Project N-rate for total N fertilizer determined for field *f*	kg N/ha
$NR_{P,S,f}$	=	Project N-rate for total synthetic fertilizer for field *f*	kg N/ha
$NR_{P,O,f}$	=	Project N-rate for total organic fertilizer for field *f*	kg N/ha

*0.10, 0.20, 0.01 and 0.0075 are IPCC Defaults, as defined in Equation 5.14.

[45] This methodology to calculate LVRO emissions reflects the MSU-EPRI methodology's adaptation of the IPCC's 2006 National GHG Inventory Guidelines for calculating LVRO emissions (Vol. 4 Ch. 11 Table 11.3). MSU-EPRI's adaptation excluded N_2O emissions from crop residue management from Equation 5.14, as those emissions reductions are not eligible for crediting. IPCC default factors are used for $Frac_{GASF}$, EF_4, $Frac_{LEACH}$ and EF_5.

5.4.3 Calculating the Primary Effect Baseline and Project N_2O Emissions

Based on direct N_2O emissions from soil and N_2O emissions from LVRO from the baseline and the project, primary effects baseline and project GHG emissions for each field are calculated using Equation 5.16.

Equation 5.16. Calculating the Primary Effect Baseline and Project GHG Emissions

$$N_2O_{B,f} = N_2O_{Dir,B,f} + N_2O_{LVRO,B,f}$$

$$N_2O_{P,f} = N_2O_{Dir,P,f} + N_2O_{LVRO,P,f}$$

Where,

			Units
$N_2O_{B,f}$	=	Total annual baseline N_2O for field *f*	Mg CO_2e/ha
$N_2O_{Dir,B,f}$	=	Annual baseline direct N_2O emissions from field *f*	Mg CO_2e/ha
$N_2O_{LVRO,B,f}$	=	Annual baseline N_2O emissions from leaching, volatilization and runoff from field *f*	Mg CO_2e/ha
$N_2O_{P,f}$	=	Total annual project N_2O for field *f*	Mg CO_2e/ha
$N_2O_{Dir,P,f}$	=	Annual project direct N_2O emissions from field *f*	Mg CO_2e/ha
$N_2O_{LVRO,P,f}$	=	Annual project N_2O emissions from leaching, volatilization and runoff from field *f*	Mg CO_2e/ha

5.4.4 Adjusting Primary Effect GHG Reductions for Uncertainty

Workgroup:

The methodology in this section is still under development, pending workgroup feedback. This green box is meant to provide background on how uncertainty deductions are handled in the RCPP and MSU-EPRI protocols, and potential issues to consider.

According to C-AGG's white paper on uncertainty, "When models are used, analyses of both structural and input uncertainty related to their use must be completed." The Reserve believes that both types of uncertainty should be addressed to ensure conservativeness, regardless of whether a biogeochemical or empirical model is used to quantify emissions, and as such the NMPP will include an uncertainty deduction. The RCPP adjusts for both types of uncertainty, while the MSU-EPRI protocol, limited by not having another independent data set with which to validate the empirical model, applies a somewhat different approach to adjust for uncertainty.

First, input uncertainty for an empirical model is subject to somewhat less uncertainty than a biogeochemical model, simply because there are significantly fewer critical inputs. As such, unlike in the RCPP, soil input uncertainty is not relevant to the quantification approach in the NMPP, as the only input variable is N rate, and it is fair to assume that there is little uncertainty around N rate. The current NMPP does not quantify this input uncertainty, but accounting for input uncertainty should not be excluded from consideration, as the protocol expands in the future.

However, structural uncertainty (termed $\boldsymbol{\mu_{struct,f}}$ as in the RCPP) is relevant to the NMPP, as it represents how well the model performs against measured emissions, regardless of whether that model is an empirical model as in the NMPP, or a biogeochemical model as in the RCPP. To estimate structural uncertainty in the RCPP, independent emissions measurement data (e.g. data which have not been used to build the model) for California rice fields was used to "validate" the DNDC model by comparing measured and modeled data. The Reserve would like to develop an uncertainty deduction methodology that is similar to the Rice Protocol (RCPP)'s structural uncertainty deduction. However, no additional field emissions measurement dataset for N-rate trials are available for the North Central Region, other than the robust dataset used to develop the MSU-EPRI methodology.

With no independent field data, the Reserve cannot explicitly quantify the structural uncertainty of the quantification approach included in the NMPP at this time. However, the MSU-EPRI methodology includes an uncertainty deduction that adjusts for *measurement* uncertainty in N_2O emissions reductions associated with a reduction in N rate. Using a bootstrap method, random pairs of baseline and project average N rates were selected and emissions reductions for each pair of averages were calculated. The range of average N_2O reductions within the 95% confidence interval was plotted against project N rate, which resulted in a relationship between uncertainty in N2O emissions reductions and project N rate (their data show that uncertainty increases as project N rate increases). The project proponent uses this relationship to calculate the uncertainty range at 95% confidence level of project emissions reductions. This relationship can be thought of as similar to the uncertainty that assumes a perfect fit of emissions to the EF curve. The Reserve proposes to increase the uncertainty by 25% to account for having no independent field data to evaluate the quantification approach. It is expected, however, that in the future (next 5 years), independent data will become available to quantify the structural uncertainty explicitly.

As indicated below, the proposed approach in the NMPP is to use the MSU-EPRI uncertainty deduction to develop a conservative overall deduction for structural uncertainty. Specifically, a look-up table (conforming with the CDM Meth Panel guidance on addressing uncertainty in its Thirty Second Meeting Report, Annex 14) is used to determine $\boldsymbol{\mu_{struct,f}}$ based on the MSU-EPRI value, according to the calculations provided below.

Looking forward, the Reserve believes that validation of models with independent data and quantifying structural uncertainty is useful and conservative, and can be done for a range of potential future empirical and biogeochemical emissions estimation models for different project activities. The same validation process (to determine the structural uncertainty for each model) could be used for biogeochemical as well as empirical models. The Reserve hopes to include sufficient guidelines for the process and types of data necessary to validate other models that may be included in this protocol in the future.

The total primary effect GHG reductions (Mg CO_2e) for the entire project area are calculated and adjusted for uncertainty in Equation 5.17. Equation 5.17 shall be applied in the same way to both single-field projects and aggregates, with the exception that the aggregate must sum the entire project area's GHG reductions (e.g. sum the GHG reductions from all fields).

Equation 5.17. Total Primary Effect GHG Reductions for the Project

$$PER = \sum_{f=1}^{nrFields} \mu_{struct,f} \times \left[\left(N_2O_{B,f} - N_2O_{P,f}\right) \times A_f\right]$$

Where,

			Units
PER	=	Primary effect GHG reductions over the entire project area	Mg CO_2e
nrFields	=	Number of fields included in the project area	
$\mu_{struct,f}$	=	Accuracy deduction for structural uncertainty for field f	
$N_2O_{B,f}$	=	Total annual baseline N_2O for field f	Mg CO_2e/ha
$N_2O_{P,f}$	=	Total annual project N_2O for field f	Mg CO_2e/ha
A_f	=	Size of field f	ha

The value of $\mu_{struct,f}$ is calculated in two steps, so as to adjust for structural uncertainty, including measurement uncertainty of emission reductions. First, the uncertainty in emission reductions, $UNC_{PER,f}$, is calculated. Then, based on the value of $UNC_{PER,f}$, the accuracy deduction for structural uncertainty $\mu_{struct,f}$ can be determined. The two-step calculation is included in Equation 5.18.

Equation 5.18. Structural Uncertainty Deduction

Step 1:

$$UNC_{PER,f} = \frac{1}{\sqrt{nrFields}}\left(100 - 63 \times e^{-40 \times 10^{-6} \times NR_{P,f}^{\;2}} + 25\right)$$

Step 2:

In case $UNC_{PER,f} < 15$:

$$\mu_{struct,f} = 1$$

In case $UNC_{PER,f} \geq 15$:

$$\mu_{struct,f} = 138 \times 10^{-7} \times UNC_{PER,f}^{\;2} - 395 \times 10^{-5} \times UNC_{PER,f} + 0.999$$

Where,

			Units
$UNC_{PER,f}$	=	Uncertainty in N_2O emissions reductions associated with a reduction in N-rate for field f relative to the average emission reduction value.	%
nrFields	=	Number of fields included in the project area	
$NR_{P,f}$	=	Project total N-rate determined for field f	kg N/ha
25	=	Additional uncertainty factor to account for potential bias introduced by non-independent data	%
$\mu_{struct,f}$	=	Accuracy deduction for structural uncertainty for field f	

Additional Rationale for Proposed Uncertainty Deduction:

The value of the uncertainty in emission reductions is calculated identically to the conservativeness factor in the MSU-EPRI protocol with 2 modifications. First, an additional uncertainty factor of 25% is added to account for the impact of using non-independent data to calculate the uncertainty deduction. It is expected that this somewhat overestimated amount will be reduced over time as additional (independent) measurement data become available. Second, the value of the uncertainty is reduced as the number of fields in the aggregate increases to account for the smoothing effect of having more fields in an aggregate.

Second, we replaced the look-up table to calculate deductions from uncertainty values with a continuous equation. More specifically, as directed by the CDM Meth Panel guidance on addressing uncertainty in its Thirty-Second Meeting Report, Annex 14, in cases where the relative uncertainty in emission reductions ($\boldsymbol{UNC_{PER,f}}$) is less than 15%, no additional deduction is necessary. However, in cases where the uncertainty is greater or equal than 15%, an accuracy deduction is required. The relation between the uncertainty in emission reductions and the accuracy deduction presented in Equation 5.18 is a quadratic version of Table G1 of CDM Meth Panel guidance on addressing uncertainty in its Thirty Second Meeting Report, Annex 14[46] acquired by using a quadratic fit. However, it should be noted that this CDM tool refers to an uncertainty deduction that is different (lesser) than the calculated uncertainty, and as such, this approach is inconsistent to rice protocol (which is more conservative, comparatively).

What reactions do you have to this methodology to quantify uncertainty?

5.5 Quantifying Secondary Effects

Secondary effect GHG emissions are unintentional changes in GHG emissions from the secondary SSRs within the GHG Assessment Boundary. Secondary effect emissions may increase, decrease or go unchanged as a result of the project activity. If emissions from secondary SSRs increase as a result of the project, these emissions must be subtracted from the total calculated primary effect GHG reductions for each reporting period.

As shown in Equation 5.19, secondary effect GHG emissions may result from increased CO_2 emissions from increased combustion of fossil fuels associated with the operation of cultivation equipment (SSR 4) plus GHG emissions due to shifted crop production outside the project boundary (SSR 5)

[46] Available at http://cdm.unfccc.int/Panels/meth/meeting/08/032/mp_032_an14.pdf

Equation 5.19. Total Secondary Effect Emissions from Project Activity for the Project Aggregate

$$SE = \sum_{f}(SE_{FF,f}) + SE_{PS}$$

Where,			Units
$SE_{FF,f}$	=	The secondary effect GHG emissions from increased cultivation equipment emissions due to fossil fuel combustion for field *f* (SSR 4), as calculated in Section 5.5.1	Mg CO_2e
SE_{PS}	=	The secondary effect GHG emissions for the project aggregate from production shifting outside of the project boundary (SSR 7), as calculated in Section 5.5.2	Mg CO_2e

5.5.1 Calculating GHG Emissions from Cultivation Equipment (SSR 4)

Included in the GHG Assessment Boundary are CO_2 emissions resulting from increased fossil fuel combustion associated with increased use of onsite equipment used for performing nitrogen management activities related to seeding, fertilizer application, and herbicide application due to the project activity.

If the changes in project management require new equipment that requires more fuel to run or an increase in the operational hours for existing equipment, the CO_2 emissions from the increased fossil fuel combustion shall be calculated using Equation 5.20 below.

Equation 5.20. Project Emissions from Fossil Fuel Combustion

$$SE_{FF,f} = \frac{\sum_j (FF_{PR,j} \times EF_{FF,j})}{1000}$$

Where,			Units
$FF_{PR,j}$	=	Total increase in fossil fuel combustion for field *f* during the reporting period, by fuel type *j*	volume fossil fuel
$EF_{FF,j}$	=	Fuel-specific emission factor	kg CO_2/volume fossil fuel
1000	=	Kilograms per Megagrams	kg CO_2/ Mg CO_2

5.5.2 GHG Emissions from the Shift of Crop Production Outside of Project Boundaries (Leakage) (SSR 5)

Econometric studies have reported considerable price elasticity for corn[47]. Therefore, it is assumed in this protocol that a statistically significant decrease in corn yields due to project activities would result in an increase of production outside of the project area. The increased emissions associated with this shift in production must be estimated if project related yield losses are statistically significant compared to historic and average yields.

[47] Haixiao Huang and Madhu Khanna. An Econometric Analysis of U.S. Crop Yield and Cropland Acreage: Implications for the Impact of Climate Change. Selected Paper prepared for presentation at the Agricultural & Applied Economics Association 2010 AAEA, CAES, & WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010.

In order to determine if crop yields have decreased across the project area during the cultivation cycle as a result of project activity, the annual yield from the project area must be compared to historical yields over the past 5 years from the same project area. Because yields fluctuate annually depending on numerous climatic drivers, for this evaluation, yields are normalized to average annual county yields using USDA NASS statistics,[48] according to the procedure below.

This normalization procedure must be followed for each cultivation cycle to demonstrate that the yields from the project area have not declined due to project activity. The following procedure is applicable for a single field project. All aggregates must apply the following procedure to the entire project area, defined as the sum of individual fields included in verification activities:

1. For each year *t* in the historical look-back period (see Section 5.3, step 1), normalize the yield of the field by the county average for that year ($\boldsymbol{y\_norm_t}$). If the project is an aggregate, calculate ($\boldsymbol{y\_norm_t}$) for each of the historical years as the weighted average (by percent of field area) of all fields in the aggregate following Equation 5.21. The distribution of ($\boldsymbol{y\_norm_t}$) will have the same number data points as the number of eligible crop years in the historical look-back period (between 3 and 5 years).

Equation 5.21. Calculating the Normalized Yield for Each Year *t* in Case the Project is an Aggregate

For single-field projects:

$$y\_norm_t = \frac{Y_{f,t}}{Y_{county,t}}$$

For aggregate projects:

$$y\_norm_t = \sum_f \left(A_f \times \frac{Y_{f,t}}{Y_{county,t}}\right) / \sum_f A_f$$

Where,

			Units
A_f	=	The size of field *f*	ha
$Y_{f,t}$	=	The yield of field *f* in year *t*	Mg/ha
$Y_{county,t}$	=	The county average yield in year *t*	Mg/ha

Note that if aggregates span multiple counties, $Y_{county,t}$ must correspond with the county in which field *f* is located.

2. For the cultivation cycle for the present reporting period, normalize the yield of each field by the county average for the growing season for the year, and, if the project is an aggregate, calculate the weighted average for all fields in the aggregate to get ($\boldsymbol{y\_norm_{t0}}$), using Equation 5.21 above and replacing *t* with t_0, i.e. the year of the present reporting period.

3. Take the standard deviation (*s*) and mean of the $\boldsymbol{y\_norm_t}$ distribution:

$$s = stdev(y\_norm_t)$$

[48] Available at (http://quickstats.nass.usda.gov)

$$\overline{y\_norm_t} = average(y\_norm_t)$$

4. Calculate the minimum yield threshold below which normalized yields are significantly smaller than the historical average. This shall be done as follows:

$$y\_\min = \overline{y\_norm_t} - 2.132 \times s$$

Where 2.132 is the t-distribution value with 95 percent confidence for a one-tailed test with 4 degrees of freedom (i.e. n is 5),[49] and *s* is the standard deviation of the y_norm_t distribution, as calculated in step 3.

5. For every year of the crediting period, calculate **y_norm_{t0}** and compare this value to **y_min**. If **y_norm_{t0}** is smaller than **y_min**, it must be assumed that leakage occurred and emissions increased outside of the project area. The project must account for increased emissions as specified in Equation 5.22 below:

Equation 5.22. Increased Emissions Outside the Project Boundary

$$SE_{PS} = \left(1 - \frac{y\_norm_{t0}}{y\_min}\right) \times \sum_i [N_2O_{B,f} \times A_f]$$

Where,

			Units
SE_{PS}	=	The total secondary effect GHG emissions from production shifting outside of the project boundary	Mg CO_2e/ha
y_norm_{t0}	=	Normalized project yield for field *f*	Mg/ha
y_min	=	Minimum yield threshold below which normalized yields are significantly smaller than the historical average for field *f*	Mg/ha[50]
$N_2O_{B,f}$	=	Total annual baseline N_2O for field *f*, see Section 5.4.3	Mg CO_2e/ha
A_f	=	Size of field *f*	ha

[49] The t-distribution value of 2.132 = **t(0.05, n – 1),** where **n** is 5, and **n-1** degrees of freedom is 4. If there are less than 5 datapoints (e.g. less than 5 eligible crop years in the historic lookback period), a different t-distribution value must be substituted for 2.132. Specifically, where n=4, t-value=2.353, and where n=3, t-value=2.920.

[50] "Mg/ha" is indicated as required units for crop yield. Note, however, that units of $y\_norm_{t0,i}$ and $y\_min_{t0,i}$ cancel each other out. Therefore, other units can be used, as long as the units for $y\_norm_{t0,i}$ are the same as the units for $y\_min_{t0,I}$.

6 Project Monitoring

Workgroup:

This section was adapted from the Rice Cultivation Project Protocol Version 1.0 (RCPP) and should be mostly complete. However, workgroup feedback is welcome on monitoring requirements that seem overly burdensome or don't make as much sense for the NMPP as it may have for RCPP.

Also, we are still trying to figure out what exactly to require, with regards to continuous reporting. Currently, all parameters must be reported on Please read this (and subsequent) sections with an eye to making recommendations on what should be required in the non-eligible years (e.g. are there certain monitoring/reporting requirements we don't need to require).

The Reserve requires that Monitoring Plans and Reports be established for all monitoring and reporting activities associated with the project. Single-field projects must develop a monitoring plan in accordance with the guidance in Section 6.1. Aggregate projects must develop monitoring plans both at an aggregate-level and field-level in accordance with the guidance in Section 6.2.

6.1 Single-Field Project Monitoring Plan

Single-Field projects must establish a Single-Field Monitoring Plan (SFMP). The SFMP will serve as the basis for verification bodies to confirm that the monitoring and reporting requirements in Section 6 and 7 are met for single-field projects, and that consistent, rigorous monitoring and recordkeeping is ongoing at the project field. The SFMP must be developed and maintained by the project developer. The SFMP must specify how required field data (Section 6.3) are collected, recorded, and managed at each field.The SFMP and must also outline procedures for developing and submitting a complete Single-Field Report in accordance with Section 7.2.1. It is the responsibility of the project developer to ensure that the SFMP meets all requirements specified and is kept on file and up-to-date for verification.

The SFMP will outline the following procedures:

- How the field perimeter GIS shape file and/or KML file will be created
- How the crediting period, verification schedule, and quantification results will be tracked for that field
- How to ensure that the project developer holds title to the GHG emission reductions as required in Section 2.3
- Procedures that the project developer will follow to ascertain and demonstrate that the project field at all times passes the Legal Requirement Test and Regulatory Compliance (Sections 3.5.2 and 3.5.1 respectively)
- A plan for monitoring the field data outlined in Section 6.3, which includes a plan for detailed record keeping and maintenance that meet the requirements for minimum record keeping in Section 7.3.1
- The frequency of data acquisition
- The frequency of sampling activities
- The role of individuals performing each specific activity, particularly monitoring and sampling

- QA/QC provisions to ensure that data acquisition is carried out consistently and with precision

6.2 Monitoring Plans for Aggregates and Participating Fields

Aggregate projects must establish an Aggregate Monitoring Plan (AMP), according to the requirements of section 6.2.1 below. It is also the responsibility of the aggregator to ensure that each of the project participants with fields enrolled in the aggregate develops a Field Monitoring Plan (FMP), according to the requirements specified in Section 6.2.2, and to ensure that a copy of each FMP is kept on file and up-to-date for verification.

