1.0 Project Proposal Summary Sheet

Project Title	Evaluating the Effectiveness of Polyacrylamide Flocculation to Reduce Suspended Solids, Bacteria and Nutrients in Agricultural Runoff

Project Period	July 1, 2014 – June 30, 2016

Project Sponsor	
Organization Name	South Dakota State University
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Project Funding
NPS Funds Request $89,746 + Match (cash/in-kind) $61,648 + Other Federal Funds $0 = Total Project Cost $151,394

Project Type
Planning/Assessment

Project Location	
Watershed(s)	Statewide
303(d) Listed Stream	Statewide
HUC(s)	Statewide
Position coordinates of project location in decimal degrees	Statewide

NPS Pollution Source categories to be addressed			
100%	Agriculture	0%	Silviculture
0%	AFOs	0%	Hydrologic Modification
0%	Urban Runoff	0%	Construction
0%	Resource Extraction	0%	Other

NPS Functional Category			
0%	BMP Implementation	0%	Technical Assistance
20%	Information and Education	70%	Planning
0%	Watershed Assessment	0%	Groundwater
10%	Water Quality Monitoring	0%	Other

NPS Pollutants to be addressed			
X	Excess Nitrogen		Pesticides
X	Excess Phosphorus		Oil and grease
X	Sedimentation		Temperature
X	Pathogens/Bacteria		pH
	Metals		Other
	Low dissolved oxygen		Other

Summary Statements	
Project Goals	The project goals are to: 1. Select effective polyacrylamides (PAMs) that can control soil erosion and reduce suspended solids, bacteria, and nutrients in agricultural runoff in South Dakota. 2. Determine factors affecting the PAM flocculation of a variety of agricultural soils in South Dakota, and determine the effectiveness of PAM flocculation under low temperatures. 3. Demonstrate runoff water quality improvement by PAM amendment at an agricultural field. 4. Provide education on PAM flocculation to producers, state regulators, water quality experts, and other stakeholders.
Project Description	Many surface water resources in South Dakota are impaired by pollutants from point and non-point sources. High levels of total suspended solids (TSS), fecal coliforms and nutrients are the primary causes of surface water quality impairment in South Dakota. Non-point source pollution from agricultural runoff has been identified as a major contributor to the surface water quality impairment in the state. PAM has been used in the US since the 1990s to reduce soil erosion and improve water quality in agricultural fields. PAM can effectively reduce sediment, nutrients, pathogenic micrograms and pesticides in agricultural runoff. The application of PAM for water quality control requires an evaluation of the specific soil and climatic conditions. The proposed project will assess factors affecting PAM flocculation of a variety of agricultural soils in South Dakota. Based on the results of this project, we will identify the optimum PAM application conditions that will effectively control soil erosion and reduce TSS, bacteria, and nutrient loadings to surface water resources. The results of this project will help policy makers and producers make informed decisions regarding the use of PAM for agricultural runoff water quality control in South Dakota.

2.0 Statement of Need

2.1 Demonstrated Water Quality Need

Natural water resources play a key role in supporting the economic and population growth in South Dakota. However, many surface waters in the state are impaired by pollutants from point and non-point sources. The 2012 Integrated Report for Surface Water Quality Assessment (SD DENR, 2012) indicates there are approximately 9,289 miles of perennial rivers and streams in South Dakota. DENR assessed about 6,388 stream miles during the five years preceding the report and the results showed that 65% of the assessed miles did not support one or more designated beneficial uses. High levels of total suspended solids (TSS), fecal coliforms and *Escherichia coli* (*E. coli*) are the primary causes of water quality impairment of rivers and streams in South Dakota. The 2012 Report also states that there are 572 lakes and reservoirs with specific aquatic life and recreational use classifications. DENR assessed 138 out of the 572 classified lakes and the results showed that 34% did not meet one or more beneficial uses. Most lakes in South Dakota are characterized as eutrophic to hypereutrophic. Runoff carrying nutrients from agricultural fields is one of the leading causes of the eutrophication in the state. The 2012 Report indicates that non-point source pollution from agricultural runoff is a major contributor to the surface water quality impairment in South Dakota. In order to improve the surface water quality in South Dakota, efficient and sustainable best management practices (BMPs) are needed to control the suspended solids, bacteria and nutrients in agricultural runoff.

Polyacrylamide (PAM) has been used in the United States since the 1990s to reduce soil erosion in agricultural fields (Ben-Hur, 1994; Lentz et al., 1994; Sojka et al., 1998; Bjorneberg et al., 2000; McLaughlin and Bartholomew, 2007). Its soil stabilizing and flocculating properties improve runoff water quality by reducing sediment, nutrients, microorganisms, pesticides and other contaminants in runoff. PAM is a class of long-chain polymers formed by the polymerization of acrylamide monomers that vary in molecular weight, type of charge, and charge densities (Barvenik, 1994). Figure 1 shows the structure unit of a PAM polymer. Anionic PAMs are preferred for soil erosion control in agricultural fields because they are environmentally safe and non-toxic to fish and other aquatic species, wildlife, and plants (USDA NRCS, 2006; Sojka et al., 2007). Anionic PAMs have been specified by the USDA Natural Resources Conservation Service (NRCS) for controlling soil erosion and water quality in agricultural fields (USDA NRCS, 2006).

