Oklahoma Carbon Program

Developing high quality carbon offset verification protocols and quantifying water quality improvements of best management practices to ensure the environmental benefits of agricultural carbon offsets

FY2010 CIG #69-3A75-10-167

OKLAHOMA CONSERVATION COMMISSION

OKLAHOMA CARBON PROGRAM

Final Report

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FY 2010 Conservation Innovation Grant
Executive Summary of Deliverables

Name: Oklahoma Conservation Commission
Project Title: Developing high quality carbon offset verification protocols and quantifying water quality improvements of best management practices to ensure the environmental benefits of agricultural carbon offsets
Agreement Number: FY10 CIG #69-3A75-10-167
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Project End Date: September 14, 2013

Introduction

This project completed carbon sequestration verification protocols under development in Oklahoma, paired them with soil sampling, and demonstrated how verified carbon offsets and related water quality improvements can be bundled for ecosystem market transactions. The purpose of this project was to develop, test, and implement carbon sequestration verification protocols for agricultural and silvicultural practices that are recognized to have carbon market value to ensure environmental benefits of ecosystem market transactions. The project was open to producers in 19 Oklahoma counties (Fig. 1).

Figure 1. Eligible counties comprising project area

The Oklahoma Carbon Program (OCP) encourages Oklahomans to protect water quality, prevent soil erosion, and improve air quality by voluntarily adopting conservation practices that sequester or avoid emissions of greenhouse gases (GHG). By developing a program that combines research, natural resource protection, and state-backed verification of carbon offsets,

Oklahoma has a model, voluntary program that maximizes the quality of offsets from agriculture, forestry, and geologic sequestration.

With enabling legislation dating back to 2001, Oklahoma was one of the first states to give a state agency the authority to verify and certify carbon offsets from voluntary practices. This is unique because it is a model different from mandatory cap and trade systems. By overlapping existing conservation programs offered by state and federal agencies, including the USDA Natural Resources Conservation Service (NRCS), the program capitalizes on the existing infrastructure of agencies that agricultural producers know and trust. The innovative program helps maintain or improve the economic vitality of the agricultural sector while encouraging voluntary practices that sustain natural resources for future generations.

The Oklahoma Carbon Program continues to explore policies, methods, and standards that are based in science, reasonable to implement, and achievable by producers willing to voluntarily commit to improved management practices that result in greenhouse gas (GHG) sequestration and other ecosystem service benefits. While all carbon market programs must strive to assure that their systems are based on sound science and create positive, verifiable benefits, we feel it is imperative that they also be user-friendly, both for those attempting to secure offsets and for those who are willing to engage in best management practices that result in carbon sequestration and an overall reduction in GHG in the atmosphere.

One of the things that make this state program unique is the partnership with other state and federal agencies, private companies, nonprofits, universities, and conservation districts working together to develop the program for optimum benefit to Oklahoma businesses and citizens. It is because of these valuable partnerships that we were able to bring this project to fruition.

For this project, an in-state electric cooperative partnered with the Oklahoma Association of Conservation Districts (OACD) to purchase carbon offsets from agricultural producers and forestland owners in 19 counties for three years. These counties comprised the CIG project area. The purpose of the purchase was to provide a framework for the development of the Oklahoma Carbon Program, and methodologies to verify carbon offsets, and to gather data on Oklahoma soil carbon sequestration rates. The buyer asked OACD to aggregate producers in the project area with 3-year carbon contracts using the same sequestration rates as the Chicago Climate Exchange (CCX) and to set the carbon offset payment at $3.50/metric ton of carbon dioxide (CO_2). This private carbon offset pilot project provided part of the required match for the CIG project.

Project Outreach

Objective: Sign producers to three-year carbon contracts. The Oklahoma Association of Conservation Districts (OACD) will provide outreach to agriculture producers and forestland owners in the project area. The goal of this outreach is to encourage producers and forestland owners to implement BMPs and contracts to sell the resulting carbon offsets to the buyer. This is necessary because participation of landowners is integral to the success of this project in order to test verification protocols and collect soil samples. OACD will hold informational workshops about the environmental and economic advantages of conservation management practices, particularly related to ecosystem market transactions. Outreach activities will include locally-led meetings, marketing, and media campaigns.

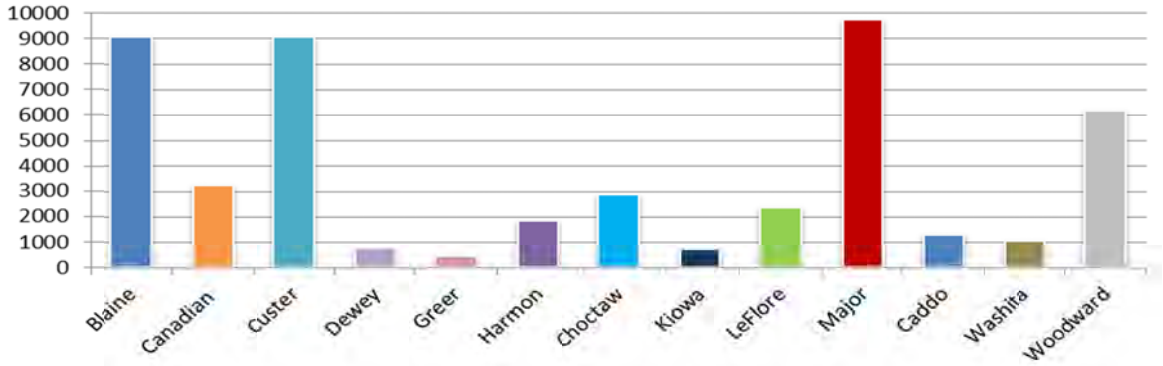
Results: Producer participation was critical to the project's success. In 2011 we spent the summer promoting the project and taking and reviewing applications to determine eligibility. Personalized fliers were designed for each participating conservation district to help promote the program and press release templates were provided to each district. This publicity, local word of mouth, and 3 informational meetings in western Oklahoma generated producer interest. Six subsequent presentations were made to producers at various locally-led meetings. As a result of outreach efforts over 73 producers signed carbon contracts to participate, with 59 of them remaining through the end of the project with 86,936 acres certified as of December 31, 2012 (Table 1).

Table 1. Project acres and estimated amount of CO2e sequestered 2010-2012

Certified	2010	2011	2012	Total
Acres	15,391	30,707	40,838	86,936
CO2e seq. (Mtons)	5,431	12,967	19,323	37,721

Outreach resumed during the final year of the project when we created personalized summaries for the participating producers. The summaries included number of acres, practice type, avoided loss of sediment, nitrogen and phosphorous from their land, estimated metric tons of CO2e sequestered, and the equivalent number of car emissions that were offset by their practice. Thanks to participating producers, we were able to field-test verification methods on over 90% of the certified acres each year, and estimate carbon sequestration totaling 37,721 metric tons of CO2e (Table 2), which is roughly the annual greenhouse gas emissions from 7,859 passenger vehicles, according to the Environmental Protections Agency's online Greenhouse Gas Equivalencies Calculator. The practices included 20,264 acres of continuous no-till; 123 acres of riparian buffer, 7,975 acres of grassland, and 10,317 acres of rangeland.

Table 2. Estimated amount of CO2e sequestered by participants per county 2010-2012



Use of Conservation Districts for Field Verification

Objective: Use Conservation Districts to conduct performance based verification of soil carbon offsets. For this project, participating Conservation Districts will field test and implement the verification protocols in no-till fields and grasslands under carbon contract in the project area. CIG funds will be used to pay Senior Verifiers certified by NRCS to re-verify 10% of the verified fields as a way to quality assure that verifiers are implementing the protocol correctly. The Project Director will compare the initial and quality assurance results and include them in the CIG final report.

Results: **Districts used the verification methods to field verify over 80,000 acres during the 3 years. We created a Verifier Training Program** (Appendix A) for approved verifiers of seeded grasslands and no-till fields. It is similar to the NRCS process for conservation plan writers and requires classroom and field instruction, as well as successful demonstration of field skills prior to certification, and continuing education thereafter. According to our new training model, districts first verified a portion of their producers' acres with a senior verifier. The first group of senior verifiers was selected based on attendance at multiple classroom and field trainings and scores on written tests. As part of their training, districts also received administrative training on preferred procedures for completing and submitting field forms, pictures, timesheets, and claims for payment. The lead verifier from the Conservation Commission traveled western Oklahoma to assist with field verification and to district offices as necessary to train district staff how to process, label, and send producer applications and verification forms in the preferred formats. Districts had to successfully demonstrate their field skills before they were approved to verify fields independently.