6.2.1 Aggregate Monitoring Plan

Aggregate projects must establish an AMP, which will serve as the basis for verifiers to confirm that the aggregate tracking requirements have been and will continue to be met for each reporting period. The AMP must be developed and maintained by the aggregator. The AMP must outline procedures on how all of the data included in the annual Aggregate Report, the requirements of which are specified in Section 7.2.2, will be collected and managed, and must outline procedures for developing and submitting a complete Aggregate Report.

The AMP will outline the following procedures:

- How the field perimeter GIS shape file and/or KML files will be created for each field
- How the crediting period, verification schedule, and quantification results will be tracked for each field included in the aggregate
- How to ensure that the title to the GHG emission reductions has been conferred to the aggregator as required in Section 2.3 for each field in the aggregate
- Procedures that the aggregator will follow to ascertain and demonstrate that all fields in the aggregate at all times pass the Legal Requirement Test and Regulatory Compliance (Sections 3.5.2 and 3.5.1 respectively)
- A plan for detailed record keeping and maintenance that meet the requirements for minimum record keeping in Section 7.3.1
- The role of individuals performing each specific activity
- QA/QC provisions to ensure that data collected from the field level, according to data acquisition requirements outlined in the Field Monitoring Plan (FMP) described below, is carried out consistently and with precision

6.2.2 Field Monitoring Plan for Project Participants in an Aggregate

The Field Monitoring Plan (FMP) will serve as the basis for verifiers to confirm that the monitoring and reporting requirements in Sections 0 and 7 are met at each field in an aggregate, and that consistent, rigorous monitoring and record keeping is ongoing at each field. The FMP must specify how required field data (Section 6.3) are collected, recorded and managed at each field.

One FMP must be developed for each project participant. If a project participant has multiple fields enrolled in the aggregate, only one FMP is required as long as it addresses the monitoring requirements at each field. The FMP can be developed by the project participant or the aggregator, depending on the arrangement specified in contractual agreements. It is the responsibility of the aggregator to ensure that the FMP meets all requirements specified, and is kept on file and up-to-date for verification.

At a minimum the FMP shall stipulate:

- The frequency of data acquisition
- The frequency of sampling activities
- The role of individuals performing each specific monitoring and sampling activity
- A plan for monitoring the field data outlined in Section 6.3, including a detailed record keeping plan meeting the minimum record keeping requirements of Section 7.3.1.2
- QA/QC provisions to ensure that data acquisition is carried out consistently and with precision

6.3 Field Data

All field-level data and information specified in this Section must be collected and retained for verification purposes. Section 7.3 provides further guidance on specific record-keeping requirements.

6.3.1 General Field Tracking Data

- Either a GIS shape file or a KML file clearly defining the field perimeter
- The coordinates of the most north-westerly point of the field, reported in degrees to four decimal places[51] (to be used for creating field serial numbers)
- The serial number of the field, constructed as specified in Section 7.2.1
- The start date of the field
- Disclosure of any material and immaterial regulatory violations, with copies of all Notices of Violations (NOVs) included in the report
- A list of the project activities implemented on the field during the reporting period
- Field crop yield during the reporting period and for five years (or at least three eligible crop years) prior to the field start date for the eligible crop(s)

6.3.2 Field Management Data

The following management data must be collected and retained at each field for each cultivation cycle during the reporting period:

- Planting date
- Fertilization types (both organic and synthetic), amounts, and application dates
- Type of irrigation system, irrigation dates and volumes (during the growing season and during post-harvest period)
- Begin and end date of harvesting on the field

6.3.3 Project Activity Data and Documentation

To corroborate field management assertions, each field must collect and retain the following documentation:

- Fertilizer types (both organic and synthetic), including purchasing records and information on each type's N-content, ascertained through laboratory test results, manufacturer specifications or fertilizer labeling[52]

[51] Longitude reported in degrees to four decimal places provides a spatial resolution of about 11 meters, the resolution of the latitude is slightly less than that.
[52] Additional guidance on determining one's N-content is provided in Section 0, and default look-up tables are available in Appendix A (to be provided), for unlabeled or unprocessed fertilizers.

- Fertilization amounts and application dates (disaggregated for organic and synthetic)
- Fertilizer application method and placement

6.3.4 Field Monitoring Parameters

Prescribed monitoring parameters necessary to calculate baseline and project emissions are provided in Table 6.1, below. Field monitoring parameters must be determined according to the data source and frequency specified. Table 6.1 specifies general monitoring parameters and requirements for “General Input Parameters,” which are those monitoring parameters required for all project fields.

Table 6.1. Field Monitoring Parameters: General Input Parameters

[NOTE: This is an old table that no longer reflects Section 5. It will be updated to reflect revised parameters, but is included as a placeholder to demonstrate measurement frequency and monitoring requirement.]

Eq. #	Parameter	Description	Data Unit	Calculated (c) Measured (m) Reference(r) Operating Records (o)	Measurement Frequency	Comment
	MB SF, t	Baseline synthetic N containing fertilizer applied	Mg/ha/yr	o	pre-project	Farmer records
	MB OF, t	Baseline organic N containing fertilizer applied	Mg/ha/yr	o	pre-project	Farmer records
	NCB SF	Nitrogen content of baseline synthetic fertilizer applied	g N/(100g fertilizer)	o	pre-project	Farmer records / Fertilizer N-content label
	NCB OF	Nitrogen content of baseline organic fertilizer applied	g N/(100g fertilizer)	o	pre-project	Farmer records / Laboratory tests
	Baseline crop yield	Crop yield (standard reporting method for particular crop, e.g. dry grain yield)	Mg/ha/yr	o, r	pre-project	Farmer records
	Baseline field area	Area of crop(s) planted, from which baseline fertilizer end rate determined	Hectare (ha)	o	pre-project	Farmer records
	FracLEACH	Fraction of N added (synthetic or organic) to project soils that is lost through leaching and runoff, in regions where leaching and runoff occur	Fraction	r	pre-project	
	MP SF, t	Mass of project synthetic N containing fertilizer applied	Mg N/yr	o	annual	Farmer records
	MP OF, t	Mass of project organic N containing fertilizer applied	Mg N/yr	o	annual	Farmer records
	NCP SF	Nitrogen content of project synthetic fertilizer applied	g N/(100g fertilizer)	o	annual	Farmer records / Fertilizer N-content label
	NCP OF	Nitrogen content of project organic fertilizer applied	g N/(100g fertilizer)	o	annual	Farmer records / Laboratory tests
	Project field area	Area of crop(s) planted, from which project fertilizer N rate determined	Hectare (ha)	o	each verification cycle	Farmer records
	FFPR, t	Total increase in fossil fuel combustion for field *i* during the reporting period, by fuel type *t*	Volume fossil fuel	o	each verification cycle	Farmer records

7 Reporting and Record Keeping

Workgroup:

This section was adapted from the Rice Cultivation Project Protocol Version 1.0 (RCPP) and should be mostly complete. However, workgroup feedback is welcome on reporting requirements that seem overly burdensome or don't make as much sense for the NMPP as it may have for RCPP.

Also, we are still trying to figure out what exactly to require, with regards to continuous reporting. Currently, all parameters must be reported on. Please read this section with an eye to making recommendations on what should be required in the non-eligible years (e.g. are there certain reporting requirements we don't need to require).

This section provides requirements and guidance on reporting rules and procedures. A priority of the Reserve is to facilitate consistent and transparent information disclosure among project developers.

7.1 Project Submittal Documentation

7.1.1 Single-Field Project Submittal Documentation

For each single-field project, project developers must provide the following documentation to the Reserve in order to submit and register a nitrogen management project.

- Single-Field Project Submittal form
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form
- Verification Report
- Verification Statement
- Annual Single-Field Report (see Section 7.2.1 below for specific requirements)

Project developers must provide the following documentation each subsequent reporting period in order for the Reserve to issue CRTs for quantified GHG reductions.

- Verification Report
- Verification Statement
- Annual Single-Field Report
- Signed Attestation of Title form
- Signed Attestation of Voluntary Implementation form
- Signed Attestation of Regulatory Compliance form

With the exception of the Single-Field Report, at a minimum, the above project documentation will be available to the public via the Reserve's online registry. Further disclosure and other documentation may be made available on a voluntary basis through the Reserve. Project submittal forms can be found at http://www.climateactionreserve.org/how/projects/register/project-submittal-forms/.

7.1.2 Aggregate Submittal Documentation

For each aggregate, aggregators must provide the following documentation to the Reserve in order to submit and register a Nitrogen Management aggregate.

- Aggregate Submittal form
  - Includes the initial number of fields and the names of project participants for each individual enrolled field
- Signed Aggregator Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form
- Verification Report
- Verification Statement
- Annual Aggregate Report (see Section 7.2.2 below for specific requirements)

Aggregators must provide the following documentation each subsequent reporting period in order for the Reserve to issue CRTs for quantified GHG reductions.

- Verification Report
- Verification Statement
- Annual Aggregate Report
- Signed Aggregator Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form

With the exception of the Aggregate Report, at a minimum, the above project documentation will be available to the public via the Reserve's online registry. Further disclosure and other documentation may be made available on a voluntary basis through the Reserve. Project submittal forms can be found at http://www.climateactionreserve.org/how/projects/register/project-submittal-forms/.

7.2 Annual Reports to be Submitted

7.2.1 Single-Field Report

For each cultivation cycle, the following information must be included in an annual report that will be submitted to the Reserve as a *.csv file:

- The field serial number, to be determined by the following algorithm, with each element separated by a dash (-):
  - First letter of the County, followed by degrees of the most north-western point of the field, (latitude, then longitude, both reported to four decimal places), followed by the acreage of the field.[53] (Example: *B-39.6123-121.5332-76* would be a 76 acre field in Butte County, CA)
- The acreage of the field (acres)
- Start date of the field
- Whether the field had previously been enrolled in an aggregate

[53] Because all fields will be located in the United States, the latitude will always be positive (i.e. degrees north of the equator), and longitude will always be negative (i.e. degrees west of the Prime Meridian). Therefore, in the example serial number, the field in Butte County California is at *+39.6123º latitude, and -121.5332º longitude.*

  - If so, include the name of the aggregate and dates of enrollment
- The field's emission reduction calculation results for the current verified cultivation cycle (corrected for structural uncertainty)

7.2.2 Aggregate Report

For each cultivation cycle, all aggregate-level monitoring information must be included in an annual Aggregate Report that will be submitted to the Reserve as a *.csv file, with accompanying documentation, at verification. The Aggregate Report must contain a list of all fields and the following information for each field:

- The field serial number, to be determined by the following algorithm, with each element separated by a dash (-):
  - First letter of the County, followed by degrees of the most north-western point of the field, (latitude, then longitude, both reported to four decimal places), followed by the acreage of the field.[53] (Example: *B-39.6123-121.5332-76* would be a 76 acre field in Butte County, CA)
- The acreage of the field (acres)
- Start date of the field
- Date field enrolled in the aggregate
  - Including a flag specifying whether the field is a new addition to the aggregate in the particular year
- Current status of field (active, active but not in an eligible crop year, terminated, transferred to a different aggregate)
- Name of project participant associated with the field
- A flag for which fields had site visit or desktop verifications, or were unverified
- The emission reduction calculation results for each field (uncorrected for structural uncertainty)
- The total verified emission reductions for the aggregate (corrected for structural uncertainty and any deductions due to errors or misrepresentations at the verified fields)

7.3 Record Keeping

For purposes of independent verification and historical documentation, project developers are required to keep all information outlined in this protocol for a period of 10 years after the information is generated or seven years after the last verification. This information will not be publicly available, but may be requested by the verifier or the Reserve.

7.3.1 Record Keeping for Single-Field Projects

The project developer should retain the following records and documentation, as well as documentation to substantiate the information in the annual Single-Field Report and all field-level data and calculations. These records include:

- Contractual arrangements with project developer, project participant and/or land owner (if applicable)
- Copies of letter of notification sent to land owner, including the date letter was sent
- GIS or KML shape file
- North-western latitude/longitude coordinates of field (to four decimal places)
- Serial number of field (according to the guidance in Section 7.2.1)
- Data inputs for the calculation of the project emission reductions

- Copies of air, water, and land use permits relevant to project activities; Notices of Violations (NOVs) relevant to project activities; and any administrative or legal consent orders relevant to project
- Executed Attestation of Title, Attestation of Regulatory Compliance, and Attestation of Voluntary Implementation forms
- Field management data (as specified in Section 6.3.2)
- Onsite fossil fuel use records
- Fertilizer purchase records
- Project activity data (as specified in Section 6.3.3), including:
    1. All time-stamped digital photographs of the fertilizer management activities
    2. Farm management records, particularly pertaining to nitrogen management.
    3. All maintenance records relevant to the farm equipment and monitoring equipment
- Results of CO_2e annual reduction calculations
- Initial and annual verification records and results

Workgroup:

Do you have suggestions on ways to verify N-rate reductions occurred as reported, other than photographs and management records? Would photographs of different NM activities actually help in verification? If so, which activities must be photographed? Are there any other data sources you can recommend to help us triangulate what really occurred?

7.3.1 Record Keeping for Aggregates

7.3.1.1 Aggregate-Level Record Keeping

The aggregator should retain the following records and documentation, as well as documentation required by Section 0 to substantiate the information in the annual Aggregate Report. System information must be retained for each field, yet collected and managed at the aggregate level. These records include all:

- Contractual arrangements with project developer, each project participant and/or land owner
- Copies of letters of notification sent to land owners, including the dates letters were sent
- GIS or KML shape files for all fields in the aggregate
- North-western latitude/longitude coordinates for each field (to four decimal places)
- Serial numbers for each field (according to the guidance in Section 7.2.2)
- Data inputs for the calculation of the project emission reductions
- Copies of air, water, and land use permits relevant to project activities; Notices of Violations (NOVs) relevant to project activities; and any administrative or legal consent orders relevant to project activities
- Executed Aggregator Attestation of Title, Attestation of Regulatory Compliance, and Attestation of Voluntary Implementation forms
- Results of CO_2e annual reduction calculations
- Initial and annual verification records and results

7.3.1.2 Field-Level Record Keeping

The project developer/aggregator should retain the following records and documentation, as well as documentation required in Section 6.3 for each field. At each field, the following records should be retained for verification purposes:

- Field management data (as specified in Section 6.3.2)
- Onsite fossil fuel use records
- Fertilizer purchase records
- Project activity data (as specified in Section 6.3.3), including:
    - All time-stamped digital photographs of fertilizer management activities
    - Farm management records, particularly pertaining to nitrogen management.
    - All maintenance records relevant to the farm equipment and monitoring equipment

7.4 Reporting Period and Verification Cycle

Project emission reductions must be quantified and verified on an annual basis, reflecting a reduction in annual N-rate over a complete cultivation cycle. The length of time over which GHG emission reductions are quantified and verified is called the “reporting period. The reporting period must be uniformly defined for the aggregate. Thus, for reporting purposes, the aggregate reporting period shall always be defined as starting on October 1 and ending on September 31 of the next year. Individual fields within an aggregate may have cultivation cycles that start on different dates; however the cultivation cycles for all fields within an aggregate must be complete before the aggregate is able to undergo verification. To ensure that only emission reductions occurring during an aggregate’s fixed reporting period is credited during that reporting period, emission reductions from each field shall be prorated as discussed further below. For single field projects, the reporting period shall be defined using the exact dates corresponding to the beginning and the end of the cultivation cycle for the particular field.

Both reporting periods and cultivation cycles must be contiguous; there can be no time gaps in reporting during the crediting period of an aggregate once the initial reporting period has commenced.[54] If the crop rotation on the project field includes ineligible crops (e.g. soy in a corn/soy rotation), the project field must report continuously on the field’s management practices, even though the project field shall only receive credit for project activities implemented on eligible crops,

Workgroup:

We are still unsure of what exactly to require, in terms of reporting in non-eligible crop years. I think we may need to include some sort of eligibility condition that the project participant must demonstrate no increase in non-eligible crop years compared to their “baseline” N-rate for those non-eligible years. We may also want to consider including a way to quantify any increases in N-rate here (e.g. a deduction that you carryover to a crediting year), instead of making it an eligibility condition, which would exclude anyone not meeting this requirement.

[54] An entire aggregate can willingly forfeit CRTs for an entire cultivation cycle in accordance with the Reserve’s zero-crediting period policy, available at http://www.climateactionreserve.org/how/program/program-manual/.

Because a single reporting period must be uniformly defined for the aggregate, the aggregator must prorate the emissions reductions from each field in the aggregate, after the field has completed its respective cultivation cycle and total emission reductions for that field have been calculated. The aggregator shall divide total emission reductions from the reporting period by 365 days to calculate the average daily emission reductions associated with a given field, and multiply by the total days of the cultivation cycle falling within the aggregate's uniform reporting period currently undergoing verification. The remaining emission reductions (applicable to the subsequent reporting period) may be verified along with the field's total emission reductions in that cultivation cycle, but shall be credited under the subsequent aggregate reporting period.

Workgroup:

As noted in Section 5, we recently added this uniform reporting requirement (above) due to concerns about overlapping reporting periods. However, there may be reporting period and verification issues associated with pro-rating that we haven't thought through yet. How workable is the concept of pro-rating, as written above?

For aggregates, no more than one reporting period can be verified at once, except during an aggregate's first verification, which may include historical emission reductions from prior years.

7.4.1 Additional Reporting and Verification Options for Single-Field Projects

For single-field projects, however, there are three verification options to choose from, which provide the project developer more flexibility and help manage verification costs associated with nitrogen management projects. The project developer may choose from these additional options after a project has completed its initial verification and registration.

A project developer may choose to use one option for the duration of a project's crediting period. Regardless of the option selected, reporting periods must be contiguous; there may be no time gaps in reporting during the crediting period of a project once the initial reporting period has commenced.

If a single-field project joins an aggregate, that field will immediately be subject to the verification schedule of the aggregate moving forward (e.g. for the first reporting period that field is enrolled in the new aggregate).

If a field exits an aggregate to become a single-field project, that project is subject to the reporting and verification requirements of an initial reporting and verification period. In other words, that single-field project's first verification as a single-field project may not take advantage of Options 2 or 3, below.

7.4.1.1 Initial Reporting and Verification Period

The reporting period for projects undergoing their initial verification and registration cannot exceed one complete cultivation cycle, which may be slightly greater or less than 365 days. The one exception is for historic projects (e.g. fields with start dates on or after June 27, 2010), which are eligible to include multiple cultivation cycles in their first reporting period, so long as the project is submitted to the Reserve by June 27, 2013 (See Section 3.2 for additional guidance). Once a project is registered and has had at least one complete cultivation cycle of emission reductions verified, the project developer may choose one of the verification options below.

7.4.1.2 Option 1: Twelve-Month Maximum Verification Period

Under this option, the verification period may not exceed one complete cultivation cycle, which may be slightly greater or less than 365 days. Verification with a site visit is required for CRT issuance.

7.4.1.3 Option 2: Twelve-Month Verification Period with Desktop Verification

Under this option, the verification period cannot exceed one complete cultivation cycle. However, CRTs may be issued upon successful completion of a desktop verification as long as: (1) Site visit verifications occur at two-year intervals; and (2) The verification body has confirmed that there have been no significant changes in selected project activities, field management or ownership and/or management control of the field since the previous site visit. Desktop verifications must cover all other required verification activities (i.e. a full desktop verification of the Single-Field Report).

Desktop verifications are allowed only for a single 12-month verification period in between 12-month verification periods that are verified by a site visit.

7.4.1.4 Option 3: Twenty-Four Month Maximum Verification Period

Under this option, the verification period cannot exceed two complete cultivation cycles (approximately 730 days or 24 months) and the project monitoring plan and Single-Field Report must be submitted to the Reserve for the interim cultivation cycle's reporting period. The project monitoring plan and report must be submitted for projects that choose Option 3 in order to meet the annual documentation requirement of the Reserve program. They are meant to provide the Reserve with information and documentation on project operations and performance. They also demonstrate how the project monitoring plan was met over the course of the first half of the verification period. They are submitted via the Reserve online registry, but are not publicly available documents. The monitoring plan and report shall be submitted within 30 days of the end of the reporting period.

