

**South Dakota Water Research Institute
Annual Technical Report
FY 2017**

Introduction

FY 2017 Annual Report Introduction

South Dakota Water Resources Institute's (SDWRI) programs are administered through the College of Agricultural and Biological Sciences at South Dakota State University (SDSU). Dr. Van Kelley has served as the Director for the Institute since August 1, 2000. Dr. Kelley is also the head of the Agricultural and Biological Systems Engineering Department. In addition to the Director, the Institute's programs are administered and executed by a staff consisting of an Assistant Professor and an Environmental Research Coordinator. During FY2017, the SDWRI financially supported, through its base funding, two graduate students (1 – MS, 1 – PhD) and four undergraduate research assistants. Two graduate students (1-MS, 1-PhD) and one undergraduate research assistant were supported through USGS 104g grant funding. Three graduate students were supported with supplemental grant funding.

The annual base grant from the United States Geological Survey (USGS) and a South Dakota legislative appropriation form the core of the SDWRI budget. The core budget is supplemented by research grants from state and federal agencies as well as private organizations and industry interested in specific water-related issues.

The mission of the South Dakota Water Resources Institute is to address the current and future water resource needs of the people, industry, and the environment, through research, education, and service. To accomplish this mission, SDWRI provides leadership by coordinating research and training at South Dakota State University and other public educational institutions and agencies across the state in the broad area of water resources. Graduate research training, technology transfer, and information transfer are services which are provided through the Institute.

This report is a summary of the activities conducted by the SDWRI during the period March 1, 2017 through February 28, 2018.

Research Program Introduction

FY 2017 Annual Report Research Program

Water is one of the most important resources in South Dakota. Together with the state's largest industry, agriculture, it will play an important role in the economic future of the state.

During FY 2017, the South Dakota Water Resources Institute (SDWRI) used its 104B Grant Program funds to conduct research of local, state, regional, and national importance addressing a variety of water problems in the state and the upper Midwest region.

The WRI 104B External Review Panel reviewed 6 grant applications, and 2 projects were funded that addressed research priorities that had a good chance of success, and would increase our scientific knowledge. The projects were titled:

- Evaluation of Nitrate Removal Rates of Denitrification Bioreactors Using Agricultural Residue Media. Lead PI: Dr. G. Hua, South Dakota State University.
- Evaluating E. coli particle attachment and the impact on transport during high flows (Year 2). Lead PI: Dr. R. McDaniel, South Dakota State University.

Furthermore, the project listed below was funded through a USGS 104G grant:

- Hydrologic Life Cycle Impact of Mountain Pine Bark Beetle Infestations. PI: J. Stone. South Dakota School of Mines and Technology.

Progress and completion reports for these projects are enclosed on the following pages.

Hydrologic Life Cycle Impact of Mountain Pine Bark Beetle Infestations

Basic Information

Title:	Hydrologic Life Cycle Impact of Mountain Pine Bark Beetle Infestations
Project Number:	2015SD248G
USGS Grant Number:	2015SD248G
Start Date:	9/1/2015
End Date:	8/30/2018
Funding Source:	104G
Congressional District:	1
Research Category:	Water Quality
Focus Categories:	Water Quality, Water Use, Surface Water
Descriptors:	None
Principal Investigators:	James Stone, Scott J Kenner, Heidi Leah Sieverding

Publications

There are no publications.

Introduction

This project is assessing the dissolved organic carbon (DOC) runoff from mountain pine beetle (MPB) impacted catchments within the ponderosa pine forest of the Black Hills of South Dakota. This project primarily involves field work measuring runoff water quality and soil changes due to MPB as well as hydrologic modeling.

Research Program

Problem

Across the Western US, both large and small population centers are situated in the foothills and mountains at the heart of the MPB epidemic. These cities are also heavily dependent on storage of surface water for drinking water resources; smaller urban areas lack the leverage, capital and resources that larger municipalities have. DOC exports from MPB-impacted forest ecosystems contain precursor compounds that can react during drinking water purification (in treatment facilities) with disinfectants such as chlorine to form highly toxic and regulated disinfection by-products (DBPs).

Research Objectives

The field work and modeling objectives include the following:

- Measure DOC and assess potential to cause DBPs.
- Determine sourcing of DOC and production triggers.
- Develop model to predict DOC production.
- Construct continuous land cover change HSPF model incorporating the MPB stages.
- Calibrate and validate the model for future year usages.
- Model past and future hydrologic impacts in the upper Rapid Creek watershed.

Methodology

Subbasins within the upper Rapid Creek area both impacted and unimpacted by MPB were identified. Water quality samples were collected from a total of 26 sampling locations with 18 infested and 8 uninfested sites from three locations within the selected subbasins: spring, mid-flow, and outlet. The goal of this sampling was to understand the impact of MPB on water quality of upwelling groundwater and overland flow. A total of 206 water samples were evaluated for 34 water quality parameters both in the field and by collaborators at USFS Rocky Mountain Research Station. Statistical and temporal correlations between water quality parameters and flow rates were evaluated to identify geochemical and biogeochemical relationships. The water quality impact due to MPB infestation are being incorporated into hydrologic models.

To model MPB impact, land use change was parameterized and incorporated into HSPF. This model includes pervious and impervious land segments and stream reaches for pre-impacted years and 2009 through 2016 for infested years which allows for the continuous land cover change to be simulated using forestry management records, meteorological hourly time series, and hydrograph data. The calibration using the 1970-2008 hydrologic record and validation using the 2009-2016 record is still on-going. Once parameterized, the HSPF model will be composed of 90 land segments and will be able to model the hydrologic impacts of MPB infestation and recovery.

Significance

The biogeochemical relationship MPB has on water quality is being identified. This will enable a better understanding of forest health and associated water quality impacts. This knowledge can and will be used to maintain and improve surface water quality locally and nationally. The calibrated HSPF model will be able to simulate the hydrologic impacts of not only future MPB outbreaks, but also any other land use change such as forest fires or urbanization. The model results will provide the data necessary for hydrological planning and mitigation. This technique of incorporating dynamic land use into hydrological models can be used and applied globally.

Principal Findings

It has been determined that the new USGS-EROS LCmap tool can be used detect the spatial and temporal (1984-present) spread of MPB mortality and recovery. The LCmap tool creates a land cover change raster (ChangeMAP) with a 30m x 30m resolution. The ChangeMAP results were validated with USFS MPB shapefiles. This tool can be used to efficiently track and monitor forest mortality on a weekly basis rather than annual.

Water quality impacts due to MPB appear to be related to post red and gray phases. Elevated DOC levels are due to the en masse decomposition of needles and wood. Measured DOC levels are not high enough to create DBP in drinking water supplies. However, there was a statistically significant relationship between MPB and water quality, even five years after peak MPB mortality within the studied watersheds. A multivariable analysis of water quality results generated a 97.6% correct classification of samples as MPB impacted or unimpacted. This grouping was best defined by Na, SO₄, Mg, Ca, DOC, Cl, NO₃, and pH water quality parameters (Table 1) with Na, Mg, Ca, and SO₄ having the largest statistical differences between infested and uninfested areas. The Ca and Mg levels were determined to be primarily geochemical in origin due to geographically coincident influences of upwelling groundwater and MPB infestation. The SO₄ levels were also geochemically influenced by groundwater source. Elevation affected SO₄ and Na levels, however, it could not fully account for variability. It is believed that MPB infestation affected forest biogeochemical S-cycling and soil moisture which affected Na levels. These findings underscore the complexity of forest-water biogeochemical relationships and the need to better understand these natural systems and cycles.

Table 1: Statistical differences in water quality between MPB impacted and unimpacted areas.

Water Quality Parameter	Significance (2-Tailed)	Mean	Impacted Mean	Impacted Std. Dev.	Unimpacted Mean	Unimpacted Std. Dev.
		Difference	----- mg/L -----			
DOC	0.000	0.61	2.26	0.99	1.65	0.85
DTN	0.001	0.30	0.68	0.66	0.38	0.39
Na	0.000	-3.92	1.89	0.77	5.81	1.40
K	0.000	-1.31	1.21	0.45	2.53	1.97
Mg	0.000	13.78	26.20	10.89	12.42	4.83
Ca	0.001	6.87	43.98	13.71	37.11	10.69
F	0.958	-0.0014	0.12	0.20	0.20	0.10
Cl	0.000	-0.63	0.84	0.44	1.47	0.53
NO ₃	0.005	0.20	0.52	0.52	0.31	0.35
SO ₄	0.000	-38.09	12.55	8.77	50.64	34.82

Evaluation of Nitrate Removal Rates of Denitrification Bioreactors Using Agricultural Residue Media

Basic Information

Title:	Evaluation of Nitrate Removal Rates of Denitrification Bioreactors Using Agricultural Residue Media
Project Number:	2017SD264B
Start Date:	3/1/2017
End Date:	2/28/2018
Funding Source:	104B
Congressional District:	SD-001
Research Category:	Water Quality
Focus Categories:	Water Quality, Agriculture, Nutrients
Descriptors:	None
Principal Investigators:	Guanghai Hua, Christopher G Schmit

Publications

There are no publications.