The methods developed during this project were taught to conservation district staff whose districts signed agreements to provide verification services for the Oklahoma Carbon Program and who committed their staff to attending verifier trainings. Over 50 hours of formal classroom and field training, and 200 hours of on the job field training during field assessments were provided to staff from 11 conservation districts within the project area (Table 3). State NRCS partners provided portions of the formal classroom training and all of the formal field

training. The on the job training was provided by a cadre of senior verifiers comprised of conservation district staff and a lead verifier from the Oklahoma Conservation Commission. A change from the stated objective is that senior verifiers were certified by the Oklahoma Carbon Program in consultation with NRCS, not certified *by* NRCS. See Appendix B for a summary of the verification results.

Challenges: Overall, the biggest educational challenge was that verification was only done annually. This meant that conservation district staff needed to retain the new knowledge year-to-year. To help verifiers keep up their skills, we emailed quizzes between verification seasons and errors in interpretation or field forms were presented at the next annual classroom training. We also asked district staff to complete post-class evaluations so we could determine if we were meeting their training needs. The comment received most often from conservation district staff was that they wanted more field training time. There was definitely a lack of memory retention from year to year, which is to be expected. This resulted in some errors on paperwork. From this we determined that we need more trainings and overall contact with verifiers throughout the year.

Figure 2. No-Till field verification training for verifiers

Table 3. Training curriculum of formal and on-the-job training provided to conservation districts

	*2009 (hours)	*2010 (hours)	2011 (hours)	2012 (hours)	2013 (hours)
Formal Training	(3)Verifier training ✓ C markets, offsets, and verification ✓ Aggregator's perspective ✓ What is soil C sequestration? ✓ Forestry carbon sequestration ✓ Recognizing what you're looking for: Assessing no-till fields I ✓ Recognizing what you're looking for: Assessing seeded grasslands I	(3)Verifier training ✓ Soil C seq: The link to conservation mgmt ✓ Aggregator's perspective ✓ Recognizing what you're looking for: Assessing no-till fields II ✓ Recognizing what you're looking for: Assessing seeded grasslands II ✓ Verifier perspective: notes from the field (6)Grassland field verification I (6)Grassland field verification II (6)No-till field verification I	(3)Continuing education for verifiers ✓ 4-level certification program requirements ✓ Project overview ✓ Producer applications ✓ OSU's soil C sampling program ✓ Related projects in OK	(3)Continuing education for verifiers ✓ Project update ✓ Nutrient mgmt for N20 reductions ✓ Improving our methods for quality results ✓ Rangeland worksheets, monitoring, and verification overview (3)Nutrient management and water quality (3)Soil sampling with a hand probe (6)Rangeland health and field monitoring I	(6)Rangeland health and field monitoring II **Coming in 2014** NRCS's Soil Health 101
**On the Job Training	• No-till field data collection	• No-till field data collection • Grassland field data collection	• No-till field data collection • Grasslands field data collection	• No-till field data collection • Grassland field data collection • Rangeland field data collection	• Rangeland field data collection

**Pre-dates project start date. **Hours vary by district.*

Load Reductions

Objective: Estimate the reduction of sediment, nitrogen, and phosphorous loading to streams in the project area using the EPA STEP-L model.

Results: The practices implemented during this project also have the co-benefit of protecting water quality so one goal of this project was to sequester GHG by financially incentivizing the installation or continuation of best management practices (BMPs) that reduce bacteria, nutrients, and sediment entering waterbodies. Using the U.S. EPA STEP-L spreadsheet tool, we estimated the reduction of sediment, nitrogen, and phosphorous loading to streams in the project area. The year 2010-2012 load reduction (the amount not leaving the land and entering water) was estimated at 203,342 pounds of nitrogen; 39,381 pounds of phosphorous; and 10,651 tons of sediment. The three practice types used to arrive at this number were: conversion from tillage to no-till cropping, conversion from cropland to seeded grassland, and installation of riparian buffer.

To further quantify this ecosystem service benefit of the practices, we plan to calculate how much it would cost a water treatment facility in western OK to remove the equivalent load of sediment and nutrients from drinking water. This is a co-benefit that could theoretically be bundled for payment with the carbon offset payment. Bundling this water quality improvement with verified soil carbon offsets can encourage the adoption of more conservation management.

Verification Protocols and Handbook

Objective: Create a verification handbook. Compile all protocols from this project into a verification handbook for use by agriculture professionals to evaluate agricultural and forestry practices for carbon sequestration in Oklahoma. These protocols will be replicable by knowledgeable agriculture and forestry professionals. The protocols can also be adopted by other states and national market registries.

Results: The project completed drafts of 3 verification protocols and a soil sampling protocol, taught the methods to conservation districts, and then used the methods to collect data from participating acres. As a verification program offering conservation districts the opportunity to provide verification services, we recognized the need to standardize data collection methods and to make them usable by non-specialists. This has the advantage of keeping future verification costs down, allowing conservation districts the opportunity to train and work as verifiers, making more offset project funds available to producers, and keeping more project funds within Oklahoma.

Two of the methodologies were based on management requirements in the Chicago Climate Exchange's (CCX) no-till and rangeland protocols. We selected the CCX protocols because the management principles in them are based on NRCS standards and management principles.

While full-scale verification (100% of acres in a project) is typically not financially feasible for a project, the field data collection methods developed may be used at any scale for verification or for ground-truthing to inform modeling results. The following field methodologies were created:

- No-Till Carbon Sequestration Verification Protocol
- Seeded Grasslands Carbon Sequestration Verification Protocol
- Improved Rangeland Management Carbon Sequestration Verification Protocol
- Soil sampling protocol

During development of the methods, we also considered how the CCX project and management requirements might apply in Oklahoma. While the primary carbon sequestration comes from the conversion from tillage to no-tillage, conversion from marginal cropland to seeded grassland, and the avoided conversion of rangeland to another use, we drafted standards that emphasize improved management for *secondary* carbon sequestration and ecosystem health. Referring to the growing body of research on quantifying ecosystem services, we drafted a 5-tier standard progressive management crediting matrix for each practice (Appendix C). Each standard is intended to result in improved soil health, reduced emissions from nutrient management, creation of wildlife habitat, and protection of water quality. The full development of the matrix and quantification of the ecosystem service benefits were beyond the scope of this project, but we plan to continue to develop it.

Program Note: *The Oklahoma Conservation Commission is still developing policies for full implementation of the Oklahoma Carbon Program in part because we were awaiting the completion and results of the CIG project. As such, the methodologies are being submitted to NRCS as drafts.*

No-Till

Objective: Implement verification protocols for no-till

Results: We developed a methodology intended for use by trained professionals with significant experience and background in agriculture. It applies to fields designated as "cropland" by FSA that were converted from conventional tillage to continuous no-tillage management. Primary carbon sequestration occurs in fields managed with no-till due to the discontinuation of tillage, which slows the oxygenation of soil and the breakdown of organic matter. However, this protocol also assesses crop rotation, residue management, and the use of cover crops as an additional resource to assess and potentially credit secondary carbon sequestration. The management restrictions and requirements in the no-till performance standard are based on NRCS management standards and a review of the scientific literature. We prepared a rationale explaining the requirements pertaining to grazing, strip-till, haying, fallowing, biomass management, and burning in Oklahoma. Each section title states the premise on which the management requirement is based and is accompanied by an

explanation. The methods were tested on over 20,000 acres. **See the draft no-till protocol for details**.

Challenges: There weren't many challenges with the development, teaching, or use of the no-till field data collection methods. The early hurdle was determining if strip-till should qualify for carbon offsets since the practice does involve tillage. We determined that because the soil condition index remains positive with strip till, we would include it for now until specific data become available to provide a clear basis for excluding the practice.

