# South Dakota Water Resources Research Institute
# Agricultural Experiment Station

## Annual Technical Report
## 2019

# Products

## Journal articles

Geza, S. *Experimental and modeling investigation of performance of septic systems in cold climates*; in preparation, Journal of Environmental Quality.

McMaine, J.T., Vogel, J.R., Belden, J.B., Schnelle, M.A., Morrison, S.A., Brown, G.O. 2019. *Field studies of pollutant removal from nursery and greenhouse runoff by constructed wetlands.* J. Env. Qual. 49:1, pp. 106-118. doi: 10.1002/jeq2.20024

Christianson, L.E., Cooke, R.A., Hay, C.H., Helmers, M.J., Feyereisen, G.W., Ranaivoson, A.Z., McMaine, J.T., McDaniel, R., Rosen, T.R., Pluer, W.T., Schipper, L.A., Dougherty, Robinson, R.J., Layden, IA., Irvine-Brown, S.M., Manca, F., Dhaese, K., Nelissen, V., von Ahnen, M. 2020. *Effectiveness of denitrifying bioreactors on water pollutant reduction from agricultural areas*. Accepted, Transactions of ASABE, doi: 10.13031/trans.14011.

Messer, T., Moore, T., Nelson, N., Ahiablame, L., Bean, E., Boles, C., Cook, S., McMaine, J., Schlea, D., Hall, S. 2021. *Constructed wetlands for water quality improvement: A synthesis on nutrient reduction from agricultural effluents.* Accepted, Transactions of ASABE.

Akhter, F., McMaine, J.T., McLemore, A.J., Hurst, M. 2021. *Validation and development of discharge equations for 3D printed flumes for flow monitoring.* In review, Transactions of ASABE

## Related reports:

Vasquez, 2019. Investigation of Removal of Heavy Metals using Biochar and Nanoscale Zero Valent Iron amended Biochar, Thesis

Hasan, Geza, and Vasquez, 2019. Removal of Heavy Metals from Urban Stormwater using Biochar and Nanoscale Zerovalent Iron Modified Biochar, 2019 Western South Dakota Hydrology Conference

McDaniel, R., J. McMaine, D. Kringen (2019) Water in South Dakota: Stakeholder Guided Strategies for Moving Forward. Posted 20 Jun 2019. https://openprairie.sdstate.edu/sdwri_pubs/1/

McDaniel, R., (2020) Persistence of E.Coli in Stream Sediments and the Impact on Water Quality. https://denr.sd.gov/dfta/wp/wqprojects/ecolisedimentstudy2020.pdf

## Radio Interviews

McMaine, J. Preparing for Spring. February 5, 2020. Pam Geppert. SD Extension iGrow Radio.

**Webinars**

McMaine, Bergstrom. Water Conservation and You: An Earth Day Discussion and Rain Barrel Workshop. April 22, 2020. McCrory Gardens. Online. https://www.youtube.com/watch?v=F7-AAj6InOo

Thaler, McMaine, Flory. May 7, 2020. Managing Swine Mortalities with Above Ground Burial. SDSU Extension. https://sdstate.zoom.us/j/92838340343

**Presentations**

Mardani, S., R. McDaniel, B. Bleakley. (2019). *The effect of edge-of-field management practices on transporting E. coli in subsurface drainage systems*. Poster Presentation at the 74th Soil and Water Conservation Society International Annual Conference. Pittsburgh, PA.

McDaniel, R. (2019). *E. coli in stream sediments*. Oral Presentation at the Wyoming Association of Conservation Districts Wyoming Watershed Conference, Casper, WY.

McDaniel, R., B. Bleakley, S. Salam, and L. Amegbletor. (2019). *Streambed sediment and E. coli variability, attachment, and the impact of riparian area management.* Oral Presentation at the 2019 Universities Council on Water Resources – National Institutes for Water Resources Annual Conference, Snowbird, UT.

McDaniel, R., S. Mardani, and B. Bleakley. (2019). *Microbial Communities in Bioreactors.* Oral Presentation at the Agricultural Drainage Management System Annual Meeting, Moorhead, MN.

McDaniel, R. (2019*). Saturated Buffers in South Dakota*. Oral Presentation at the June East Dakota Water Development District Board Meeting, Brookings, SD.

McMaine, J. *Nutrient Loss and the Nutrient Loss Calculator*. July 11, 2019. Oral Presentation at Agricultural Drainage + Future of Water Quality Workshop. Marshall, MN. https://www.sdstate.edu/agricultural-and-biosystems-engineering/nutrient-loss-calculator

McMaine, J. *Stormwater - Why We Care and Water We Can Do.* November 5, 2019. Oral presentation at Rotary Club Monthly Meeting. Brookings, SD.