Under this option, CRTs may be issued upon successful completion of a site visit verification for GHG reductions achieved over a maximum of 24 months. CRTs will not be issued based on the Reserve's review of project monitoring plans or reports. Project developers may choose to have a verification period shorter than 24 months.

8 Verification Guidance

This section provides verification bodies with guidance on verifying GHG emission reductions associated with the project activity. This verification guidance supplements the Reserve's Verification Program Manual and describes verification activities specifically related to nitrogen management projects.

Verification bodies trained to verify nitrogen management projects must be familiar with the following documents:

- Climate Action Reserve Program Manual
- Climate Action Reserve Verification Program Manual
- Climate Action Reserve Nitrogen Management Project Protocol (NMPP)

The Reserve Program Manual, Verification Program Manual, and project protocols are designed to be compatible with each other and are available on the Reserve's website at http://www.climateactionreserve.org.

Only ISO-accredited verification bodies with lead verifiers trained by the Reserve for this project type are eligible to verify nitrogen management project reports. Verification bodies approved under other project protocol types are not permitted to verify nitrogen management projects. Information about verification body accreditation and Reserve project verification training can be found on the Reserve website at http://www.climateactionreserve.org/how/verification/.

In addition, all verification bodies must have an accredited Professional Agronomist, Crop Advisor or similar agricultural specialist on the verification team in order to verify nitrogen management projects.

8.1 Preparing for Verification

The project developer is responsible for coordinating all aspects of the verification process, coordinating with the verification body, project participants (in the case of an aggregate), and the Reserve, and submitting all necessary documentation to the verification body and the Reserve.

The project developer is responsible for selecting a single verification body for the entire project or aggregate for each reporting period. The same verification body may be used up to six consecutive years (the number of consecutive years allowed, according the Reserve Verification Program Manual[55]). Verification bodies must pass a conflict-of-interest review against the project developer, and in the case of aggregates, all project participants and the aggregator.

Each year, project developers of single-field projects must make the Single-Field Report, which is submitted to the Reserve annually, and the Single-Field Monitoring Plan available to the verification body. These documents must meet the requirements in Sections 6 and 7.

In aggregates, each year, project participants must submit all field data to the aggregator according to the guidelines in Sections 0 and 7. Aggregators must make all Field Monitoring

[55] http://www.climateactionreserve.org/how/verification/verification-program-manual/

Plans (FMPs) available to the verification body, as well as the Aggregate Monitoring Plan (AMP) and the Aggregate Report.

In all cases, the above documentation should be made available to the verification body after the NOVA/COI process is complete.

Aggregators may assist project participants in preparing documents for verification and in facilitating the verification process. The scope of these services is determined by the specific contract between project participants and the aggregator. However, the ultimate responsibility for monitoring reports and verification compliance is assigned to the aggregator.

For aggregates, a field is considered verified if it is in the pool of fields for which site visits or desktop verifications are conducted, even if not selected for either a site visit or desktop verification (See Section 8.3 for details on sampling for verification). As a preliminary step in preparing for verification, the aggregator may choose to exclude fields from the pool of fields that may be selected for verification activities. Aggregators must report to the verification body all instances of field exclusion. The excluded fields shall be removed from the acreage totals and from field numbers used to determine field eligibility and verification sampling methodologies (in Section 8.2) and are therefore not considered verified.

8.2 Verification Schedule for Single-Field Projects

Single-field projects are comprised of exactly one field, and as such, there is no sampling methodology to select the fields undergoing verification. The single-field project shall be verified according to the verification schedule outlined below.

This protocol provides project developers three verification options, Sections 8.2.1 to 8.2.3, for a single-field project after its initial verification and registration in order to provide flexibility and help manage verification costs associated with nitrogen management projects. For each option, verification bodies may need to confirm additional requirements specific to this protocol, and in some instances, utilize professional judgment on the appropriateness of the option selected.

The actual requirements for performing a site visit verification and desktop verification are the same. A desktop verification is equivalent to a full verification, without the requirement to visit the site. A verification body has the discretion to visit any site in any reporting period if the verification body determines that the risks for that field warrant a site visit.

8.2.1 Option 1: Twelve-Month Maximum Verification Period

Option 1 does not require verification bodies to confirm any additional requirements beyond what is specified in the protocol. (See Section 7.4.1.2 for requirements)

8.2.2 Option 2: Twelve-Month Verification Period with Desktop Verification

Option 2 requires verification bodies to review the documentation specified in Section 7.4.1.3 in order to determine if a desktop verification is appropriate. The verifier shall use their professional judgment to assess any changes that have occurred related to project data management systems, equipment or personnel and determine whether a site visit should be required as part of verification activities in order to provide a reasonable level of assurance on the project verification. The documentation shall be reviewed prior to the NOVA/COI renewal submitted to the Reserve, and the verification body shall provide a summary of its assessment and decision on the appropriateness of a desktop verification when submitting the NOVA/COI renewal. The Reserve reserves the right to review the documentation provided by the project developer and the decision made by the verification body on whether a desktop verification is appropriate.

8.2.3 Option 3: Twenty-Four Month Maximum Verification Period

Under Option 3 (see Section 7.4.1.4), verification bodies shall look to the project monitoring report submitted by the project developer to the Reserve for the interim 12-month reporting period as a resource to inform its planned verification activities. While verification bodies are not expected to provide a reasonable level of assurance on the accuracy of the monitoring report as part of verification, the verification body shall list a summary of discrepancies between the monitoring report and what was ultimately verified in the List of Findings.

8.3 Verification Sampling and Schedule for Aggregates

Guidelines for verification sampling of the aggregate and the aggregate's verification schedule are different for "small aggregates," "large single-participant aggregates," and "large multi-participant aggregates." This approach allows a consistent application of verification requirements across all aggregates regardless of size or number of participants.

In all cases, the verification schedule shall be established by the verification body using random sampling, according to the verification schedule and sampling methodologies outlined in Sections 8.3.1, 8.3.2, and 8.3.3. These sampling methodologies establish the minimum verification frequencies; the verification body may at any time add fields beyond the minimum number required for site visit and/or desktop verification and may use verifier judgment to determine the number of additional fields and method for selecting fields if a risk-based review indicates a high probability of non-compliance. The verification sampling requirements are mandatory regardless of the mix of entry dates represented by the group of fields in the aggregate.

The initial site visit verification schedule for a given year shall be established after the completion of the NOVA/COI process and prior to the commencement of any verification activities. This is meant to allow for the aggregator and verification body to work together to develop a cost-effective and efficient site visit schedule. Specifically, once the sample fields designated for a site visit have been determined, the verification body shall document all fields selected for planned site visit verification and provide a list of project participants and fields receiving a visit to the aggregator and the Reserve. The aggregator shall be responsible for informing project participants of their selection for a planned site visit. Following this notification, the aggregator shall supply the verification body with all the required documentation to demonstrate field-level conformance to the protocol. When a verification body determines that additional sampling is necessary, due to suspected non-compliance, however, a similar level of advance notice may not be possible.

Though significant advance notice of a field's selection for a site visit is required, aggregators and project participants shall not be given advance notice of which fields' data will be subject to desktop verification in a given year. A field shall be prepared for desktop verification during every reporting period, so long as the field's FMP is implemented and up-to-date and all record-keeping requirements of this protocol are followed.

Regardless of the size of an aggregate, if the aggregate contains any fields that did not pass site visit verification the year before and wish to re-enter the aggregate, those fields must have a full verification with site visit for the subsequent reporting period. These fields must be site visited *in addition* to the verification sampling methodology and requirements outlined below in Sections 8.3.1, 8.3.2, and 8.3.3.

For the purposes of verification, a “small aggregate” is defined as an aggregate comprised of 10 or fewer fields, regardless of the number of project participants. Small aggregates will meet fixed site visit and desktop verification frequency requirements based on a verification schedule determined by the verifier, in compliance with Section 8.3.1 of this protocol.

A “large single-participant aggregate” is defined as an aggregate comprised of more than 10 fields all managed by one single project participant. For large single-participant aggregates, fields will be randomly selected for site visit and desktop verification, according to the sampling method in Section 8.3.2, which is based on a non-linear scale where the relative fraction of fields undergoing verification activities gets smaller as the aggregate size gets larger.

A “large multi-participant aggregate” is defined as an aggregate comprised of more than 10 fields and more than one project participant. For large multi-participant aggregates, participants and their fields will be randomly selected for site visit and desktop verification, according to the sampling method in Section 8.3.3, which is based on a non-linear scale where the relative fraction of participants undergoing verification activities gets smaller as the aggregate size, in terms of number of participants, gets larger.

In all cases, when determining the sample size for site visits and desktop verifications, the verification body shall round up to the nearest whole number.

The actual requirements for performing a site visit verification and desktop verification are the same. A desktop verification is equivalent to a full verification, without the requirement to visit the site. A verification body has the discretion to visit any site in any reporting period if the verification body determines that the risks for that field warrant a site visit.

8.3.1 Verification Schedule for Small Aggregates

Workgroup:

This section is written to be very similar to the verification requirements in rice. In particular, we did not change the frequency of site visits or desk visits, or even the fixed requirements (e.g. each field in a small aggregate must of 2 SV minimum) based on a changed reporting period length. Please let us know if you think changes are necessary. (The Reserve thinks they may be and will continue to work on this, as needed).

8.3.1.1 Site Visit Verification Schedule for Small Aggregates

Each field in a small aggregate shall undergo initial site visit verification within the first two cultivation cycles for each crediting period. In the first year of the aggregate or in subsequent years when new fields enter the aggregate, a minimum of 30 percent of the newly enrolled fields shall complete the initial site visit verification in their first year of enrollment.

In addition, site visit verifications must be conducted on a schedule such that:

1. Each field in the aggregate must successfully complete a minimum of two site visit verifications per crediting period (e.g. the initial site verification in addition to one more).

2. A minimum of 20 percent of the fields in the aggregate shall be site verified in any given year, selected at random.

8.3.1.2 Desktop Verification Schedule for Small Aggregates

In any given year, a number of desktop verifications of field data must be conducted, with the number inversely related to the number of fields undergoing a site visit that year. Specifically, the number of desktop verifications (**D**) shall equal 50 percent of the number of fields (**n**) in the aggregate that will not receive a site visit that year, rounding up in the case of an uneven number of fields. In other words,

$$\boldsymbol{D} = \frac{(\boldsymbol{n} - \boldsymbol{S})}{\boldsymbol{2}}$$

Where,

n	=	Number of fields in the aggregate
S	=	Number of site visits
D	=	Number of desktop verifications

Fields shall not be selected for a desktop verification in years that the field is undergoing a site visit. If a site visit is planned for a field randomly selected for a desktop verification, the verification body will continue randomly drawing additional fields until the total number selected for a desktop verification reaches the value of (**D**) per the equation above.

8.3.2 Verification Schedule for Large Single-Participant Aggregates

In contrast to small aggregates, it is possible that a field in a large aggregate is never verified, either via site visit or desktop verification, during its entire crediting period. Therefore, random sampling is a particularly important component of enforcement.

8.3.2.1 Sampling for Site Visit Verification for Large Single-Participant Aggregates

The verification body determines the number of enrolled fields that must be randomly selected for site visit verification in a given year. The required number of site visits (**S**) shall equal the square root of the total number of fields (**n**) enrolled in the large single-participant aggregate that year (i.e. $\boldsymbol{S} = \sqrt{\boldsymbol{n}}$ rounded up to the nearest whole number).

8.3.2.2 Sampling for Desktop Verification for Large Single-Participant Aggregates

In addition to site visit verifications, verification bodies shall randomly select a sample of fields to undergo a desktop verification (**D**) equal to two times the square root of the total number of fields in the aggregate.

Fields shall not be selected for a desktop verification in years that the field is undergoing a site visit. If a site visit is planned for a field randomly selected for a desktop verification, the verification body will continue randomly drawing additional fields until the total number selected for a desktop verification reaches the square root of the total number of fields in the aggregate.

8.3.3 Verification Schedule for Large Multi-Participant Aggregates

The random sampling methodology shall be applied first at the project participant level and then at the field level. A random sampling methodology will be applied for site visit and desktop verification selection. However, the verification body shall select fields for site visits first as described in Section 8.3.3.1 and desktop verifications second as described in Section 8.3.3.2.

In contrast to small aggregates, it is possible that a field in a large aggregate is never verified, either via site visit or desktop verification, during its entire crediting period. Therefore, random sampling is a particularly important component of the enforcement mechanism.

8.3.3.1 Sampling for Site Visit Verification for Large Multi-Participant Aggregates

1. The verification body shall determine the number of project participants that must be randomly selected for a site visit in a given year, as follows:

$$S = \left(1 + \left(\frac{P}{500}\right)\right) \times \sqrt{P}$$

Where,

S	=	Number of site visits required (rounded up to the nearest whole number)
P	=	Number of project participants in the aggregate

2. The verification body shall randomly select (**S**) project participants to receive site visits that year.

3. The verification body shall select which fields of the selected project participants will receive a site visit. For project participants with six enrolled fields or fewer, the verification body shall site visit at least 50 percent of the fields, selected at random. For project participants with more than six fields enrolled in the aggregate, the verification body shall site visit at least 33.3 percent of the fields, selected at random.

4. A minimum of the square root of the total number of fields in the aggregate must be site visited. If this number is not met after following Steps 1 to 3, then the verification body shall randomly select one additional project participant and the sample of fields, according to Step 2 and 3 above, and repeat this until the number of site visits meets this minimum requirement. Note that Step 3 must be completed in full and therefore could result in a greater number of fields selected for site visits than the minimum requirement.

8.3.3.2 Sampling for Desktop Verification for Large Multi-Participant Aggregates

In addition to site visit verifications, each year verification bodies shall also randomly select fields to undergo a desktop verification of their field data. Verification bodies shall randomly select a sample of fields to undergo a desktop verification equal to two times the square root of the total number of fields in the aggregate (rounded up to the next whole number).

Fields shall not be selected for a desk-audit in years that the field is undergoing a site visit. If a site visit is planned for a field randomly selected for a desktop verification, the verification body will continue randomly drawing additional fields until the total number selected for a desktop verification reaches the square root of the total number of fields in the aggregate.

8.4 Standard of Verification

The Reserve's standard of verification for nitrogen management projects is the Nitrogen Management Project Protocol (this document, the NMPP) and the Reserve Program Manual and Verification Program Manual. To verify a nitrogen management aggregate, verification bodies apply the guidance in the Verification Program Manual and this section of the protocol to the standards described in Sections 2 through 7 of this protocol. Sections 2 through 7 provide eligibility rules, methods to calculate emission reductions, performance monitoring instructions and requirements, and procedures for reporting project information to the Reserve.

8.5 Monitoring Plan

The Aggregate Monitoring Plan (AMP) and Field Monitoring Plan (FMP) serve as the basis for verification bodies to confirm that the monitoring and reporting requirements in Section 0 and Section 7 have been met, and that consistent, rigorous monitoring and recordkeeping is ongoing by the aggregator and all enrolled fields. Verification bodies shall confirm that the Monitoring Plan covers all aspects of monitoring and reporting contained in this protocol and specifies how data for all relevant parameters in Table 6.1 are collected and recorded.

8.5.1 Annual Reports

The single-field project's project developer must annually submit field data for single-field projects to the Reserve. The Single-Field Report will consist of a *.csv file and attachments, as described in Section 7.2.1. Verification bodies must review the Single-Field Report to confirm project information and data collected according to the SFMP.

The aggregate must annually submit an Aggregate Report to the Reserve. The report will consist of a *.csv file and attachments, as described in Section 7.2.2. Verification bodies must review the Aggregate Report to confirm project information and data collected according to the AMP.

The verification body will need to review field data during desktop verifications of randomly selected fields in an aggregate. The field data must be made available to the verification body in order to confirm field-level information collected according to the FMP.

8.6 Verifying Eligibility at the Field Level

Verification bodies must affirm each project field's eligibility during site visit and/or desktop verifications according to the rules described in this protocol. The table below outlines the eligibility criteria for each project field. This table does not present all criteria for determining eligibility comprehensively; verification bodies must also look to Section 3 and the verification items list in Table 8.3.

Table 8.1. Summary of Eligibility Criteria for a Nitrogen Management Project

Eligibility Rule	Eligibility Criteria	Frequency of Rule Application
Start Date	The first day of the cultivation cycle, which begins immediately after completion of the previous crop's harvest, in which the approved project activity is adopted at the field. For 12 months following the Effective Date of this protocol, a pre-existing field with a start date on or after June 27, 2010 may be submitted for listing; after this 12 month period, projects must be submitted for listing within 6 months of the project start date	Once during first verification
Location and Crop Type	The field is located in an approved area of the U.S. and U.S. tribal areas and contains a corresponding eligible crop, according to Table 3.1	Every verification

Performance Standard	The field passes the Performance Standard Test for its respective state-crop combination.	Every verification
Legal Requirement Test	Signed Attestation of Voluntary Implementation form and monitoring procedures for ascertaining and demonstrating that the project passes the Legal Requirement Test	Every verification
Legal Title to CRTs	Aggregator Attestation of Title to CRTs	Every verification
Regulatory Compliance	Signed Attestation of Regulatory Compliance form and disclosure of all non-compliance events to verification body; project must be in material compliance with all applicable laws. In particular, no violations to the Safe Drinking Water Act or Clean Water Act, due to agricultural discharges.	Every verification
Applicability Conditions	▪ Verify that the total OSN values in the project are within the range allowable, as calculated in Section 5.3, Step 5 ▪ Verify that no fields have histosol soils ▪ Verify that only eligible N fertilizers have been used	Every verification

8.7 Core Verification Activities

The NMPP provides explicit requirements and guidance for quantifying the GHG reductions associated with the implementation of approved nitrogen management practice changes on project fields. The Verification Program Manual describes the core verification activities that shall be performed by verification bodies for all project verifications. They are summarized below in the context of a nitrogen management project, but verification bodies must also follow the general guidance in the Verification Program Manual.

Verification is a risk assessment and data sampling effort designed to ensure that the risk of reporting error is assessed and addressed through appropriate sampling, testing, and review. The three core verification activities are:

1. Identifying emission sources, sinks, and reservoirs (SSRs)
2. Reviewing GHG management systems and estimation methodologies
3. Verifying emission reduction estimates

Identifying emission sources, sinks, and reservoirs for each field
The verification body reviews for completeness the sources, sinks, and reservoirs identified for a single-field project or aggregate, ensuring that all relevant secondary effect SSRs for each field are identified.

Reviewing GHG management systems and estimation methodologies at the field level
The verification body reviews and assesses the appropriateness of the methodologies and management systems that are used to gather data and calculate baseline and project emissions for each field.

Reviewing GHG management systems and estimation methodologies at the aggregate level
The verification body reviews and assesses the appropriateness of the methodologies and management systems that the project aggregator uses to gather data and calculate baseline and project emissions on the aggregate level.

Verifying emission reduction estimates at the field level
The verification body further investigates areas that have the greatest potential for material misstatements and confirms whether or not material misstatements have occurred for all fields undergoing verification. This involves site visits to a random sample of project fields, according to the sampling methodology outlined in Section 8.3.2.1, to ensure systems on the ground correspond to and are consistent with data provided to the verification body, combined with a random sample of desktop verifications of remaining project fields according to Section 8.3.2.2. In addition, the verification body recalculates a representative sample of the performance or emissions data from fields for comparison with data reported by the project aggregator in order to confirm calculations of GHG emission reductions.

Verifying emission reduction estimates at the aggregate level
The verification body further investigates areas that have the greatest potential for material misstatements at the aggregate level, including whether the appropriate structural uncertainty factors (Section 5.4.4) and yield-loss statistical tests (Section 5.5.2) have been performed for the aggregate.