Seeded Grasslands

Objective: Implement verification protocols for grasslands

Results: We developed a methodology for use by persons trained in grassland data collection working in consultation with an experienced grazinglands specialist. It applies to fields with a cropping history, designated as "cropland" by the Farm Services Agency (FSA), seeded or sprigged to permanent perennial grass on or after January 1, 2001. It is based on the premise that tilled cropland is a source of GHG until it is converted to seeded grassland and is well-managed it has the potential to store greater amounts of GHG and provide a broader suite of ecosystem service benefits. The methods were field tested on over 7,500 acres.

The methods and values developed were based on common Oklahoma NRCS evaluation methods. Due to many variables and other indicators not evaluated on the field form, the parameters assessed cannot be used to establish an overall value or rating for condition or health, but can be used to determine a level of stand establishment and maintenance, which is where the secondary GHG sequestration results. The parameters assessed with this methodology include: number of acres seeded, vegetation type, plant cover, soil cover, current management, and plant production. The protocol contains a rationale explaining the requirements pertaining to grazing, haying, and biomass management. Each section of the rationale states the premise on which the management requirement is based accompanied by an explanation. **See the draft seeded grasslands protocol for details.**

Challenges: Much time was spent screening the producer applications to determine the eligibility of the acres under application. Producers provided their FSA Form 578 with their application and we needed to establish how to differentiate between seeded grasslands and rangeland on the FSA Form 578, which was the primary document we used to determine initial eligibility. To assist producers and conservation districts with this step in the future, we created a decision tree, which is included in the protocol. Late in this process we learned that there is a "historic 578 form" that producers can obtain from FSA. Once we sorted through the pre-screening, we determined there were more rangeland acres eligible than anticipated. See the rangeland section for more details about that.

The other challenge was that after learning the no-till methods, the grasslands methods seemed difficult to the districts, at first. We also added some confusion by teaching two

separate methods and talking about clipping and weighing. After the first field training, we decided not to use hoops and weighing, and instead taught the walking field transect method of gathering data with a pasture stick, visual observations, and associated calculations. The more experience they had with the methods, the more comfortable the districts became and the more reliable the results.

Rangeland

Objective: Adapt an existing rangeland verification protocol for Oklahoma. Continue to work with OK NRCS to choose an existing rangeland verification protocol and adapt it to Oklahoma. We will hire a retired NRCS (or equivalent) employee to field test the protocol by verifying carbon offsets during year one. Current rangeland verification protocols are much more technical than grassland or conservation tillage verification protocols. This step will be used to determine if rangeland verification can be done by conservation districts and to set minimum requirements for rangeland verifiers in Oklahoma.

Results: **We developed a methodology intended for use by persons with training in rangeland health and monitoring working in consultation with an experienced grazinglands specialist.** It is intended for use on actively grazed or hayed native grass rangelands in Oklahoma that support the historic plant community and are used for grazing or haying according to a management plan. The methods were field tested on over 8,000 acres of rangeland in Dewey and Woodward Counties.

After talking with rangeland specialists and researchers in Oklahoma, we determined that the rangeland verification protocol created years ago by CCX and partners contained the rangeland health principles that we want to encourage in Oklahoma. Based on the management requirements in the CCX protocol, we set out to develop a field data collection methodology, usable by conservation districts, which could be used to monitor rangelands to verify they meet management requirements. This approach is more expensive than using project-based land appraisals to evaluate project additionality and baseline scenarios. However, field monitoring can be scaled as needed and used for ground-truthing for model calibration and validation. Overall, our experience has shown us that carbon offset buyers want eyes on the ground to complement modeled assumptions of GHG reductions.

We held two field trainings and two classroom sessions where rangeland health principles and variations of the line-point intersect and dry-weight rank methods were taught by an NRCS grazinglands specialist. Producers with rangeland contracts were invited so they could use the methods throughout the year to help inform their management decisions. Two of the seven producers in attendance stayed for the field training. To facilitate learning and retention by the districts, we created a *Common Rangeland Plants of Dewey and Woodward Counties* field guide and a “training refresher” video using photos and footage from the two trainings.

We hired a retired NRCS soil scientist and a graduate student from OSU with rangeland data collection experience to do on-the-job training of districts during the collection of field data.

The graduate student also provided a technical consultation on rangeland deliverables, including an analysis of the districts' proficiency with the methods, and suggested changes (Appendix D).

Challenges: We ended up with more rangeland acres participating than planned. We didn't want to turn away interested producers, so we raised our cap of 3,000 acres up to 10,000 acres. This affected how we designed the methodology, which turned out to more accurately reflect the reality of how the process would work in the future. We had originally planned that an NRCS grazinglands specialist would conduct baseline inventories and then prescribe a grazing system for each producer. Then, a monitoring plan would be created for the producer, and monitoring methods would be taught to producers and districts so districts could assist producers with monitoring. These data were to be used with ecological site descriptions and management records, in consultation with a grazinglands specialist, to assess forage production, progress toward grazing management plan goals, and ultimately for the OCP to estimate GHG sequestration of rangelands verified for carbon credits.

Gathering baseline data on 10,000 acres was too much to ask of the one state NRCS grazinglands specialist working with us. As an alternate plan, we worked with NRCS to train the districts to collect baseline data. First, we created a management planning form that districts helped producers fill out. The form collected management information by field, including turn in/out dates, number of livestock, weight, and key grass species in the field. This information, paired with ecological site descriptions, and aerial maps, was used by NRCS to create a general grazing plan for each producer. The districts then used the line-point transect and dry-weight rank methods to collect field data to determine if changes to the management plans were needed. Rangeland data collection is challenging, especially when looking at diverse landscapes. The data collection results from the first year were not of the quality we wanted, so we held a second training before the next round of verification. We prepared an assessment of district proficiency with the methods as observed in 2013 (Appendix D). We plan to make changes to the methods based on the assessment.

Forestry

Objective: Adapt a forestry verification protocol for Oklahoma. OCC will continue our work with Oklahoma Forestry Services (OFS) to develop a carbon sequestration verification protocol for forestry. The protocol will be field tested by foresters verifying forestry carbon offsets in the project area. We will submit the protocol to the American Carbon Registry (ACR) for peer review. Resources used to adapt a forestry protocol will include the Oklahoma Forest Resource Assessment written for the USFS, Georgia's forest verification protocol, Forest Stewardship Program forest management guidelines, principles for forest carbon sequestration developed by the Southern Group of State Foresters, and the USFS COLE carbon sequestration rate calculator.

Results: We set out to use the Climate Action Reserve's Improved Forest Management (IFM) protocol to verify a forestry carbon offset sub-project. This was in consideration of the

Oklahoma Carbon Program, working with Oklahoma Forestry Services, to potentially pursue becoming an approved verifier for a national registry and for performing verification of Oklahoma carbon offset projects. After reviewing multiple forestry verification protocols, and consulting with a professional forester versed in carbon markets, protocols, and accounting, we determined that the Climate Action Reserve's IFM protocol *IFM for quantifying GHG removals and emissions reductions through increased forest carbon sequestration on non-federal U.S. forestlands* was the one we wanted to test in Oklahoma. We worked with five landowners and certified 2,075 acres for payment (Table 4). We had several challenges, but did learn from those challenges what resources we would need to successfully verify an IFM for carbon sequestration project in the future.

Table 4. Description of forested acres that participated in the project

Acres	Description
206	Loblolly pine/hardwood plantation – planted 3/2012
320	Loblolly pine plantation – planted 3/2010
155	Loblolly pine/hardwood – age 32
4	SMZs
154	Loblolly pine/hardwood - age 32
10	Loblolly pine plantation - age 12
20	Loblolly plantation - age 14
10	Uneven aged shortleaf/oak stand - age 30
10	Uneven aged shortleaf/oak stand - age 30
40	Loblolly plantation - age 3
148	Uneven aged hardwood stand - age 60
90	Uneven aged shortleaf/hardwood stand - age 50
200	Uneven aged shortleaf/hardwood stand - age 30
540	Uneven aged oak/hardwood stand - age 35
26	Loblolly plantation – planted 2/2012
112	Loblolly plantation – planted 3/2011
15	Loblolly pine – age 21
15	SMZs loblolly/hardwood - age 21
2075	Total

Challenges: Oklahoma was plagued with drought and wildfires during the first year of the project. This meant that foresters were busy fighting fires. Trees were very drought stressed so OFS recommended we delay the initial assessments until the following year because we wouldn't know until then the full scale of mortality.