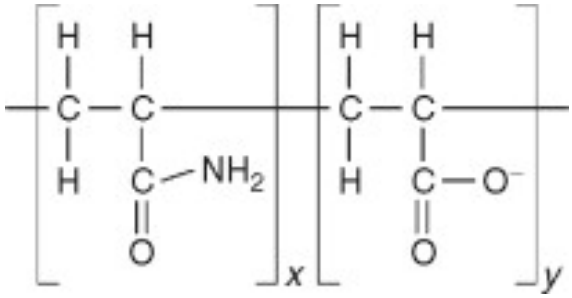

Figure 1. PAM Polymer Structure Unit

The most common forms of PAM are as aqueous solutions, emulsions, and dry forms. By far the greatest use of PAM in agricultural fields focuses on the use of dry granular PAM products. PAM can be directly applied through irrigation water or applied initially as dry granules to the soil surface and activated by water (irrigation or rain). Water soluble PAMs can be used to stabilize soil surface, control surface sealing, increase infiltration, reduce runoff and erosion, as well as reduce fertilizer and pesticide losses. PAM for large-scale agricultural and environmental applications is able to prevent erosion when applied to the soil surface in small amounts (1-5 kg/ha). High effectiveness and low cost of PAM for erosion control, coupled with easier implementation than traditional conservation measures, has resulted in rapid adoption in agriculture (Sojka et al., 2007). PAM has been identified by the USDA NRCS as an effective, agriculturally significant, and environmentally important advance in soil conservation management (USDA NRCS, 2006). Some states and federal institutions have developed the guidelines for PAM use for erosion and runoff control (WDNR, 2000; VDCR, 2002; USDA NRCS, 2006).

PAM has been shown to be a highly effective erosion-preventing and infiltration-enhancing polymer, when applied in surface irrigation and sprinkler irrigation at low concentrations (1-10 ppm). Field studies indicate that PAM can eliminate more than 90% of sediment loss in runoff from furrow irrigation, and the infiltration rate can be increased by more than 30% compared to untreated controls (Sojka et al., 2007). Figure 2 presents a comparison of irrigated furrows with and without PAM addition. PAM has also been successfully used in areas of rain-fed agriculture and sprinkler irrigation (Shainberg and Levy, 1994). PAM can be used to maintain adequate infiltration under high intensity rainfall conditions. Cochrane et al. (2005) evaluated PAM amendment on steep coarse-textured soil and found an average of 90% erosion reduction and 35% runoff reduction when PAM was sprayed before rainfall. PAM use for erosion control benefits water quality in a number of ways. By preventing erosion, it reduces suspended solids, nutrients and pesticides released from eroded sediment (Entry and Sojka, 2003). PAM has also been proven to be highly effective at sequestering microorganisms in runoff (Entry et al., 2003). Therefore, PAM can significantly reduce the risk of pathogen contamination of surface waters when applied to fields amended with animal manures.

Figure 2. Effect of PAM on Irrigation Erosion Control (Source: USDA)

PAM is a highly versatile material for soil erosion control. PAM improves soil stability to prevent soil detachment and increase infiltration rates. PAM can provide quick stabilization where vegetation has yet to be established. Multiple water quality parameters can be improved by PAM due to its unique flocculation properties. The cost of PAM application is typically less than conventional BMPs (VDCR, 2002; Sojka et al., 2007). Because of these benefits, PAM has become a popular soil erosion control tool in agriculture especially in surface irrigated agricultural systems in the Western US. In addition to agricultural erosion control, PAM has been successfully used for construction site erosion control and stormwater treatment in recent years. By far the most significant environmental effect of PAM use for erosion reduction is its improvement of surface water quality. This is achieved through reduction in sediment and nutrient losses, and decreases in contaminants released from sediment in runoff.

PAM use is one of the most effective, economical, and easily implemented technologies that can achieve required water quality improvements. PAM application is a promising technology that can be used in South Dakota to control soil erosion and improve surface water quality. The effectiveness of PAM is affected by many parameters including soil type, pH, temperature, organic matter, and the type and dose of PAM (McLaughlin and Bartholomew, 2007). The optimum PAM application conditions are site-specific. Therefore, the application of PAM for water quality control requires an evaluation of the specific soil and climatic conditions. We propose to evaluate the effectiveness of PAM flocculation to reduce suspended solids, bacteria and nutrients in agricultural runoff in South Dakota. The proposed project will assess factors affecting PAM flocculation of a variety of agricultural soils in the state. Based on the results of this project, we will identify the optimum PAM application conditions that will effectively control soil erosion and reduce sediment, bacteria, and nutrient loadings to surface water resources. The results of this project will help policy makers and producers make informed decisions regarding the use of PAM for agricultural runoff water quality control in South Dakota.

The South Dakota Nonpoint Source Pollution (NPS) Program is implemented through the watershed project work group in the DENR. The Program focuses on the restoration and maintenance of the beneficial uses of the State's water resources impaired by nonpoint source pollution. The proposed project will evaluate the use of PAM to control the levels of TSS, bacteria and nutrients in agricultural runoff. These contaminants have been identified as the leading causes of water quality impairment in the State. PAM has great potential to improve surface water quality in South Dakota. Therefore, the proposed project is consistent with water quality priorities specified in the SD NPS Program Management Plan (SD DENR, 2007).