8.8 Project Type Verification Items

The following tables provide lists of items that a verification body needs to address while verifying a nitrogen management project. The tables include references to the section in the protocol where requirements are further specified. The table also identifies items for which a verification body is expected to apply professional judgment during the verification process. Verification bodies are expected to use their professional judgment to confirm that protocol requirements have been met in instances where the protocol does not provide (sufficiently) prescriptive guidance. For more information on the Reserve's verification process and professional judgment, please see the Verification Program Manual.

Note: These tables shall not be viewed as a comprehensive list or plan for verification activities, but rather guidance on areas specific to nitrogen management projects that must be addressed during verification.

8.8.1 Project Eligibility and CRT Issuance

Table 8.2 lists the criteria for reasonable assurance with respect to eligibility and CRT issuance for nitrogen management aggregates. These requirements determine if the aggregate is eligible to register with the Reserve and/or have CRTs issued for the reporting period. If any one requirement is not met, either for one or more fields, then the entire aggregate may be determined ineligible or the GHG reductions from the reporting period may be ineligible for issuance of CRTs, as specified in Section 3.

Table 8.2. Eligibility Verification Items

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
2.2	Verify that all verified fields meet the definition of a nitrogen management project	No
2.3	Verify ownership of the reductions by reviewing Aggregator Attestation of Title	No
2.3	Verify ownership of the reductions by reviewing Letters of Notification	No

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
	and contracts between aggregators, project participants, and land owners	
3.2	Verify the project start date for all fields	No
3.2	Verify accuracy of project start date for all verified fields based on operational records	Yes
3.3	Verify that each field is within the 14-year crediting period and seven eligible crop years within that crediting period.	No
3.5.1	Verify that each field meets the Performance Standard Test	No
3.5.2	Confirm execution of the Attestation of Voluntary Implementation form to demonstrate eligibility under the Legal Requirement Test	No
3.5.3	Verify that any ecosystem service payment or credit received for activities on a project field has been disclosed and is allowed to be stacked	No
3.6	Verify that the project activities at all verified fields comply with applicable laws, particularly water quality laws, by reviewing any instances of non-compliance provided by the aggregator and performing a risk-based assessment to confirm the statements made by the project developer in the Attestation of Regulatory Compliance form	Yes
5.1	Verify that all applicability conditions have been met for the project activity, including that no histosol soils are present in a field's project area, that the OSN has been consistent in the project and baseline, and that only eligible N fertilizers have been used.	No
6.1, 6.2, 6.2.2	Verify that the project Monitoring Plan contains a mechanism for ascertaining and demonstrating that all fields pass the Legal Requirement Test at all times	No
6.1, 6.2.2, 6.3	Verify that field-level and aggregate-level monitoring meets the requirements of the protocol. If it does not, verify that a variance has been approved for monitoring variations	No

8.8.2 Quantification

Table 8.3 lists the items that verification bodies shall include in their risk assessment and re-calculation of the GHG emission reductions. These quantification items inform any determination as to whether there are material and/or immaterial misstatements in the aggregate GHG emission reduction calculations. If there are material misstatements, the calculations must be revised before CRTs are issued.

Table 8.3. Quantification Verification Items

Protocol Section	Quantification Item	Apply Professional Judgment?
4	Verify that all SSRs in the GHG Assessment Boundary are accounted for	No
5.1	For each field, ensure that the baseline and project N-rate have been determined correctly	No
5.4	For each field, verify that input parameters for both the baseline and the project are represented by the appropriate data and the calculations are accurate for the baseline and the project emissions calculations	Yes
5.4.4	For the aggregate, verify that all field emission reductions are summed correctly, and that the structural uncertainty factor is properly applied	No

Protocol Section	Quantification Item	Apply Professional Judgment?
5.5.1	Verify that the aggregator correctly monitored, quantified and aggregated fossil fuel and electricity use changes	Yes
5.5.2	For the aggregate, verify that the statistical test for reduced yield is properly performed, and that increased emissions outside the project boundary are properly quantified for significant yield losses	No

8.8.3 Risk Assessment

Verification bodies will review the following items in Table 8.4 to guide and prioritize their assessment of data used in determining eligibility and quantifying GHG emission reductions.

Table 8.4. Risk Assessment Verification Items

Protocol Section	Item that Informs Risk Assessment	Apply Professional Judgment?
0	Verify that all contractors are qualified to perform the duties expected. Verify that there is internal oversight to assure the quality of the contractor's work	Yes
6.1, 6.2, 6.2.2	Verify that the project has documented and implemented the Single-Field Monitoring Plan or Aggregate Monitoring Plan, and all necessary Field Monitoring Plans	No
6.1, 6.2, 6.2.2	Verify that the project monitoring plans are sufficiently rigorous to support the requirements of the protocol and proper operation of the project	Yes
6.3	Verify that appropriate monitoring data is measured or referenced accurately	No
0, 7	Verify that the individual or team responsible for managing and reporting project activities are qualified to perform this function	Yes
0, 7	Verify that appropriate training was provided to personnel assigned to GHG reporting duties	Yes
7.2	Verify that the Single-Field Report or Aggregate Report was uploaded to the Reserve software	No
7.2, 7.3	Verify that field data has been gathered by project participants and made available to the aggregator	No
7.3	Verify that all required records have been retained by the project developer	No

8.9 Successful and Unsuccessful Verifications

Successful verification of each field in the sample of fields selected for site visit and desktop verifications results in the crediting of all fields participating in the entire aggregate, as calculated by the aggregator according to the quantification methodology in Section 5.

Verification may uncover any number of material and immaterial errors at the field, project participant or aggregate level, and the extent to which an error was propagated through the aggregate can affect whether a verification is determined to be "unsuccessful."

8.9.1 Field-Level and Project Participant-Level Errors

If material issues arise during verification of a participating field, verification bodies shall issue Corrective Action Requests, as needed. The aggregator will need to work with the project participant to independently address the issues and required corrective actions using the same process taken with standalone projects. These are described in the verification guidance of this protocol and the Reserve Verification Program Manual. If the error can be corrected at the field level and is the type of error which will not be propagated across an individual participant's fields or the entire aggregate, then the error shall be corrected and the field verification shall be considered successful. Errors shall be considered immaterial at the field level if they result in a discrepancy that is less than 5 percent of the total emission reductions quantified for that field.

If verification of a field reveals material non-compliance with the protocol, and no corrective action is possible, that field shall receive a negative verification and no CRTs shall be issued for that field, effectively removing the field from the aggregate for that year. When verification is unsuccessful for a participating field, the verification body must verify additional fields until the total number of successful verifications reaches the required number (as described in Section 8.2), starting with fields managed by the same participant, as follows. If the project participant managing the unsuccessfully verified field also manages other fields enrolled in the aggregate, the verification body shall site visit a minimum of two additional fields or 50 percent of the remaining unverified fields, whichever is larger, that are managed by that project participant. If the verification of the additional fields is also unsuccessful, no CRTs shall be issued for any of the fields managed by the project participant.

Deliberate non-compliance may result in disqualification of the project participant including all of their enrolled fields. Additionally, if the project participant failing verification and their negatively verified fields re-enter the aggregate the following year, each of the fields that failed verification the previous year shall be required to undergo a site visit, in addition to the minimum sampling requirements in Section 8.2.

Whenever a project participant receives a negative verification for all of their enrolled fields, the verification body shall use their professional judgment and a risk-based assessment to determine whether sampling additional project participants for site visit verification, beyond the minimum requirements of this protocol, is necessary to verify the entire aggregate to a reasonable level of assurance.

8.9.1.1 Cumulative Field-Level Error of Sampled Fields

Total errors and/or non-compliance shall be determined for the sampled fields and the offset issuance for those fields corrected, as required, by the Verification Program Manual. Should the aggregated error and/or non-compliance rate for the sampled fields be less than 5 percent, CRT issuance for fields not subjected to site visit or desktop verification shall be equal to the amount reported by the aggregator. However, if the aggregated percent error and/or non-compliance rate (i.e. the percentage of verified fields failing verification) for sampled fields is greater than 5 percent, CRT issuance for fields not subjected to site visit or desktop verification shall be reduced by the total amount of aggregated percent error or non-compliance rate.

8.9.2 Aggregate-Level Errors

If verification reveals a potential systemic error, which may be propagated out to the aggregate level (e.g. a qualitative error with regard to the input parameters or a quantitative error repeated in multiple field-level calculations), the verification body shall use their professional judgment to sample additional fields, as necessary, to determine whether the error is truly systemic. Systemic errors must be corrected at the aggregate level.

8.10 Completing Verification

The Verification Program Manual provides detailed information and instructions for verification bodies to finalize the verification process. It describes completing a Verification Report, preparing a Verification Statement, submitting the necessary documents to the Reserve, and notifying the Reserve of the project's verified status.

9 Glossary of Terms

Accredited verifier	A verification firm approved by the Climate Action Reserve to provide verification services for project developers.
Additionality	Project activities that are above and beyond business-as-usual operation, exceed the baseline characterization, and are not mandated by regulation.
Aggregate	*Need to add*
Aggregator	*Need to add*
Anthropogenic emissions	GHG emissions resultant from human activity that are considered to be an unnatural component of the Carbon Cycle (i.e. fossil fuel destruction, deforestation, etc.).
Biogenic CO_2 emissions	CO_2 emissions resulting from the destruction and/or aerobic decomposition of organic matter. Biogenic emissions are considered to be a natural part of the Carbon Cycle, as opposed to anthropogenic emissions.
Carbon dioxide (CO_2)	The most common of the six primary greenhouse gases, consisting of a single carbon atom and two oxygen atoms.
CO_2 equivalent (CO_2e)	The quantity of a given GHG multiplied by its total global warming potential. This is the standard unit for comparing the degree of warming which can be caused by different GHGs.
Direct emissions	Greenhouse gas emissions from sources that are owned or controlled by the reporting entity.
Effective Date	The date of adoption of this protocol by the Reserve Board.
Eligible crop year	A creditable year of the crediting period, in which an eligible crop (see Table 3.1) is grown. Eligible crop years are not required to be consecutive.
Emission factor (EF)	A unique value for determining an amount of a greenhouse gas emitted for a given quantity of activity data (e.g. metric tons of carbon dioxide emitted per barrel of fossil fuel burned).
Field	*Need to add*
Fossil fuel	A fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals.
Greenhouse gas (GHG)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs).

GHG reservoir	A physical unit or component of the biosphere, geosphere, or hydrosphere with the capability to store or accumulate a GHG that has been removed from the atmosphere by a GHG sink or a GHG captured from a GHG source.
GHG sink	A physical unit or process that removes GHG from the atmosphere.
GHG source	A physical unit or process that releases GHG into the atmosphere.
Global Warming Potential (GWP)	The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of CO_2.
Indirect emissions	Reductions in GHG emissions that occur at a location other than where the reduction activity is implemented, and/or at sources not owned or controlled by project participants.
Metric ton or “tonne” (MT)	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1 short tons.
Methane (CH_4)	A potent GHG with a GWP of 21, consisting of a single carbon atom and four hydrogen atoms.
MMBtu	One million British thermal units.
Mobile combustion	Emissions from the transportation of materials, products, waste, and employees resulting from the combustion of fuels in company owned or controlled mobile combustion sources (e.g. cars, trucks, tractors, dozers, etc.).
Project baseline	A “business as usual” GHG emission assessment against which GHG emission reductions from a specific GHG reduction activity are measured.
Project developer	An entity that undertakes a GHG project, as identified in this protocol, Section 2.3.
Project participant	*Need to add*
Stationary combustion source	A stationary source of emissions from the production of electricity, heat, or steam, resulting from combustion of fuels in boilers, furnaces, turbines, kilns, and other facility equipment.
Verification	The process used to ensure that a given participant’s greenhouse gas emissions or emission reductions have met the minimum quality standard and complied with the Reserve’s procedures and protocols for calculating and reporting GHG emissions and emission reductions.

Verification body	A Reserve-approved firm that is able to render a verification opinion and provide verification services for operators subject to reporting under this protocol.

10 References

In development (citations included as footnotes throughout protocol).

Appendix A Summary of Performance Standard Development

A.1 Practices and Data Availability

This appendix summarizes performance standard development and research into industry trends in nitrogen management practices in crop cultivation that have the potential to reduce nitrous oxide emissions. This appendix primarily lays out the background and rationale for the performance standard test for the approved project activity of reducing nitrogen application rate (or "reducing N-rate"), which was identified in other methodologies (Millar et al., 2010) and by the Reserve's Science Advisory Committee (SAC, see Appendix B) as a practice with consistent N_2O emission reduction potential. While nine N_2O mitigation practices were prioritized for consideration in the NMPP, the lack of comprehensive datasets on business as usual nitrogen management practices hindered the development of performance standards for a number of these practices, as shown in Table A.1.[56] Where available, USDA ARMS datasets, discussed further below, were used to analyze common practice nitrogen management, and where sufficient data were available, research outcomes informed development of a performance standard. The only complete performance standard currently included in the NMPP is for N-rate reduction projects for corn in the North Central Region, and as such this appendix primarily addresses that performance standard and its development. This Appendix (Section A.7) also summarizes the preliminary performance standard research done on other priority nitrogen management practices for which data were available, namely switching from fall to spring application and using nitrification inhibitors (or using both nitrification *and* urease inhibitors), which may be included as approved project activities under a future version of this protocol. This Appendix (Section A.7) also summarizes the preliminary performance standard research done on N-rate reduction projects for other crops and regions, which also may be included under a future version of this protocol.

[56] The Background Paper on Quantification of N2O Mitigation Options, prepared by Terra Global Capital for the Climate Action Reserve provides an extensive review of datasets considered for use in developing the performance standard. Only the most promising and comprehensive of datasets are discussed here.

Table A.1. Priority List of Practices and Data Availability

Priority list of practices to include in NMPP (based on SAC report)	Comprehensive data available to develop performance standard (USDA ARMS)?
Reduce N Applied w/out Going Below N Demand	Yes
Use of Nitrification and Urease Inhibitors / Use of Nitrification Inhibitors (only)	Yes
Switch from anhydrous ammonia to urea	No
Switch from Fall to Spring Application	Yes
Change to Slow Release Fertilizer	No
Change to Fertigation	No
Apply N Closer to Roots	No[57]
Add N Scavenging Cover Crops	No

A.2 Nitrogen Cycling and Nitrogen Use Efficiency

Metrics to set a performance standard threshold must be simple and consistent. Though the annual N fertilization rate may seem like a straightforward metric for setting a performance threshold, particularly for practices that reduce nitrogen rates, it is not a consistent metric. More specifically, fields that receive an equal amount of N fertilizer can vary drastically in terms of yield, how much N crops take up, how much N is lost, and how much residual N remains after crop uptake, all of which influence the quantity of N available for processes that lead to N_2O emissions. This difference in efficiency across sites can be understood if one considers the nitrogen cycle.

Nitrogen cycles through cropland systems in a way that is influenced by a wide range of site-specific variables such as soil type, climate, cropping system and previous and current N management. A simplified diagram of the N-cycle is depicted in Figure A.1 below. N inputs in most agricultural systems consist of synthetic N fertilizer (e.g. anhydrous ammonia or urea), organic fertilizer (e.g. manure, compost, or sewage sludge), or carryover from legumes in the rotation. N can also become available through mineralization of organic matter or residual soil N carried over from one season to the next. Major N losses include leaching, NH_3 volatilization or emission of NO, N_2O or N_2. Finally, N is also removed from the system through harvest, with the amount of N removed by harvest depending on the crop type and crop usage (e.g. corn for grain versus silage). As a consequence, the most appropriate N-rate for a given field will vary drastically across and within cropping systems and regions, due to differences in climates, soil types and crop physiologies

[57] Though some N placement data is available through ARMS, the Reserve does not believe this data is sufficient to develop a performance standard for changing N-placement, at this time.

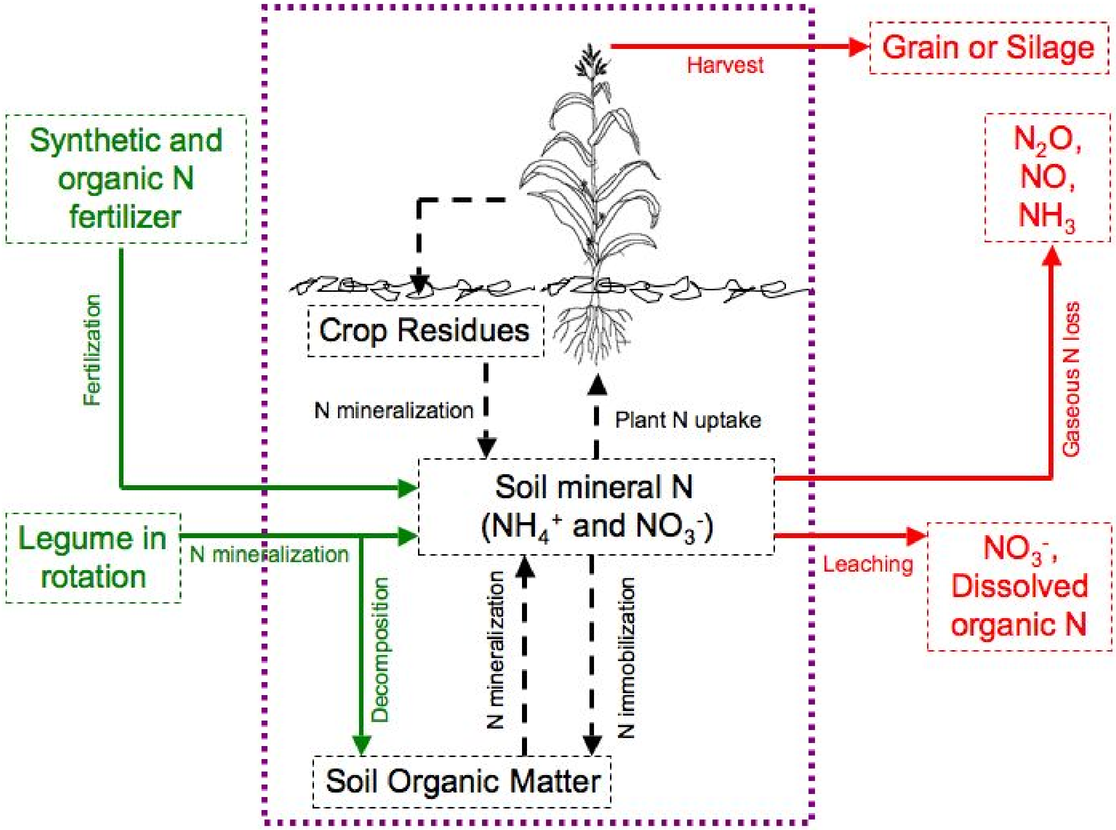

Figure A.1. Nitrogen Sources, Cycling, and Losses in Agricultural Systems

Red arrows represent losses from the system, green arrows external inputs and dashed arrows internal recycling. The purple dotted line marks the accounting boundary. (Drawing of corn plant was obtained from www.inra.fr).

The most comprehensive evaluations of N budgets and N cycling in the system take into account all N inputs, losses and internal N cycling. A commonly used metric in the industry to characterize N-budgets of cropland systems is Nitrogen-Use Efficiency (NUE). The NUE takes the form of a ratio that considers an output (e.g. crop biomass at harvest or economic yield) as the numerator and input (N supply) as the denominator (Ladha et al., 2005). The crop biomass at harvest (i.e. the “biological yield”) can include either total aboveground plant dry matter or total plant N, whereas the economic yield includes either grain yield or total grain N (Ladha et al., 2005). The N supply can be from soil (N mineralization, carryover of residual N, N credit from legumes), fertilizer (organic or inorganic), or soil plus fertilizer (Ladha et al., 2005). Consequently, various working definitions and methodologies to measure and calculate NUE are in circulation, each of which find their use in answering particular agronomic, ecological or economic questions. NUE can be used at various geographic scales, from studying and fine-tuning the N budget of a single field to evaluating nitrogen balances at a watershed or landscape scale. In a recent USDA report on N-use (Ribaudo et al., 2011), BMP N-rates for a particular field were defined as N-rates applied at less than 40% excess of N removed by harvest. At a landscape scale, NUE has been used by the International Plant Nutrition Institute (IPNI, (e.g. NuGIS, Fixen 2010)), the Agricultural Sustainability Institute (ASI) at UC Davis, and other entities as an important indicator to evaluate the sustainability and performance of various agricultural regions and cropping systems (Fixen, 2010; Ladha et al., 2005; Rosenstock et al., In Review). Regardless of the definition used for NUE, higher values for NUE generally reflect improved utilization of N by the crop, often decreasing the risk for harmful loss of N to the environment, such as N_2O emissions.