McMaine, J. *Livestock and Water Quality*. December 11, 2019. Oral presentation at SD Livestock Environmental Training. Huron, SD.

McMaine J., Trooien, T. *Nutrient Loss in Native Landscapes.* January 10, 2020. Oral presentation at Agricultural Fertilizer Research and Education Council. Eagan, MN.

McMaine, J. *Tile Drainage - What you need to know*. March 5, 2020. Oral presentation at Aberdeen Farm Show Aberdeen, SD.

McMaine J., Bergstrom, J. *Stormwater Solutions for Brookings*, SD. January 23, 2020. Oral presentation at Brookings Sustainability Council. Brookings, SD.

McMaine, J. *Nutrient Loss in Tile Drainage*. March 10, 2020. Oral presentation at NDSU. Fargo, ND

McMaine, J. *Conservation Drainage – Managing Water for the Future*. June 22, 2020. Oral presentation to North Central Climate Collaborative. Online.

Thaler R., McMaine J. *Above Ground Burial for Swine Mortality Disposal*. November 5, 2019. Oral presentation at SDSU Swine Day. Brookings, SD.

***WRI Newsletter articles:***

Delfanian, Christie. *Underwater drone expands water quality testing capabilities.* Posted May 14, 2020. https://www.sdstate.edu/news/2020/05/underwater-drone-expands-water-quality-testing-capabilities

Delfanian, Christie. *SDSU landscape architects use 'green' approach to reduce runoff*. Posted May 7, 2020. https://www.sdstate.edu/news/2020/05/sdsu-landscape-architects-use-green-approach-reduce-runoff

Delfanian, Christie. *New model to predict weather for S.D. climate divisions*. Posted May 7, 2020. https://www.sdstate.edu/news/2020/05/new-model-predict-weather-sd-climate-divisions

Delfanian, Christie. *2D materials help prevent corrosion*. Posted May 7, 2020. https://www.sdstate.edu/news/2020/05/2d-materials-help-prevent-corrosion

## Information Transfer Program

The Information Transfer Program included public outreach, participation in the annual DakotaFest Farm Show, annual Ag PHD field day, serving on the steering committee and participation in the Big Sioux Water Festival, participation in the Sioux Empire Water Festival, interactions with extension specialists, local, state and federal agencies, participation and presentations at regional and national conferences, youth education, adult education, and university student training and education. The SDWRI hosted the 2019 Eastern South Dakota Water Conference. This conveyed information and research of regional significance to the public, state agencies, and other stakeholders.

Outreach activities included communication using the Institute's website. Project reports, newsletters, and other information are now being archived and converted to a format that can be read by text reading software. This information can now be found on

the Open Prairie: https://openprairie.sdstate.edu/sdwri_news/. The Institute uses the WRI Twitter account to communicate with stakeholders. The account was started in March 2019 and has 117 followers.

Publications, (pamphlets, educational materials, reports, peer-reviewed journal articles) are being disseminated in electronic formats through the WRI website, Twitter account, and iGrow. The Institute also promoted its activities and impacts through its biannual newsletter, as well as presentations at conferences and meetings.

WRI personnel continue to work with local, state, and federal agencies/entities to develop management solutions to water-related problems in South Dakota. Institute personnel continue our strong collaboration with the USDA Natural Resources Conservation Service to analyze and interpret information from ongoing research by the WRI and others to develop conservation practice standards.

## Student Support

Undergraduates: 2

Graduate Students: 3

Post-Doc: 0

# Mitigating Impacts Of Excess Water Quantity Through Improved Soil Health

**Project Type:** Annual Base Grant
**Project ID:** 2019SD237B

**Project Impact:**

Implementation of practices which improve hydraulic properties of soil will result in reduced runoff and increased infiltration. These changes can alter modeling outputs for commonly used techniques. The Soil Plant Atmosphere Water (SPAW) model simulates daily water balance from crop systems. This model is widely used by the Natural Resource Conservation Service (NRCS) to size impoundments. If runoff varies significantly due to variables that are assumed or assessed without field confirmation, model applications could result in significant error. This study assessed the change in the ratio of runoff to precipitation for various soil, cover crop, and weather treatments. Soil profiles in 135 combinations were developed with three soil classes (sandy loam, silt loam, and clay), five organic matter levels (1%, 2%, 3%, 4%, and 5%), three levels of compaction (low, medium and high), and three topsoil layer thicknesses (3'', 4.5'' and 6''). Also, three cover crop treatments were simulated by modifying surface cover and evapotranspiration. Finally, two precipitation regimes were considered (Iowa City, IA as high precipitation and Brookings, SD as low precipitation). In total, 810 scenarios were run resulting in over 300 million data points. This study confirmed that soil texture, bulk density, and topsoil thickness significantly influence runoff-precipitation ratio and infiltration-precipitation ratio ($p<0.01$). Interestingly, organic matter level (1% to 5%) had no significant effect on runoff. Cover crop scenarios had reduced runoff-precipitation ($p<0.01$) and increased infiltration-precipitation ($p<0.05$) ratios compared to no cover crop. This simulation demonstrates that runoff estimations can be significantly influenced by properties that can change due to soil health practices. Models must account for these changes rather than relying only on historical or remote sensing inputs.