2.2 Water Body Information

The proposed project will evaluate the effectiveness of PAM to reduce the TSS, bacteria, and nutrients in agricultural runoff in South Dakota. We will determine the optimum PAM application conditions to reduce soil erosion and improve surface water quality. The results of this project can be used by producers to improve water management and reduce the loads of suspended solids, nutrients and bacteria to natural water bodies in South Dakota. Therefore, the proposed project will have statewide implications. We will evaluate the PAM application on a variety of soils collected from different agricultural fields. The project will involve multiple watersheds in South Dakota.

2.3 Project Map

Figure 3 presents the surface water resources of South Dakota and status of total maximum daily loads (TMDL) of each water body. This Figure is adopted from the 2012 Integrated Report for Surface Water Quality Assessment (SD DENR, 2012).

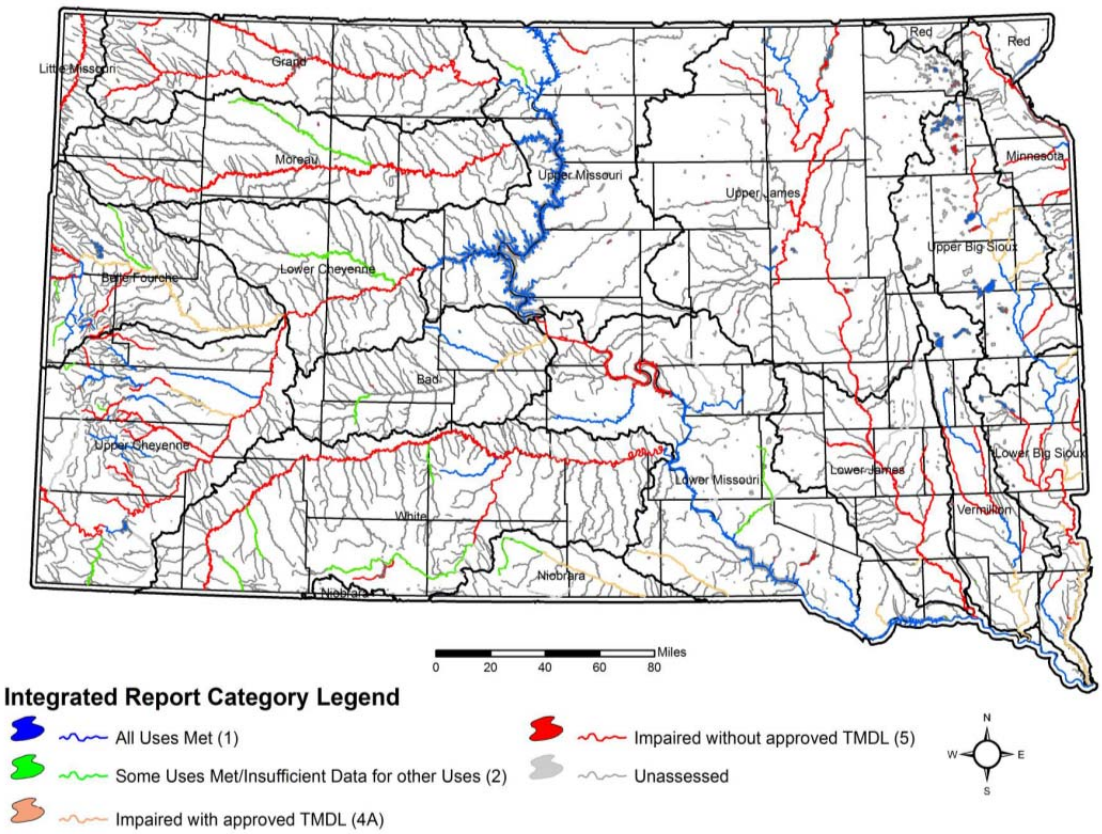

Figure 3. Surface water resources in South Dakota and their TMDL status (DENR 2012 Integrated Report for Surface Water Quality Assessment)

2.4 General Watershed Information

South Dakota has 14 major watershed basins, as shown in Figure 4. The Missouri River watershed is the biggest watershed covering South Dakota. The majority of the watershed basins in South Dakota are part of the larger Missouri River drainage. Only two watersheds do not drain into the Missouri River. The Red River in northeastern South Dakota starts at Lake Traverse and drains north into Lake Winnipeg. The Minnesota River drains east and flows into the Mississippi River. Eastern South Dakota typically has greater precipitation and lower topography than the western part of the state. Western South Dakota is part of the Great Plains with a semi-arid climate and more rugged topography.