Evaluation of Nitrate Removal Rates of Denitrification Bioreactors Using Agricultural Residue Media

Progress Report: March 1, 2017 to February 28, 2018

Report Submitted to the South Dakota Water Resources Institute under the USGS 104b program

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Introduction

Agricultural subsurface drainage is a widely adopted water management practice to increase crop production in the Midwestern United States and many other areas (Fausey et al., 1995). However, nutrients such as nitrate-nitrogen can be transported from agricultural fields to surface water through subsurface drainage systems (Sims et al., 1998; Jaynes et al., 2001). Nitrate in subsurface drainage water is a major water quality concern. It has been reported that nitrate-nitrogen concentrations in subsurface drainage water often exceed the United States Environmental Protection Agency (USEPA) drinking water standard of 10 mg/L. The elevated nitrate concentration can lead to eutrophication and harmful algal blooms, hypoxic zones in the ocean, and contamination of drinking water supplies (Rabalais et al., 2002). Therefore, it is necessary to reduce the loss of nutrients through subsurface drainage to protect natural water resources.

Denitrification bioreactors have emerged as an important edge-of-field treatment technology to reduce nitrate loads from subsurface drainage (Blowes et al., 1994; Schipper et al., 2010; Christianson et al., 2011). These bioreactors typically utilize an organic carbon medium like woodchips to support the growth of denitrifying bacteria which reduce nitrate to nitrogen gas (Greenan et al., 2006; Blowes et al., 1994; Robertson, 2010; Cooke and Bell, 2014). The nitrate removal efficiency of denitrification bioreactors is dependent on the quantity of readily biodegradable carbon that can be utilized by the denitrifying bacteria. However, a major portion of organic carbon derived from wood materials is not easily biodegradable, which can limit the nitrate removal rates. It has been reported that organic carbon media derived from agricultural residues such as corn cobs, corn stover and wheat straw have the ability to produce high quantities of easily biodegradable carbon and to support high densities of denitrifying microorganisms in bioreactors (Feyereisen et al., 2016; Healy et al., 2012).

The goal of this project is to evaluate the dissolved organic carbon (DOC) leaching potential of agricultural residues and determine their nitrate removal rates. The tested materials are corn cobs, corn stover and barley straw. The results of this study can lead to the development of a new bioreactor system that uses a combination of an agricultural residue and woodchips to increase the nitrate removal efficiency and reduce the cost of the bioreactors. The use of on-farm residues may also increase the acceptance of this technology for agricultural water management.

Materials and Methods

Materials

Corn cobs, corn stover, and barley straw were obtained from South Dakota State University Southeast Research Station near Beresford, South Dakota (SD) and wood chips were collected from a supplier in Sioux Falls, SD. All agricultural residue materials were cut in 3 cm length and wood chips were sorted in the same size from the supply. All materials were washed with distilled water to remove dirt and floating fine particles, then dried in 104 °C overnight prior to use.

DOC leaching test

The leaching potential of the materials was determined using a sequential batch leaching procedure. The leaching test was conducted at a ratio of liquid to solid (L/S) 0.9:0.02 L/kg. A 20 g oven dried (104°C) sample of each material were added to a conical flask with 900 ml water and shaken on an orbital shaker at 200 rpm for 24 h. All samples were removed from the shaker and manually inverted two times and immediately filtered with a 0.45 µm filter and stored in refrigerator. This sequential batch leaching procedure was repeated every 24 h until the DOC of the leachate water was below 2 mg/L.

Analytical Methods

All solutions used in this study were prepared with ultrapure water (18 MΩ-cm) produced by a Barnstead Nano pure system. The analysis of total and dissolved phosphate (TP, PO₄-P), total nitrogen (TN) and nitrate-nitrogen (NO₃-N) was carried out in duplicate using UV-visible spectrophotometer (HACH, DR 4000, USA) based on the standard method (4500-P-E Phosphate, 4500-NO₃—B Nitrate, 4500-N C Total Nitrogen) (APAH et al., 2012). The DOC concentrations were measured in duplicate with a Shimadzu TOC-5000 Analyzer (Shimadzu Corp., Kyoto, Japan) according to Standard Method 5310 B (APAH et al., 2012). The UV absorbance at 254 nm (UV₂₅₄) of DOC was measured by a Hach DR4000U spectrophotometer (Hach, Loveland, CO). SUVA (specific ultraviolet absorbance) was calculated from UV₂₅₄ divided by the DOC. Chemical oxygen demand (COD) and biological oxygen demand (BOD) were determined according to Standard Method 5220 D and 5210 B, respectively (APAH et al., 2012).

Results and Discussion

DOC leaching from Agricultural Residues and Woodchips

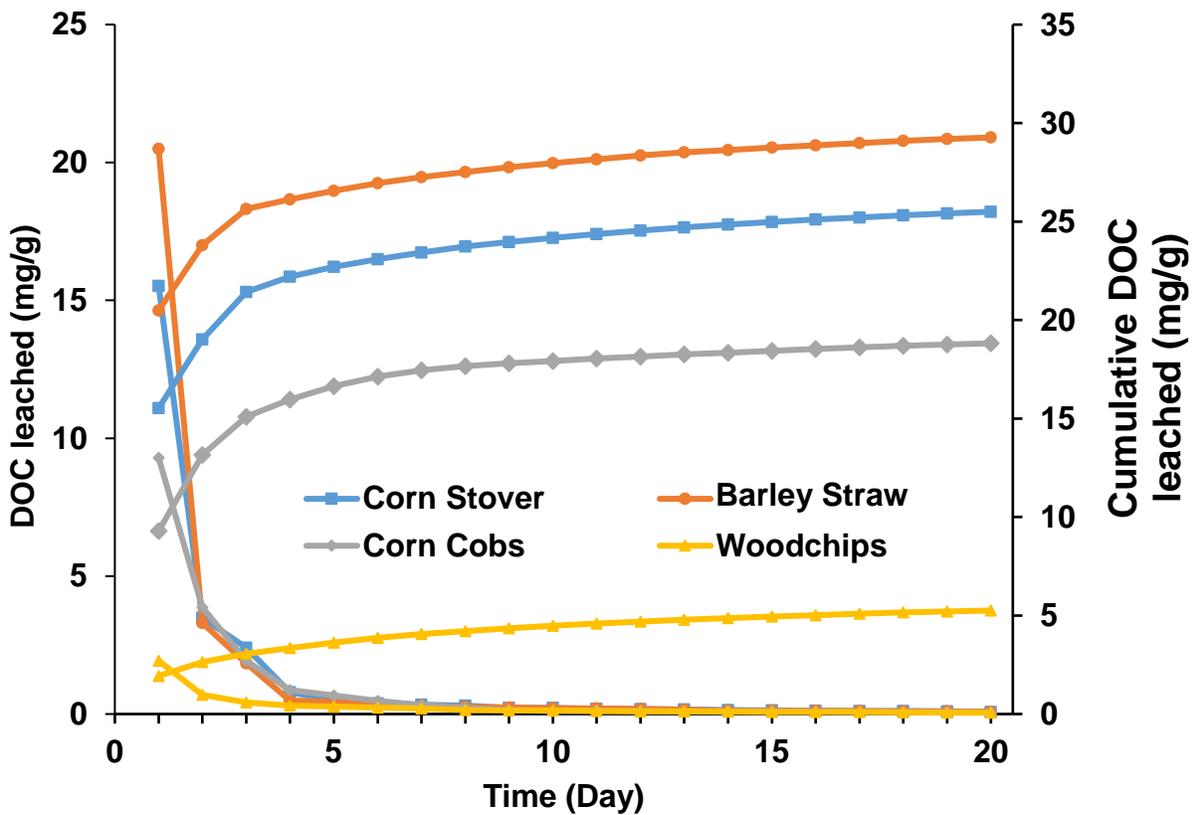


Figure 1. DOC leaching during the sequential batch test

Figure 1 presents the DOC leached from four materials during the sequential batch test. According to the results, barley straw leached the highest cumulative amount of DOC (29.27 mg/g) among the materials and wood chips has the lowest cumulative leached DOC (5.25 mg/g) after 20 days. The release of DOC was characterized by an initial high release within initial time period (<24 h) for all agricultural residues followed by a rapid decline in DOC values after day 1 and by a slower rate during later time periods. The initial leaching DOC of 20.49 mg/g barley straw, 15.52 mg/g corn stover, and 9.28 mg/g corn cobs in day 1 decreased to 3.30, 3.48, and 3.87 mg/g in day 2, respectively and gradually decreased to <1 mg/g after day 3. Woodchips showed the lowest amount of 1.93 mg/g DOC leached in day 1 decreased to 0.70 mg/g in day 2. All agricultural residues showed the higher amount of leaching DOC than woodchips during the sequential batch test. The results of this test suggest that agricultural residues can produce high quantities of organic carbon that can support denitrifying microorganisms in bioreactors. The results of this study was similar to a previous study by McLaughlan and Al-Mashaqbeh, (2009) who obtained the high release of DOC from composted garden organics, pine and hard wood materials within the initial time period (<24 h) and followed by a rapid decline afterwards.