A performance standard threshold that is solely based on N fertilizer rates will be insufficient to deduce performance consistently across sites, due to the inability to account for site-specific factors. A high N-rate threshold may be appropriate for high-yielding fields, but not for marginal fields within the same geographic region. A performance metric based on nutrient use efficiency rather than absolute N rate can overcome this issue. NUE-based performance metrics reflect N management that limits N losses and maximizes N use by crops.

A.3 Ratio of Removed To Available Nitrogen (RTA) as Performance Standard Threshold

In the previous section, it was explained how a performance threshold for reducing N rates shall be based on some measure of NUE. Ideally, inputs, losses (including N removed by harvest) and internal recycling should be considered when characterizing cropland NUE. However, in practice, such data is lacking, both in terms of regional data sets needed to set a threshold, as well as site-specific data that would be needed to compare a field's performance against the threshold. The only data readily available to assess these respective NUE values and set NUE-thresholds is limited to synthetic and organic fertilizer N inputs and cropping yields, which can be used to calculate the N removed by harvest. Though more comprehensive NUE metrics, which include many additional variables, may approximate NUE more accurately in theory, these more comprehensive metrics can become rather complicated and opaque, making their use less desirable in the context of an offset protocol. For testing additionality, the focus should be on metrics for which sufficient data is available to define the common practice and that can be calculated for individual fields using historic data that is readily available to the grower. Metrics that reflect the system's N budget to its fullest extent will require additional data gathering and field sampling that are likely prohibitive to conduct at a field scale due to practical and financial constraints.

Therefore, this protocol uses a simple NUE-metric, defined as the "ratio of Removed To Applied N" (RTA). The terminology "RTA" rather than "NUE" was selected to avoid confusion with more complicated definitions of NUE used in the industry and to acknowledge that RTA as it is used in the protocol does not necessarily provide the most precise quantification of the cropping system's N balance. The RTA metric is calculated in Equation 3.1 as the ratio of N removed by harvest to N applied, where N removed by harvest is determined by multiplying yield by a crop-specific default factor for N content, found in Table A.2. Therefore, RTA values increase when yield increases or N rate decreases. If a large number of producers in a specific state apply relatively low N rates because they account for potential residual N at the beginning of the growing season or legume N credits, the state-average RTA will be relatively small. Vice versa, if the selection of an appropriate N rate is not commonly discounted for residual N or N credit from legumes, the state-average RTA will be relatively high. Therefore, simple state-average RTA values implicitly take into account the adoption of best management practices with respect to N-rate, and state-specific threshold values can be used to ensure additionality and promote environmental integrity.

It should be noted that the RTA is a kind of intensity-based metric that normalizes N rates by using cropping yields. However, it is important to note that while the performance standard is based on an intensity-based approach, quantification of N_2O emission reductions in the NMPP is not intensity-based, but rather based on total reductions quantified for a given project area.

The RTA equation (Equation 3.1) introduced in this section is used to calculate average state-level RTAs for developing performance standard thresholds (See Appendix A.5 and A.6), as well as used to determine baseline and project RTAs, based on project participants' crop production management records as described in Section 3.5 of the NMPP protocol.

Calculation of the RTA, both at the project-level and for the regional threshold, relies on the use of default values for N-content of crops, as listed in Table A.2 below, which are adopted from the USDA N use report (Ribaudo et al., 2011). Default values for N-content are used instead of field-specific N sampling because the variation in crop N contents across fields under the same crop cultivation is likely small relative to the variation in N rates and yield, while the use of crop-specific default values also allows for a more straightforward comparison of field-specific and state-specific RTAs. Further, field-specific crop N-contents are not typically measured by the grower, and the measurements could be cost-prohibitive in a performance standard test.

Table A.2. Default Values for Average N-Content
Source: (Ribaudo et al., 2011)

Crop Type	Yield Units	N-Content	N-Content Units
Corn for grain	Bushels/acre	0.8	lb N/bushel
Corn for silage	Tons/acre	7.09	lb N/ton
Winter wheat	Bushels/acre	1.13	lb N/bushel
Spring wheat	Bushels/acre	1.39	lb N/bushel
Durum wheat	Bushels/acre	1.29	lb N/bushel

A.4 Analysis of Grower Decision-Making to Determine N-Rates

This section summarizes research into how farmers decide on the N application rate, as further background to the performance standard threshold. In particular, the use of recommended N-rates as a proxy for common practice was investigated for corn cropping systems in selected states in the North Central Region. More information is available in a Background Paper prepared for the Reserve by Terra Global Capital,[58] which evaluated a regional N-rate calculator using the Maximum Return to N approach (MRTN) and N application rates based on N-use surveys; the analysis of those methods will be discussed further below.

In the Background Paper analysis, recommended N-rates were determined using the Iowa State University Corn Nitrogen Rate Calculator[59] (Sawyer et al., 2006). This calculator provides a regional (corn belt) approach to N-rate guidelines and finds the Maximum Return To N (MRTN), which is the N-rate where the economic net return to N application is greatest given current prices for fertilizer N and projected corn grain prices. The calculator was calibrated for several states and for specific regions within some of the states, using corn yield data from N response trials (Sawyer et al., 2006). The MRTN approach to decide on N fertilizer rate is more commonly used today than the yield-goal approach,[60] which was the dominant approach to determine N-rates for corn throughout the last four decades. MRTN-based recommended N-rates are often lower than yield-goal based N-rates. To assess the suitability of MRTN as a proxy for common practice, MRTN-based recommended N rates for selected N-to-corn grain price ratios were

[58] Available on the Climate Action Reserve's website: http://www.climateactionreserve.org/how/protocols/agriculture/nitrogen-management/
[59] http://extension.agron.iastate.edu/soilfertility/nrate.aspx
[60] The yield-goal approach recommends that N-rates be determined by multiplying the expected yield by a factor that expresses N requirements in function of expected yields.

compared with state-average N rates from USDA-ARMS (Table A.3). Price ratios were selected assuming that 50% of fertilizer use consists of urea and 50% consists of anhydrous ammonia, and based on the observation that price ratios fluctuated between 0.07 and 0.14 with an average of 0.10 over the period 1999-2011[61].

Table A.3. Actual and Recommended N-Rates for Corn in Selected States in the North Central Region

States	Actual Corn N fertilization rate [lbs N/acre] 2005	2010	Region Within State	Recommended N rate - MRTNs at different price ratios [lbs N acre-1] Average price ratio (0.10) SC	CC	Low price ratio ~2010 (0.07) SC	CC	High price ratio ~2005 (0.14) SC	CC
Illinois	146	167	North	145	185	157	201	132	167
			Central	168	185	183	200	152	169
			South	172	188	190	205	155	171
Indiana	147	178	West & North-west	169	NA	177	NA	156	NA
			East and Central	202	NA	214	NA	191	NA
			Remainder	176	NA	189	NA	161	NA
Iowa	141	142	State	133	190	145	199	120	176
Michigan	128	122	State	131	NA	141	NA	122	NA
Minnesota	139	125	State	109	148	120	154	103	144
Ohio	161	141	State	175	197	190	214	158	182
Wisconsin	107	92	VH/HYP	125	151	131	160	107	139
			M/LYP	94	109	107	118	89	94
			Irr. Sands	209	209	209	209	197	197
			non-irr. Sands	130	130	130	130	122	122

Red cells indicate MRTN N rates that are greater than the actual corn N fertilization rate at a specific year. Green cells indicate MRTN N rates that are less than the actual corn fertilization rate at a specific year. SC = Soy-corn rotation, CC = Continuous corn, NA = not available, VH/HYP = very high and high yield potential, M/LYP = medium to low yield potential, Irr. = irrigate, Non-irr. = non-irrigated

For continuous corn systems, the recommended MRTN rates were generally greater than the actual corn N fertilization rates at average and low price ratios. However, the N-rate did fluctuate somewhat based on the price ratio. When the price ratio was small, as in 2010, the actual N fertilization rate tended to be lower than the recommended rates for soybean-corn systems in more states compared to when the price ratio was large, as in 2005. Consequently, whether the actual N rate is above or below the recommended N rate depends greatly on the crop rotation and price ratio. In agreement with Snyder et al. (2011), the outcomes of the comparison suggest that the average farmer in leading corn-producing states does not commonly apply more N than the recommended N-rate based on the corn N-rate calculator. Because the recommended N-rate does not always compare well with the state-averaged N-rates and does not capture potential variability in N-rates between farmers within a state or geographic region, the Reserve deemed recommended N-rates unsuitable as a proxy for common practice in this protocol. This is further supported by the low percentage of farmers (17.3% in 2005) reporting that the cost of

[61] See NMPP background paper for more details.

nitrogen and/or expected commodity price was the driving factor in determining their N rates, as reported in a recent USDA N-use report by Ribaudo et al. (2011) and presented in Table A.4, below.

Lastly, the suitability of historic or “routine practice” N-rates (e.g. simply basing this year’s N-rate decision on previous years’ historic N-rates) as a proxy for common practice was investigated. A historic N-rate has the advantage of taking into account site-specific variables that influence growers’ management decisions, including soil fertility, soil N retention and previous management. Furthermore, survey data presented by Ribaudo et al. (2011) indicate that over 70% of growers base N-rates on their routine practice (Table A.4). Consequently, historic or routine practice N-rate is likely a sensible proxy for common practice on a particular site. As such, the Reserve determined that historic N-rate shall be used to set the project’s baseline under this protocol.

Table A.4. Factors Influencing Farmers’ N-Rate Decision
(Adopted from Ribaudo et al. 2011)

Application Used	2001	2005
	Percent of Farmers	
Soil or tissue test	18.8	27.0*
Crop consultant recommendation	13	17.6*
Fertilizer dealer recommendation	28.7	41.2*
Extension service recommendation	3.2	4.6*
Cost of nitrogen and/or expected commodity price	11.4	17.3*
Routine practice	70.9	71.7*
	Number	
Observations	1,646	1,344

*Statistically different from 2001 at the 1-percent level, based on pairwise two-tailed delete-a-group Jackknife t-test (Dubman, 2000). Source: USDA, Economic Research Service using data from USDA’s 2001 and 2005 Agricultural Resource Management Survey, Phase II, Cost of Production and Costs Report.

In most cases, recommended N-rates are underpinned by results from N response trials, where the relationship between N-rate and yield is assessed. Recommended N rates are designed to maximize yield or profit, but are not specifically optimized to minimize harmful N losses (Ribaudo, 2011). Similarly, an N rate survey in Minnesota indicated that average N fertilizer use by Minnesota corn farmers was generally consistent with University of Minnesota Extension N management guidelines (Bierman et al., 2011).

A.5 Historic Trends and Distributions of State RTAs

Under development

A.6 Setting the Performance Standard RTA Threshold

Under development

A.7 Discussion of Performance Standard Research for N-Rate Reductions in Other Regions

Preliminary Work on RTAs for Other Crops and Regions

We will include an additional brief summary of work done with ARMS data for other crops and regions here.

Preliminary Work on California RTAs

The state of California is included in the ARMS data survey for some crops, such as wheat. However, due to the large variety of crops grown in California, most of which are speciality crops, the ARMS data are not particularly helpful. However, N-rates and yields for various cropping systems in California, can be found in the forthcoming California Nitrogen Assessment (CNA) performed by the Agricultural Sustainability Institute at UC Davis. This is likely the most comprehensive resource on N management in California. N-rates reported in the CNA are derived from expert opinions taken from the most recent UC ARE Cost and Return Studies (2000-present)[62] and from growers surveys included in the USDA Chemical Usage Reports between 1999 and 2009. Grower survey data is the preferred data source for developing performance standard tests, especially given that experts likely overestimate N application rates (Rosenstock et al., In Review). However, some crops are not included in the USDA Chemical Usage Reports (see REF). Adoption rates for other N-management practices are currently not publicly available. Surveys of extension specialists could be considered for developing performance standard test for eligible project activities.

[62] http://coststudies.ucdavis.edu/current.php

Table A.10. N-Rates for Selected Crops in California

Source: California Nitrogen Assessment (http://asi.ucdavis.edu/research/nitrogen/n-science/nitrogen-use-efficiency)

					Nitrogen application rates (lbs./acre)	
Commodity	Acreage[1]	Yield (lbs./acre)[1]	% moisture[2]	% N content[2]	USDA[3]	UCD cost study[4]
Almond	580000	1882	4.42	3.34	NA	200
Avocado	61820	6592	72.56	1.23	116	153
Broccoli	123600	14900	89.70	5.65	216	135
Carrot	71620	32040	88.00	1.51	180	70
Celery	25740	71300	94.55	2.42	344	226
Corn - grain	146000	9544	13.52	1.64	NA	230
Cotton[5]	404000	1397	9.00	0.20	123	250
Grapes - wine	477800	13388	80.28	0.57	33	100
Lemons	45000	34772	87.20	1.51	152	130
Lettuce - head	130600	37000	94.80	3.81	200	150
Melons - honeydew	17360	20900	88.33	0.91	58	150
Oranges	183100	23238	86.81	1.25	85	110
Peach - freestone	36400	22364	87.83	0.95	122	151
Pepper - bell	20700	36500	92.50	2.18	283	342
Plums - dried	67800	3596	85.20	0.85	130	150
Potato	43020	35720	77.20	1.61	NA	250
Rice	535800	7912	11.33	1.39	124	120
Strawberry	33680	60600	91.28	1.25	215	180
Tomato - proccessing	279400	75328	94.00	2.56	188	178
Walnut	215200	3116	3.65	2.37	NA	200

[1]Data is the average of 2003 -2007 from historical NASS data archieve. (http://www.nass.usda.gov/Statistics_by_State/California/Historical_Data/index.asp)

[2]Nitrogen content data from USDA crop nutrient tool (http://npk.nrcs.usda.gov/).

[3]USDA application rates are from the most recent USDA chemical usage reports (http://usda.mannlib.cornell.edu/MannUsda/search.do).

[4]UCD cost study application rates are from the UC Davis Cost Studies published by the Agricultural and Resource Economics Department (http://coststudies.ucdavis.edu)

[5]Moisture and nitrogen content values are for lint.

Note: The final draft of the protocol will include this table, as well as the respective RTA calculations for these crops.

A.8 Discussion of Performance Standard Research for Other Practices

Preliminary performance standard research for other practices has been undertaken by the Reserve, with the aim of eventually developing practice-based positive lists. The Reserve is looking at both absolute levels of and temporal trends in penetration rates of project activities as a decision criterion for including project activities on a positive list (i.e., activities on the positive list are automatically considered additional). Preliminary data for the project activities “changing N-timing” and “use of N-inhibitors,” the only two priority practices for which USDA-ARMS datasets are available, are presented in Sections 7.1 and 7.2 of this appendix, respectively. If quantification methodologies for these practices become available, the Reserve will complete work on the positive list, with the hopes of expanding the protocol to include these new practices. The Reserve will also continue to evaluate, on an ongoing basis, additional datasets for the other priority practices, to determine whether there may be enough data for those practices to develop a performance standard, as discussed further below.

A.8.1 Data Available Using the USDA ARMS Dataset

The most comprehensive data source for developing robust and widely applicable performance standard tests for this NMPP protocol is the USDA Agricultural Resources and Management Survey (ARMS).[63] This survey includes three phases, Phase II of which includes surveys conducted to obtain physical and economic data on production inputs, management practices (including a fertilizer management survey), and commodity cost of production. Averages and relative standard errors (RSE) around survey data on crop production practices for selected major field crops and their respective top producing states can be downloaded from the USDA ARMS website[64]. The crop practice categories and crops for which data is readily downloadable are listed in Table A.11. The states and years for which phase II data was collected are presented per crop in Table XX. Note that only a selected subset of the survey data is available to download. Also, for data that is characterized by continuous variables (e.g. N rate), data distributions are not available. This provides a major limitation for developing robust performance standard tests. For calculating RTAs, crop yield data are required in addition to N-rates. Crop yield data are not available from the USDA ARMS survey, but can be downloaded from USDA/NASS Quickstats[65]. Yield data for a large variety of crops are available at the state level. Within some state, agricultural district or county-averaged crop yields are available. No standard errors or distributions are available for yield data.

Table A.11. Crops and Crop Practices for which USDA ARMS Data is Readily Downloadable
The state and year combinations for which the data is available can be found in REF.

Crops	Subgroups	Manure table
corn	farm production region	manure type
soybean	irrigation system	manure application method
cotton	highly erodable land	manure application timing
rice	previous crop harvested	distance to manure production site
spring wheat	tillage system	tillage system
sorghum	ownership status	ownership status
oats		
peanuts		
barley feed		
barley malt		
Nutrient use and management	**Nutrient use by application method**	**Synthetic N application timing**
N rate	no N broadcast	N in fall before planting
manure applied	all N broadcast with incorporation	N in spring before planting
compost applied	all N broadcast without incorportation	N at planting
soil and/or plant tissue N test	mixed N application method, with incorporation	N after planting
nitrification inhibitor used	mixed N application method, without incorportation	

63 General documentation on ARMS can be found at http://www.ers.usda.gov/Data/ARMS/GlobalDocumentation.htm
64 Go to http://www.ers.usda.gov/Data/ARMS/CropOverview.htm and select “tailored reports”.
65 http://quickstats.nass.usda.gov/

A.8.2 Preliminary Analysis for N-timing (Switching from Fall to Spring Application)

Survey data on penetration rates for fall N application in corn cropping systems was obtained from USDA-ARMS to evaluate the trends in switching from Fall to Spring. Both penetration rates and trends in penetration rate over time differ across states (Figure A.7, Table A.12). For a large number of states, not enough data are available for trend analysis. In states where enough data were available, no trends over time were observed. Across all states and years, the smallest observed penetration rate was 2% (Kentucky 2010) and the largest 64% (Iowa 2010).