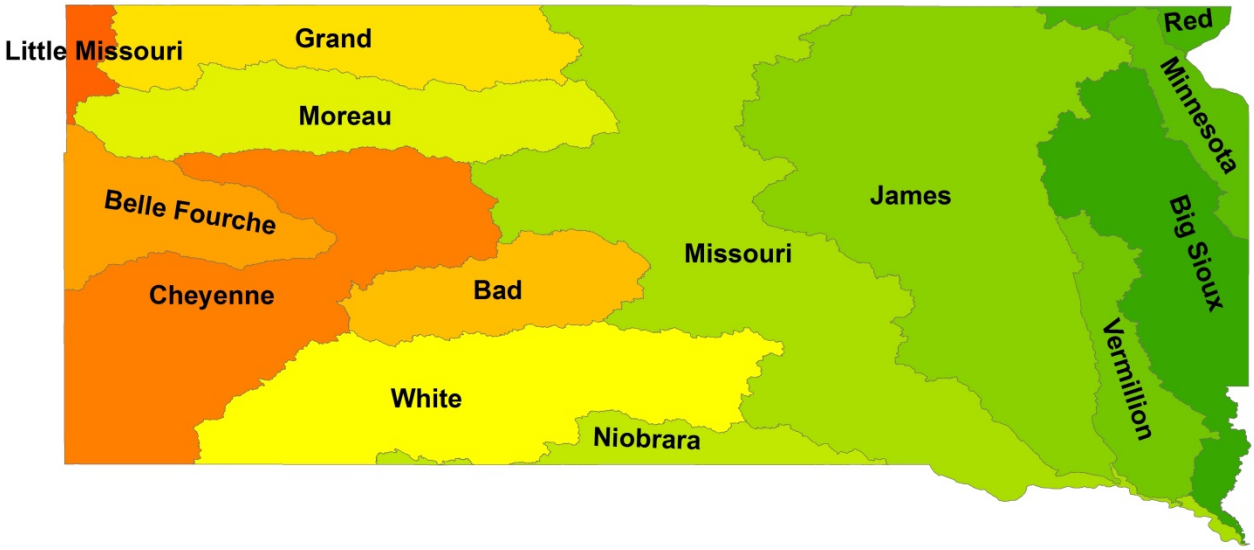

Figure 4. Major South Dakota watersheds

3.0 Project Description

3.1 Project Outcomes

The primary objective of this demonstration project is to evaluate the effectiveness of PAM flocculation to reduce the levels of TSS, nutrients and bacteria in agricultural runoff in South Dakota. The long-term goal of the project team is to develop an efficient and sustainable PAM BMP that can be used by producers to improve surface water quality in the state. The proposed project will assess factors affecting PAM flocculation on a variety of agricultural soils in South Dakota. Based on the results of this project, we will identify the optimum PAM application conditions that will effectively control soil erosion and reduce sediment and nutrient loadings to surface water resources. The results of this project will help policy makers and producers make informed decisions regarding the use of PAM for agricultural runoff water quality control in South Dakota.

The anticipated outcomes of this project are as follows:

1. Select effective PAMs that promote TSS flocculation of agricultural soils in South Dakota.

2. Demonstrate the effectiveness of PAMs on TSS removal of agricultural runoff.

3. Demonstrate runoff water quality improvement (TSS, nutrients, and fecal coliforms) by PAM amendment at a pilot-scale agricultural field.

4. Provide education on PAM flocculation to producers, state regulators, water quality experts, and other stakeholders.

3.2 Outcomes, Targets, and Tasks

Outcome 1: Select effective PAMs that promote TSS flocculation of agricultural soils in South Dakota

PAM is a class of long-chain polymers that has many different properties. The critical PAM characteristics are net charge, charge densities, and molecular weight. The flocculation of PAM and soil particles is affected by the physical and chemical properties of the particles, PAM types, and environmental conditions. Many studies and field applications show that the effectiveness of PAM flocculation is influenced by soil texture, multivalent cations, pH, clay mineralogy, temperature, and type and dose of PAM. The selection of a specific PAM for a given soil is often accomplished through the batch screening process. We will select representative agricultural soils in South Dakota to perform laboratory flocculation tests to determine the effectiveness of PAM on soils in the state. Key factors will be considered in the agricultural soil selection include soil types, geographic locations, and proximity to a watershed. We expect to collect at least 6 different soils across South Dakota, and these soils will cover both Eastern and Western South Dakota.

Once a specific agricultural soil is collected, we will mix the soil with water to produce a solid suspension. Then, we will perform flocculation tests to determine the TSS removal by different PAMs at different doses under controlled conditions. We will select commercially available PAMs that have different molecular weights and charge densities for this project. Turbidity and TSS removal will be monitored for each flocculation test. Table 1 present the properties of several commercial PAMs that can be used for the flocculation tests. We will select a final list of the PAMs for this project based on their physical and chemical properties, availability, cost, and reported performance.

Table 1. Properties of Several Commercial PAMs

PAM Type	Molecular Weight ($Mg\ mol^{-1}$)	Charge Density (%)
SF N300	15	0
SF N300LMW	6	0
SF A100	16	7
SF A110	15	18
SF 150	15	50
SF A150HMW	17	50
SF 1606	28	30
Soil Polybead	16	30
Chemtall 923VHM	14-17.5	20

The impact of low temperatures on PAM flocculation should be considered when applying PAM in cold regions. The flocculation process tends to be slower at low temperatures, and the size and strength of the flocs are also affected by the temperature. Most of the investigations on erosion control using PAM are conducted at relatively high temperatures. Little is known about the effect of low temperatures on the effectiveness of PAM. We will perform a number of PAM flocculation testes under low temperatures (4 ^{o}C) to determine their impact on different PAMs

and soils. The results of the low temperature flocculation tests will have significant implications on PAM applications in South Dakota.