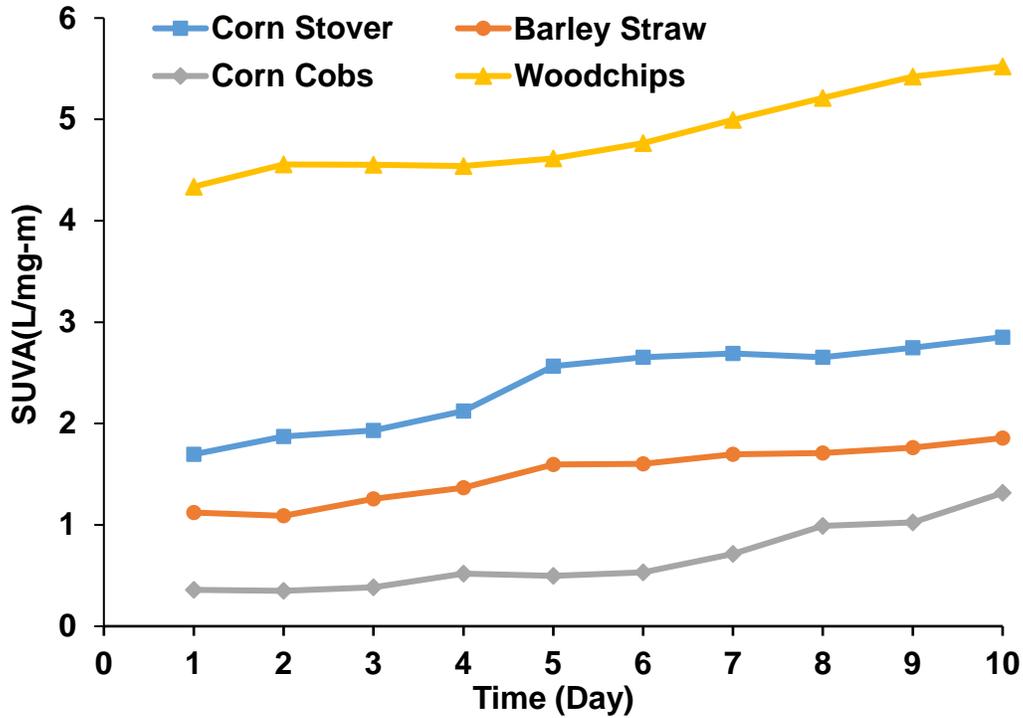


Figure 2. SUVA levels of leached DOC

As shown in the Figure 2, wood chips showed the highest SUVA values among the tested materials. The highest SUVA values were likely attributed to the hydrophobic and high molecular weight (MW) organic compounds released by woodchips (Abusallout and Hua, 2017). The hydrophobic natural organic matter is typically rich in aromatic carbon and UV-absorbing compounds (Hua and Reckhow, 2007), and they are not easily consumed by microorganism in the degradation process. The SUVA values gradually increased as the percentage of hydrophobic fraction increased with time. The increased hydrophobic fraction with longer operation time agrees with the BOD/COC results shown in Figure 3.

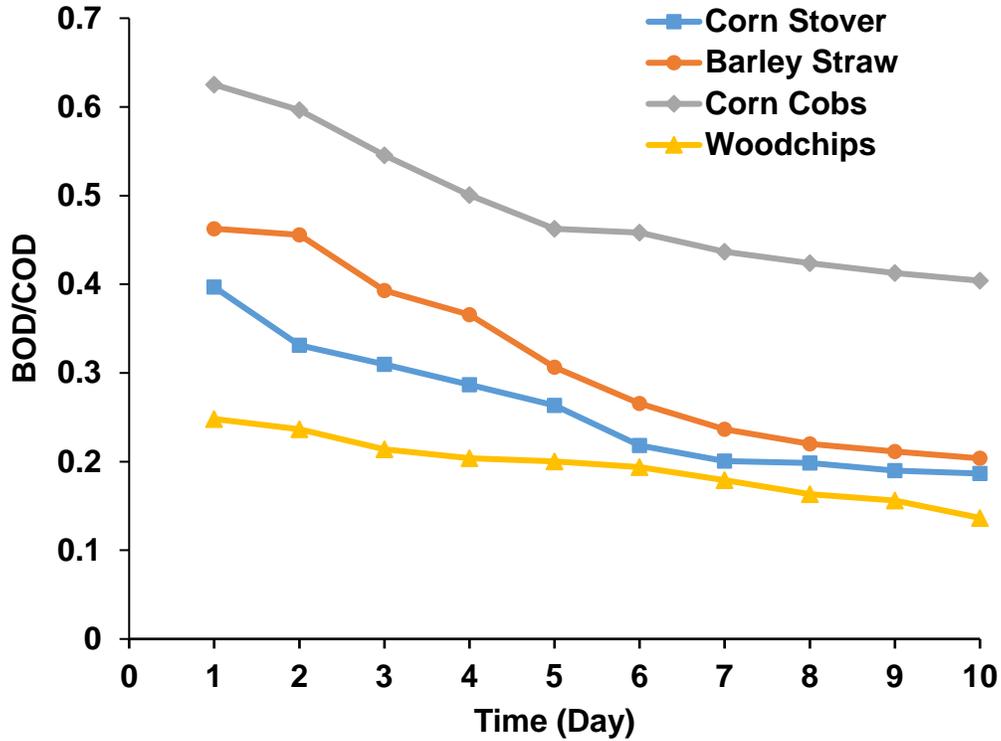


Figure 3. Specific UV absorbance (SUVA) of leached DOC

As can be seen in the Figure 3, woodchips has the lowest BOD/COD ratio and the ratio decreased by increasing time. If BOD/ COD is > 0.6 then the waste is fairly biodegradable. If BOD/COD ratio is between 0.3 and 0.6, then the process will be relatively slow. If BOD/COD < 0.3 , biodegradation will not proceed (Abdalla and Hammam, 2014). Thus, the reduced BOD/COD ratio with longer operation time indicates the increasing hydrophobic fraction of organic carbon which is not biodegradable by microorganism. Corn cobs has the highest BOD/COD ration which is associated with the lowest SUVA values indicating the most biodegradable organic carbon with the lowest hydrophobic fraction. The results of this study suggest that agricultural residues could be the more biodegradable source of organic carbon for microorganism in comparison with wood chips.