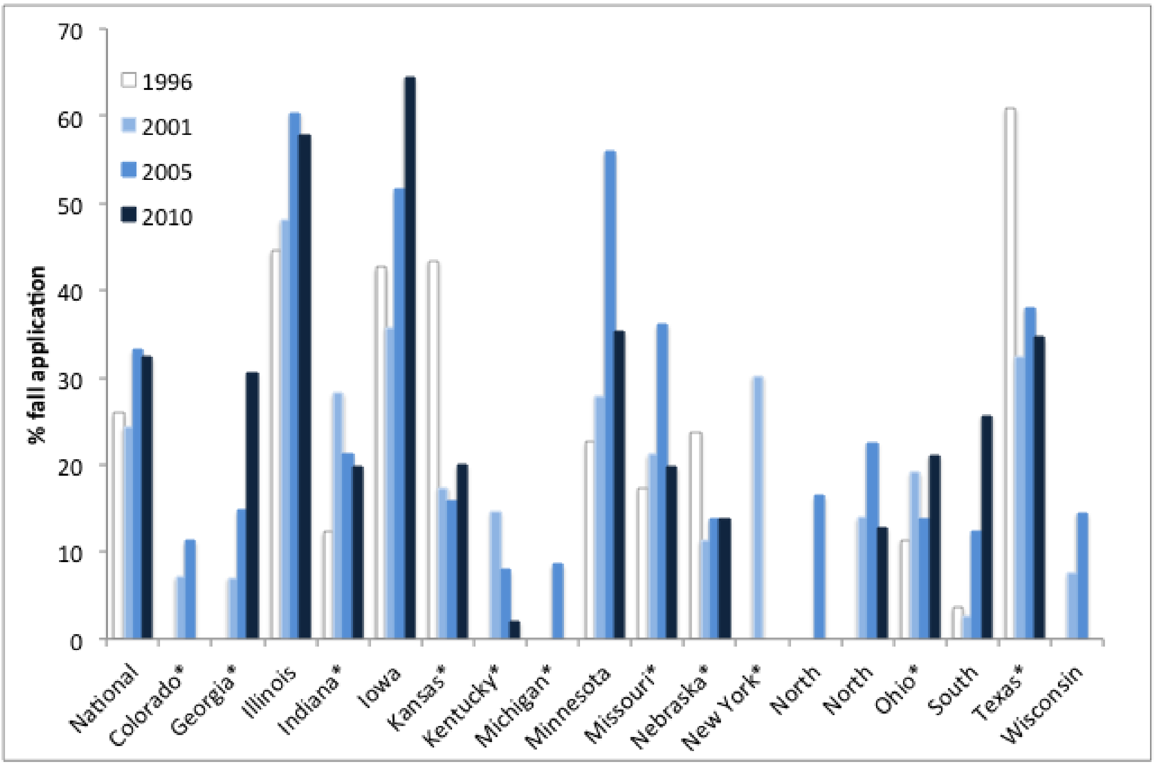

Figure A.2. Penetration Rate of Fall N Application for Corn

Table A.5. Trends in Penetration Rate of Fall N Application Over Time

State	Case
Colorado	Case 5: Insufficient data and no recent data
Georgia	Case 3: Insufficient data but recent data is available
Georgia	Case 3: Insufficient data but recent data is available
Illinois	Case 1: no significant trend over time
Indiana	Case 1: no significant trend over time
Iowa	Case 1: no significant trend over time
Kansas	Case 1: no significant trend over time
Kentucky	Case 5: Insufficient data and no recent data
Michigan	Case 5: Insufficient data and no recent data
Minnesota	Case 1: no significant trend over time
Missouri	Case 5: Insufficient data and no recent data
Nebraska	Case 5: Insufficient data and no recent data
North Carolina	Case 5: Insufficient data and no recent data
North Dakota	Case 5: Insufficient data and no recent data

Ohio	Case 5: Insufficient data and no recent data
Pennsylvania	Case 5: Insufficient data and no recent data
South Dakota	Case 5: Insufficient data and no recent data
Texas	Case 1: no significant trend over time
Wisconsin	Case 5: Insufficient data and no recent data
New York	Case 5: Insufficient data and no recent data

A.8.3 Preliminary Results for the Use of N-inhibitors

Data on adoption of N-inhibitors in corn cropping systems was also obtained from USDA-ARMS. It should be noted that 'N-inhibitor' as defined in the USDA-ARMS survey includes nitrification inhibitors, urease inhibitors and chemical coated (controlled release) fertilizers. Only aggregated data on penetration rates for N-inhibitors are publicly available. However, the survey question was phrased in a manner that disaggregation per N-inhibitor type should theoretically be possible. Consequently, penetration rates presented in Figure A.8 should be interpreted with caution but are conservative, as the penetration of one particular type of N-inhibitor will be lower than the penetration of the umbrella-group of N-inhibitors. Both penetration rates and trends in penetration rate of N-inhibitors over time differ across states (Figure A.8, Table A.13). For a large number of states, not enough data are available for trend analysis. In states where enough data were available, no trends over time were observed. Across all states and years, the smallest observed penetration rate was 2% (Missouri and Nebraska 2001) and the largest rate 44% (Indiana 2010). Penetration rates in 2010 were lower than 10% in Minnesota, Nebraska and Ohio.

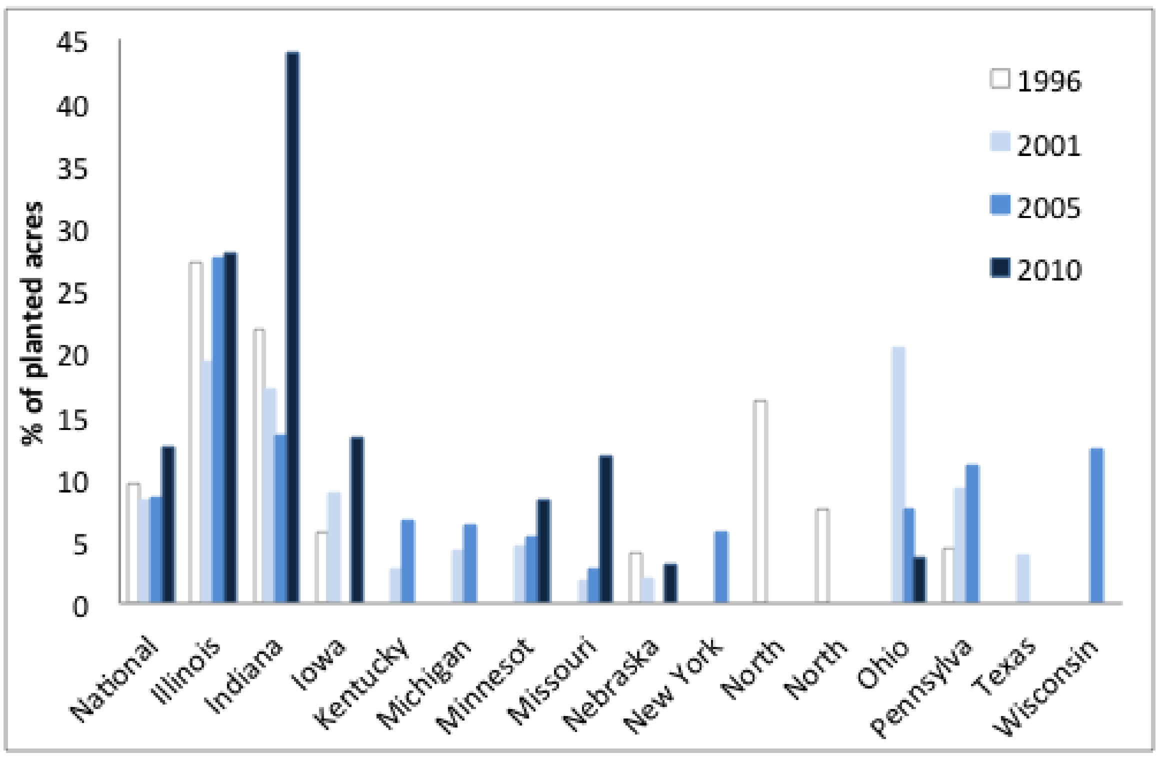

Figure A.3. Penetration Rate of Use of N-Inhibitors for Corn

Table A.6. Trends in Penetration Rate of Use of N-Inhibitors Over Time

State	Case
Iowa	Case 1: no significant trend over time
Illinois	Case 1: no significant trend over time
Indiana	Case 1: no significant trend over time
Kentucky	Case 1: no significant trend over time
Michigan	Case 5: Insufficient data and no recent data
Minnesota	Case 1: no significant trend over time
Missouri	Case 1: no significant trend over time
Nebraska	Case 1: no significant trend over time
New York	Case 5: Insufficient data and no recent data
Ohio	Case 1: no significant trend over time
Pennsylvania	Case 1: no significant trend over time
South Dakota	Case 5: Insufficient data and no recent data
Texas	Case 5: Insufficient data and no recent data
Wisconsin	Case 1: no significant trend over time

A.9 Complete RTA and N-Rate Historic Trend Tables for All States with ARMS Data for Corn

Table A.7. Low, Average, and High State- and Crop-Specific RTA Values and Trends Over Time

n.s. = not statistically significant (p<0.5), * = not enough data was available for trend analysis, positive = the trend in RTA over time was statistically significant and positive (p < 0.05)

Crop	Previous Crop	State	nrObs	Lowest Historic RTA	Average Historic RTA	Highest Historic RTA	Trend
corn grain	corn grain	Colorado	6	0.60	0.79	1.15	n.s.
corn grain	corn grain	Georgia	2	0.62	0.81	1.00	*
corn grain	corn grain	Iowa	8	0.75	0.92	1.39	n.s.
corn grain	corn grain	Illinois	8	0.62	0.70	0.77	n.s.
corn grain	corn grain	Indiana	7	0.58	0.75	0.89	n.s.
corn grain	corn grain	Kansas	7	0.52	0.62	0.70	n.s.
corn grain	corn grain	Kentucky	6	0.50	0.72	1.01	n.s.
corn grain	corn grain	Michigan	7	0.68	0.87	1.18	n.s.
corn grain	corn grain	Minnesota	8	0.98	1.17	1.42	n.s.
corn grain	corn grain	Missouri	8	0.42	0.68	1.12	positive
corn grain	corn grain	North Carolina	7	0.52	0.83	1.58	n.s.
corn grain	corn grain	North Dakota	3	0.84	0.94	1.12	n.s.
corn grain	corn grain	Nebraska	8	0.57	0.74	0.84	n.s.
corn grain	corn grain	New York	4	1.05	1.51	1.95	n.s.
corn grain	corn grain	Ohio	7	0.64	0.74	0.87	n.s.
corn grain	corn grain	Pennsylvania	6	0.76	1.09	1.40	n.s.
corn grain	corn grain	South	1	0.59	0.59	0.59	*

		Carolina					
corn grain	corn grain	South Dakota	6	0.67	0.87	1.02	n.s.
corn grain	corn grain	Texas	7	0.54	0.69	0.88	n.s.
corn grain	corn grain	Wisconsin	8	1.10	1.31	1.46	n.s.
corn grain	soybean	Georgia	1	0.89	0.89	0.89	*
corn grain	soybean	Iowa	8	0.84	0.93	0.99	n.s.
corn grain	soybean	Illinois	8	0.65	0.74	0.80	n.s.
corn grain	soybean	Indiana	8	0.67	0.76	0.89	n.s.
corn grain	soybean	Kansas	7	0.70	0.82	1.02	n.s.
corn grain	soybean	Kentucky	7	0.45	0.58	0.67	n.s.
corn grain	soybean	Michigan	8	0.58	0.77	1.02	n.s.
corn grain	soybean	Minnesota	8	0.87	0.96	1.10	positive
corn grain	soybean	Missouri	8	0.49	0.65	0.78	n.s.
corn grain	soybean	North Carolina	7	0.37	0.61	0.79	n.s.
corn grain	soybean	North Dakota	4	0.63	0.76	0.87	n.s.
corn grain	soybean	Nebraska	8	0.81	0.94	1.06	n.s.
corn grain	soybean	New York	1	1.74	1.74	1.74	*
corn grain	soybean	Ohio	8	0.59	0.69	0.86	positive
corn grain	soybean	Pennsylvania	5	0.78	1.03	1.50	n.s.
corn grain	soybean	South Carolina	1	0.52	0.52	0.52	*
corn grain	soybean	South Dakota	8	0.77	0.87	1.05	n.s.
corn grain	soybean	Texas	1	0.78	0.78	0.78	*
corn grain	soybean	Wisconsin	8	0.70	1.01	1.19	n.s.
corn silage	corn silage	Colorado	6	0.89	1.15	1.69	n.s.
corn silage	corn silage	Georgia	2	0.81	1.00	1.20	*
corn silage	corn silage	Iowa	8	0.80	1.00	1.56	n.s.
corn silage	corn silage	Illinois	8	0.59	0.69	0.78	n.s.
corn silage	corn silage	Indiana	7	0.67	0.86	1.13	n.s.
corn silage	corn silage	Kansas	7	0.49	0.63	0.74	n.s.
corn silage	corn silage	Kentucky	6	0.59	0.83	1.19	n.s.
corn silage	corn silage	Michigan	7	0.68	0.95	1.28	n.s.
corn silage	corn silage	Minnesota	8	0.80	1.11	1.43	n.s.
corn silage	corn silage	Missouri	8	0.40	0.69	1.21	positive
corn silage	corn silage	North Carolina	7	0.63	1.03	1.91	n.s.

corn silage	corn silage	North Dakota	3	0.64	0.78	0.97	n.s.
corn silage	corn silage	Nebraska	8	0.56	0.74	0.84	n.s.
corn silage	corn silage	New York	4	1.33	1.84	2.37	n.s.
corn silage	corn silage	Ohio	7	0.64	0.80	0.93	n.s.
corn silage	corn silage	Pennsylvania	6	0.97	1.41	1.66	n.s.
corn silage	corn silage	South Carolina	1	0.83	0.83	0.83	*
corn silage	corn silage	South Dakota	6	0.57	0.75	0.84	n.s.
corn silage	corn silage	Texas	7	0.84	0.94	1.07	n.s.
corn silage	corn silage	Wisconsin	8	1.14	1.35	1.49	n.s.
corn silage	soybean	Georgia	1	1.17	1.17	1.17	*
corn silage	soybean	Iowa	8	0.91	1.00	1.10	n.s.
corn silage	soybean	Illinois	8	0.59	0.72	0.78	n.s.
corn silage	soybean	Indiana	8	0.72	0.87	1.00	n.s.
corn silage	soybean	Kansas	7	0.69	0.83	1.16	n.s.
corn silage	soybean	Kentucky	7	0.47	0.68	0.82	n.s.
corn silage	soybean	Michigan	8	0.68	0.84	1.02	n.s.
corn silage	soybean	Minnesota	8	0.81	0.91	1.10	n.s.
corn silage	soybean	Missouri	8	0.43	0.66	0.82	n.s.
corn silage	soybean	North Carolina	7	0.42	0.76	1.00	n.s.
corn silage	soybean	North Dakota	4	0.55	0.65	0.70	n.s.
corn silage	soybean	Nebraska	8	0.79	0.94	1.10	n.s.
corn silage	soybean	New York	1	1.95	1.95	1.95	*
corn silage	soybean	Ohio	8	0.66	0.73	0.79	n.s.
corn silage	soybean	Pennsylvania	5	1.02	1.33	1.78	n.s.
corn silage	soybean	South Carolina	1	0.73	0.73	0.73	*
corn silage	soybean	South Dakota	8	0.60	0.74	0.81	n.s.
corn silage	soybean	Texas	1	1.31	1.31	1.31	*
corn silage	soybean	Wisconsin	8	0.71	1.05	1.32	n.s.
spring wheat	NA	national	4	0.67	0.75	0.80	n.s.
spring wheat	NA	Colorado	1	1.57	1.57	1.57	*
spring wheat	NA	Idaho	3	0.92	0.97	1.04	n.s.
spring wheat	NA	Minnesota	4	0.67	0.74	0.80	n.s.
spring wheat	NA	Montana	4	0.62	0.74	0.88	n.s.
spring wheat	NA	North Dakota	4	0.61	0.71	0.86	positive
spring wheat	NA	Oregon	3	0.81	1.00	1.14	n.s.

spring wheat	NA	South Dakota	4	0.70	0.79	0.84	n.s.
spring wheat	NA	Washington	3	0.59	0.77	0.92	n.s.
winter wheat	NA	national	4	0.72	0.76	0.80	n.s.
winter wheat	NA	Arkansas	1	0.60	0.60	0.60	*
winter wheat	NA	California	1	0.85	0.85	0.85	*
winter wheat	NA	Colorado	4	0.82	0.95	1.25	n.s.
winter wheat	NA	Georgia	1	0.50	0.50	0.50	*
winter wheat	NA	Idaho	4	0.77	0.86	0.94	n.s.
winter wheat	NA	Illinois	4	0.56	0.64	0.75	n.s.
winter wheat	NA	Kansas	4	0.67	0.80	0.92	n.s.
winter wheat	NA	Kentucky	1	0.66	0.66	0.66	*
winter wheat	NA	Louisiana	1	0.49	0.49	0.49	*
winter wheat	NA	Michigan	2	0.71	0.80	0.88	*
winter wheat	NA	Minnesota	1	0.76	0.76	0.76	*
winter wheat	NA	Mississippi	1	0.37	0.37	0.37	*
winter wheat	NA	Missouri	4	0.50	0.57	0.68	n.s.
winter wheat	NA	Montana	4	0.62	0.81	1.01	n.s.
winter wheat	NA	Nebraska	4	0.83	0.97	1.19	n.s.
winter wheat	NA	North Carolina	2	0.46	0.47	0.48	*
winter wheat	NA	North Dakota	1	0.58	0.58	0.58	*
winter wheat	NA	Ohio	4	0.77	0.80	0.82	n.s.
winter wheat	NA	Oklahoma	4	0.44	0.57	0.72	n.s.
winter wheat	NA	Oregon	4	0.96	1.08	1.17	n.s.
winter wheat	NA	South Dakota	4	0.66	0.81	0.95	n.s.
winter wheat	NA	Texas	4	0.40	0.52	0.60	n.s.
winter wheat	NA	Washington	4	0.87	1.08	1.37	n.s.
durum wheat	NA	National	4	0.64	0.77	0.94	n.s.
durum wheat	NA	California	1	0.51	0.51	0.51	*
durum wheat	NA	Idaho	1	0.64	0.64	0.64	*
durum wheat	NA	Montana	2	0.72	0.76	0.80	*
durum wheat	NA	North Dakota	4	0.56	0.68	0.81	n.s.

Table A.8. Low, Average, and High State- and Crop-Specific N-Rates and Trends Over Time

n.s. = not statistically significant (p<0.5), * = not enough data was available for trend analysis, positive = the trend in N-rate over time was statistically significant and positive (p < 0.05), negative = the trend in N-rate over time was statistically significant and negative (p < 0.05)

Crop	Previous Crop	State	nrObs	Lowest Historic N Rate	Average Historic N Rate	Highest Historic N Rate	trend
corn grain	corn grain	Colorado	6	101	150	195	n.s.
corn grain	corn grain	Georgia	2	107	136	166	*
corn grain	corn grain	Iowa	8	84	134	159	n.s.
corn grain	corn grain	Illinois	8	155	164	172	n.s.
corn grain	corn grain	Indiana	7	113	150	175	n.s.
corn grain	corn grain	Kansas	7	150	178	206	negative
corn grain	corn grain	Kentucky	6	99	145	186	n.s.
corn grain	corn grain	Michigan	7	97	110	130	n.s.
corn grain	corn grain	Minnesota	8	75	103	142	positive
corn grain	corn grain	Missouri	8	88	154	219	negative
corn grain	corn grain	North Carolina	7	48	106	135	n.s.
corn grain	corn grain	North Dakota	3	80	103	123	n.s.
corn grain	corn grain	Nebraska	8	144	156	177	n.s.
corn grain	corn grain	New York	4	51	65	75	n.s.
corn grain	corn grain	Ohio	7	130	148	177	n.s.
corn grain	corn grain	Pennsylvania	6	70	89	117	n.s.
corn grain	corn grain	South Carolina	1	107	107	107	*
corn grain	corn grain	South Dakota	6	78	105	131	n.s.
corn grain	corn grain	Texas	7	132	141	154	n.s.
corn grain	corn grain	Wisconsin	8	70	84	105	positive
corn grain	soybean	Georgia	1	115	115	115	*
corn grain	soybean	Iowa	8	120	129	140	positive
corn grain	soybean	Illinois	8	146	156	167	n.s.
corn grain	soybean	Indiana	8	140	149	164	n.s.
corn grain	soybean	Kansas	7	116	135	154	n.s.
corn grain	soybean	Kentucky	7	159	172	188	n.s.
corn grain	soybean	Michigan	8	87	128	143	n.s.
corn grain	soybean	Minnesota	8	114	123	134	n.s.
corn grain	soybean	Missouri	8	129	150	173	n.s.
corn grain	soybean	North Carolina	7	98	133	153	n.s.
corn grain	soybean	North Dakota	4	113	129	142	n.s.
corn grain	soybean	Nebraska	8	109	123	140	positive
corn grain	soybean	New York	1	69	69	69	*
corn grain	soybean	Ohio	8	150	160	174	n.s.
corn grain	soybean	Pennsylvania	5	68	94	122	n.s.

