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GRANT APPLICATION TRANSMITTAL

This page indicates university endorsement of the referenced proposal and is intended to be submitted to the sponsor organization.

Sponsor Organization: EPA/North Dakota Department of Health

Project Title *Demonstration and Evaluation of Vegetative Buffer Strips to Minimize Runoff Pollution and Pathogen from Feedlot*

Project Director: Shafiqur Rahman

Department: Agricultural and Biosystems Engineering

Project Budget:

Total Direct Costs		$ 76,770
F&A/In-direct Costs		$ 8,530
F&A/IDC Rate	10%	
Total Requested		$ 85,300

Authorized University Representative: Amy Scott

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Date: 11-8-11

Any future notifications regarding this proposal, including award notices, should be directed to the authorized university representative at the address listed above.
Thank you.

1.0 PROJECT PROPOSAL SUMMARY SHEET- PHASE II

PROJECT TITLE: Demonstration and Evaluation of Vegetative Buffer Strips to Minimize Runoff Pollution and Pathogen from Feedlot

LEAD PROJECT SPONSOR: North Dakota State University

CONTACT PERSONS:

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STATE: North Dakota WATERSHED: Statewide

PROJECT TYPES: I&E

WATERBODY TYPES: Lakes/reservoirs, Rivers, Streams

NPS CATEGORY: Agriculture

PROJECT LOCATION: Cass County and Sargent County

SUMMARIZATION OF MAJOR GOALS:

This project will focus on best management practices to minimize nutrients and pathogen runoff from feedlot. This project, during and upon completion, will provide educational and informational support to ongoing NPS 319 projects in the state of ND to improve public understanding and increase awareness of non-point source (NPS) pollution control and minimize NPS pollution to water bodies.

PROJECT DESCRIPTION:

With expanding livestock facilities, animal agriculture is facing increasing environmental concern i.e. water and air pollution due to increased manure volume from expanding livestock facilities. Runoff from feedlot, manure storage can contaminate surface and groundwater, increasing the risk of waterborne illness. Runoff of nutrients (phosphorus and nitrogen) is causing eutrophication to surface waters in North Dakota. Similarly, runoff of manure borne pathogen may contaminate feed or feed crops (Berry et al., 2007). This project will demonstrate the effectiveness of vegetative buffer strips at to reduce NPS pollution from livestock feedlot areas. Upon completion of this project, recommendations for establishing buffer strips will be made.

FY12 -15 319 Funds requested ---$85,300 - Match $56,868 Total project costs $ $142,168

2.0 STATEMENT OF NEED:

With expanding livestock facilities, animal agriculture is facing increasing environmental concern i.e. water and air pollution due to increased manure volume from expanding livestock facilities. Similarly, pathogen presents in manure would likely to move into groundwater and surface water through runoff from feedlot. Waterborne illness is linked to municipal water supply is caused by runoff from land application of manure and runoff from feedlot (O'Connor, 2002; Berry et al., 2007). According to Burkholder et al. (2007) United States produces 133 million tons of manure per year on a dry basis, and the bulk of the manure is applied to crop and pastureland. Although manure is an excellent source of nutrients for plants and a good soil conditioner, but excessive field application of manure and improper manure management can negatively influence water quality. Runoff from feedlot, manure storage can contaminate surface and groundwater, increasing the risk of waterborne illness. Runoff of nutrients (phosphorus and nitrogen) is causing eutrophication to surface waters in North Dakota. Similarly, runoff or manure borne pathogen may contaminate feed or feed crops (Berry et al., 2007). According to the North Dakota 2010 integrated water quality assessment report a significant portion of aquatic life of North Dakota's rivers and streams are either considered threatened or not supporting aquatic life use due to non-point source pollution from animal feeding operations. The primary cause of impairment is excessive nutrient loading. Similarly, in the report they also indicated that pathogen (e.g., fecal coliform bacteria) resulting from animal feeding operations and riparian area grazing are the primary cause of recreational water impairment.

The major issue facing animal agriculture is managing excess P, N, pathogen and other pollutants in manure due to rapid growth of small and medium size animal feeding operations (AFOs). According to Koelsch et al. (2006) runoff from feedlot is a major contributor and it will continue to be a contributor to surface and groundwater impairment. Therefore, it is clear that NPS pollution of surface water from feedlot runoff is a growing concern in North Dakota, but no data on runoff water quality is available.