The forester most familiar with carbon markets and forestry verification protocols was promoted to OFS director and had to reduce his consulting time on the project. Other OFS staff we engaged contributed to the project but were much less familiar with carbon protocols and did not have the time to delve into the complexities during the timeframe allotted.

The aggregator's contract with forest landowners did not contain language that allowed OFS to share the management plans with the project director. This made it difficult for the project director to fully understand the assessment findings and prescriptions made for each tract.

We could not determine Oklahoma carbon sequestration rates for forests without a validated model, and there were not enough Forest Inventory and Analysis (FIA) data points for Oklahoma to calculate statistically valid sequestration rates for Oklahoma. Knowing this would be a barrier to future projects, we searched for another approach.

We looked at the rates used by Texas and Arkansas since they have the same vegetation types (cross-timbers, loblolly, shortleaf pine) and soil types as Oklahoma. We considered using Oklahoma's vegetation type and soil type, but using the other states' data points to extrapolate Oklahoma values. It was determined that this was not the best idea. We considered using the lookup tables in CCX's August 2009 protocol, but we didn't like that it used averages. Ultimately we decided to use the *USFS COLE 1605(b) Report for Oklahoma*.

We began the forestry project by sending promotional fliers to conservation districts in the four eligible counties in southeast Oklahoma. We held an informational meeting for producers who had submitted no-obligation applications to participate, pending more information. After the meeting, 10 of the 15 producers decided not to participate in the project. The reason most cited was that the potential carbon offset payments did not mitigate the costs of the increase in management that would likely be required. Ultimately, 5 producers contracted over 2050 acres of privately owned forests under the categories of afforestation, reforestation and improved forest management. The contracts were for three years as the offset buyer's commitment matched the duration of the CIG project. Management activities ranged from new plantings to management of 60-year old hardwoods for timber. A buffer pool of 30% payment holdback was put in place by the aggregator.

Three foresters spent a significant amount of time doing forest assessments on the contracted acres to determine eligibility and to write new, or update, management plans that included carbon sequestration as a management objective. An additional forester compiled the results and spot-checked the tracts. Each tract of land with improved forest management and carbon sequestration as an objective had an individual stewardship plan written for those acres. Stewardship Program management plan guidelines were followed. Data gathered included date of visit, tract number, county, legal description, forestry practice type, number of acres, date planted or stand age, trees per acre if less than three years of age, basal area, and species/stand type.

We had problems calculating the carbon sequestration rate with the information we had. We determined we had not gathered enough data during the assessments of the contracted acres so we could not calculate the baseline, which is necessary to fully implement the IFM protocol. This was due to a lack of understanding of exactly what was needed and why, and a breakdown in communication between the project director and OFS.

We did not contact a resource for assistance calculating net present value. Calculating net present value was also necessary to fully implement the IFM protocol.

Throughout the project we repeatedly encountered people in the forestry sector who held anecdotal assumptions about additionality, which made the project more challenging. Many believed that just increasing management increases carbon sequestration and thought that was enough to justify a carbon offset payment. This was a difficult mindset to overcome within the project's timeframe. We developed a rationale statement for the project that allowed us to continue based on the information we had:

Most non-industrial private forest landowners (NIPF) in Oklahoma do not actively undertake forest improvement practices and manage their forest resources using a long-term forest management plan. Those landowners who take the time and initiative to sign carbon contracts and voluntarily agree to manage their forests to a higher standard than the average landowner, by working with a Professional Forester to develop or revise a Forest Stewardship Program management plan that includes carbon sequestration objectives, are eligible to receive carbon offset payments for the estimated metric tons of atmospheric carbon dioxide equivalent (CO2e) that are being sequestered on their lands.

Given the limited information we had, we were unsure of how to best use the *USFS COLE Report for Oklahoma* to arrive at sequestration rates. The COLE report gives values in metric tons carbon (C), for live tree, dead tree, understory, down dead wood, forest floor, soil (down to 1 meter) and total non-soil in the charts. We considered using the difference in C values for the total non-soil from the current age class from the value of the previous age class since the soil C value is constant from year 1-100. However, the resulting carbon sequestration rates seemed unreasonably high especially considering our lack of baseline data.

As it was later explained to us, most guidelines for identifying the "extra" carbon are quite detailed in the use of forest growth and yield models to first project the "baseline" carbon dynamics for the business as usual forest management, and again for the carbon sequestration management plan. The difference between these over a representative timeframe (often 20 yrs) is used for the carbon credits. COLE can provide some information toward this, but only where extended rotations are used, in afforestation cases, where deforestation is precluded, or where a species change is planned, for example from mixed conifer/hardwoods to loblolly plantations. COLE has very limited ability to make valid comparison between baseline forest management and management where carbon sequestration is a goal.

To be conservative, after we converted from metric tons of carbon to metric tons CO2, we decided to use the live tree category and take the difference between the current age class and the previous age class divided by 5, or 10, depending on the age class separation in the COLE table. Since we used this approach, we did not use a discount rate for conservativeness.

Based on the estimated rates, participating forest landowners were paid a total $18,333 for two years. We did not gather information to determine leakage as only tracts that had or agreed to come under a management plan were assessed.

It is our hope that Oklahoma forest landowners can participate in carbon offset projects. The Oklahoma Carbon Program will continue to consider whether there is enough interest, potential offset funding, and resources available to pursue becoming approved verifiers for a national registry or creating a protocol specifically for Oklahoma. We plan to convene an advisory group whose members we identified during this project but were not able to meet in the time allotted.

Soil Sampling

Objective: Implement soil sampling in tandem with performance based verification of fields under carbon contracts. OSU will take 500 soil samples year one of the carbon contract and resample at the same locations in year three. Our goal is to take soil samples from at least 50% of the fields under carbon contract in the project area. The innovation in this part of the project is that OSU will use an established manual soil sampling method to establish that there is a minimum number of samples within a project area that provides an accurate average carbon sequestration rate in that project area. Once the minimum point sampling number is determined, this sampling method can be used in combination with performance based verification by carbon offset verifiers across the nation, including conservation district employees and NRCS staff. Soil samples will be used to gather baseline soil carbon data from fields included in the project during year one, and to determine sequestration rates at the end of year three. The protocol will be used to collect geo-referenced samples from fields to provide point measurements of carbon stocks. The variation across a field is too large to expect that we can assess carbon sequestration on a whole field; therefore, we will monitor the accumulation of carbon at random points in each field. This will give baseline data and an estimate of the carbon sequestration occurring throughout the total aggregated acres.

Results: We developed a soil sampling methodology to allow the trained non-scientist to collect soil samples from fields during field verification of agricultural practices. The method was developed and tested for use in no-till cropland and planted grasslands. It is for use by persons trained in soil sampling methods. It is limited to soils that are less than 5% gravel because it has not been tested in soils with greater than 5% gravel due to the limitations of using soil probes in gravely soil. However, if augers were used to collect the soil sample, these methods could likely be adapted to gravely soils if accurate measures of soil mass could be achieved. When project costs allow, and with land manager consent, these methods could be used to collect soil samples during verification of fields under carbon contract.

The soil sampling protocol was developed and tested to provide a consistent and cost effective way to monitor organic carbon mass (OCM) with the primary goal to determine the amount of carbon sequestered in a pool of aggregated acres under contract for carbon offset payments. The secondary goal was to use the site-specific data collected to determine the impacts of soil type, land management, and geographic location on the rate of carbon sequestration. Realization of the first goal allows for accurate valuation of carbon credits generated from the aggregated acres under contract during the contract period. Realization of the second goal through long term monitoring will improve current soil carbon sequestration rate estimates and

allow carbon credit payments to take into consideration site-specific variables instead of current practice-based payments based on regional default values.