Nutrient leaching from Agricultural Residues and Woodchips

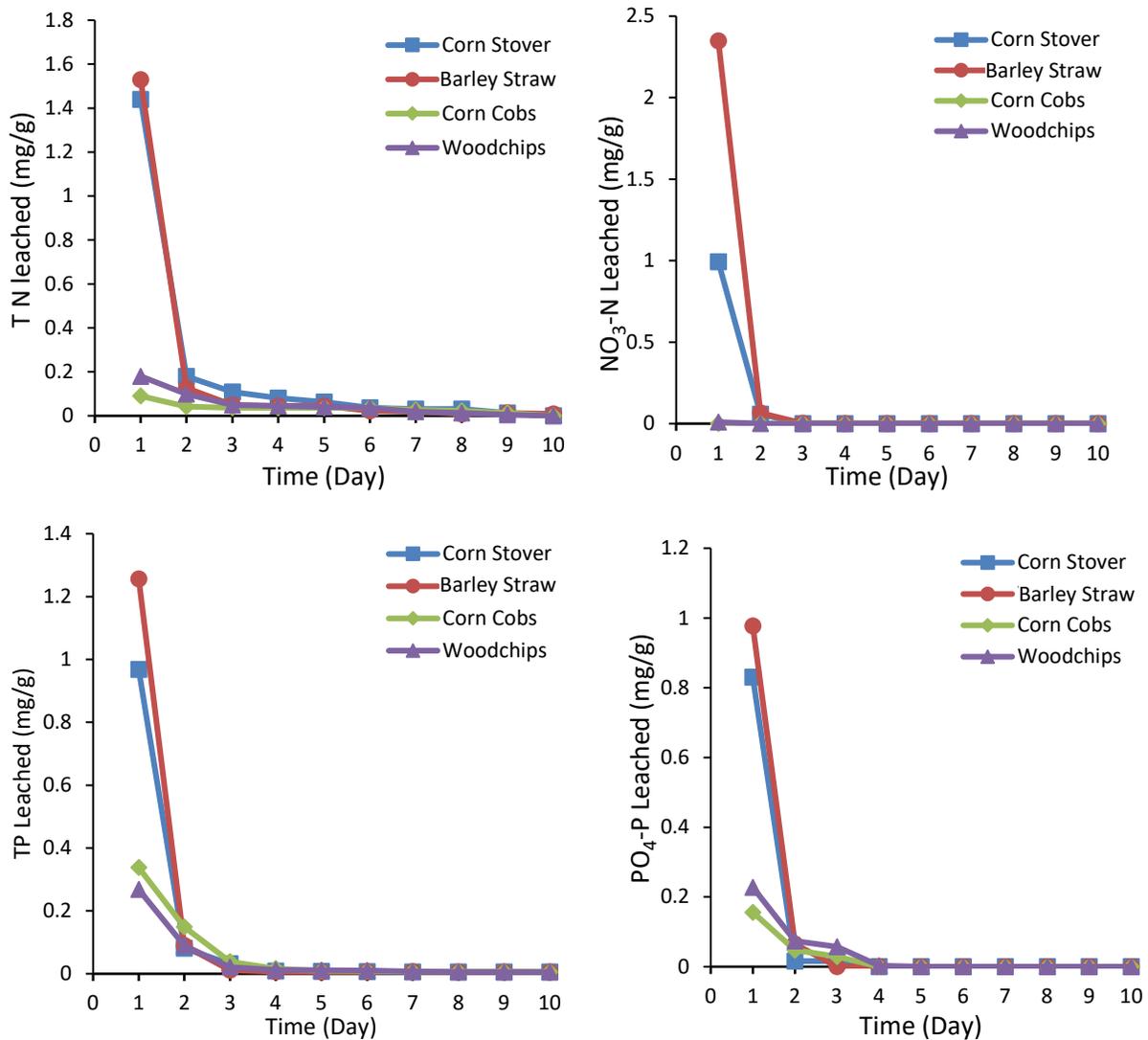


Figure 4. Nutrient leaching from agricultural residues and woodchips

As can be seen in Figure 4, corn stover and barley straw showed the highest amount of nutrient leaching among the materials. They also exhibited the fast nutrient depletion rates, and the leaching nutrients substantially decreased in day 2 and gradually reduced to zero after one week. Woodchips showed the least amount of NO₃-N and TP release among the materials. Corn cobs showed no release of NO₃-N and much less release of TN, TP and PO₄-P than other materials except woodchips which had a lower TP leaching than corn cobs. Corn cobs also exhibited much slower rates of nutrients depletion after day 1. Generally, the leaching nutrient may come from either the soil nutrient accumulation attached to the materials or the nature of agricultural residues. If a relatively large amount of nutrient was present in the residue material, then a greater quantity of nutrient was leached into solution (Cermak et al, 2004). Cermak et al, (2004)

investigated the nutrient leaching from corn and barley residues. They found more PO₄-P and NO₃-N leaching from corn residue than barley residue after one day contact time. This can be explained by the time that barley residue collected after harvest. Before it was collected, the barley residue had been in the field for 119 days after harvest, and thus substantial leaching of nutrients may have already taken place (Cermak et al, 2004).

Ongoing Experiments for Project Year 2

We will built column reactors to evaluate the DOC leaching characteristics under continuously flow conditions. After the DOC leaching experiments, we will conduct column experiments to determine the nitrate removal rates of agricultural residues and woodchips.

Conclusions

Woodchips are the most commonly used organic substrate in denitrification bioreactors for subsurface treatment. However, some of the aromatic organic compounds leached from woodchips may not be easily biodegradable which can limit the denitrification efficiency. Organic carbon media derived from agricultural residues such as corn cobs, corn stover and barley straw can produce high quantities of easily biodegradable carbon to support denitrifying microorganisms in bioreactors. The objective of this study was to evaluate the dissolved organic carbon (DOC) leaching characteristics of selected agricultural residues and determine their nitrate removal rates. The results of this study showed that the DOC leaching potential followed the order of barley straw>corn stover>corn cobs>woodchips. Agricultural residues also exhibited faster DOC leaching kinetics and higher biodegradation potentials than woodchips. Although agricultural residues leached higher concentrations of nutrients during initial flush, those concentrations quickly declined within several days of leaching. The results of this study indicate that organic substrates derived from agricultural residues are well suited for the application of denitrification bioreactors.

Acknowledgements

This research is funded by the USGS 104b program, the East Dakota Water Development District, and South Dakota State University.

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Evaluating E. coli particle attachment and the impact on transport during high flows (Year 2)

Basic Information

Title:	Evaluating E. coli particle attachment and the impact on transport during high flows (Year 2)
Project Number:	2017SD265B
Start Date:	3/1/2017
End Date:	2/28/2018
Funding Source:	104B
Congressional District:	SD-001
Research Category:	Water Quality
Focus Categories:	Water Quality, Non Point Pollution, Water Use
Descriptors:	None
Principal Investigators:	Rachel McDaniel, Bruce Bleakley

Publications

There are no publications.

Evaluating *E. coli* particle attachment and the impact on transport during high flows

Annual Report: March 1, 2017 – August 31, 2018

Report Submitted To:

South Dakota Water Resources Institute under the USGS 104b program

Prepared By:

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1. Introduction

59% of South Dakota's assessed rivers and streams are considered impaired, and another 10% are threatened of becoming impaired (EPA, 2015). The primary causes for impairments are total suspended solids (TSS) and bacteria including *Escherichia coli* (*E. coli*). *E. coli* alone is responsible for poor water quality in over 2,000 miles of streams in South Dakota. Indicator organisms, such as *E. coli*, are used to indicate the presence of fecal pollution which can contain pathogenic microorganisms. Indicator organisms have been shown to be positively correlated with increases in gastrointestinal illnesses in recreational waters (e.g. Wade et al., 2006), therefore increasing public health risks.

High flows associated with storm events have been shown to greatly increase *E. coli* concentrations in streams (Krometis et al., 2007) and over 95 % of *E. coli* loading can occur during storm events (McKergow and Davies-Colley, 2010). Sediment resuspension may account for a major amount of fecal coliform (FC) and *E. coli* numbers during or soon after rainfall events (Pachepsky and Shelton, 2011). Bacteria often attach to particles (Krometis et al., 2007), such as silt, which causes them to settle out of the water column more rapidly, thus limiting their transport downstream. Free (unattached) bacteria, on the other hand, are more buoyant and have the ability to remain in the water column longer and travel farther in surface waters. Similarly, different particle sizes settle at different rates; for example, silt will settle faster than clay.

Krometis et al. (2007) evaluated microorganisms, including *E. coli*, during storm events and partitioned out those attached to settleable particles. About 40% of *E. coli* was found to be attached to settleable particles with the highest concentrations of the associated settleable microbes occurring at the beginning of the storm. Attachment of fecal bacteria to various

particle sizes in storm runoff was examined by Soupir et al. (2010). They determined that more bacteria are attached to finer particles (i.e. silt and clay) than coarser particles (i.e. sand).

The Big Sioux River flows through Sioux Falls, SD, the largest city in the state, and is used for recreational purposes. However, water quality in the river, including *E. coli*, does not meet water quality standards. The poor water quality of the river has become a major concern. In response, the city of Sioux Falls has initiated an annual conference, the Big Sioux Water Summit, to inform local stakeholders of the current issues and progress in the watershed as well as discuss potential solutions to the water quality problems.

Skunk Creek is a tributary to the Big Sioux River and is a major contributor of *E. coli* to the river. The 2014 Water Quality Assessment Report lists Skunk Creek as impaired for *E. coli*, fecal coliforms, and TSS. Limited Contact Recreational and Warmwater Marginal Fish Life uses are not supported in Skunk Creek. To address these issues, best management practices have been implemented along the creek including Riparian Area Management (RAM) and Seasonal RAM (SRAM). These systems are focused on minimizing fecal bacteria loading from cattle by reducing or eliminating their time in the stream as well as providing a buffer between grazing lands and the stream to reduce overland transport.

The South Dakota Department of Environment and Natural Resources (DENR), East Dakota Water Development District (EDWDD), and the South Dakota Association of Conservation Districts are working to reduce *E. coli* loading in streams; however, high concentrations of *E. coli* are still often observed. Therefore, there is interest in furthering the understanding of how *E. coli* is transported to and within stream environments.

2. Objectives

The overall goal of this project was to evaluate *E. coli* attachment to particles of different sizes and estimate the impact of attachment on *E. coli* transport in streams during high flows. *E. coli* fate and transport are difficult to predict and this information may be incorporated into existing or future models to estimate *E. coli* concentrations in streams as well as contribute to the development of management practices to reduce transport. This goal was achieved through the following objectives:

- Evaluate *E. coli* concentrations and attachment rates to different particle sizes in runoff from an agricultural field and a stream;
- Evaluate the relationship between particle size association of *E. coli* and shear stress,
- Estimate the *E. coli* load contribution by particle size; and
- Estimate the transport distance of the *E. coli* by particle size.

3. Methods

3.1 Study Sites

The study site is located on Skunk Creek (Fig. 1) in eastern South Dakota (SD) near the intersection of 248th St. and Burk Ave. Eastern SD's climate has a humid continental climate with an average rainfall of about 27 inches annually. The land use surrounding the study site is largely rangeland and Seasonal Riparian Area Management (SRAM) is practiced in the immediate vicinity of the site. Producers enrolled in the SRAM program agree to keep their cattle out of the stream during the recreation season, roughly May through October, and are allowed to hay the buffer a few times during the year. Skunk Creek is a tributary to the Big Sioux River and is impaired for Total Suspended Solids (TSS) and *E. coli*.