It is important to establish treatment system that effectively contain or reduce runoff pollutant from feedlot and manure storage areas. In recent years, vegetative filter strips/vegetative treatment system have become an important best management practices to minimize runoff from feedlots (Gilley et al. 2008) and land application (Stout et al., 2005; Woodbury et al., 2005). Others also demonstrated that vegetative buffers can be used to mitigate fecal coliform bacteria (Sullivan et al., 2007) and *Cryptosporidum* (Miller et al., 2008). Buffer is vegetative land that is managed so that pollutant transport does not occur from pollution source area to surface water that we wish to protect (Sullivan et al., 2007). Vegetative buffer strips (VBS) are widely used and are increasingly viewed as an alternative technology for improving the quality of runoff from pollutant source areas. For the past decades, researchers have demonstrated the effectiveness of VBS for nutrient and solids removal from feedlot (Lim et al., 1998). However, the occurrence and fate of pathogens in VFS had not been extensively monitored, especially due to elimination of long-term storage of runoff water.

Many different designs exist and the effectiveness of a VBS is highly dependent on site specific conditions as well as buffer location, width and length, vegetation type and species. In North Dakota, rainfall is highly spatial and temporally variable and the same is also true for cropping pattern. Due to diverse weather and cropping pattern, most of the existing technologies or best management practices developed to minimize runoff under a different geographic region are not directly transferable in North Dakota conditions. Besides, in North Dakota, NRCS is designing different types of vegetative treatment systems such as with and without settling basin. It is important to monitor and quantify runoff quality from different type of vegetative filter strip designs for improving the existing design and establishing new buffer areas.

Under the Phase-I, the PI is evaluating the performance of buffer strips for some time and preliminary results indicated that VFS was somewhat effective in reducing concentration of total solids (TS) by 33.7%, total suspended solids (TSS) by 68.0%, total phosphorous (TP) by 29.9%, ortho-phosphorous (OP) by 19.3%, ammonium nitrogen (NH_4-N) by 31.8%, total Kjeldahl nitrogen (TKN) by 35.6%, and potassium (K) by 19.8%. Figures 1-2 show some of the beneficial effects of vegetative buffer strip to reduce runoff pollution. Nitrate nitrogen (NO_3-N) concentrations at the outlet samples increased as expected, and the buffer was not effective in reducing soluble nutrients. Performance of the VFS indicated that a VFS can be used for reducing runoff pollution that comes directly from feedlot into VFS without passing through the settling basin. However, longer buffer lengths might be required for reducing soluble pollutants. Furthermore, in Phase I, pathogen component was not included. Further long term monitoring on the effectiveness of buffer is needed to prevent or minimize the movement of pollutants from livestock feeding area.