Determining the amount of carbon sequestration in *each field* is not a goal of this protocol. We assume that the variability in soil carbon stocks across a typical field in the region would limit the success of efforts to determine the carbon sequestered on a field-by-field basis. During the assessment of data collected during testing of this protocol, this assumption was validated: Practical limitations to accurate determination of carbon sequestered in a four-year period on a site-by-site basis are severe. Only 4% of the sites sampled could be monitored with 10 or fewer cores being collected. It is important that sample numbers be limited so that site disturbance and costs are limited. Here is a summary of our results:

- Collected 2300 samples from project fields using various methods.
- Conducted a soil sampling training for verifiers on the proper collection of samples for carbon stock measurements using a push probe. Led by OSU, the training was attended by 7 conservation districts (9 district employees) and 6 OCC staff. Field verifiers collected soil samples from 15 locations and mailed them to OSU to field test the soil sampling protocol developed by OSU.
- Soil sample analysis showed that probes can be used interchangeably but that a fixed mass method of calculating carbon stocks was required to overcome differences in measured bulk density. The analysis shows that the variance is minimized by using the hand push probe.
- Variability on carbon stocks within sample sites as well as between sample sites is controlled by carbon concentrations and bulk density has only a small impact.
- Using the fixed mass method to calculate carbon stocks is very effective at removing the small variability caused by bulk density.
- Through power analysis, on average 123 cores per site would be required to statistically measure a difference of 1.1 Mg C ha-1 (this is the amount of carbon potentially sequestered in 4 years based on the current estimate of 0.27 Mg C ha-1 yr-1) at each location. Specifically, in order to determine a significant change in carbon stocks on a by site basis, 123 cores would be required from each sample site. However, if we are interested in simply knowing the aggregate sequestration we only need 13 sample sites with 10 cores collected from each site.
- Created and began populating an Access/GIS soil carbon database with over 6,000 soil samples.

Soil sample collection will allow Oklahoma's soil carbon data set to expand, eventually allowing for a more accurate monetary valuation of Oklahoma carbon offsets. Combining soil carbon sampling data with visual, performance-based verification makes buyers of carbon credits more confident that they are getting what they pay for. This means more demand for offsets, which can stimulate more adoption of practices by producers. The data will be available for future soil carbon modeling, which can then be used to account for variability within fields and across the diverse landscape of the Southern Plains. **See the soil sampling protocol for research and methodology details.**

Project Administration

Objective: Attend at least one NRCS CIG Showcase or comparable NRCS event.

Results: Warren, J., S. Sharma, A. Mullock and T. Wilson. 2013. Feasibility of Soil Carbon Monitoring for Carbon Offsets. Presented at the International SWCS conference. Reno, NV on 23 July. The soil sampling research will be submitted to peer reviewed journals for publication.

Objective: Submit semi-annual performance progress reports and final report documenting project results.

Results: We submitted 12 quarterly financial reports and 6 semi-annual progress reports in addition to this final report.

Budget: We successfully met the budget and match requirements for this project with only slight budget modifications. Because verification is done in the fall, we did not get year 2013 verification completed before the CIG project ended. This meant that the 2013 carbon offset payments weren't made to producers during the project and those funds couldn't be used as match as planned. We replaced this match with state locally led cost-share program overmatch from funds paid to participating producers who installed the practice of no-till within the project area. Federal funds were not paid to producers. The other budget revision came when we found it necessary to hire additional temporary personnel during the last 6 months of the project. Funds allocated for OSU's soil sampling work were used for this without impact to OSU's work. Given the high number of deliverables for this project, this budget revision became necessary. The third budget revision was made when Oklahoma Forestry Services (OFS) authorized us to use their cash overmatch from their work on the project (Table 5).

Table 5. Proposed and actual project budget expenditures

Project Total			Project Total	
	Proposed		Actual	
Category	**Federal**	**Non-Federal**	**Federal**	**Non-Federal**
OCC Personnel	$75,000	$0	$94,915	
Supplies	$4125	$0	In contractual	$0
Contractual:	$224,467	$303,592	$208,677	$303,592
OSU	$137,466	$28,591 (in-kind)	$120,770	$29,832 (in-kind)
Conservation Districts	$12,001	$22,500 (cash)	$12,907	$9,975 (cash)
OACD	$75,000	$20,000 (in-kind)	$75,000	$20,000 (in-kind)
OACD		$255,000 (cash)		$110,895 (cash)
Unexpected Matching Funds:				
OCC	$0	$0	$0	$109,289 (cash)
OFS	$0	$0	$0	$23,601 (cash)
Total	**$303,592**	**$303,592**	**$303,592**	**$303,592**

Recognition. As a result of its unique approaches and work on this project, the Oklahoma Carbon Program has been recognized locally, nationally, and internationally for its innovation at developing a program that is outside of the federal regulatory arena, yet having success at meeting regulatory goals through voluntary means: The program was awarded the 2012 Henry Bellmon Sustainability Awards "Environmental Stewardship Award," which recognized the Oklahoma Carbon Program and its work on the CIG project. Recognition of the Program's success has also appeared in multiple publications since 2011, including the *Journal Record*, the *Southwest Farm Press*, the Soil and Water Conservation Society "Conservation NewsBriefs," *Natural Awakenings* magazine, *The Oklahoman* newspaper, the *Oklahoma Gazette*, *Future Friendly Farming: Seven Agricultural Practices to Sustain People and the Environment*, by the National Wildlife Federation, and a report by Forest Trends Ecosystem Marketplace called *Bringing it Home: Taking Stock of Government Engagement with the Voluntary Carbon Market* in which Oklahoma was one of only three U.S. states (including Oregon and California) featured alongside programs in other countries including Australia, Chile, Brazil, Netherlands, Japan, and China.

Transferability. The methods included here were developed in consultation with NRCS professionals, are based on NRCS methods, and are simplified to assist the non-specialist to collect field data that is audited and acted upon after the results are reviewed by a specialist. The Oklahoma Conservation Commission operates in partnership with conservation districts, the Oklahoma office of NRCS, Oklahoma State University Cooperative Extension Service, Oklahoma Forestry Services, the Oklahoma Association of Conservation Districts. The Oklahoma Carbon Program model ties together several natural resource initiatives including Farm Bill Programs, habitat improvement and restoration programs, riparian buffer easement programs, and water quality programs. By sharing goals and technical resources with other programs and agencies, the program takes a holistic ecosystem approach to conservation management, which means realizing the benefits of multiple conservation strategies working synergistically in a defined area, such as a farm, watershed, county, or group of counties.

NRCS and conservation district budgets are suffering and a new conservation model is emerging. The methods discussed here are a first step to standardizing the way conservation districts can assist state and federal programs at the local, field level when training and support is provided.

Offsets verified to high quality standards can bring an optimum price for agriculture producers and forestland owners. The more benefits to producers the more likely they are to continue conservation practices, which means that ultimately soil, air, and water – and all of us –also benefit. The methods resulting from this project can be used by carbon offsets verifiers, NRCS staff, and other states looking to create a program similar to Oklahoma's.

Publicity and Recognition. Project publicity occurred throughout the project: At least 11 presentations were made to government and private sector conservation professionals; 3 academic presentations were made at national and international conferences.

Professional Outreach

- 2010 Presentation at X-AGG meeting in Chicago, IL
- 2010 Presentation to the Oklahoma Clean Lakes and Watersheds Association
- 2011 Presentation to NACD annual meeting ecosystem markets breakout session
- 2011 Presentation to Oklahoma Chapter of Soil and Water Conservation Society
- 2012 Presented project at N. Canadian River Project tour for Sustainable OKC
- 2012 Display at four Ken Burns *The Dust Bowl* screening events across Oklahoma
- 2012 Project presentation to WFEC board of directors
- 2012 Presentation to the group "North America 2050"
- 2013 Presented project to Sarah Bittleman, Agriculture liaison to the U.S. EPA
- 2013 Presented to National Rural Assembly in Washington, DC
- 2013 US House of Representatives Agriculture Committee staff where we discussed, in depth, the verification program and how the Oklahoma model, made possible by the CIG award could be replicated and used across the country

Academic Presentations and Publications

- Poster at the American Society of Agronomists Meetings in Cincinnati, OH Oct. 21-24.Title: Assessment of sampling methods for carbon credit monitoring. Published in *Agronomy* abstracts CD-ROM. ASA, Madison, WI.
- Warren, J., S. Sharma, and T. Wilson. 2013. Variability in Soil Carbon Stock Measurements. Presented at the Southern Soil Physics Working Group meeting. Lexington, KY on 24 May.
- Warren, J., S. Sharma, A. Mullock and T. Wilson. 2013. Feasibility of Soil Carbon Monitoring for Carbon Offsets. Presented at the International SWCS conference. Reno, NV on 23 July.