Target 1: Select representative agricultural soils and PAMs for this project

Task #1: Selection of Representative Agricultural Soils		
Task Description:	The project team will select representative agricultural soils for the flocculation tests. The selection will be based on soil types, proximity to surface water resources, and geographical locations.	
Task Output:	Representative agricultural soil samples are collected for this project.	
Cost:	Federal (319) Funds:	$1,000
	Non-Federal Match:	$2,000
	Other Federal Funds:	$0
	Total Task Cost:	$3,000

Task #2: Selection of PAMs for the Flocculation Tests		
Task Description:	The project team will conduct a comprehensive review of the commercially available PAMs. We will select several PAMs for the flocculation tests based on their reported performance, physical and chemical properties, and costs.	
Task Output:	Several commercial PAMs are selected for the flocculation tests.	
Cost:	Federal (319) Funds:	$0
	Non-Federal Match:	$1,000
	Other Federal Funds:	$0
	Total Task Cost:	$1,000

Target 2: Evaluate the impact of PAM types and doses on the flocculation of agricultural soils

Task #3: Flocculation Tests of Different PAMs and Soils		
Task Description:	The project team will conduct a series of laboratory flocculation tests under controlled conditions. We will create simulated runoff samples by mixing soil samples with water. We will investigate the reduction of turbidity and TSS of each sample through flocculation with selected PAMs at different doses.	
Task Output:	The effectiveness of PAM flocculation on agricultural soils is determined through laboratory tests.	
Cost:	Federal (319) Funds:	Labor costs are included in the overall budget.
	Non-Federal Match:	$0
	Other Federal Funds:	$0
	Total Task Cost:	Labor costs are included in the overall budget.

Target 3: Evaluate the impact of low temperature on the effectiveness of PAM flocculation

Task #4: PAM Flocculation Tests Under Low Temperatures		
Task Description:	The project team will conduct a series of laboratory flocculation tests under a temperature at 4 ^{o}C. We will select several PAMs and soil samples based on the results of Task #3. We will determine the impact of low temperature on PAM flocculation.	
Task Output:	The impact of low temperature on PAM flocculation of agricultural soils is determined through laboratory tests.	
Cost:	Federal (319) Funds:	Labor costs are included in the overall budget.
	Non-Federal Match:	$0
	Other Federal Funds:	$0
	Total Task Cost:	Labor costs are included in the overall budget.

Outcome 2: Demonstrate the effectiveness of PAMs on TSS removal of agricultural runoff

The project team will conduct PAM flocculation tests on runoff samples collected from a silt clay loam soil. The goal of these flocculation tests is to demonstrate the effectiveness of PAMs on TSS removal from actual field runoff samples. We will use the agricultural field that is currently used for an existing SD 319 project titled "Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading". One of the project team members for this proposal, Jeppe Kjaersgaard is the primary contact for this 319 project. We will collect at least 4 runoff samples from the field. These samples will cover different seasons. The advantages of using runoff samples from this site for this project are that the project team has already gained a good understanding of the runoff water quality of this site, and that automated runoff water sample collection equipment has been installed at the site.

The location of this site is in Moody County approximately 8 miles southeast of Colman SD. Surface runoff from the demonstration site drains into Bachelor Creek located about a half mile south of the site. Bachelor Creek drains into the Big Sioux River (BSR) about five miles east of the site. The BSR drains part of the Coteau des Prairies, a plateau rising above the prairie composed of thick glacial deposits. The glacial drift overlays bedrock and ranges in thickness from a few feet to nearly 200 feet and groundwater levels are typically shallow. The average annual precipitation at the field site is 23 inches, of which three-quarters typically falls during the growing season April through October. The average annual snowfall is 37 inches per year (SDSU Climate Office, 2012).

Target 4: Collect runoff samples from the selected agricultural field

Task #5: Agricultural Runoff Collection		
Task Description:	The project team will collect runoff samples from the selected agricultural field using existing automated sampling equipment. We will collect at least 4 runoff samples that represent different seasons.	
Task Output:	Representative runoff samples are collected from an agricultural field.	
Cost:	Federal (319) Funds:	$1,000
	Non-Federal Match:	$1,000
	Other Federal Funds:	$0
	Total Task Cost:	$2,000

Target 5: Perform laboratory flocculation tests to demonstrate the effectiveness of PAMs on TSS removal from the agricultural runoff samples

Task #6: PAM Flocculation Tests of Agricultural Runoff Samples		
Task Description:	The project team will conduct a series of laboratory flocculation tests of the collected agricultural runoff samples. We will select PAMs for runoff sample tests based on the results of soil sample tests (Tasks #3 and #4). The impact of PAM doses and temperatures on TSS removal will be investigated during the runoff flocculation tests.	
Task Output:	The effectiveness of PAM on TSS removal from the agricultural runoff samples is determined through laboratory flocculation tests.	
Cost:	Federal (319) Funds:	Labor costs are included in the overall budget.
	Non-Federal Match:	$0
	Other Federal Funds:	$0
	Total Task Cost:	Labor costs are included in the overall budget.

Outcome 3: Demonstrate runoff water quality improvement by PAM amendment at a pilot-scale agricultural field

We will conduct a field test to demonstrate the runoff water quality improvement by PAM amendment at a pilot-scale agricultural field. We will use SDSU Southeast South Dakota Experiment Station as the demonstration site for this project. The Southeast Experiment Station is located at Beresford, SD. The station focuses on production agronomics in the heart of South Dakota's corn and soybean country. It consists of 550 acres of dryland row crops, small grains, and forages, and annually feeds nearly 1,000 head of beef cattle and swine. The combination of crops and livestock makes this research station unique among the SDSU research stations, allowing scientists to take a systematic approach much like those on diversified farms in the area. This station is often the final testing ground where producers see and evaluate new technology before adapting it to their operations.