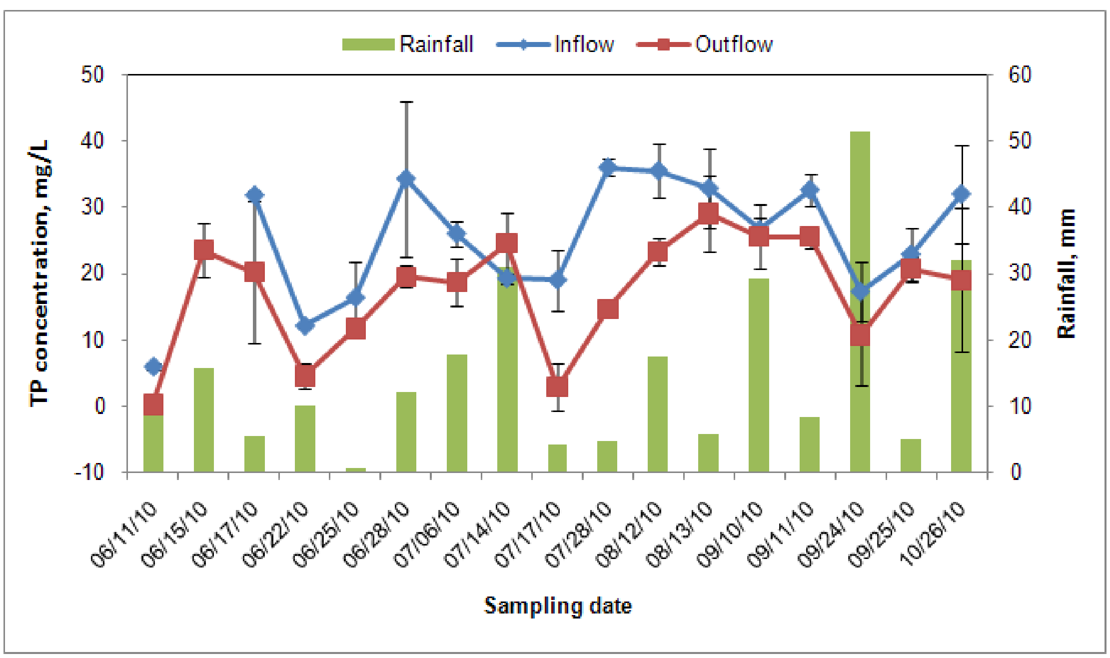

Figure 1. Variation in average TP concentration and standard deviation at different sampling events.

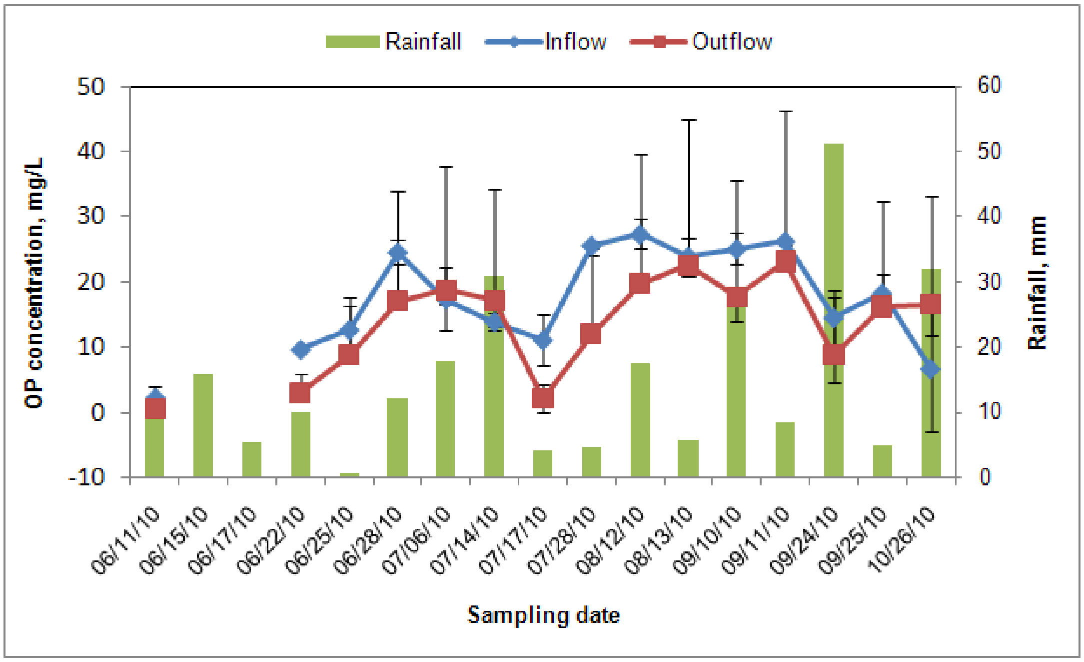

Figure 2. Variation in average OP concentration and standard deviation at different sampling events.

Therefore, this demonstration project will focus on evaluating performance of different types of vegetative filter strip design to reduce nutrient and pathogen runoff from feedlot under North Dakota management practices and climatic conditions. *This proposed project will be an extension of previously funding project (Project # H075-9).* The overall objective of this demonstration project is to reduce NPS pollution of nutrients and pathogen by implementing vegetative buffer strip.