Appendix A: Verifier Training Program

Verifier Training Program
For Approved Verifiers of Seeded Grasslands & No-Till Fields

With input from Oklahoma NRCS, the Oklahoma Carbon Program has developed a 4-level training program for approved verifiers of seeded grasslands and no-till fields. It is similar to the NRCS process for conservation plan writers and requires classroom and field instruction, as well as successful demonstration of field skills prior to certification, and continuing education after. The four verifier skill levels are as follows:

Level 1 – Trainee

- Has obtained awareness and education by attending **annual** classroom training **and** field training as requested.

Level 2 – Apprentice

- Level 1 Trainee certification
- Has accompanied a Senior Verifier during verification of at least 2 grasslands ***and/or** 2 no-till fields and asked questions as much as necessary to understand the process.

Level 3 – Independent Verifier

- Level 2 Apprentice certification
- Has been observed by a Senior Verifier to accurately verify at least 3 grasslands ***and/or** 3 no-till fields. Senior Verifier only offers guidance as necessary to facilitate accuracy of process and information gathered.
- Certification by the Director of the Oklahoma Carbon Program

Level 4 – Senior Verifier / Trainer

- Level 3 Independent Verifier certification
- Has successfully instructed at least 1 classroom ***and/or** 1 field session on grasslands ***and/or** no-till verification.
- Certification by Director of the Oklahoma Carbon Program

**Separate certifications are required to verify grasslands and no-till: Verifiers may choose to pursue certification in one or both practices. Senior Verifiers/Trainers will be certified to teach classroom sessions and/or field sessions based on interest and aptitude.*

NOTE: To maintain certification at any level, verifiers must keep up knowledge and skills by participating in continuing education sessions.

Appendix B: Field Verification Results

In 2010, the Pool 1 project contracts (the first ones signed outside of the pilot program counties) sequestered an estimated 1,886 metric tons of CO2e with continuous no-till. Pool 1 contracts consist of those signed in 2010 and early 2011 consisting of 7,223 acres of no-till. Verification occurred on 6,130 acres, or 85% of the acres under contract. Of the total acres, 821 acres were found to be out of compliance and 6,435 acres were certified by the Oklahoma Conservation Commission by field verification and desk audit. Producers were paid $3.50 per metric ton of CO2e from matching funds. This totaled a payment to producers of $6,601.50 for Year 1, Pool 1 of the project.

In 2010, the Carbon Pilot Program in the N. Canadian River Watershed sequestered an estimated 3,629 metric tons of carbon dioxide equivalent with conservation practices (no-till, conversion to grasslands, riparian buffers) on agricultural lands. The sequestration was confirmed by field verification of 100 percent of the fields totaling 9,650 acres. Of those acres, 516 were ineligible. The remaining 9,134 acres were certified by the Conservation Commission by a desk audit of producer information and field verification. Producers were paid $3.50 per metric ton of CO2 from matching funds. This totaled a payment to producers of $12,701.

In 2011, the Carbon Pilot Program in the N. Canadian River Watershed sequestered 3,193 metric tons of carbon dioxide equivalent (CO2e) with conservation practices (no-till, conversion to grasslands, riparian buffers) on agricultural lands. The sequestration was confirmed by field verification of 100 percent of the fields totaling 9,900 acres. Of those acres, 2,278 were ineligible. The remaining 7,622 acres were certified by the Conservation Commission by a desk audit of producer information and field verification documents. Producers were paid $3.50 per metric ton of CO2. This totals a payment to producers of $11,175.50.

In 2011 the Project sequestered an estimated 9,943 metric tons of CO2e with 15,196 acres of continuous no-till and 7,889 acres of seeded grasslands. Verification occurred on 23,396 acres under contract. Of the total acres verified, 23,085 acres (>99%) were certified by the Oklahoma Conservation Commission. Of the acres verified, 388 acres were determined to be ineligible for payment, and 74.5 acres were certified without field verification. Producers were paid $3.50 per metric ton of CO2. This totals a payment to producers of $34,800.50.

In 2011-2012 the forestry subproject of the project sequestered an estimated 5,238 metric tons of CO2e on 2,075 acres of forestland. Producers were paid $3.50 per metric ton of CO2e. This equals payments to producers totaling $18,333 for two years.

In 2012 the reports for the pilot and expansion project were combined. The agricultural management practices in this project sequestered an estimated 13,649 metric tons of CO2e on 36,711 acres, which included 20,264 acres of continuous no-till; 7,889 acres of grassland; 123 acres of riparian buffer, and 8,349 acres of rangeland. Verification occurred on 36,679 acres under contract. Of the total acres verified, more than ninety-nine percent (>99%) were certified by the Oklahoma Conservation Commission. Of the acres verified, 427 acres, or less than one

percent (<1%) were determined to be ineligible for payment, and 2,541 acres, or six and a half percent (6.5%) were certified without field verification. Producers were paid $3.50 per metric ton of CO2e. This totaled a payment to producers of $49,300.

Note: Amounts here include the 20% of each agricultural payment and 30% of each forestry payment held in reserve.

Appendix C: Progressive Management Crediting Matrix

The management standard is a critical informational and motivational tool for producers. For the project, it simply wasn't prudent for us to require the most advanced, ideal, land management from producers whom we were only paying $3.50/metric ton CO2e. If we wanted them to participate, we had to keep it simple. However, we realize that there are higher levels of management that can result in more ecosystem service benefits. Thinking of management in both levels of complexity and co-benefits, we drafted a 5-tier standard for progressive crediting.

The 5-tier standard serves two purposes: It clearly lays out in a matrix for producers and project proponents 5 management levels from the most basic to advanced management that result in greater ecosystem services benefits. The second purpose of the matrix is that it can be used to reward producers who are in the early stages of conservation management to benefit from carbon offset payments, but at a lesser payment level than a producer who is doing more aggressive, progressive conservation management. For example, stopping tillage has immediate, quantifiable, ecosystem benefits, but not as many benefits as stopping tillage, using cover crops, using precision application for fertilizer application, avoiding herbicide use, and fencing cattle from a stream. Why not pay both of these producers. The progressive management crediting matrix lets carbon offset project proponents and credit buyers decide the price and level of management effort that they can afford, while still allowing producers to have an incentive and benefit, and clear goals for stepping up their management.

It is common practice that when change is demanded for air and water quality improvements, the energy sector and industries are given time to phase-in progressive technologies due to the high costs and other barriers involved with change. The OCP believes that this same phase-in approach should be applied to agricultural producers venturing to make voluntary changes in land management that have co-benefits to society.

Oklahoma Carbon Program
Practice Performance Standards v.2013

Ecosystem Services Progressive Management Crediting Matrix DRAFT

	No-Till	Grasslands	Rangeland
Eligible	Fields with a cropping history designated as "cropland" by FSA and converted to no-till on or after January 1, 2001, and that is not managed with any full width tillage implements	Fields with a cropping history designated as "cropland" by FSA that were seeded or sprigged to permanent perennial grass on or after January 1, 2001.	Grazed land on which the historic plant community is principally native grasses, grass like plants, forbs or shrubs suitable for grazing and browsing that is extensively managed through the control of livestock rather than by agronomic practices, such as fertilization, mowing, or irrigation.
Ineligible	Cropland managed with full width tillage implements including chisels, cultivators, disks, harrows, plows, rotary hoes, or sweeps; any portion of no-tilled cropland that is tilled or otherwise disturbed; no-till cropland fallow for greater than 1 year; no-till cropland with residue absent or less than expected based on previous crop and weather.	"Go back land," cropland that is no longer cropped, with permanent vegetation established by passive growth.	Edge of field parcels receiving incidental grazing. Rangeland that is too degraded to sequester carbon at the expected rate during the length of the project. "Soil bank fields" from the 1960s lost their topsoil ("A" Horizon) and therefore do not have the capacity to sequester CO2 like unbroken, native, rangelands. "Go back land," cropland that is no longer cropped, with permanent vegetation established by passive growth or seeding.