To measure concentrations of *E. coli* in runoff from an agricultural field, a site was set up near Coleman, SD. Three fields were monitored; two fields receive manure application while one does not.

3.2 Sample Collection

An Avalanche Teledyne ISCO refrigerated autosampler (Fig. 2) with velocity, depth, temperature, and turbidity sensors was installed at the site which provided data at 5-15 minute intervals throughout season. Water samples were collected during storm events over a five hour period at 30 minute intervals for a total of ten samples during each storm event. The samples were stored in the refrigerated unit until collected, usually within three hours of the sample collection completion. In addition, periodic grab samples were collected to assess baseflow conditions. Non-refrigerated ISCO autosamplers were used at the edge of each field sampled for runoff. All samples were collected in sterilized bottles and transported in an ice chest to the laboratory for processing and analysis.



Figure 1: Sampling was conducted in Skunk Creek located in eastern SD. The creek is impaired for bacteria and is surrounded by Seasonal Riparian Area Management which is intended to assist with the reduction of *E. coli*.



Figure 2: An Avalanche Teledyne ISCO autosampler was used to collect water samples during high flow events.

3.3 Sample Processing

Sample processing began immediately after the sample was collected and returned to the lab. Stoke’s Law (eq. 1) was used to partition bacteria attached to different particle sizes. Three

particle size ranges were assessed which included sand and coarse silt (diameter ≥ 0.016 mm), fine silt (0.016 mm to 0.004 mm), clay and unattached particles (diameter < 0.004 mm) for the stream samples; however, bacteria were only partitioned between attached and unattached (diameter < 0.004 mm) for the runoff samples. Bacteria attached to clay and unattached bacteria were combined due to their similar transport behaviors (i.e. both are relatively buoyant) and time constraints of settling the clay particles out of suspension.

$$v_s = \frac{g}{18} \left(\frac{\rho_s - \rho_w}{\mu} \right) d^2 \quad (\text{eq. 1})$$

Where v_s is the settling velocity, ρ_s is the particle density, ρ_w is the density of water, μ is the dynamic viscosity of water, and d is the particle diameter.

To begin the settling process, the sample was inverted in the sample bottle to resuspend the particles and bacteria in the water. Approximately 500 mL of water was transferred to a graduated cylinder which was then placed in a refrigerator to minimize the growth or decay of bacteria during the settling process. One sub-sample was collected from the graduated cylinder immediately to determine the total concentration of bacteria within each sample. Additional sub-samples were collected as the particles settled out of the water column at 6.25 minutes and at 2.22 hours, allowing the sand and coarse silt, and fine silt to settle out, respectively. Each sub-sample was processed in triplicate using standard membrane filtration on modified mTEC agar.

Once plated, the bacteria were placed in a water bath at 35°C for two hours to allow for the resuscitation of any stressed bacteria. Next, the plates were placed in an incubator at 44.5°C for an additional 22 hours. The resulting magenta colonies were counted and recorded.

3.4 Data Processing and Analysis

Shear stress is the force per unit area parallel to a surface and is associated with resuspension of *E. coli* reservoirs from stream bed sediments into the water column. Shear stress was calculated via Equation 2 (Jamieson et al., 2005) and compared to *E. coli* concentrations measured during the sampling period. The shear stress required to resuspend *E. coli* varies based on if the bacteria are attached to particles and the size of particle they are attached to.

$$\tau_b = \gamma S^{1/4} \left(\frac{n}{A} \right)^{3/2} Q^{3/2} \quad (\text{Equation 2})$$

Where τ_b is the bed shear stress, γ is the specific weight of water, S is the slope, n is Manning's roughness coefficient, A is the cross-sectional area, and Q is flow.

The *E. coli* loads (Equation 3) from the 5 hour sampling period were evaluated for total *E. coli*, unattached *E. coli*, and the attachment to each particle size. The loads provide knowledge about the quantity of *E. coli* moving through the sampling location during high flow conditions. By splitting the load into size fractions, estimates were made about how each fraction is moving in the stream, including how far each fraction was transported.

$$L = cQt \quad (\text{Equation 3})$$

Where L is the *E. coli* load, c in the *E. coli* concentration, Q is the flow, and t is time. The flow data was determined using a velocity and depth meter connected to the autosampler. Evaluating the *E. coli* loading during each time interval for each particle size provides information on when the various partitions are mobile and which particle sizes are contributing the highest *E. coli* load during high flow events.

A preliminary estimate of the transport distance (Equation 4) was made by combining Stoke's law (Equation 1 above), the stream depth, and the stream velocity. The result provides an initial prediction of the distance each fraction of the *E. coli* load is moving during high flow periods. Future work will need to be completed to incorporate other potential forces, stream characteristics, etc. that may affect the transport of *E. coli* in the stream environment.

$$D_T = \frac{Q}{W v_s} \quad (\text{Equation 4})$$

Where D_T is the transport distance, Q is the flow, W is the average width of the stream, and v_s is the settling velocity.

4. Results and Discussion

A total of eight storm events, hereafter referred to as S1, S2, S3, S4, S5, S6, S7, and S8, were processed for *E. coli* concentrations and attachment in the stream during 2016 and 2017; however, two of the storms (S3 and S6) only collected samples for three of the five hours planned, resulting in six samples instead of ten. Runoff at the Coleman field sites occurred once in 2017. Additional runoff samples will be assessed if possible during the 2018 field season.

4.1 *E. coli* Concentrations and Attachment Rates

The total average *E. coli* concentrations from the eight storms ranged from 7.8×10^2 to 119.3×10^2 CFU 100mL⁻¹. Seven baseflow samples were collected and had a lower range of concentrations, 2.1×10^2 to 36.7×10^2 CFU 100mL⁻¹, when compared to the storm samples. The majority of the *E. coli* were unattached (Table 1) which was consistent with both baseflow and storm flow samples. The average unattached rates ranged from approximately 75 – 85% of the total *E. coli* concentrations, the average medium and coarse silt attachment rates was approximately 9 – 15 %, and the average fine and very fine silt attachment rate was the lowest, ranging from 5 – 13 % (Figure 3). These ranges were consistent with what was observed in the baseflow, which had an average of 81% unattached, 9% attached to medium and coarse silt, and 10% attached to fine and very fine silt. Models often simulate bacteria in the unattached state; therefore, the unattached concentrations were compared to the total concentrations to determine if there was a significant difference. Only three out of the eight storms showed a significant difference between the unattached and total *E. coli* concentrations, indicating that 37% of the

storms could not be modeled using the simplified assumption that all bacteria are transported in an unattached state.

Overall, the total *E.coli* concentrations exceeded the single sample maximum (SSM) water quality standard (1178 CFU 100mL⁻¹) 70 out of 72 total samples. If the *E. coli* attached to particles were able to settle out of the water column, the standard would still have been exceeded 52 out of the 72 samples collected, indicating that settling alone is not enough to improve water quality sufficiently.

Table 1: Mean *E. coli* concentrations for baseflow and the eight storm events associated with different particles. The majority of the *E. coli* were unattached to particles. The standard deviations are presented in parentheses.

Storm Event	Concentration by Particle Size		
	Medium and Coarse Silt(10 ² CFU/100 mL)	Fine and Very Fine Silt (10 ² CFU/100 mL)	Clay and Unattached (10 ² CFU/100 mL)
Baseflow	0.1 ± (0.7)	0.9 ± (0.7)	10.2 ± (11.6)
S1	6.0 ± (7.9) b	6.4 ± (5.2) b	34.7 ± (11.9) a
S2	0.8 ± (0.6) b	0.8 ± (0.4) b	6.2 ± (0.4) a
S3	17.9 ± (18.1) b [†]	8.6 ± (9.8) b	92.8 ± (43.8) a
S4	6.9 ± (5.7) b	3.7 ± (3.7) b	63.1 ± (9.5) a
S5	6.9 ± (5.7) b	3.2 ± (2.8) b	38.4 ± (25.3) a
S6	3.9 ± (2.8) b [†]	6.2 ± (4.4) ab	48.7 ± (49.2) a
S7	1.0 ± (0.7) b	1.0 ± (0.7) b	9.3 ± (1.1) a
S8	6.4 ± (5.9) b	3.0 ± (2.9) b	45.0 ± (13.2) a

Values followed by the same letter are not significantly different within each storm event according to Tukey HSD multiple comparison test ($p < 0.05$) after ANOVA test.

[†]Number of samples (n) = 6, due to overflow from autosampler.

S = Storm Event.