We will use a rainfall simulator to simulate the runoff for the demonstration tests. The project team will conduct rainfall simulation tests to demonstrate water quality improvement by PAM amendment at a pilot-scale agricultural field. We will select one PAM for the demonstration tests based on results of laboratory flocculation tests. We will develop two identical soil plots at the

demonstration site, and apply the selected PAM at one of the two soil plots. The other plot serves as the control. Rainfall simulation tests will be performed on both plots under the same conditions. Runoff samples will be collected and transported to the laboratory at SDSU immediately after the rainfall simulation tests. These runoff samples will be analyzed for pH, TSS, turbidity, fecal coliforms, nitrate, and phosphate.

Target 6: Perform rainfall simulation tests to demonstrate the water quality improvement by PAM amendment at a pilot-scale agricultural field

Task #7: Rainfall Simulator Setup at SDSU Southeast South Dakota Experiment Station		
Task Description:	The project team will develop two identical soil plots at the demonstration site. We will set up the rainfall simulator at the two soil plots.	
Task Output:	A rainfall simulator and soil plots are set up at the SDSU Southeast South Dakota Experiment Station.	
Cost:	Federal (319) Funds:	$0
	Non-Federal Match:	$1,000
	Other Federal Funds:	$0
	Total Task Cost:	$1,000

Task #8: Field Demonstration of Water Quality Improvement by PAM Amendment		
Task Description:	The project team will conduct rainfall simulation tests to demonstrate water quality improvement by PAM amendment. We will apply the selected PAM at one of the two soil plots. The other plot serves as the control. We will analyze TSS, fecal coliforms, nitrate and phosphate of the simulated runoff samples from the two soil plots.	
Task Output:	Field demonstration of water quality improvement by PAM amendment is performed using a rainfall simulator.	
Cost:	Federal (319) Funds:	$0
	Non-Federal Match:	$1,000
	Other Federal Funds:	$0
	Total Task Cost:	$1,000

Outcome 4: Provide education on PAM flocculation to producers, state regulators, water quality experts, and other stakeholders

We will maintain a project website to share the information gained through this project. The project team will present the results of this project at regional and national conferences. At the completion of this project, we will develop educational brochures summarizing the results of this project. The educational brochures will be distributed to producers, state regulators, water quality experts, and other stakeholders at project meetings, conferences, and appropriate seminars and workshops. These educational documents will also be available to the public through the project website.

Target 7: Maintain the project website and upload project materials, and develop and distribute educational brochures

Task #9: Maintain the Project Website		
Task Description:	The project team will maintain a website for this project. We will post project results, presentations, and other pertinent information at the website.	
Task Output:	An active project website is maintained by the project team.	
Cost:	Federal (319) Funds:	Labor costs are included in the overall budget.
	Non-Federal Match:	$0
	Other Federal Funds:	$0
	Total Task Cost:	Labor costs are included in the overall budget.

Task #10: Develop Educational Brochures		
Task Description:	We will develop educational brochures based on the results of this project. We will distribute these brochures through appropriate conferences, workshops, and meetings.	
Task Output:	Project educational brochures are produced and distributed to policy makers, producers, water quality experts, and other stakeholders.	
Cost:	Federal (319) Funds:	$500
	Non-Federal Match:	$0
	Other Federal Funds:	$0
	Total Task Cost:	$500

Target 8: Submit annual and final reports to SD DENR summarizing the project activities, results and conclusions

Task #11: Semi-annual, Annual and Final Reports		
Task Description:	The project team will prepare semi-annual and annual reports for the SD DNER summarizing the project progress and results. We will prepare a final report for the SD DENR summarizing the project activities, results and conclusions.	
Task Output:	Annual and final reports are submitted to SD DENR on time.	
Cost:	Federal (319) Funds:	Labor costs are included in the overall budget.
	Non-Federal Match:	$0
	Other Federal Funds:	$0
	Total Task Cost:	Labor costs are included in the overall budget.

3.3 Milestone Table

The milestone table is included as Attachment 1.

3.4 Project Management and Tracking

The primary project team members include the following faculty members from SDSU:

Guanghui Hua, PhD, Civil and Environmental Engineering (Principal Investigator, PI)
Christopher Schmit, PhD, Civil and Environmental Engineering (Co-PI)
Jeppe Kjaersgaard, PhD, South Dakota Water Resources Institute (Co-PI)
Christopher Hay, PhD, Agricultural and Biosystems Engineering (Co-PI)

The team members for this project have extensive experience and technical expertise in the areas of agriculture and water quality control. The project team members have successfully managed and completed many application projects in the areas of agricultural water quality and quantity, water and wastewater treatment, and education and outreach. PI Hua is currently managing a USDOT project to evaluate the PAM application to reduce turbidity from construction site runoff. Co-PI Schmit has substantial experience with laboratory and pilot-scale water and wastewater treatment projects. Co-PI Kjaersgaard is currently managing an existing SD 319 project titled "Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading". Co-PI Hay is the coordinator for a SD 319 project titled "Cropland Planning for Water Quality Improvement". Therefore, the project sponsors are well qualified to manage this demonstration project.

3.5 Permits

This project will use existing facilities to collect agricultural runoff samples. No permit is required for the proposed project.

4.0 Coordinating Plan

4.1 Cooperating Organizations

South Dakota State University
The SDSU faculty and staff members assembled for this project have substantial experiences in agriculture and water quality issues. The PAM flocculation tests and water quality analysis will be conducted at the Water and Environmental Engineering Research Center (WEERC), located in the College of Engineering at SDSU. The WEERC has ample bench and lab space for this project. The WEERC is equipped with a variety of instruments capable of analyzing the water quality parameters required for this project. The project team has access to a rainfall simulator for the field demonstration tests. The project team also has access to automated sampling equipment to collect runoff samples from the selected agricultural field. All equipment to maintain the existing runoff sampling is available.