Continuous No-Till Progressive Management Crediting Matrix

Mgmt Level	1	2	3	4	5
Soil Health & GHG Seq Mgmt	◦ Conversion of FSA "cropland" from conventional tillage to no tillage ◦ Growing crop present ◦ Residue present and evenly distributed ◦ Anchored stalks present ◦ Cover crops follow low residue crops ◦ Burning does not occur ◦ Grazing ends by 3/15 ◦ Fallow <12 months ◦ Hayed annual crops followed by high residue cover crop	◦ At least 50% of soil covered with residue ◦	◦ Plants deep-rooted cover crop ◦ Adds legume cover crop ◦	◦ Rotating high residue crops or ◦ Adds additional crop to rotation or ◦ Cover crop cocktail of at least 3 species ◦	◦ Use of continuous cover crops OR ◦ Cover crop cocktail 7 species or greater OR ◦ Add 2 additional crops to rotation
Nutrient Mgmt & Avoided Emissions	◦ Conversion of FSA "cropland" from conventional tillage to no tillage ◦	◦ Soil test annually ◦ Fertilizes according to soil test recommendations and ◦ Uses split N application, when applicable to crop ◦	◦ In-season N incorporation/injection or ◦ Slow release nutrients or ◦ Nitrogen inhibitors or ◦ Use of N-rich strips	◦ Applying fertilizer at variable rates through the use of electronic maps with a GPS receiver by using grid sampling or EC mapping	◦ Uses sensor based variable rate application techniques such as NDVI sensing to apply nitrogen fertilizer
Wildlife Mgmt	◦ Conversion of FSA "cropland" from conventional tillage to no tillage ◦	◦ Plants a cover crop and/or has implemented other contingencies or plantings specifically for improving wildlife habitat	◦ .Buffer strips exist around riparian areas ◦ Adds pollinator species to cover crop ◦	◦ Leaves un-harvested strip around perimeter of field ◦ Buffer strips exist along field edges that create corridors for wildlife movement ◦ Buffer strips all at least 30 m wide along drainages	◦ Using a stripper header for harvesting ◦ Buffer strips all at least 46 m wide along drainages ◦ Utilizes IPM for pest control
Water Quality Mgmt	◦ Conversion of FSA "cropland" from conventional tillage to no tillage	◦ If irrigated, an irrigation plan is adhered to ◦ Fertilizing according to soil test recommendations	◦ Riparian buffer is in place ◦ Filter strips established ◦ Applying split nitrogen applications ◦	◦ Livestock excluded from buffer ◦ Utilizing nitrogen injection ◦ Applying nitrogen rich strip	◦ Livestock excluded from stream ◦ Has field border ◦ GPS targeted pest spray ◦ IPM plan in place ◦ Using precision equipment to apply nitrogen

Cropland Converted to Seeded Grasslands Progressive Management Crediting Matrix

Mgmt Level	1	2	3	4	5
Soil Health & GHG Seq Mgmt	◦ Conversion from marginal cropland to seeded, managed grassland ◦	◦ Grazing management plan created and implemented ◦ Manages biomass removal from haying, grazing, or burning so that residual cover remains. ◦ Harvest deferment occurs for up to two years when precipitation is less than 60% of local average annual rainfall during the preceding 12 months. ◦ Herbicide are not applied unless recommended in the brush management plan and then no more than every 2-3 years at most	◦ Stocking rate does not exceed carrying capacity of the field; ◦ Grazing does not exceed the recovery capacity of the individual plant species or the plant community based on NRCS Standard 528. ◦ Supplemental feeding by grain is minimized or unnecessary. ◦ Approved prescribed burn plan in place ◦ Drought plan in place and used when needed ◦ Bare ground below 75% ◦ Pasture Trend analysis < 18	◦ Grazing meets or exceeds heights as suggested in Table 3 (Bidwell) ◦ Actively controlling woody encroachment* ◦ Residue height reaches minimum as outlined in Table 3 for non-native forages ◦ Pasture Trend analysis 18-24 ◦ Cool season grasses < 33% cover	◦ Pasture Trend analysis 25-40 ◦ Grazing on clay soils Light in wet years ◦ Grazing on sandy soils Light in dry years ◦ Diversifies pasture with 3 or more functional groups ◦ Pasture Trend analysis 25-40 ◦
Nutrient Mgmt & Avoided Emissions	◦ Conversion from marginal cropland to seeded, managed grassland ◦	◦ Soil test is done annually ◦ Fertilizer applied no more than once annually unless done as split application and only at rates based on soil test results and nutrient removal calculation. when using a fertilizer that may volatilize.	◦ No supplemental feeding ◦ Pasture Trend analysis < 18 ◦ Reduced fertilizing due to legume management	◦ Pasture Trend analysis 18-24	◦ Fertilizes no more than once every 3 years ◦ Pasture Trend analysis 25-40 ◦
Wildlife Mgmt	◦ Conversion from marginal cropland to seeded, managed grassland ◦	◦ Has implemented contingencies or plantings specifically for improving wildlife habitat. ◦ Refrains from herbicide application	◦ Hays late June to early July and no shorter than 10 inches ◦ Riparian buffer in place providing corridor ◦ Water sources available for wildlife use ◦ Pasture Trend analysis < 18	◦ Grazing, fire and haying disturbance managed strategically to create a variety of vegetative cover across property ◦ Livestock excluded from buffer or only flash grazing ◦ Pasture Trend analysis 18-24	◦ Water sources exist with native wetland species present ◦ Pasture Trend analysis 25-40 ◦
Water Quality Mgmt	◦ Conversion from marginal cropland to seeded, managed grassland	◦ Refrains from herbicide application ◦	◦ Riparian buffer in place ◦ Pasture Trend analysis < 18	◦ Livestock excluded from buffer or only flash grazing ◦ Pasture Trend analysis 18-24	◦ Livestock excluded from stream ◦ Pasture Trend analysis 25-40

Improved Rangeland Management Progressive Management Crediting Matrix

Mgmt Level	1	2	3	4	5
Soil Health & GHG Seq Mgmt	◦ Grazing plan created and implemented ◦ Maintains written logs that document forage-animal balance, grazing schedule with stocking rates, with any use of the contingency plan. ◦	◦ Drought plan in place and used when needed ◦ Approved prescribed burn plan in place. ◦ Brush management plan in place ◦ Hay harvested no more than once yearly before July 15 to height at least 4" ◦ Harvest deferment occurs for up to 2 years when precipitation is <60% of local avg annual rainfall during preceding 12 mos.	◦ Vegetation and residue covering >60% of soil surface ◦ Range Health -10 to -5 ◦ Soil disturbance during brush removal less than 50% and not accelerating erosion ◦ Plant species observed in 1m by 1m quadrats 35-59% of ecological site ◦ Refrains from herbicide application unless prescribed ◦	◦ Key species average height taller than 6 inches (as listed in ecological site descriptions from NRCS) ◦ Actively controls woody encroachment* ◦ Utilizes exclosures to monitor growth of key species ◦ Prescribed fire applied in accordance with historic frequency and approved plan ◦ Plant species observed in 1m by 1m quadrats 60-74% of ecological site ◦ Range Health -4 to 5	◦ Grazing on clay soils Light in wet years ◦ Grazing on sandy soils Light in dry years ◦ Range Health 5+ ◦ Plant species observed in 1m by 1m quadrats represent >75% of ecological site
Nutrient Mgmt & Avoided Emissions	◦ Soil test annually on hayed lands	◦ Fertilizer application does not occur except on hayed lands and then when based on soil test results and nutrient removal calculations	◦ Brush removal via chemical or mechanical techniques occurs on less than 10% of the acreage.	◦ Supplemental feeding of cattle does not occur ◦	◦ Range Health 5+ ◦
Wildlife Mgmt	◦ Grazing plan created and implemented ◦	◦ Creates and implements wildlife management plan ◦	◦ Implements contingencies for improving wildlife habitat. ◦ Refrains from herbicide application ◦ Water sources available for wildlife use ◦ Refrains from haying until after July 1 and no shorter than 10 inches	◦ Grazing, fire and/or haying disturbance managed strategically to create a variety of vegetative cover ◦ Range Health -4 to 5 ◦	◦ Range Health 5+ ◦ Plant diversity >30 species in a 1m by 1m quadrat ◦ Water sources exist with native wetland species present ◦
Water Quality Mgmt	◦ Grazing plan created and implemented	◦ Plant base pedestalling < 10 mm high ◦	◦ Livestock excluded from buffer or only flash grazing ◦ Fire return interval 3+ years ◦ Refrains from herbicide application.	◦ Livestock excluded from stream or drawn away using fire ◦ Plant base pedestalling < 5mm high, ◦ Range Health -4 to 5	◦ Exposed soil is <5% ◦ No evidence of rill, pedestals or terracettes

Appendix D: Analysis of Conservation District Proficiency with Rangeland Monitoring Methods

Rangeland Monitoring:
An Analysis of Conservation District Proficiency with Methods

District Proficiency with Data Collection Methods. One 200 foot transect could be completed in 1-2 hours. Two people were found to be most efficient for each transect. One person could complete the monitoring of a transect, but the time per transect would increase to 3 hours. Some time was taken to locate fields and access points. Hopefully this time could be reduced with the use of GPS points and notes taken by verifiers noting access points to each property. Monitoring went more smoothly when verifiers contacted landowners ahead of time to ensure gates would be open, and also gain clarification on the exact location of the property.