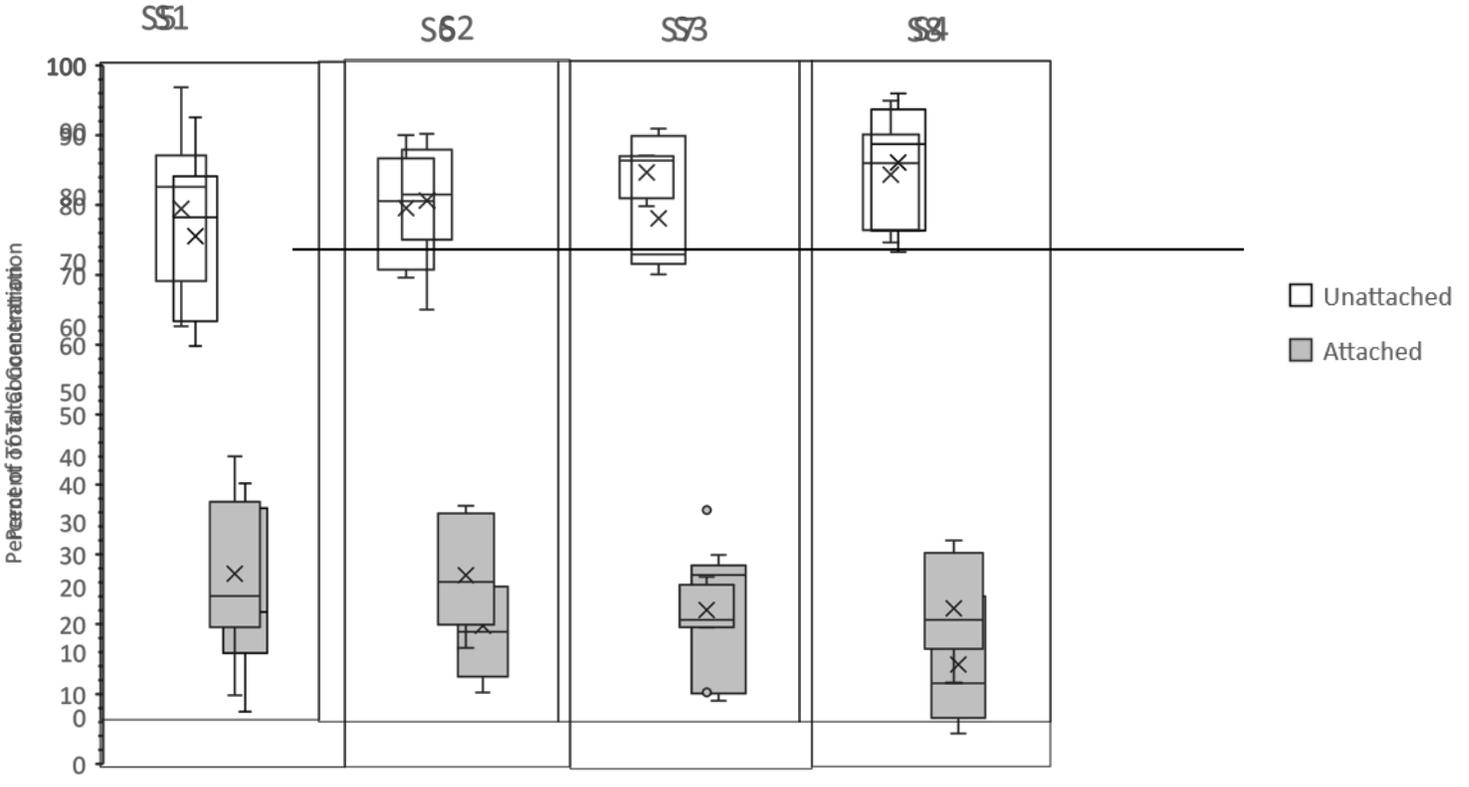


Figure 3: Percent of *E. coli* unattached (white) to particles and attached (gray) to settleable particles for all storm events. Settleable particles include silt and sand. Attached bacteria consisted of approximately 20% on average while the remaining 80% was unattached.

4.2 *E. coli* Concentrations and Shear Stress

The Spearman's Rank Correlation was calculated between *E. coli* concentrations and shear stress, turbidity, water temperature, and bed shear stress. No significant correlations were found between the *E. coli* concentrations (total concentration, bacteria attached to medium and coarse silt particles, bacteria attached to fine and very fine silt particles, the number of bacteria attached to any particles, and unattached bacteria) and the physical parameters. Only turbidity had significant correlations ($p \leq 0.05$) with flow ($\rho = -0.47$), water temperature ($\rho = 0.99$), and bed shear stress ($\rho = -0.32$) (Table 2).

Table 2: Spearman's Rank Correlation coefficient between *E. coli* concentrations, water quality parameters, and some hydrological factors.

	<i>E. coli</i> (CFU/100 mL)					
	Turbidity	TC	MC	FVF	PAF	CU
Flow ($\text{m}^3 \text{s}^{-1}$)	-0.47*	-0.02	-0.05	-0.16	-0.10	0.00
Water Temperature ($^{\circ}\text{C}$)	0.99*	0.14	0.06	0.20	0.13	0.13
Turbidity (NTU)	NA	0.13	0.06	0.21	0.13	0.12
Bed Shear Stress (N m^{-2})	-0.32*	0.13	0.05	-0.09	0.01	0.15

NTU = Nephelometric Turbidity Unit

TC=Total *E. coli* concentration, MC = *E. coli* attached to medium and coarse silt, FVF = *E. coli* attached to fine and very fine silt, PAF = Total *E. coli* attached to particles (MC + FVF)

*Significant correlation ($p \leq 0.05$)

NA = Not Applicable.

4.3 *E. coli* Load by Particle Size

E. coli loads ranged from 10^{10} to 10^{12} CFU over the sample period with the majority of the load from the unattached fraction (Figure 4). Most of the storms (5 out of the 8) had similar loads for *E. coli* attached to medium silt, coarse silt, and sand and *E. coli* attached to fine and very fine silt particles. The equivalent baseflow period (Figure 5) is the number of days it would take to see the same load of bacteria pass this site and for three out of the eight storms the equivalent baseflow period was similar (less than one day). Two of the storms had high equivalent baseflow periods, meaning it took a large number of days (over 20 days) to see the same load of bacteria pass during baseflow periods that occurred during the storm events.

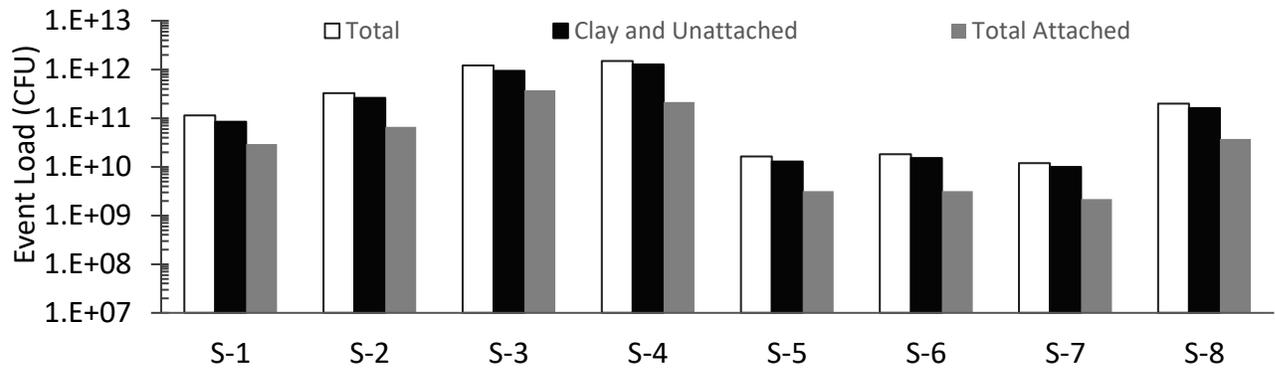


Figure 4: The *E. coli* loads for all *E. coli* (total, white bars), clay and unattached *E. coli* (black bars), and all the attached *E. coli* (total attached, gray bars).

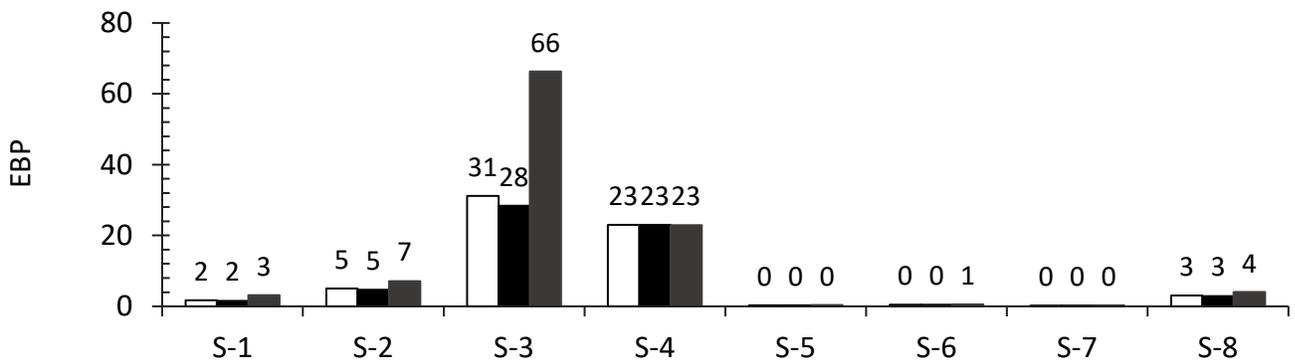


Figure 5: The equivalent baseflow period (EBP) for all all *E. coli* (total, white bars), clay and unattached *E. coli* (black bars), and all the attached *E. coli* (total attached, gray bars).