corn grain	soybean	South Carolina	1	122	122	122	*
corn grain	soybean	South Dakota	8	89	105	133	positive
corn grain	soybean	Texas	1	103	103	103	*
corn grain	soybean	Wisconsin	8	89	111	146	n.s.
corn silage	corn silage	Colorado	6	101	150	195	n.s.
corn silage	corn silage	Georgia	2	107	136	166	*
corn silage	corn silage	Iowa	8	84	134	159	n.s.
corn silage	corn silage	Illinois	8	155	164	172	n.s.
corn silage	corn silage	Indiana	7	113	150	175	n.s.
corn silage	corn silage	Kansas	7	150	178	206	negative
corn silage	corn silage	Kentucky	6	99	145	186	n.s.
corn silage	corn silage	Michigan	7	97	110	130	n.s.
corn silage	corn silage	Minnesota	8	75	103	142	positive
corn silage	corn silage	Missouri	8	88	154	219	negative
corn silage	corn silage	North Carolina	7	48	106	135	n.s.
corn silage	corn silage	North Dakota	3	80	103	123	n.s.
corn silage	corn silage	Nebraska	8	144	156	177	n.s.
corn silage	corn silage	New York	4	51	65	75	n.s.
corn silage	corn silage	Ohio	7	130	148	177	n.s.
corn silage	corn silage	Pennsylvania	6	70	89	117	n.s.
corn silage	corn silage	South Carolina	1	107	107	107	*
corn silage	corn silage	South Dakota	6	78	105	131	n.s.
corn silage	corn silage	Texas	7	132	141	154	n.s.
corn silage	corn silage	Wisconsin	8	70	84	105	positive
corn silage	soybean	Georgia	1	115	115	115	*
corn silage	soybean	Iowa	8	120	129	140	positive
corn silage	soybean	Illinois	8	146	156	167	n.s.
corn silage	soybean	Indiana	8	140	149	164	n.s.
corn silage	soybean	Kansas	7	116	135	154	n.s.
corn silage	soybean	Kentucky	7	159	172	188	n.s.
corn silage	soybean	Michigan	8	87	128	143	n.s.
corn silage	soybean	Minnesota	8	114	123	134	n.s.
corn silage	soybean	Missouri	8	129	150	173	n.s.
corn silage	soybean	North Carolina	7	98	133	153	n.s.
corn silage	soybean	North Dakota	4	113	129	142	n.s.
corn silage	soybean	Nebraska	8	109	123	140	positive
corn silage	soybean	New York	1	69	69	69	*
corn silage	soybean	Ohio	8	150	160	174	n.s.
corn silage	soybean	Pennsylvania	5	68	94	122	n.s.
corn silage	soybean	South Carolina	1	122	122	122	*

corn silage	soybean	South Dakota	8	89	105	133	positive
corn silage	soybean	Texas	1	103	103	103	*
corn silage	soybean	Wisconsin	8	89	111	146	n.s.
spring wheat	NA	national	4	72	75	78	n.s.
spring wheat	NA	Colorado	1	80	80	80	*
spring wheat	NA	Idaho	3	106	111	117	n.s.
spring wheat	NA	Minnesota	4	86	93	99	positive
spring wheat	NA	Montana	4	49	55	58	n.s.
spring wheat	NA	North Dakota	4	72	76	80	n.s.
spring wheat	NA	Oregon	3	59	71	82	n.s.
spring wheat	NA	South Dakota	4	56	71	87	positive
spring wheat	NA	Washington	3	75	87	105	n.s.
winter wheat	NA	national	4	62	66	68	n.s.
winter wheat	NA	Arkansas	1	101	101	101	*
winter wheat	NA	California	1	93	93	93	*
winter wheat	NA	Colorado	4	36	41	50	n.s.
winter wheat	NA	Georgia	1	97	97	97	*
winter wheat	NA	Idaho	4	108	113	118	n.s.
winter wheat	NA	Illinois	4	86	97	103	n.s.
winter wheat	NA	Kansas	4	54	58	62	n.s.
winter wheat	NA	Kentucky	1	97	97	97	*
winter wheat	NA	Louisiana	1	101	101	101	*
winter wheat	NA	Michigan	2	88	95	102	*
winter wheat	NA	Minnesota	1	67	67	67	*
winter wheat	NA	Mississippi	1	139	139	139	*
winter wheat	NA	Missouri	4	86	99	109	n.s.
winter wheat	NA	Montana	4	46	54	60	n.s.
winter wheat	NA	Nebraska	4	44	49	59	n.s.
winter wheat	NA	North Carolina	2	96	110	124	*
winter wheat	NA	North Dakota	1	94	94	94	*
winter wheat	NA	Ohio	4	89	95	102	n.s.
winter wheat	NA	Oklahoma	4	57	64	73	n.s.
winter wheat	NA	Oregon	4	54	65	72	n.s.
winter wheat	NA	South Dakota	4	50	62	72	n.s.
winter wheat	NA	Texas	4	47	68	84	n.s.
winter wheat	NA	Washington	4	60	70	77	n.s.
durum wheat	NA	National	4	60	63	69	n.s.
durum wheat	NA	California	1	226	226	226	*
durum wheat	NA	Idaho	1	164	164	164	*
durum wheat	NA	Montana	2	53	55	56	*
durum wheat	NA	North Dakota	4	60	62	63	n.s.

Cited Literature

Bierman, P., Rosen, C., Venterea, R.T., Lamb, J. (2011) Survey of Nitrogen Fertilizer Use on Corn in Minnesota. Minnesota Department of Agriculture.

Fixen, P. (2010) A Preliminary Nutrient Use Geographic Information System (NuGIS) for the U.S. International Plant Nutrition Institute. IPNI Publication No. 30-3270.

Janzen, R., Baumann, T., Dyer, L., Hardly, P., Reed, D., (2012) Additionality in Agricultural Offset Protocols. Climate Check.

Ladha, J.K., Pathak, H., J Krupnik, T., Six, J., van Kessel, C. (2005) Efficiency of fertilizer nitrogen in cereal production: retrospects and prospects. Advances in Agronomy 87, 85-156.

Millar, N., Robertson, G.P., Grace, P.R., Gehl, R.J., Hoben, J.P. (2010) Nitrogen fertilizer management for nitrous oxide (N2O) mitigation in intensive corn (Maize) production: an emissions reduction protocol for U.S. Midwest agriculture. Mitigation and Adaptation Strategies for Global Change 15, 185-204.

Ribaudo, M., Delgado, J., Hansen, L., Livingston, M., Mosheim, R., Williamson, J. (2011) Nitrogen in Agricultural Systems: Implications for Conservation Policy. ERR-127. U.S. Dept. of Agriculture, Econ. Res. Serv. September 2011.

Rosenstock, T., Liptzin, D., Six, J., Tomich, T. (In Review) The paradox of nitrogen fertilizer use in California: Simultaneous increases in agronomic efficiency and pollution potential.

Sawyer, J.E., Nafziger, E., Randall, G., Bundy, L., Rehm, G., Joern, B. (2006) Concepts and rationale for regional nitrogen rate guidelines for corn. Iowa State University, University Extension.

Snyder, C.S., Fixen, P., Johnston, A., (2011) Reducing Nitrous Oxide Emissions Through Improved Nitrogen Stewardship: Balancing Crop Production Management and Environmental Protection, Soil Science Society of America annual Meeting, San Antonio, TX.

Appendix B Overview of the Science Advisory Committee Process and SAC Recommendations of Nitrogen Management Practices for Inclusion

Workgroup:

This section is adapted from the Final Report the Reserve published on our SAC meeting. Draft Appendix B is included for your reference, but please be aware that it is not final and subject to further edits.

B.1 Committee Background

The Reserve together with the Nicholas Institute of Duke University assembled a group of leading scientific experts to form a Science Advisory Committee (SAC). The purpose of the SAC was to help the Reserve interpret and apply the best available science into the Nitrogen Management Project Protocol.

Committee membership was by invitation from the Reserve and the Nicholas Institute. Involvement in the Technical Working Group on Agricultural Greenhouse Gases (T-AGG), led by the Nicholas Institute, was a priority qualification as this is an established body of agricultural scientists with relevant scientific expertise, knowledge of GHG offset protocol development issues, and an explicit interest in translating research into GHG mitigation policy applications for agriculture. In addition, scientists must have met the following criteria to be eligible to participate in the committee: (1) a PhD in soil science or related field, (2) 10+ years of experience in research, with a research emphasis directly relevant to agricultural nitrogen management and N_2O emissions, and (3) multiple publications in soil science, ecosystem science, agronomy or related fields.

The SAC, alongside the protocol workgroup, has provided invaluable input during the protocol development process in determining appropriate performance standards for nitrogen management practices, boundaries for accurate and conservative greenhouse gas project assessment, and scientifically valid and economical quantification methods. A list of SAC members is available in the Acknowledgements section of this protocol and a summary of the SAC effort is presented below.

B.2 Potential Nitrogen Management Practices

The SAC evaluated a list of nitrogen management practices identified by T-AGG to result in N2O emissions reductions, using criteria such as the available number of side-by-side comparison studies showing measured N_2O emission reductions in the field, whether these studies showed consistent results, and whether N_2O emission reductions were direct or indirect. SAC members rated the practices and made recommendation on which practices had the highest potential of being incorporated into a project protocol based on best available science. Summaries of the priority list of practices (included in Table XX of the protocol) are provided below.

B.2.1 Reducing the Amount of Nitrogen Applied

This practice involves reducing the amount of nitrogen applied to a field without going below the nitrogen uptake demand of crops. This practice is well-studied with consistent N_2O effects in terms of directional certainty. The SAC determined that there should be a focus on nitrogen-use efficiency rather than nitrogen application rates because management systems have different agronomic optimum nitrogen application rates, which affects how much nitrogen can be reduced before exhibiting yield effects.

The relationship between N_2O emissions and nitrogen application rate can be linear or non-linear depending on characteristics of specific crops and regions. However, these relationships can be described with the development of system-specific (as opposed to generic) emission factors. This practice was determined to be eligible in all U.S. regions.

B.2.2 Using Nitrification Inhibitors or Using Nitrification Inhibitors Combined with Urease Inhibitors

A literature review by Akiyama et al. (2010)[66] showed emission reduction potential for the use of nitrification inhibitors in certain regions and the SAC was also confident about the combination of nitrification and urease inhibitors.

However, Akiayama et al. (2010) include relatively few North American sites and other studies on U.S. sites show no effects or inconsistent effects. On the other hand, the practice could be an enabler for lower N rate. In some cases, nitrification inhibitors may have the adverse effect of decreasing yield potential and increasing residual soil nitrogen by maintaining immobile ammonia (NH_4) in the soil during the critical crop development stage.

There is likely to be regional variability in the effect of this practice on N_2O. The practice consistently reduces emissions in western climates and where water is intensively managed. Results in rain fed regions are inconsistent, particularly for nitrification inhibitors by themselves. In the mid-southern U.S., due to the types of soils, the activity could potentially increase nitrogen losses.

B.2.3 Using Slow-Release Fertilizer

High N_2O emissions may occur when slow-release fertilizer application is followed by significant precipitation events. However, GHG reductions are assessed relative to a project's "business as usual" baseline in which the precipitation event also would have happened. Therefore, the precipitation effect is factored into the baseline *and* project emission estimates, resulting in a net N_2O reduction when slow-release fertilizer is applied.

It should be noted that the use of slow-release fertilizer could have an adverse effect of decreasing yield potential and increasing residual soil nitrogen, if the activity limits available nitrogen in the soil during the critical crop development stage.

This practice results in less consistent emission reductions in wetter regions due to greater volatilization. Slow-release fertilizers are more consistent at reducing emissions in a no till system compared to a conventional till system.

[66] Akiyama, H., X.Y. Yan, and K. Yagi. 2010. Evaluation of effectiveness of enhanced-efficiency fertilizers as mitigation options for N_2O and NO emissions from agricultural soils: Meta-analysis. *Global Change Biology* 16(6):1837–46.

B.2.4 Changing Fertilizer Composition

This practice shows potential for certain fertilizer sources, particularly switching from anhydrous ammonia to urea. The effects are mostly consistent, but depend on the application rate (before and after switch). The practice change will have less N_2O emission reduction effect at lower nitrogen rates than at higher nitrogen rates.

Production of urea fertilizer results in significantly more emissions than production of anhydrous ammonia, so the difference in production emissions may need to be considered for conservativeness. Switching to urea from anhydrous ammonia may also increase nitric oxide emissions, an issue that would need to be addressed from an environmental impact perspective.

There was consistent directional certainty regardless of region. However, results from Canada showed no difference in N_2O emissions between Aqua Ammonia and urea, demonstrating potential regional differences.

Other fertilizer source switching may have potential, but were not directly addressed by the SAC.

B.2.5 Synchronizing Plant Nitrogen Uptake with Nitrogen Application

B.2.5.1 Increasing the Number of Applications

This practice showed possible potential for fertigation only. There are not enough studies that show consistent direct N_2O emission reductions; some studies have yielded conflicting results and may have simultaneously tested other management changes. The results of this practice are highly dependent on water management, placement of the increased number of applications, and how the applications are delivered. In some cases, the practice could increase emissions as a result of a pulsing response (i.e. bursts of N_2O emissions associated with the application). However, more applications over a season with fertigation (i.e. applying nitrogen through sprinkler and drip irrigation systems) generally would be expected to reduce nitrogen losses and N_2O emissions; though, it is not entirely known whether fertigation alone or the change in irrigation cause the effects.

Also, by providing nitrogen to crops in a manner more synchronous to crop nitrogen uptake, it helps to limit the pool of nitrogen available at any given time. Generally, this will reduce nitrate runoff and leaching, leading to indirect emission reductions. In regions with a deep water table, the amount of nitrogen leached is generally less.

There may be potential for N_2O emission reductions from increasing the number of nitrogen applications delivered via fertigation in irrigated western regions. However, rain fed systems would require further study, as results are unpredictable.

B.2.5.2 Switching from Fall to Spring Application

This practice could have significant potential, particularly in regions with winter freeze or spring thaw but the number of studies is limited, with some conflicting results. Additional research is needed for spring-planted crops before strong conclusions can be drawn.

This practice generally results in reduced nitrate leaching, leading to indirect emission reductions. In regions with a deep water table, there is usually less leached nitrogen. There is likely to be regional variability in potential for this practice with the largest consistent reductions in northern and Corn Belt regions of the U.S. where there is typically a spring thaw.

B.2.6 Applying Nitrogen Closer to the Root System

This practice showed possible potential when changing the placement of fertilizer. There are conflicting results from studies in different regions, but there may be limited potential in dry regions with irrigated systems, where reductions have been observed. The potential of this practice in rain fed systems in humid climates (i.e. defined as greater than 500 mm growing season precipitation) is less predictable.

Some studies have also shown that banding applications will increase N_2O emissions.

B.2.7 Adding Nitrogen Scavenging Cover Crops

Emission reduction potential of this practice is highly dependent on cover crop mixture and fertilizer management. However, if managed properly, there is potential to reduce N_2O emissions and increase yield, although studies show no or small reductions in indirect N_2O emissions. The practice may enable a nitrogen rate reduction and reduce nitrate leaching.

B.3 GHG Assessment Boundary for Nitrogen Management

The SAC briefly discussed which GHG sources, sinks, and reservoirs (SSRs) must be quantified to accurately and conservatively assess the net effect of a change in nitrogen management.

Direct N_2O emissions from soil are the primary GHG source intended for quantifying GHG reductions. While there may be soil carbon benefit from some practices, all of the practices recommended for inclusion in the protocol should primarily have the potential to reduce direct N_2O emissions. Some practices may also incidentally reduce indirect N_2O emissions from leaching, runoff, and volatilization. Soil carbon impacts would need to be included in the GHG accounting boundary, but only for practices that decrease soil carbon stocks and generate higher CO_2 emissions.

Notwithstanding the potential of some practices to increase soil carbon sequestration, it is conservative to exclude the soil carbon pool from the quantification methodology. While some practices (e.g. cover crops) have the potential to both decrease N_2O emissions and increase soil carbon sequestration, none of the practices are likely to substantially *decrease* soil carbon stocks or sequestration rates as a result of project activities.

The majority of SAC members agreed that it is important to include indirect N_2O emissions from volatilization, leaching, and runoff in the GHG accounting boundary for completeness. Indirect N_2O emissions result from the transport of nitrogen away from the project site via air or water (surface and groundwater) and eventual conversion to N_2O elsewhere. The ability to directly monitor the movement of nitrogen and the eventual indirect N_2O emissions is fairly limited. Therefore, the SAC felt the IPCC methodology for estimating indirect N_2O emissions for national GHG inventory reporting purposes was sufficient and is the best available option for capturing these effects.

B.4 Quantifying GHG Reductions from Nitrogen Management Practices

The SAC discussed scientifically valid, economically practical, and verifiable approaches to quantifying GHG reductions from nitrogen management projects. The following points summarize their conclusions about prioritizing quantification approaches.

- It is advisable to use the most accurate quantification methods possible that meet a minimum data standard. Ideally, additional costs of using more accurate methodologies are balanced by the value of being able to more accurately estimate reductions. (See discussion of methodology "Tiers" in Section XX.)
- It is believed that not enough practice-based trials have been conducted to develop biogeochemical process models, such as DNDC, with site-specific inputs or site-specific measurement of N_2O emissions (the latter of which is too costly given current technology and therefore impractical for offset projects) into a comprehensive protocol methodology at this point in protocol development. However, there may be potential for using DNDC to develop regionally-specific emission factors based on biogeochemical process model results, in circumstances where the model is known to perform well.
- Regionally-specific emission factors or simplified multivariate statistical models, derived from field data or biogeochemical process model runs, are ideal as a quantification method at this point in time. Data are available to develop models for nitrogen-rate reduction accounting for soils and climate as well as other practices like inhibitors, fall to spring, and formulation.
- General emission factors may be appropriate, especially at regional and national scales and when regionally-specific emission factors are not available (e.g. for indirect emission quantification). However, they should be used with care and it is preferable to work towards developing regionally-specific approaches.

B.4.1 Quantifying Aggregated Projects

The SAC established that allowing for unlimited numbers of fields to join together in an aggregate and act as a single project would generate improved accuracy of GHG reduction estimates at the aggregate scale. They noted that a key consideration is making sure the fields within the aggregate represent a diversity of situations so as to avoid propagating systematic biases in estimation methods, which would skew the aggregate total. It was suggested that if aggregates were made up of a variety of climates and practices, this particular risk could be addressed. The SAC discussed how a minimum aggregate size could be constructed from rough estimates of what is an economically viable quantity of GHG emission reduction credits for a project.

Appendix C Overview of Water Quality Regulations and their Impact on Legal Requirements and Regulatory Compliance for the NMPP

Workgroup:

This draft version of Appendix C is included for your reference, as we believe it is helpful to your general understanding of the legal requirements that may affect project eligibility. Please be aware that we have not quite finished writing up this section, even though research is complete. As such, this section is likely to receive significant further revisions.

If you do read this section closely, please let us know if you notice that the Reserve's interpretation of any of the legal requirements is incorrect.

No federal laws exist that regulate the composition or efficacy of fertilizers. State-level laws addressing composition and/or efficacy will be discussed further below. Numerous regulations exist, including at the federal level, concerning the production of fertilizer. However, as fertilizer production is outside the GHG project boundary under this protocol, regulations on fertilizer production will not be addressed here. Regulations concerning the use and disposal of hazardous materials, such as fertilizer, and regulations protecting against the contamination of drinking and surface water and even against air pollution, related indirectly to the land application of fertilizers will be addressed further, below.[67]

C.1 Clean Water Act

Though the Reserve could identify no existing federal regulations that explicitly and consistently require implementation of the approved project activities, state or local implementation of the federal Clean Water Act may result in direct and indirect requirements for nutrient management.

The Clean Water Act (CWA) is the federal law regulating water quality for surface waters in the United States It establishes a comprehensive federal system for regulating the discharge of pollutants into navigable waterbodies, while restoring and maintaining the health of the nation's surface waters.[68] The CWA meets these objectives by authorizing water quality standards, requiring and issuing permits for point source discharges (the National Pollution Discharge Elimination System, NPDES),[69] assists with the funding of municipal sewage treatment plant construction, and helps with planning to manage nonpoint source pollution. The CWA authorizes EPA as the primary agency tasked with implementation and enforcement, but in practice, most implementation is through state environmental agencies and state-level regulations, and as such state-level implementation can be highly variable. States have the authority to set their own water quality standards, so long as they meet or exceed EPA's minimum requirements.