3.0 PROJECT DESCRIPTION – PHASE II

Demonstration and Evaluation of Vegetative Buffer Strip to Minimize Nutrient and Pathogen Runoff from Feedlot

3.1. Goal

In the Phase I, no pathogen analysis was conducted. Therefore, the goal of this project is to continue project based on the outcome of Phase I to collect additional data on the effectiveness of vegetative buffer strips in reducing nutrients and pathogen runoff from livestock feedlots. Upon completion of this project, recommendations will be made for establishing and managing buffer strips for better performance. Also, data will be made available to state agencies, producers, stakeholders, and public for their uses and better decision. Presentations and publications will be made to increase awareness and understanding of the vegetative buffer strips and their effectiveness to reduce NPS pollution.

3.2 Objectives

Objective 1. Monitoring the effectiveness of vegetative buffer strips to reduce nutrients and pathogen runoff from feedlot under North Dakota management practices and climatic conditions

Currently, there are some limited data on nutrients runoff from feedlot, but no data on pathogen. Based on the data from Phase-I, it is important to continue monitoring runoff water quality from vegetative treated feedlot under different vegetative treatment design and management practices for a longer time to confirm the effectiveness. Additionally, there is a need to monitor runoff for pathogen, since both nutrients and pathogen contributed to water quality impairment and waterborne illness. Therefore, the following tasks will be carried out in Phase II.

Task 1: This demonstration will be carried out in two sites: at NDSU beef-cattle research complex at Fargo and KT Cattle farm at Congswell, ND. A support letter from the producer is included. These feedlots have unique characteristics. NDSU beef-cattle research facility has a monoslope barn, which is very unique and getting popular in the Midwest and no data is available on nutrient and pathogen runoff from this kind of barn. At the same time, vegetative design is also different from each other. At NDSU barn, runoff from feedlot is drained over the vegetative grass area and stored in the settling basin. While in the KT feedlot, it has a solid separator and following some sorts of separation, runoff went through the vegetative filter area to spreading area.

Product Selection of sites to collect runoff water samples

Estimated cost Both sites have already established vegetative filter strips. No additional costs for buffer areas establishment.

New task: As per NPS Pollution Task Force recommendation, additional suitable feedlot with buffer was explored, but no convenient location was found for field visit and sampling. Still, the PI is exploring an alternate site if one of the proposed sites is not suitable for demonstration and monitoring.

Task 2: Runoff collection and sampling structures will be installed in the inflow (at the end of pen) and outflow of filter strips (at the end of buffer length) to measure inflow and outflow nutrients and pathogen concentration in runoff to and from the VBS. A rain gauge will be installed on site to monitor precipitation; as well NDWAN weather station data will be used. ISCO automatic samplers will be installed to collect runoff at a predefined setup, as well grab sampling will be collected as needed. ISCO sampler will be set to activate automatically when runoff begins. A detailed sampling and analysis plan (SAP) has been included in Appendix 3. The activity will involve the inputs from PI, research specialist, graduate student, and other collaborators.

Collected runoff samples will be kept on ice and transported to the laboratory. Samples will be divided for nutrients and pathogen analysis. Due to budgetary constrain, samples will be analyzed for the presence of nitrite+nitrate--nitrogen (NO_2+NO_3-N), total

Kjeldahl nitrogen (TKN), orthophosphate phosphorus (PO_4-P), total phosphorus (TP) only. These parameters will be measured because these parameters are good indicators of water quality with respect to NPS pollution. All nutrient analysis will be determined by using EPA laboratory procedures (Budde, 1995) and Standard Methods (APHA, 2005).

Due to budget constrain, runoff samples will be quantified for bacterial count (e.g., most probable number - MPN) using IDEXX Quanti Tray/2000 procedure rather than sending them in a different lab for analysis. Depending on the MPN count, periodically, some samples will be cultured **for *E. coli* O157:H7** in the veterinary and microbiology sciences department in Dr. Margaret Khaitsa's lab as described in Khaitsa et al. (2005).

Product It is difficult to predict how many samples will be collected, since runoff is highly depended on antecedent soil moisture content, rainfall amount and rainfall frequency. Based on previous year sampling roughly 200-300 samples will be collected for selective nutrients and pathogen as indicated in Task 2.

Estimated Cost $142,168---$85,300 - 319 Grant, $56,868 in-kind match (salaries and fringe benefits of NDSU personnel contributing to the project as listed in Appendix-2 Table 1)

Task 3 Develop report and educational outreach materials to increase awareness about VBS and its effectiveness to minimize runoff pollutions. Provide valuable information to regulators and policy makers to minimize nutrient loading to surface water from feedlot operations.