East Dakota Water Development District
The East Dakota Water Development District (EDWDD) will be a partner with SDSU to develop PAM flocculation technology for water quality improvement by contributing $6,000 over a two-year period. The matching funds from EDWDD will be used to support travel and laboratory costs. A letter of commitment is included as Attachment 2.

4.2 Local Support for the Project

The EDWDD has provided a matching fund to support this project. The EDWDD will also be involved in the education portion of this project. We will use an existing runoff collection system at a local land to collect runoff samples for the flocculation tests. The water sample collection system is established for an existing SD 319 project titled "Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading".

4.3 Duplicate Effort

The proposed project is designed to develop a PAM flocculation technology to reduce TSS, bacteria, and nutrients in agricultural runoff, thereby improving surface water quality. No similar activities are being undertaken to duplicate efforts.

4.4 Assumption of the Responsibilities of Other Entities

The proposed project does not fall under the responsibility of other entities.

5.0 Evaluation and Monitoring Plan

5.1 Monitoring Strategy

A water quality monitoring plan for a watershed is not proposed for this project. The project will involve water quality analyses for laboratory PAM flocculation tests and field demonstration tests. The water quality analyses for those tests are described in Section 3.2.

5.2 Sampling and Analysis Plan

The protocols for field sampling and water quality analyses will follow the Standard Methods (APHA et al., 2012) and the DENR standard operating procedures.

5.3 Quality Assurance Project Plan

This project will be evaluated based on the proposed project activities, schedule, and outcomes. The following project performance measures are proposed for the evaluation of success.

1. The project is completed on time based on the proposed project schedule.
2. The effectiveness of PAM flocculation on TSS removal is determined through laboratory flocculation tests. Effective PAMs that promote TSS flocculation of agricultural soils in South Dakota are selected through these tests.
3. A field test is performed to demonstrate the water quality improvement through PAM amendment.
4. Semi-annual and annual reports are submitted to DENR on time. A final report is submitted to DENR at the end of this project. The report summarizes the objectives, activities, and outcomes of the project. The report provides recommendations on the application of PAMs in South Dakota to reduce TSS, bacteria and nutrients in agricultural runoff.

The field sampling procedures and laboratory water quality analyses will follow the Standard Methods (APHA et al., 2012) and the DENR standard operating procedures. We will use agricultural soil flocculation tests, runoff flocculation tests, and a field demonstration to

determine the effectiveness of PAMs to improve agricultural runoff water quality in South Dakota. For Outcome 1, we will collect a variety of soil samples at different geological locations such that the results of PAM flocculation tests will have statewide applications. For Outcome 2, we will collect runoff samples from different storm events including the spring snow melting and summer storms to determine the impact of different runoff water quality on PAM effectiveness. For Outcome 3, field demonstration tests using a rainfall simulator will be performed to verify the water quality improvement (TSS, bacteria and nutrients) through PAM amendment.

The results from the laboratory flocculation tests and field demonstration tests will determine types of PAMs that can effectively reduce TSS, bacteria and nutrients in agricultural runoff in South Dakota. We will perform a number of flocculation tests at low temperatures to determine the effectiveness of PAM during cold weather. The results of this project will help policy makers and producers make informed decisions regarding the use of PAM for agricultural runoff water quality control in South Dakota.

We will produce educational brochures to provide education on PAM flocculation to producers, state regulators, water quality experts, and other stakeholders. We will distribute the brochures through appropriate meetings, workshops, and conferences. Semi-annual and annual reports will summarize the project activities, progress toward project millstones, and cumulative progress toward meeting the project goals. A final report will be submitted to DENR at the end of this project.

5.4 Data Collection, Management, and Analysis

The soil and runoff sample collections are described in Section 3.2. The soil and runoff samples will be transported to the WEERC at SDSU immediately after collection. The WEERC has the necessary bench area, equipment, and instrument for the experiments and sample analyses for this project. We will perform the PAM flocculation tests and required water quality analyses at the WEERC.

5.5 Models

The proposed project does not involve the use of models.

5.6 Operation and Maintenance

The proposed project does not involve the operation and maintenance of BMP facilities.

6.0 Information and Education

6.1 Information and Education Activities

Information and education activities are described in Section 3.2.

7.0 Budget and Budget Justification

Budget and budget justification are provided in Attachment 3.