[67] EPA, "Background Report on Fertilizer Use, Contaminants, and Regulations," January, 1999, Office of Pollution, Prevention and Toxics, EPA 747-R-98-003. Available at: http://www.epa.gov/oppt/pubs/fertilizer.pdf

[68] The Clean Water Act (CWA) was formerly known as the Federal Water Pollution Control Act (FWPCA), which was first enacted in 1948. Following its significant reorganization and amendments in 1972 and 1977, the FWPCA came to be known by its current name, the CWA. The FWPA / CWA can be found in 33 U.S.C. §§ 1251-1387.

[69] Legal requirements of NPDES permits, as they pertain to CAFOs, will be addressed in Section XX of this Appendix.

Though the CWA explicitly defines "point sources" (e.g. industrial or sewage treatment plants, CAFOs), and it does not define nonpoint sources (e.g. agricultural runoff, urban runoff), instead defining nonpoint sources as anything not considered a point source by the CWA or EPA regulation. The CWA makes it unlawful for point sources to discharge any pollutant into navigable waters without a permit (specifically an NPDES permit). Nonpoint source (NPS) pollution, however, comes from many defuse sources and is caused by runoff from rainfall or snowmelt moving over and through the ground, picking up pollutants and eventually depositing them in waterbodies. When watersheds are successfully meeting the CWA's water quality standards, nonpoint sources are generally unregulated, and in fact agricultural stormwater discharges and return flows from irrigated agriculture are specifically exempt under the CWA.[70]

However, in polluted watersheds that are not attaining the proper water quality standards (e.g. "impaired" waters), nonpoint sources may come under regulation as part of the efforts to restore water quality,

States are responsible for monitoring water quality of surface waters within their jurisdiction, and biennially, states are required to provide an inventory of the condition of state waterbodies and progress toward CWA goals (305(b) for) as well as to identify which waters are "impaired" (e.g. not currently meeting water quality standards) or "threatened" (e.g. believed likely to become "impaired" by the time the next "303(d) List" is due).[71] Subsequent to listing waters on the 303(d) List, states are required to prioritize restoration of these waters based on the severity of pollution and begin developing Total Maximum Daily Loads (TMDLs)[72] for these waters. In practice, once a TMDL is established, the state implements a concrete plan to reach this limit through a combination of regulations and voluntary incentives that reduce NPS pollution. EPA funding is typically available to help states implement their nonpoint source management programs.[73] If runoff from agricultural sources is determined to be contributing the impairment, the TMDL implementation plan typically will include some degree of agricultural Best Management Practices (BMPs). Typically, voluntary incentive payments are the preferred policy mechanism, as has been the strategy for Maryland, where the state is working towards its Chesapeake Bay TMDL goals through incentive payments which have significantly increased the acres of farmland voluntarily planting cover crops. However, states may also chose to legally require conservation or nutrient management plans, as has recently become the case in California, where the Central Coast Water Board adopted new stringent regulations on March 15, 2012.[74] Particularly relevant to the NMPP, if agriculture is determined to be the source of impairment, and the waterbody is impaired by high levels of Nitrogen (in any of its forms, e.g.

[70] King, Ephraim, "Nutrients: A National Overview Need for Strong Partnerships & Joint Accountability," U.S. EPA, Office of Science and Technology, Presented at "Nutrient Summit" Springfield, Illinois, 13 September 2010. Available at: http://www.epa.state.il.us/water/nutrient/presentations/ephraim_king.pdf

[71] These reports contribute to the "National Water Quality Inventory" (Part 305(b) of CWA) and the "Impaired or Threatened Waters List" or the "303(d) List" (Part 303(d) of the CWA), respectively. Once identified as impaired or threatened, these waters will appear on the "303(d) List." As this list is updated frequently, project developers and verifiers should refer to the U.S. EPA website for the most up-to-date list of impaired watersheds: http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T

[72] Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant, such as nitrate, that a given waterbody can receive without violating water quality standards. The term TMDL, however, is often used to refer to the whole process of establishing a TMDL, including all aspects of TMDL implementation and monitoring.

[73] Specifically, EPA funding is available through CWA Section 319(h) grants specifically for nonpoint source management, while states can also participate in the Clean Water State Revolving Fund (CWSRF) program, in which EPA to provide grants to states to establish loan funds which then provides low-cost financing to third parties (municipalities, non-profits, businesses) to implement water quality infrastructure projects.

[74] Add reference to CA circumstances below.

nitrate, nitrite, etc.), BMPs related to nitrogen management are likely to become part of the TMDL.

Circumstances exist where the agricultural producer has significant flexibility for meeting their TMDL obligations, where producers self-select which best management practices will become part of their legally required pollution reduction strategy (typically in the form of Conservation Management Plans (CMPs), which address a variety of conservation management practices, or in the form of Nutrient Management Plans (NMPs), which focus more nutrient management practices, particularly those related to nitrogen management. As noted in Section 3.5.2, once a practice is self-selected as part of an NPS pollution obligation, the Reserve considers that practice non-voluntary, as continued implementation of that practice is required by law, and that practice will not be considered an eligible project activity for that farm.

C.2 NCR Circumstances (placeholder)

C.3 California Circumstances (placeholder)

In California, water quality is governed by a State Water Resources Control Board (SWRCB) and nine Regional Water Quality Control Boards (RWQCB). The State Water Board sets overall state policy, such as the comprehensive statewide Nonpoint Source Pollution Control Program (NPS Implementation Program, which ensures that the Regional Water Boards have the same administrative tools available to each to implement their respective Basin Plans. However, the Regional Boards then develop and implement regional water quality control plans (Basin Plans) for each of the state's nine hydrologic regions, which are reviewed and updated triennially and serve as the implementation instruments for state and federal water policy. Notably, the Regional Water Boards have a significant degree of autonomy and flexibility with regards to the implementation of Basin Plans, as long as the Region's water quality objectives are met. This autonomy is particular notable in a comparison of the irrigated lands programs across Regions, which vary significantly.

California's regulation of nonpoint source pollution is considered progressive compared to other states and has continued to evolve since the state's first nonpoint source control plan in 1987.[75] Until 1999, California agriculture historically avoided direct regulations by securing conditional waivers (frequently referred to as "Ag Waivers" or "Ag Orders") from the Regional Water Boards, which temporarily allow individuals to discharge agricultural waste water from fields without securing individual permits. Though meant to be conditional, in reality, these waivers have historically been granted with relatively few conditions or monitoring requirements, were typically were not subject to much oversight, and were not reviewed periodically.

Though agricultural nonpoint discharges are still not "directly regulated," nonpoint source pollution regulations in California has continued to move in that direction. Since 1999, all Regional Water Boards were required to begin reviewing all conditional waivers and either renew the waivers or replace them with a more appropriate permit (specifically a Waste Discharge Requirements permit (WDR), which is functionally similar to an NPDES permit). Today, all conditional waivers must be renewed at minimum every five years. Conditional waivers today also require more extensive monitoring and reporting, require education of the discharger on best management practices and typically require some level of implementation of best management practices (referred to as "management measures" in California law), notably

[75] Smith, Lee N. and Loren J. Harlow. "Regulation of Nonpoint Source Agricultural Discharge in California."

including management measures for both nutrient management and irrigation water management. However, even where agricultural producers are required to implement these management measures, compliance is not measured in terms of whether or not the management measures are implemented, but rather whether water quality objectives are being met. As such, regulatory compliance is assessed at the watershed-scale.

Further, the individual agricultural producer that is required to implement management measures is given significant flexibility to implement management measures, which will help them achieve their water quality objectives without yield impacts. The State's management measure for nutrient management instructs growers to "develop, implement, and periodically update a nutrient management plan to (1) apply nutrients at rates necessary to achieve realistic crop yields, (2) improve the timing of nutrient application, and (3) use agronomic crop production technology to increase nutrient use efficiency," and the State Water Board encourages development of a nutrient management plan (NMP) in accordance with the USDA NRCS Standard 590. [76] However, the producer may choose from a long list of management practices known to reduce nutrient loss to include in their NMP, meaning that management plans for individual farms will vary greatly.

Though conditional waivers may theoretically be issued to individual dischargers, they are typically issued to "coalition groups," which are essentially third-party groups representing a certain type of discharger (e.g. agricultural). Dischargers must file a "Notice of Intent" to join a coalition group and be covered by the waiver, and coalition groups in turn help perform much of the monitoring and reporting required by the conditional waiver on behalf of their members, to demonstrate that the coalition group is helping implement the Region's water quality objectives.

The specific conditions and requirements of a conditional waiver, the makeup of coalition groups, and which sectors or coalition groups are granted waivers vary across Regional Water Board jurisdiction, making a standardized assessment of the legal requirements for agricultural discharges in California somewhat challenging. The Regional Water Boards of the Los Angeles, Central Coast, Central Valley, and San Diego Regions, for example, have all adopted comprehensive conditional waivers that vary somewhat. A standardized assessment of legal requirements is further complicated by the fact that not all Regional Boards have decided to use conditional waivers. The Colorado River Basin and North Coast RWQCBs have adopted Conditional Prohibitions as part of their respective Basin Plans, and the Santa Ana RWQCB is in the initial phases of developing an irrigated lands regulatory program. San Francisco Bay and Lahontan RWQCBs have no immediate plans to adopt comprehensive waivers for agricultural discharges,[77] though San Francisco is in the early stages of developing a waiver for vineyards. More detail on each Region can be found in the table below. Ultimately, however, it seems that legal requirements for irrigated lands in California may need to be assessed at the Basin-level.

[76] "1C-Nutrient Management," *NPS Encyclopedia,* 2009, California State Water Resources Control Board. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/1c_nutrnt.shtml
[77] "Irrigated Lands Regulatory Program Fact Sheet" http://www.swrcb.ca.gov/water_issues/programs/agriculture/docs/about_agwaivers.pdf

Region	Status of Irrigated Lands Program
3 – Central Coast	Have adopted and renewed multiple conditional waivers for agriculture. The 2004 Agricultural Order first expired in 2009 and has been temporarily renewed (by both the Board and Executive Officer) numerous times. Most recently expired September 30, 2011, due to lack of quorum needed to vote on the new regulation, and was extended one year by the Executive, as well as amended to include additional monitoring and reporting.[78] Growers must enroll in waiver by submitting Notice of Intent, and must then develop a Farm Water Quality Management Plan and implement water quality management practices.[79] [NOTE: this section will be updated to reflect March 15, 2012 decision]
4 – Los Angeles	Conditional Waiver was renewed on October 7, 2010. There are two discharger groups (LA and Ventura counties). Dischargers must submit notice of intent to join waiver and are required to implement Best Management Practices (BMPs) to attain water quality benchmarks, which they must then monitor and report on to comply
5 – Central Valley	Adopted comprehensive conditional waivers for agriculture in 2003, renewed in 2006. Currently 25,000 growers (out of 35,000 in CV) with 5 million acres of land are regulated and part of coalition groups. The Board is exploring issuing up to 7 or 8 geographic or commodity-specific Orders with waste discharge requirements (WDRs) tailored to each geography or commodity.[80]

C.4 Coastal Zone Management Act

The CZMA encourages states/tribes to preserve, protect, restore or enhance natural coastal areas, including wetlands, floodplains, estuaries, beaches, and dunes. Eligible areas border the Atlantic, Pacific, and Arctic Oceans, Gulf of Mexico, Long Island Sound, and Great Lakes. Participation is completely voluntary. To encourage states/tribes to participate, the act makes federal financial assistance available to develop and implement a comprehensive coastal management program. Most eligible states/tribes participate in the program. Section 6217 of the CZMA, administered jointly by EPA and the National Oceanic and Atmospheric Agency (NOAA), specifically supports states to develop and implement nonpoint pollution control programs for coastal areas.[81] Within a guiding document specifying typical measures to control nonpoint source pollution published by the EPA[82] in 1993, commercial N fertilizer is identified as a pollutant to coastal areas. Management measures to reduce pollution include development and implementation of a nutrient management plan focusing on (1) applying nutrients at rates necessary to achieve realistic crop yields, (2) improving the timing of nutrient application, and (3) using agronomic crop production technology to increase nutrient use efficiency. In 2003, EPA updated and expanded the 1993 coastal nonpoint source manual to address the control of agricultural nonpoint source pollution for the entire United States.[83] National Management Measures to Control Nonpoint Source Pollution from Agriculture highlights best available, economically achievable means of combating nonpoint source pollution, and discusses monitoring techniques, load estimation techniques, and watershed approaches.

[78] Oct 2011 Irrigated Lands report
[79] http://www.waterboards.ca.gov/centralcoast/water_issues/programs/ag_waivers/index.shtml
[80]http://www.swrcb.ca.gov/centralvalley/water_issues/irrigated_lands/long_term_program_development/long_term_program_q&a.pdf
[81] See http://coastalmanagement.noaa.gov/nonpoint/welcome.html
[82] Available at http://water.epa.gov/polwaste/nps/czara/MMGI_index.cfm
[83] Available at http://water.epa.gov/polwaste/nps/agriculture/agmm_index.cfm

C.5 Safe Water Drinking Act

The Safe Drinking Water Act (SDWA), the main federal law to ensure drinking water quality, requires actions to prevent the contamination of surface and ground sources of drinking water (e.g. rivers, lakes, reservoirs, springs, ground water wells, but not private wells, serving less than 25 people). Although EPA is primarily responsible for enforcement of the federal SDWA, states may apply to EPA for the authority to implement the SDWA and its enforcement within their jurisdictions (e.g. "primacy"), so long as they can demonstrate that state standards will be at least as stringent as the national standards and that state water systems meet these standards.

The SDWA authorizes the USEPA to set national health-based standards limiting the amount of contaminants, such as nitrates and nitrites, in drinking water. In practice, these health-based standards are legally enforceable limits, called maximum contaminant levels (MCLs). The SDWA includes MCLs for both nitrates and nitrites, for which fertilizer runoff and leaching from agriculture is the major source in drinking water. The MCL for nitrate is set at 10 mg/L or 10 ppm, while the MCL for nitrite is set at 1 mg/L or 1 ppm, both of which are measured in Nitrogen.

The SDWA requires states and water suppliers to conduct assessments of potential contamination of water sources, and states are required to implement measures to protect water sources through voluntary incentive programs (to encourage agricultural Best Management Practices) or legal enforcement actions, such as notices of violation (NOVs). Any individual discharger could, in theory, be found to be causing levels of nitrate or nitrite to exceed the MCL and receive a notice of violation. However, due to the nonpoint source nature of agricultural discharges, it is relatively difficult to identify one agricultural discharger as the source of an impairment and, as such, NOVs are typically only issued against agricultural discharges when the discharge is particularly egregious.

Though one of the main tools to limit agriculture's effect on drinking water quality are agricultural Best Management Practices, to our knowledge, there is no legal requirement within the context of the SDWA to require best nitrogen management practices. However, any case of regulatory non-compliance, such as a NOV due to a violation of the SDWA, must be reported to the verifier, who will determine if the violation is material to the project.

C.6 Water Quality Regulations for CAFOs

Confined Animal Feeding Operations (CAFOs) are required to seek NPDES permit coverage (National Pollutant Discharge Elimination System) if they will discharge or if they propose to discharge pollutants into waters of the United States.[84] This requirement applies to all owners and operators of CAFOs regardless of the volume or duration of the discharge.[85] For the Nitrogen Management Project Protocol, the extent to which legal requirements for CAFOs and NPDES permits apply to land application of manure is of primary concern. All other onsite manure management practices (whether legally required or not) are outside the scope of this protocol.

---

[84] On March 15, 2011, the U.S. 5th Circuit Court of Appeals vacated the requirement that CAFOs "proposing" to discharge apply for NPDES permits, as required by the 2008 Rule. EPA is revising the NPDES CAFO regulations to be consistent with that ruling. However, regardless of the time frame for finalizing this rule, conclusions made by this review are not expected to be impacted.

[85] Regulations include the Clean Water Act, as well as 40 CFR 122.23, 123.

According to 40 CFR 122.23(e), "Land application discharges" from a CAFO are exempt from NPDES permit requirements if the discharge qualifies as an "agricultural storm water discharge." Agricultural storm water discharge is defined as discharge "where the manure, litter or process wastewater has been applied in accordance with site specific nutrient management practices that ensure appropriate agricultural utilization of the nutrients in the manure, litter or process wastewater" and is specifically "a precipitation-related discharge of manure, litter or process wastewater from land areas under the control of a CAFO." Notably, any discharges from land application when the weather is dry, and therefore not due to precipitation, are not exempt from NPDES regulations.[86]

NPDES permits for CAFOs require implementation of a nutrient management plan (NMP), which must (among other things), identify site specific conservation practices to be implemented, such as buffers, establish protocols for testing of manure and land application of manure than ensures appropriate agricultural utilization of the nutrient in the manure, and identify recordkeeping procedures. In short, once a CAFO is regulated by a NPDES permit, they will be required to implement a NMP that prevents over-application of manure.

However, not all CAFOs are required to secure NPDES permits; CAFOs only discharging "agricultural stormwater" are not required to secure NPDES permits, and in some states and regions, where EPA is the permitting authority, non-discharging CAFOs may actually seek certification demonstrating that status. Because any discharge from an unpermitted CAFO is illegal, including agricultural stormwater discharges which may later be determined to *not* be exempt due to over-application of manure, the unpermitted CAFO must continually reexamine its compliance with the CWA. In fact, EPA guidance strongly encourages unpermitted CAFOs to implement the best management practices for land applying manure, which are outlined in land application protocols and standards and site specific Nutrient Management Plans, as well as to keep detailed operations and maintenance records, so as to demonstrate that the CAFO's agricultural stormwater discharges continue to be exempt from regulation.[87]

In practice, the combination of NPDES permits and EPA guidance impose a *de facto* regulation on land application of manure, in that land application must ensure the "appropriate utilization of manure," as outlined in "technical standards" for land application by the state permitting authority level.

C.6.1 Inclusion of CAFO's Croplands in the NMPP

Though a certain level of nutrient management best practices are legally required on the croplands of CAFOs used to produce feed crops, the Reserve believes there may be additional potential to reduce nitrous oxide emissions from these croplands, since these BMPs and NMPs have been implemented so as to limit water quality impacts, not air quality ones. For both CAFOs that are required to hold NPDES permits and for those that are not, historic practices and rates for land application of manure are likely to be a good representation of the baseline, as well as a good approximation of the site-specific legally required N-rate, as long as no notices of violation have been issued. In the case of CAFOs that have held NPDES permits for less than five years, the baseline shall be based on the historical land application practices from the time period since the NPDES permit was issued.

---

[86] EPA, Office of Water, "Implementation Guidance on CAFO Regulations – CAFOs that Discharge or Are Proposing to Discharge," EPA-833-R-10-006

[87] Ibid.

C.7 Fertilizer Content Labeling Laws

There are no federal laws in the U.S. regulating the composition or efficacy of fertilizer in the U.S., but most states have developed their own fertilizer regulatory programs, which are generally administered by their respective departments of agriculture. These regulatory programs typically address efficacy claims and composition statements of the active ingredients displayed on labels for commercially available fertilizer.

Therefore, the Association of American Plant Food Control Officials (AAPFCO), tasked with making regulation among states uniform, stated that metals in N fertilizer generally do not pose harm to the environment as long as the metal concentration in fertilizer is below a specific threshold.[88] In addition to trace metal composition testing, state fertilizer laws generally require product registration, licensing and efficacy testing to assure that statements made on the label are correct. Also, at the state level, fertilizer is primarily regulated for quality, as for any manufactured good. These regulations are usually administered through the state's department of agriculture.

[88] See http://www.aapfco.org/rules.html for the specific heavy metal threshold concentrations.

Appendix D Criteria Considered for Adoption of New Methodologies and Justification of Approved Quantification Methodologies

Workgroup:

This appendix is still in development and will include an adapted version of the data standard that outlines the criteria we will be looking for in expanding the protocol to include new quantification methodologies. Protocol expansions will still be directed by Reserve staff and adopted by our Board (counter to previous proposals).

This Appendix will also likely include some justification for adopting the MSU methodology in this protocol.