Product Data will be available to public uses. To increase awareness and understanding, data will be presented at different venues and appropriate Extension publications/bulletins will be made. Disseminate findings in peer reviewed publications and scientific meetings. Roughly, one presentation per year and one Extension bulletin will be published on buffer effectiveness depending on the project outcome.

Estimated cost: $1,000---$1,000- 319 Grant, in-kind personal match

3.4 Briefly explain why the lead project sponsor is the appropriate entity to coordinate and/or carry out the project

North Dakota is a Land Grant University and the PI of this project has experiences and resources to undertake this proposed research successfully. As a result, NDSU is the appropriate entity to carry out the project.

4.0 COORDINATION PLAN:

The project leader (Dr. Rahman) has extensive experiences in designing, conducting and coordinating field experiment in manure management. Dr. Rahman will design and implement the project activities and will be responsible for installing monitoring instruments, coordinating and conducting the objective outlined in the project proposal.

Dr. Larry Cihacek will provide technical support in conducting laboratory analysis of soil and runoff water samples.

Dr. Margaret Khaitsa will provide technical support in conducting laboratory analysis of soil and runoff samples in determining pathogen.

Ron Wiederholt (Nutrient management specialist at Carrington REC) and Chris Augustin have extensive experiences in extension activities. They will assist in delivering educational program, conducting field days and other extension publications.

Dr. Saidul Borhan (research specialist), James Moos, and Jana Daeuber will assist with instrument installation, data logging and data processing during and following sample collection from field.

Kevin Throener, will provide access to his feedlot and also provide other logistical support during the monitoring period.

Trent Gilbery, NDSU Beef Research Center, will provide access to NDSU feed lot for installing instrumentation and sampling.

5.0 EVALUATION PLAN

The primary audiences addressed in this project are those engaged in managing nutrient runoff from beef cattle feedlot and manure applied to fields in North Dakota to protect water bodies within the state. This will include 319 watershed coordinators, stakeholders, extension agents, and other interested parties. The outcome of this demonstration project will be disseminated through workshop, fact sheets, leaflets, presentations and by other means to increase public awareness of best management practices to minimize NPS pollution. Following steps will be taken for evaluation purpose:

1. The effectiveness of buffer will be evaluated in terms of pollutant (nutrients and pathogen) reduction within the targeted buffer (e.g., pollutant entering and leaving buffer)

2. At the end of the project, recommendation will be made based on monitoring outcome

A detailed sampling and analysis plan (SAP) is included in Appendix 3.

6.0 BUDGET:

Due to budget constrain, a significant changes has been made. Initially, funding for graduate student was requested for three years, the revised budget is for two years. In the original budget, budget was requested for nutrient and pathogen analysis in a different lab. Now the PI has the capacity to do sample analysis in his lab rather than sending them in a different lab. As a result, sample analysis parameter and number of sample to be analyzed has been reduced significantly. However, it will not compromise the quality of the data collection and analysis. Similarly, in the original budget, pathogen analysis cost was included, but in the revised project the PI is requesting money to buy an IDEXX Quanti Tray system to quantify bacterial counts, which will reduce cost significantly. However, some budget has been requested for sample analysis to cross check with PI's lab analysis results. A detailed of budget has been listed in Appendix 2. The budget consisted of two parts: 319 fund and matching fund. The matching fund is in-kind match from the following contributors:

1. Shafiqur Rahman
2. Larry Cihacek
3. Ron Wiederholt
4. Saidul Borhan
5. James Moos
6. Jana Daeuber

The detailed of the budget has been outlined in part1 and part2 of appendix 2.