We tried many combinations of sampling order. What worked best was to conduct the line-point and production at the same time, thus reducing walking time up and down the transect. Length of time to sample depended on species abundance (lots of production meant multiple bags to weigh), diversity (species identification takes time), and the wind (windy days made it harder to sample production). This step can only be sped up with increased plant ID knowledge, and teamwork between verifiers.

Each field took about 4 hours for travel, monitoring, and data entry. The current protocols are not sustainable from a financial standpoint. An organized district employee could shave off almost 2 hours a day by having accurate maps, knowing where fields are, and knowing if gates need to be unlocked. However, even with 2 skilled employees and low plant diversity, each field took at least 1 hour to monitor, in addition to the driving time to get there. As the program moves forward, we will need to find ways to shave off the amount of time designated to each property enrolled.

Establishing a Baseline. The methods currently outlined are vital to gain a clear picture of the overall health of the landscape. The information collected is also used to design grazing plans for the landowner. We suggest using the proposed protocol to gather a baseline datasheet for each property that enrolls. In this way, we can use minimal monitoring, or monitoring on rotation later to track the progress of the landscape while enrolled in the Oklahoma Carbon Program. We recommend baseline sampling for the first 2 years in the program. If one of those years contains a severe drought (less than 40% of average rainfall), then baseline could be extended 1 more year for a total of 3 years. This is to gain a good representation of the average production for that property. If we try to design a grazing plan or estimate site condition during a severe drought, our data will be skewed toward less healthy rangeland. By buffering a severe drought with other years, hopefully the plants will meet a more expected production levels.

Rotational Monitoring. After a baseline has been established, we suggest sampling a portion of the registered properties each year. 1/4 to 1/3 of rangeland properties registered should be a frequent enough return interval to observe any shifts in the health of the rangeland. Since rangelands vary so much from year to year, long-term datasets are better for representing the

landscape trends. The Oklahoma Carbon Program is interested in the addition of GHG into the soil or plant biomass. We are not particularly concerned with species composition. We are more concerned with functional group representation. Carbon storage rates of C_4 and C_3 grasses, woody shrubs, and annual forbs will be generalized for carbon calculations. Gaining a general idea of the presence and abundance of these groups on the landscape will serve the needs of auditors.

We suggest collecting a new baseline datasheet every 10 years or so. After being registered, the 10-year check-up for all properties could be done 50% at a time. This spreads the workload out and hopefully keeps monitoring times to a minimum each year. Table D-1 shows the sampling schedule for a set of properties enrolled in the program within the same year. The first 2 years, all properties enrolled will be sampled (100% of those enrolled). Years 3-9, monitoring will rotate, covering only 20% of enrolled properties.

Reduction of Transect Line or Sampling Points. Rangelands are highly variable, but spending 2 hours per field is too much time for carbon verifiers. To try and shorten this, we have come up with a few suggestions.

1. **Reduce the number of production samples by half.** Sample production every 20 feet instead of 10 feet (5 clipped, 5 estimated). For the OCP, we only need a general idea of production rates for major plant groups: Woody, Perennial Forb, C_4 grasses, C_3 grasses, and annual forb. We don't need a large number of samples to gain this quick estimate. Landscape pictures will assist in estimating production amounts per field. This will cut down sampling time by 30 minutes

2. **Drop Line-Point and replace with Top Dominant Species**. Line-point requires intermediate/advanced knowledge of rangeland plant identification. This form is the most limiting for inexperienced employees. We found, while working, that this form gave district employees the most difficulty and we did not observe any mastery of this form by any employee. Most botanists use a frame to estimate diversity and cover. By using the production hoop, we are gaining diversity estimates. For cover, we suggest adding a new datasheet that verifiers can use to identify the top 5 dominant species and estimate the percent cover of those species on the landscape. This will cut sampling time by 15-20 minutes.

3. **Continue using Range Health Assessment Form.** This form takes 10 minutes to fill out, and with enough sampling, can be calibrated to production and overall range health.

4. **Continue using 200-ft transect**. Because of rangelands variability, it will serve the OCP's goals better to keep the longer transect and just sample fewer times along the transect.

In total, we believe we can cut monitoring time to 30 minutes during non-baseline data collection years by alternating between baseline collections and simplified summaries (as suggested above).

Mastery of Methods. The weakness of the rangeland methods is that verifiers need to have good plant identification skills. We found that the four district employees we were training did not have any plant ID background. We taught them simple concepts of plant pressing for identification, keeping track of unknown plants, looking for key characteristics of plants, and researching plants using on-line databases. We aren't confident all this training will be remembered next year. This is understandable as plant ID can be difficult even for professionals. The training sessions we held are not enough to prepare a new verifier for rangeland monitoring at the detail currently required.

Time Spent. To shorten monitoring time, we suggest that a small set of long-term employees are trained and required to attend plant ID training and practice plant ID skills on a semi-annual basis. Knowing the plants can cut the Line-Point sampling time from 50 minutes to 25 minutes. We can train 3-4 people to become Senior Range Verifiers. These people can partner up with the local district employee and complete rangeland monitoring together. We would still strongly suggest the annual trainings for everyone. And, with time, practice, and training, a district employee can prove their plant ID skills and can be promoted to a Senior Verifier. But until then, a Senior Verifier should lead the monitoring at each district to ensure efficiency and accuracy.

Data Entry. We reviewed the rangeland data collection packets submitted to the auditor for 2013.We entered all the data for Dewey County. It took 2 of us working together 8 hours to enter the data for 12 fields: 40 minutes per field. Cutting out the line-point data form will shorten this time by half. We also suggest linking the Range Health Assessment form and the Production form to a database. This will cut down on processing time in the office.

We found numerous errors in the forms entered by the district employees. There were still "unknown" plants entered into the electronic forms. The production form had many ranking errors where sampling points had duplicates, or were missing ranks. These forms need to be double-checked before submission. We believe district employees can fill out the electronic forms with more practice.

Conclusion. The training sessions we held are not enough to prepare a new verifier for rangeland monitoring at the detail currently required. The district staff trained for rangeland verification for this project were not vetted for aptitude. They were selected because their offices were located in the project area, and their conservation district was a willing participant in the project. As a result of our findings, we plan to add rangelands to the 4-Level Verifier Training Program and continue monitoring with two people per field, with one being a senior verifier. We also plan to introduce plant identification into the verifier training curriculum.

Table D-1. Proposed rangeland monitoring schedule

Year of enrollment = 2013	GPS point	Line-Point Intercept	20 Production Samples	Range Health Assessment	Landscape Picture	10 Production Samples	Top Dominant Species	Percent Sampled
2013	√	√	√	√	√			100%
2014		√	√	√	√			100%
2015				√	√	√	√	25%
2016				√	√	√	√	25%
2017				√	√	√	√	25%
2018				√	√	√	√	25%
2019				√	√	√	√	25%
2020				√	√	√	√	25%
2021				√	√	√	√	25%
2022				√	√	√	√	25%
2023		√	√	√	√			50%
2024		√	√	√	√			50%
2025 etc				√	√	√	√	25%