# Evaluating And Predicting The Risk Of Algal Blooms In South Dakota Lakes Using Remote Sensing (Year 2)

**Project Type:** Annual Base Grant
**Project ID:** 2019SD238B

**Project Impact:**

Regulated algal growth is a natural component of freshwater ecosystems, however excess algal growth caused by increased nutrient loading can cause significant environmental, human health, and economic harm. Algal concentration monitoring is usually performed by collecting in-situ data using a sonde or through lab analysis of collected water samples. The objective of this research is to use satellite imagery to quantify algae concentration in a freshwater lake. Lake Mitchell, near Mitchell, SD, was used as a case study. In–situ ground truth chlorophyll a data was collected in Lake Mitchell at over 50 points, multiple times over two years using an EXO2 Multiparameter sonde. Each sampling event data set was compared with Level-2 Sentinel-2A cloud free satellite images taken within ±1 day of each sampling event. A regression model was developed in R studio, with ground truth data as the dependent variable and the surface reflectance value for each band as explanatory variables. This regression model was then used in the Raster Calculator tool in ArcGIS Pro to evaluate the spatial distribution of algae in the study lake. Future applications of this research will enable lake managers to monitor lake conditions remotely and make management decisions without needing highly resource intensive in-situ monitoring.

# Assessment And Improvement Of Performance Of Septic Systems In Cold Climates

**Project Type:** Annual Base Grant
**Project ID:** 2019SD239B

**Project Impact:**

Onsite septic systems are used for wastewater treatment for households not connected to sewers. There is a concern about surface and groundwater pollution when effectiveness becomes limited due to soil texture, soil temperature, neighborhood density, and distance to water resources. The goal of this study was to assess treatment performance of local soils and selected treatment media. Lab-scale column experiments were conducted using wastewater from Wastewater Reclamation Facility in Rapid City. The experiments were conducted inside and outside the lab to evaluate the effect of temperature. The columns outside the lab were subject to seasonal variation in temperature. Moisture content, temperature, and flow volume were monitored. This preliminary report includes results for experiments conducted in the lab at room temperature. The results indicated that higher nitrate removal was observed using redwood, biochar, and woodchips, respectively, when compared to the local soils. Average effluent nitrate concentration was 16.3 mg/L for alluvial columns followed by cedar soil (13.1 mg/L) and sand (11.3 mg/L). The performance of biochar, woodchip, and redwood was significantly higher than the local soils with an average effluent concentration of 8.5, 8.3, and 6.7 mg/L respectively. The reduction in nitrate concentration relative to alluvial columns were 20%, 31%,48%,49% and 59% respectively for cedar soil, sand, biochar, woodchips, and redwood. The performance of redwood was relatively better than biochar and woodchip. Findings from this study are useful for development of novel subsurface treatment systems, and for identifying parameters for assessing watershed-scale impacts in cold climatic regions.

# Improvement Of Denitrification Bioreactor Performance Using Weathered Woodchips And Wet-dry Cycle Control

**Project Type:** Annual Base Grant
**Project ID:** 2019SD240B

**Project Impact:**

Woodchip bioreactors have emerged as an important treatment technology to reduce nitrate loads from agricultural subsurface drainage, urban stormwater, and wastewaters. Woodchips are used in bioreactors to support the growth of denitrifying bacteria which reduce nitrate to nitrogen gas.
Many studies have evaluated the impact of reactor size, nitrate concentrations, hydraulic retention times and other environmental factors on the performance of woodchip bioreactors.
Little is known about the effect of woodchip quality on denitrification efficiency. The objective of this study is to evaluate the use of weathered woodchips and a wet-dry bioreactor control strategy to improve the performance of woodchip bioreactors. Three weathering processes were used in this study to treat fresh woodchips, and these included solar irradiation, natural weathering, and composting. The woodchip weathering experiments were conducted for five months for each treatment. After the weathering processes, flow through column experiments are conducted to evaluate denitrification performance of fresh and weathered woodchips. The results show that nitrate removal efficiency of different woodchips follows the order of solar irradiated woodchips > naturally weathered woodchips > composted woodchips > fresh woodchips.Weathered woodchips exhibit higher denitrification potential than fresh woodchips. The results of this study suggest woodchip weathering before bioreactor installation can be used as a cost- effective and practical management tool to improve denitrification efficiency of woodchip bioreactors.