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APPENDIX 1

Milestone Table for Demonstration and Evaluation of Vegetative Buffer Strips to Minimize Runoff Pollution and Pathogen from Feedlot

Task/Responsible Organizations	Output	Qty	Year 1	Year 2	Year 3
Objective 1. Evaluation of Vegetative Buffer Strips to Minimize Runoff Pollution and Pathogen from Feedlot					
Task 1	Installation, monitoring & sampling of runoff from VBS	2			
Task 2	Data processing and analysis	2			
Task 3	Educational and outreach materials development	1-2			

APPENDIX 2

BUDGET TABLE FOR DEMONSTRATION AND EVALUATION OF VEGETATIVE BUFFER STRIP TO MINIMIZE RUNOFF POLLUTION

Part 1- Funding Source

Funding Source	2012-13	2013-14	2014-15	Total
EPA section 319 funds 1. FY09 Funds (FA)	35,070	29,570	12,130	76,770
Admin. Cost	3,897	3,286	1,348	8,530
Total EPA 319 Funds	**38,967**	**32,856**	**13,478**	85,300
State/Local Match Salaries and fringe benefits of NDSU personnel contributing to the project				
Shafiqur Rahman (4%)	4271	4399	4943	13613
Larry Cihacek (3%)	3134	3228	3324	9686
Ron Wiederholt (1%)	932	961	989	2882
Saidul Borhan (7%)	3875	3991	4111	11977
Jana Daeuber (3%)	2047	2107	2171	6325
James Moos (3%)	2167	2232	2299	6698
Admin. Cost match	**1,825**	**1,880**	**1,982**	**5,687**
Total NDSU Matching Funds	**18,251**	**18,798**	**19,819**	**56,868**
Total Budget	**57,218**	**51,653**	**33,297**	**142,168**

Percentages shown are for the first year, effort in subsequent years is adjusted according to project needs.

Part 2- Funding

Personnel / Support	2012-13	2013-14	2014-15	319 funds	In-kind/Cash	Total costs
Salary (1 graduate student)	16320	16320		32640		**32,640**
Travel (field trip and professional meeting)	2000	3500	2500	8000		**8,000**
Equipment/Supplies	13750	6750	5630	26130		**26,130**
Subtotals	***32,070***	***26,570***	***8,130***	***66,770***		**66,770**
Objective: Demonstration and Evaluation of Vegetative Buffer Strips to Minimize Runoff Pollution and Pathogen from Feedlot						
Salaries & fringe benefits of NDSU personnel	16,426	16,918	17,837		51,181	**51,181**
Sample analysis	3,000	3,000	3,000	9,000		**9,000**
Publication			1000	1,000		**1,000**
Subtotals	***3,000***	***3,000***	***4,000***	***10,000***	*51,181*	**61,181**
Administrative	3897	3286	1348	8,530	5687	**14,217**
Subtotals	***3,897***	***3,286***	***1,348***	***8,530***	***5687***	**14,217**
Total 319/Non-federal budget	**38,967**	**32,856**	**13,478**	**85,300**	**56868**	**142,168**

Revised Budget Justification

As per ND NPS Pollution Task Force recommendation, requested 319 funding amount for the proposed project cannot exceed $85,300. As a result, significant changes has been made in the revised budget in the project personal, sample analysis cost, lab supply, travelling and other direct cost as outlined below:

Personal: ($32,640)
One graduate student will conduct field data collection and assist in data analysis. Standard fringe rate (2%) for the North Dakota State University is applied to each year of salary. Total annual salary plus benefits is thus $16,320 per year for graduate student for two years. Total requested amount for the project $32,640.

Travel: ($8,000)

- Travel to animal feeding operations (300 miles round trip per sampling event at a rate of $0.51) to collect runoff samples manure samples. Also, funding has been requested to attend a professional meeting. Total trip 10-15 per year ($1,500 - $2,500)
- Travel to outreach Extension activities for the PI ($1,500)

Total travel expenses for year 1, 2, and 3 are $2,000, $3,500 and $2,500, respectively, and $8,000 for the project.

Lab supply ($26,130)
Due to budget constrain, most of the sample analysis will be conducted at PI's lab. As a result, budget has been requested for purchasing an IDEXX Quanti tray system, as well as for supplies to reduce sample analysis costs:

- IDEXX Quanti tray system (roughly **$7,500**) for pathogen quantification
- ISCO bottles, water samples collection bottles, reagents, IDEXX Quanti tray supply, software for sample analysis, etc. The requested amount for Yr1, Yr2, and Yr3 are $6,250, $6,750, and $5,630, respectively, and $**18,630** for the project.

Sample analysis ($9,000)
Due to budget constrain, most of the sample analysis will be conducted at PI's lab. However, for cross checking, samples will be sent to other labs from time to time.