4.4 *E. coli* Transport Distance

The transport distance was estimated using the settling velocity for the particle size and the average velocity at the time of the given sample. Bacteria attached to coarse silt settled out the soonest, traveling an estimated average distance from less than 1 km to over 43 km; whereas unattached bacteria were calculated to travel 41 km to over 10,000 km. Additional factors, such as turbulent flow, varying channel depth, etc., were not considered. Further investigations will need to be conducted to improve the accuracy of these estimates.

5. Summary and Conclusions

The concentrations of *E. coli* observed during high flows were consistently above the SSM standard for limited contact recreation. Removing the easily settleable, attached bacteria still resulted in concentrations above the SSM during the majority of the storms examined. Approximately 75-85% of *E. coli* were transported unattached to particles, indicating a long time period would be required to settle the majority of the bacteria out of suspension. The *E. coli* loads attached to the coarse and fine silt particle sizes were similar in many of the storm events. In addition, shear stress, flow, water temperature, and turbidity were not significantly correlated with *E. coli* concentrations. This work demonstrates that management practices that can reduce the unattached bacteria load will play a vital role in achieving bacteria levels within the SSM for limited contact recreation in Skunk Creek.

1. Acknowledgements

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Information Transfer Program Introduction

FY 2017 Annual Report Information Transfer Program

The SDWRI Information Transfer Program includes public outreach; steering committee representation and leading involvement in the Big Sioux Water Festival hosting about 1,100 fourth grade students; interactions with extension agents and local, state and federal agencies; participation and presentations at regional and national conferences; youth education, adult education and university student training and education. Publications, such as pamphlets, educational materials, reports and peer-reviewed journal entries are made available in paper format and electronically through the Institute's website and are designed to support the mission of the Institute.

South Dakota Water Resources Institute FY2017 Information Transfer Program

Basic Information

Title:	South Dakota Water Resources Institute FY2017 Information Transfer Program
Project Number:	2017SD266B
Start Date:	3/1/2017
End Date:	2/28/2018
Funding Source:	104B
Congressional District:	SD-001
Research Category:	Biological Sciences
Focus Categories:	Education, Management and Planning, Conservation
Descriptors:	None
Principal Investigators:	Van Kelley, Rachel McDaniel, David Kringen

Publications

There are no publications.

PUBLIC OUTREACH

Public outreach and dissemination of research results are cornerstones of the South Dakota Water Resources Institute's (SDWRI) Information Transfer Program. The Institute distributes information through a variety of outlets, including interactive information via the Internet, pamphlets and reports, direct personal communication, hands-on demonstrations and through presentations and discussions at meetings, symposia, and conferences. These outlets are described below.

SDWRI Website

The SDWRI website is accessible through <https://www.sdstate.edu/water-resources-institute>. An update of the SDWRI website is underway. The website will contain information relating to water resources, current and past research projects, reference materials, and extension publications. One feature of the SDWRI website will allow users access to links such as publications and on-line tools to help diagnose and treat many water quality problems. The "Research Projects" section of the SDWRI website will contain past and present research projects, highlighting the Institute's commitment to improving water quality.

Conference Proceedings

Sadeghi, S., Min, K., Hua, G., Johnson, T., Hooshyari, G., 2017. *Synergistic effects of polyaluminium chloride and phoslock on phosphate and cyanobacteria removal in eutrophic lakes*. In Proceedings of Water Quality Technology Conference, Portland, OR.

Conference Papers or Posters Presented, Invited Lectures

Sadeghi, S, Min, K., Hua, G., Johnson, T., Hooshyari, G., 2017. *Synergistic effects of polyaluminium chloride and phoslock on phosphate and cyanobacteria removal in eutrophic lakes*. Water Quality Technology Conference, Portland, OR, November 13. (Poster Presentation)

R. McDaniel, B. Bleakley, A. Witmuss, and J. Gilbertson. (2017). *Impact of management practices on bacteria in the Upper Great Plains*. In: Proceedings of the 2017 UCOWR/NIWR Annual Conference "Water in a Changing Environment". Fort Collins, CO: UCOWR/NIWR. Oral presentation, Fort Collins, CO.

Salam, S., R. McDaniel, and B. Bleakley. (2017). *Variability of E. coli in stream bottom sediments and the implications for sediment sampling*. Oral presentation at the ASABE Annual International Meeting, Spokane, WA

Shokrana, M.S.B., L. Ahiablame, R. McDaniel, and G. Hua. (2017). *Impacts of Rainfall Intensity and Duration on Woodchip Bioreactor Performance*. Oral Presentation at the ASABE International Meeting, Spokane, WA

Salam, S., R. McDaniel, and B. Bleakley. (2017). *Variability, antibiotic sensitivity, and the influence of particle size on E. coli in Eastern South Dakota's streambed sediment*. Oral presentation at the 2017 AWRA Annual Water Resources Conference, Portland, OR

Amegbletor, L., R. McDaniel, and B. Bleakley. (2017). *Evaluating E. coli particle attachment and the impact on transport during high flows*. Oral presentation at the 2017 AWRA Annual Water Resources Conference, Portland, OR

Mardani, S., R. McDaniel, and B. Bleakley. (2017). *Antibiotic sensitivity of bacteria isolates in woodchips bioreactors and their transport to the environment*. Oral presentation at the 2017 AWRA Annual Water Resources Conference, Portland, OR

Sharma, A., R. McDaniel, and T. Trooien. (2017). *Application of controlled drainage and saturated buffers use for conservation drainage in South Dakota*. Poster presentation at the 2017 Eastern South Dakota Water Conference, Brookings, SD

Shokrana, M.S.B., L. Ahiablame, R. McDaniel, T. Trooien, and G. Hua. (2017). *Performance of Woodchip Bioreactors in Eastern South Dakota: Impact Assessment of Rainfall Intensity and Duration*. Poster presentation at the Western South Dakota Hydrology Conference, Rapid City, SD.

Min, K., Sadeghi, S., Hua, G., 2017. *Cyanobacteria removal in eutrophic lakes by alum coagulation with natural mineral particles*. The 3rd International Conference on Water Resource and Environment, Qingdao, China, June 28.

Siverling, Bryce Albert, Erin L Cortus, and Todd P Trooien. *Runoff Prediction in Eastern South Dakota: A Comparison Between Runoff Programs/Curve Method and Empirical Data*. ASABE Paper 1701236. St Joseph, MI, USA: ASABE, 2017.

Ahiablame, L., C. H. Hay, J. Kjaersgaard, and T. P. Trooien. *The water balance of drained fields*. Presented to the 2017 Field Day of the U of MN Southwestern Research-Extension Center, Lamberton, MN. 18 July 2017. Presentation by Trooien.

Trooien, Todd P. et al. *Bioreactors and saturated buffers for water quality protection*. Display at the 2017 Hefty Bros Field Day, Baltic, SD. 28 July 2017.

Trooien, Todd P. *Water management for crop production in the middle USA*. Guest lecture to graduate course entitled Local to global water vulnerability and resilience. Stockholm University, Stockholm, Sweden. 20 October 2017.

McMaine, John. New Tech High Environmental Science class, Sioux Falls, SD, October 6, 2017 – Gave a short talk about water research and outreach at SDSU, gave detailed feedback on student water quality projects. Approximately 20 high school students were present.

McMaine, John. New Tech High Environmental Science class, Sioux Falls, SD, May 25, 2017 – Gave a short talk about water research and outreach at SDSU, gave detailed feedback on student water quality projects.

Peer-Reviewed Publications

Ahiablame, L., Sheshukov, A., Rahmani, V, Moriasi, D. (2017). *Annual baseflow variations as influenced by climate variability and agricultural land use change in the Missouri River Basin*. Journal of Hydrology, 551, 188-202.

Ahiablame, L., Sinha, T., Ji, J., Paul, M., Rajib, A.M. (2017). *Response of streamflow to potential climate and land use changes in the James River watershed, Upper Midwest United States*. Journal of Hydrology: Regional Studies, 14, 150-166.

Abusallout, I., Hua, G. (2017). *Characterization of dissolved organic carbon leached from a woodchip bioreactor*. Chemosphere 183, 36-43.

Boger, A., Ahiablame, L., Mosase, E., Beck, D. (2018). *Effectiveness of Roadside Vegetated Filter Strips and Swales at Treating Roadway Runoff: A Tutorial Review*. Environmental Science: Water Research & Technology, DOI: 0.1039/C7EW00230K.