8.0 Literature

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Attachment 1
Milestone Table

Project Name: Evaluating the Effectiveness of Polyacrylamide Flocculation to Reduce Suspended Solids, Bacteria and Nutrients in Agricultural Runoff
Date: July 1 2014 – June 30 2016

Task	Group	Quantity	2014		2015				2016	
			July-Sep	Oct-Dec	Jan-Mar	Apr-Jun	July-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Outcome 1: Selection of Effective PAMs										
Target 1: Agricultural Soils and PAMs										
Task 1: Soils collection	1,4	6	2	2	2					
Task 2: PAMs collection	1,4	6	2	2	2					
Target 2: Soil Flocculation Tests										
Task 3: PAM and soil flocculation	1	6 tests			2	2	2			
Task 4: Low temperature flocculation	1	6 tests			2	2	2			
Outcome 2: Runoff Flocculation Tests										
Target 4: Runoff Samples										
Task 5: Runoff samples collection	1,4	4 samples				2		2		
Target 5: Runoff Sample Flocculation										
Task 6: Runoff samples flocculation tests	1	4 tests				2		2		
Outcome 3: Field Demonstration										
Target 6: Field Rainfall Simulation Tests										
Task 7: Rainfall simulator setup	1,4	1								1
Task 8: Field PAM amendment tests	1,4	2 tests								2
Outcome 4: Education and Reporting										
Target 7: Information Transfer										
Task 9: Project website	1	2 years				1				1
Task 10: Educational brochures	1,2,3,4	300 copies							150	150
Target 8: Reports										
Task 11: Semi-annual reports	1,3	2 reports				1				1
Task 11: Annual reports	1,3	2 reports		1				1		
Task 11: Final report	1,3	1 report								1

Groups:
1. Project coordinator and SDSU project staff
2. Federal: NRCS
3. State: DENR
4. Local: EDWDD, Local Agricultural Fields

Attachment 2

Attachment 3

Budget

Project Name: Evaluating the Effectiveness of Polyacrylamide Flocculation to Reduce Suspended Solids, Bacteria and Nutrients in Agricultural Runoff
Date: July 1 2014 – June 30 2016

Item	Year 1	Year 2	Total	319-EPA	State	Local
	2014-2015	2015-2016			SDSU	EDWDD
Project Coordinator and staff, including benefits	$32,662	$33,672	$66,334	$23,792	$42,542	
Graduate assistant, including benefits	$18,805	$19,369	$38,174	$38,174		
Travel	$2,000	$2,000	$4,000	$2,000		$2,000
Tuition remission	$3,000	$3,200	$6,200	$6,200		
Project Task Costs (most of the costs are included in personnel and travel)						
Task 1: Soils collection	$1,000		$1,000			$1,000
Task 2: PAMs collection	$500	$500	$1,000			$1,000
Task 3: PAM and soil flocculation						
Task 4: Low temperature flocculation						
Task 5: Runoff samples collection						
Task 6: Runoff samples flocculation tests						
Task 7: Rainfall simulator setup		$1,000	$1,000			$1,000
Task 8: Field PAM amendment tests		$1,000	$1,000			$1,000
Task 9: Project website						
Task 10: Educational brochures		$500	$500	$500		
Task 11: Reports						
Indirect costs (27%)	$15,786	$16,400	$32,186	$19,080	$13,106	
Total Project Cost	$73,753	$77,641	$151,394	$89,746	$55,648	$6,000
Match					$55,648	$6,000

Match percentage: 40.7%

Budget Justification

Personnel Support for Project Staff

Project Principal Investigators

$6,264 and $6,452 for project years 1 and 2 are requested for salary for project PI Hua. $2,001 and $2,061 for project years 1 and 2 are requested for salary for project Co-PI Kjaersgaard. $1,927 and $1,985 for project years 1 and 2 are requested for salary for project Co-PI Hay. The overall fringe benefit rate for the PIs at SDSU is 15% of the annual salary plus $7,629 annual health and life benefit prorated to percent effort on the project. The funds will be used by the PI and Co-PIs to manage the project, direct the field sampling and laboratory tests, oversee the field demonstration tests, prepare educational brochures, and write the reports.

Other Personnel

Support for a graduate student is requested for project years 1 and 2 at $18,436 for project year 1 and $18,989 for project year 2 with benefits corresponding to 2% of the salary. The graduate student will collect field samples, perform laboratory flocculation tests, analyze water quality parameters, conduct field demonstration tests, and assist with the project outreach efforts.

Travel

$1,000 is requested for travel each project year at 2000 miles per project year at $0.50 per mile. This fund will be used to collect soil samples across South Dakota, collect runoff samples at the selected agricultural field, and perform field demonstration tests. State motor poll cars and pickups will be used for the travelling.

Publication

$500 is request to produce 300 copies of the educational brochures. These brochures will be used to provide education on PAM flocculation to producers, state regulators, water quality experts, and other stakeholders.

Other Direct Costs

Tuition Remission

The student tuition remission rates at South Dakota State University are $3,000 and $3,200 for academic years 2014 and 2015.

Indirect Costs

As specified in the SD Board of Regents (SD BOR) Policy Manual 5:2:3 indirect costs are real and defensible costs of conducting sponsored activities. As per guidelines in the SD BOR Policy Manual 5:2:4 indirect costs for state agencies are calculated using 60% the federally negotiated indirect cost rate of 45%, or 27% of the project direct costs. The SDSU Cognizant Agency is DHHS, Helen Fung, phone 415-0437-7820.

Matching Funds

Cash Match

A total of $6,000 in cash match is provided.

The East Dakota Water Development District will provide a total of $6,000 in cash to support travel, laboratory supplies and field demonstration tests.

In-Kind Match

Project PI Hua will provide in-kind match corresponding to 8.3% of his annual salary. Project Co-PI Schmit will provide in-kind match corresponding to 5% of his annual salary. Project Co-PI Kjaersgaard will provide in-kind match corresponding to 3% of his annual salary. Project Co-PI Hay will provide in-kind match corresponding to 3% of his annual salary. Benefits are an additional 15% of the salary request plus $7,629 health and life insurance prorated to percent effort on the project. The indirect cost rate is 27%.