- Contractual (Lab analysis fee $30/sample @50 samples/year for nutrients and 50 samples for pathogen, respectively). Lab analysis will include selective nutrients and pathogen only as indicated in Task 2. Requested amount for year 1, year 2 and year 3 are $3,000, $3,000, and $3,000, respectively. Total requested amount for the project **$9,000**

Publication ($1,000)

- Requested amount from year 3 is $1,000. Total requested amount **$1,000**.

319 funds

Total Direct Costs:	*$76,770*
Total Indirect Costs (10% of the total funds)	*$8,530*
Total Fund Requested	***$85,300***

Non-federal budget:
Match consists of NDSU salaries, fringe benefits, and administrative costs. Faculty and staff contributions are outlined in the project narrative. NDSU in-kind match is as follows:

Salaries	*$38,656*
Fringe benefits	*$12,525*
Administrative	*$5,687*
Total non-federal	**$56,868**

APPENDIX 3

Sampling and Analysis Plan (SAP)

Sample collection, preparation, and analysis

This project is designed to evaluate the efficacy of VBS to reduce total P, SRP, and other nutrients by sampling and analyzing the feedlot runoff entering and leaving VBS. In addition, pathogen quantification and reduction will also be performed on selected samples. Each demonstration site will be demonstrated for a period of three years.

Runoff samples entering and leaving VBS will be collected in a bucket and sample for the bucket will be collected using an automatic ISCO sampler. ISCO sampler will be set to activate automatically when runoff begins. The ABEN Department's research specialist and research assistant (graduate student) will collect and transport field samples to the Waste Management Lab (at ABEN department) for subsequent analysis. All sampling will occur depending on natural rainfall and runoff events. All field sampling activities (sampling location, sample ID, sampling time, etc.) will be documented into a field notebook. Following sample collection in each runoff event, bucket will be emptied for collecting next runoff. Upon collection, all samples will be kept in ice and transported to the laboratory ASAP for analysis.

In the waste management lab, samples will be subdivided for nutrient and pathogen analysis. Samples for nutrients will be analyzed for the presence of NO_2+NO_3-N, TKN, PO_4-P, and TP. All nutrient analysis will be conducted at the PI Waste Management Lab. From time to time, samples will be sent to other lab for cross checking.

For pathogen, IDEXX Quanti Tray/2000 procedure will be followed for bacterial counts. Also, runoff samples for pathogen will be analyzed for presence and absence **for *E. coli* O157:H7** in the veterinary and microbiology sciences department at NDSU. These parameters will be measured because these parameters are good indicators of water quality with respect to NPS pollution.

Failures in Sampling Methods Requirements and/or Deviations from Sample Design and Corrective Action

Any deviations of sampling and analysis procedure will require corrective action. Corrective action may include samples to be discarded and re-collected or outlier data will be discarded. It is the responsibility of the Project Leader, in consultation with collaborators, to ensure that any actions and resolutions to the problems will be documented and maintained in accordance with SAP.

Analytical Methods Requirements

A listing of analytical methods and equipment is provided in Table 1. Standard operating procedures will be established for all procedures undertaken by project personnel that concerns sample monitoring and analysis, and copies of the SOPs will be provided upon request.

Table 1. Laboratory Analytical Methods will be used in this project

Parameter	Method	Equipment Used
Nitrite+Nitrate Nitrogen	EPA 353.2	Lachat® QuickChem Autoanalyzer
Total Kjeldahl Nitrogen	EPA 353.2, modified	Lachat® QuickChem Autoanalyzer
Orthophosphate Phosphorus	EPA 365.2	Beckman® DU 640 Spectrophotometer
Total Phosphorus	EPA 365.4, modified	Lachat® QuickChem Autoanalyzer
E. coli O157:H7	Khaitsa et al. (2005)	PCR assay
E. coli O157:H7	IDEXX Quanti Tray/2000	IDEXX Quanti Tray 2000

EPA = Methods for Chemical Analysis of Water and Wastes, March 1983 and version 2, June 1999.

Failures in Measurement Systems and Corrective Actions

In the event of a failure in the analytical system, research specialist or research assistant will be able to correct the problem. If the problem is resolvable by the research specialist, then they will document the problem on the laboratory notebook and complete the analysis.