Clay, David E., and Todd P. Trooien. (2017). *Understanding Soil Water and Yield Variability in Precision Farming*. In "Practical Mathematics for Precision Farming", 2017. Madison, WI, USA: American Society of Agronomy. Available: <https://dl.sciencesocieties.org/publications/books/tocs/acsesspublicati/practicalmath>.

Jahandideh, Arash, Sara Mardaninedjad, Rachel McDaniel, Bruce Bleakley and Gary Anderson (2018). *Fungal Treatment of Pharmaceuticals in Effluents: Current State, Perspectives, Limitations, and Opportunities*. Life Cycle Assessment of Wastewater Treatment, edited by Mu. Naushad

McDaniel, Rachel, Clyde Munster, and Tom Cothren. (2017). *Crop and Location Specific Agricultural Drought Quantification: Part I – Method Development*. Transactions of the ASABE. 60(3): 721-728

McDaniel, Rachel, Clyde Munster, and Tom Cothren. (2017). *Crop and Location Specific Agricultural Drought Quantification: Part II – Case Study*. Transactions of the ASABE. 60(3): 729-739

McDaniel, Rachel, Clyde Munster, and John Nielsen-Gammon. (2017). *Crop and Location Specific Agricultural Drought Quantification: Part III – Forecasting Water Stress and Yield Trends*. Transactions of the ASABE. 60(3): 741-752

Reyes-Gonzalez, Arturo, J. Kjaersgaard, Todd P. Trooien, Chris Hay, and Laurent Ahiablame. (2018). *Estimation of Crop Evapotranspiration Using Satellite Remote Sensing-based Vegetation Index*. Advances in Meteorology 2018. Article ID 4525021 (2018). Available: <https://www.hindawi.com/journals/amete/2018/4525021/>.

Reyes-Gonzalez, Arturo, J. Kjaersgaard, Todd P Trooien, Chris Hay, and Laurent Ahiablame. (2017) *Comparative Analysis of METRIC Model and Atmometer Methods for Estimating Actual Evapotranspiration*. International Journal of Agronomy 2017.3632501. Available: <https://www.hindawi.com/journals/ija/2017/3632501/>.

Singh, Shikha, Nathan Brandenburg, Laurent Ahiablame, Arturo Reyes-Gonzalez, Jeppe Kjaersgaard, Todd P. Trooien, and Sandeep Kumar. (2017). *Response of Winter Manure Application on Surface Runoff Water Quantity and Quality from Small Watersheds in South Dakota*. *Water, Air, and Soil Pollution* 228: 389. Available: <https://doi.org/10.1007/s11270-017-3572-5>.

Singh, S., Brandenburg, N., Ahiablame, L., Gonzalez, A., Kjaersgaard, J., Trooien, T., Kumar. S. (2017). *Response of Winter Manure Application on Surface Runoff Water Quantity and Quality from Small Watersheds in South Dakota*. *Water, Air, & Soil Pollution*, 228(10), 89 DOI 10.1007/s11270-017-3572-5.

Sellner, Bjorn, Guanghui Hua, Laurent Ahiablame, Todd P. Trooien, Chris Hay, and Jeppe Kjaersgaard. (2017). *Evaluation of Industrial Byproducts and Natural Minerals for Phosphate Adsorption from Subsurface Drainage*. *Environmental Technology*. <https://doi.org/10.1080/09593330.2017.1407364>.

Extension Articles

Kringen, D. (2017) *Agricultural Water Testing Project*. SDSU iGrow Article.

Kringen, D. (2017) *FSA Disaster Assistance During Times of Drought*. SDSU iGrow Article.

Kringen, D. (2017) *Playing in the Sandbox at Dakotafest 2017*. SDSU iGrow Article.

Kringen, D. (2017) *Deadline to Sign Up for SD Riparian Buffer Classification Program is Oct 15th*. SDSU iGrow Article.

Kringen, D. (2017) *SD Group Attends 2017 North American Manure Expo in Wisconsin*. SDSU iGrow Article.

Kringen, D. (2017) *North Central Region Soil Health & Water Quality Initiative*. SDSU iGrow Article.

Kringen, D. (2018) *Road Salt & Water Quality: Growing Concern in Some Northern States*. SDSU iGrow Article.

Kringen, D. (2017) *2016 Eastern SD Water Conference*. SDSU iGrow Publication.

Kringen, D., C. Hay, T. Trooien, G. Karki. (2017) *Optimal Design Drainage Rates for Southeastern South Dakota*. SDSU iGrow Publication Vol. 03-2004-2017.

Other Media

Kringen, David. *News Release. 2017 Eastern SD Water Conference November 8th*. Published 19 Sep 2017.

Kringen, David. *Woodchip Bioreactor Project*. NRCS Radio March 29, 2017.

Kringen, David. *Testing Subsurface Drainage for Nitrate*. SDSU iGrow Radio, July 7, 2017.

Kringen, David. *Eastern SD Water Conference*. South Dakota Public Radio interview, October 18, 2017.

McMaine, John. *Strategies for Improving Water Quality while Maintaining Profitability*. KELO Radio Interview, It's Your Business with Bill Zortman, January 3, 2018.

AGENCY INTERACTIONS

SDWRI staff and affiliates served on several technical committees and boards, including:

- Eastern South Dakota Water Conference Steering Committee
- Steering Committee for the National eXtension Conference
- Steering Committee for the Big Sioux Water Festival
- North American Manure Expo Planning Committee

Several other local, state, and federal agencies conduct cooperative research with SDWRI or contribute funding for research. Feedback to these agencies is often given in the form of reports and presentations at state meetings, service through committees and local boards, and public informational meetings for non-point source and research projects.

YOUTH EDUCATION

Non-point source pollution contributes to the loss of beneficial uses in many impaired water bodies in South Dakota. An important part of reducing non-point pollution is modifying the behavior of people living in watersheds through education. Programs designed to educate youth about how their activities affect water are important because attitudes regarding pollution and the human activities that cause it are formed early in life. For these reasons, Youth Education is an important component of SD WRI's Information Transfer Program.

Big Sioux Water Festival

Water Festivals provide an opportunity for fourth grade students to learn about water. SDWRI personnel were part of the organizing committee for the 2016 Big Sioux Water Festival held on May 9, 2017 with about 1100 fourth grade students from eastern South Dakota participating. SDWRI was responsible for coordination of volunteers and helpers, and co-coordinating the exhibit hall.

ADULT EDUCATION

DakotaFest

As part of SDWRI's outreach to the agricultural community, WRI affiliates host a booth at DakotaFest, a three-day agricultural fair held in August each year near

Mitchell, SD, which each draws approximately 30,000 people. Personnel field a variety of questions concerning water quality and current research for farm and ranch families.

Eastern South Dakota Water Conference

SDWRI was a sponsor of the annual Eastern South Dakota Water Conference. This event was held on November 8, 2017 at the University Student Union on the SDSU campus. The theme for the 2017 conference was entitled “South Dakota’s Water Resources: Where Are We Headed and How Will We Get There?” The morning portion of the conference featured a series of speakers discussing the current status of our water resources in eastern South Dakota. Poster presentations covered the latest strategies and research for water managers and water users in the Northern Great Plains. The afternoon sessions brought stakeholders from diverse backgrounds together in moderated roundtable discussions to address concerns and needs for studying and protecting our water resources. A white paper is being developed from these discussions.

The event attracted attendees from academia; students; agriculture interest groups; local, state, and federal government agencies; and other concerned stakeholders. Attendance at the 2017 event consisted of approximately 90 paid registrants with an additional 100 SDSU students that joined the conference as class schedules allowed. Topics covered during the conference gave participants a better understanding of the current focuses of concern, research, and management of regional water resources.

SDWRI staff and affiliates additionally participated in and presented at several regional and national meetings and conferences, including:

Conference Name	Organizing Organization	Location	Date
Ag Horizons Conference	South Dakota Crop Improvement Association, South Dakota Oilseeds Council, South Dakota Pulse Growers, South Dakota Seed Trade Association, South Dakota No-Till Association, South Dakota Soil Health Coalition and South Dakota Wheat Inc.	Pierre, SD	Dec 5-6, 2017
Livestock Environmental Training	SD Extension Service	Huron, SD	Nov 1, 2017
Western SD Hydrology Conference	USGS	Rapid City, SD	Apr 19, 2018
Eastern South Dakota Water Conference	EDWDD, SDSU, SD WRI, USGS, and SDSU WEERC	Brookings, SD	Nov 8, 2017
Dakota Farm Show	Farm Shows USA	Vermillion, SD	Jan 4, 2018
Sioux Falls Farm Show	Farm Shows USA	Sioux Falls, SD	Jan 26, 2018
Ag PhD Field Day	Hefty Seed	Baltic, SD	Jul 27, 2017

USGS Summer Intern Program

None.

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	4	1	0	0	5
Masters	1	1	0	3	5
Ph.D.	1	1	0	0	2
Post-Doc.	0	0	0	0	0
Total	6	3	0	3	12

Notable Awards and Achievements