Developing BMP’s to Minimize the Water Quality Impacts of Winter Manure Spreading - Amendment

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Project purpose

• Install and maintain surface runoff monitoring infrastructure.
• Assess water quality impacts of land application of manure during winter time.
• Develop management strategies for land application of manure.
• Provide state-specific information for e.g. a state manure management strategy and the NRCS 590 nutrient management standard.
• Outreach and education.
Rationale

• The proposed project is designed to fill some of the knowledge gaps that have been identified in understanding winter manure spreading and impacts on water quality, and to collect runoff data under conditions common to the state.

• Based on the information gained, we will develop tools to manage manure application in an environmentally responsible manner.
Work Plan

• 3-year project continuation
• Monitor surface runoff water quality impacts of winter manure application
• Monitor nitrate leaching from manure piles to shallow groundwater
• Explore computer-based modeling to characterize runoff and erosion behavior
Project Advisory Board

We have established an advisory board with members from the following organizations:

- SD DENR
- USDA-NRCS
- SD Cattlemen’s Association/Cattle Feeders Council
- SD Farm Bureau
- Moody County Conservation District
- East Dakota Water Development District
- Big Sioux Community Water System
- ...we welcome representatives from other organizations
Monitoring infrastructure has been installed at three adjacent watersheds 6-10 acres in size located SE of Colman SD.
Project components

Spreading zone identification using GPS

Spreading February 16-17 2012

Stage recorder

Water Sampler

Spreading March 4-5 2011

Water monitoring station during 2011 snow melt

Spreading February 16-17 2012
Methods

Water exiting the south flume.

Spring 2011

Water exiting the north flume.

Spring 2012
2nd Year Improvements

• Better winterization
• Heating elements (heat pad) for freezing conditions
  – Not needed this year
• Game camera monitoring
• E. Coli sampling
Improvements

Game cameras added for constant monitoring.

Guide boards to prevent interflow between watersheds.
2nd Year Progress

- **Dry Winter**
  - 2 Snow Events

- **Snowmelt Events** [1]
  - February 28 - March 2, 2012
  - March 5-7, 2012

- **Rainfall Events**
  - May 1, 2012
  - May 4
  - May 5-6, 2012 (10 Year 24-Hour Storm)
  - May 26, 2012

[1] Localized melting of snow banks, runoff was not representative across field
2\textsuperscript{nd} Year Discoveries (so far)

• Value of “eyes on the field”
  – Game cameras used to monitor the outflow of the flumes showed us what volume of runoff really occurred.
  – Camera was very useful during freezing conditions
  – Data from the May 5\textsuperscript{th} event was lost on the stage recorders but recreated using cameras.
The number of days having surface runoff from at least one of the watersheds is shown in the table below:

<table>
<thead>
<tr>
<th>Year</th>
<th>From snow melt</th>
<th>Pre-planting</th>
<th>Growing season</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010*</td>
<td>n/a</td>
<td>None collected</td>
<td>None collected</td>
</tr>
<tr>
<td>2011</td>
<td>6</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2012</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

*The project principal investigator changed in December 2010.
Other Flow Quantities
Snowmelt Runoff

*Localized melting of snow banks, runoff was not representative across field
2011 vs. 2012
Rainfall Runoff

2011

Volumetric Flow Rate (m³/s⁻¹)


2012

Volumetric Flow Rate (m³/s⁻¹)

## Snowmelt Runoff Quality

<table>
<thead>
<tr>
<th>TKN</th>
<th>South</th>
<th>2011[^1]</th>
<th>5 kg/ha</th>
<th>2012:</th>
<th>0.01 kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>2011[^2]:</td>
<td>5 kg/ha</td>
<td></td>
<td>2012:</td>
<td>0.03 kg/ha</td>
</tr>
<tr>
<td>East</td>
<td>2011[^2]:</td>
<td>20 kg/ha</td>
<td></td>
<td>2012:</td>
<td>0.006 kg/ha</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TSS</th>
<th>South</th>
<th>2011[^1]</th>
<th>10 kg/ha</th>
<th>2012:</th>
<th>0.06 kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>2011[^2]:</td>
<td>18 kg/ha</td>
<td></td>
<td>2012:</td>
<td>0.1 kg/ha</td>
</tr>
<tr>
<td>East</td>
<td>2011[^2]:</td>
<td>13 kg/ha</td>
<td></td>
<td>2012:</td>
<td>0.03 kg/ha</td>
</tr>
</tbody>
</table>

[^1]: Estimation of runoff loss
[^2]: Possible cross contamination between North and East WS kg/ha≈lb/acre
Rainfall Runoff Quality

- **TKN**
  - South
    - 2011: 0.2 kg/ha
    - 2012 [1]: 5 kg/ha
  - North
    - 2011 [1]: 0.4 kg/ha
    - 2012: 2 kg/ha
  - East
    - 2011: 0.4 kg/ha
    - 2012 [1]: 8 kg/ha

- **TSS**
  - South
    - 2011: 73 kg/ha
    - 2012 [1]: 588 kg/ha
  - North
    - 2011 [1]: 37 kg/ha
    - 2012: 304 kg/ha
  - East
    - 2011: 40 kg/ha
    - 2012 [1]: 1090 kg/ha

[1] Estimation of runoff loss

kg/ha ≈ lb/acre
In-Field Sediment Movement (May 5)
## 2011 vs. 2012 Runoff Quality

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TKN</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
</tr>
<tr>
<td></td>
<td>40-130 ppm</td>
<td>1-12 ppm</td>
<td>2-7 ppm</td>
<td>14-16 ppm</td>
</tr>
<tr>
<td>NH₃</td>
<td>30-60 ppm</td>
<td>0.5-3.5 ppm</td>
<td>0.25-2 ppm</td>
<td>0.8-0.9 ppm</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>5-8 ppm</td>
<td>0.25-11 ppm</td>
<td>0.5-2 ppm</td>
<td>4-14 ppm</td>
</tr>
<tr>
<td>TP</td>
<td>6-18 ppm</td>
<td>0.1-0.8 ppm</td>
<td>NA</td>
<td>0.5-0.6 ppm</td>
</tr>
<tr>
<td>TDP</td>
<td>5-17 ppm</td>
<td>0.1-0.8 ppm</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>TSS</td>
<td>30-190 ppm</td>
<td>15-36 ppm</td>
<td>50-300 ppm</td>
<td>1800-3300 ppm</td>
</tr>
</tbody>
</table>
Project description etc. is available at the project website.

http://www.sdstate.edu/abe/wri/research-projects/winter-manure-spreading.cfm

Developing BMP's to Minimize the Surface Water Quality Impacts of Winter Manure Spreading

The timing and amount of manure application to land is important in order to manage nutrients and to meet the regulatory requirements and guidelines developed by the South Dakota Department of Environment and Natural Resources and the Natural Resources Conservation Service as outlined in e.g., the conservation practice standard 590 on nutrient management.

Spreading manure on frozen ground is an important management option for livestock producers since winter spreading of manure reduces the quantity of winter storage needed, provides more time for application on cropland and reduces soil compaction by heavy equipment. Because of reduced infiltration capacity of the soil when frozen and manure being applied on snow, there is a risk of manure including fecal coliform bacteria, nutrients and suspended particles being carried off the field with water runoff. Fecal coliform bacteria, nutrients, and sediment have been identified as sources of water resource impairment in many South Dakota watersheds. There is a need, therefore, to balance the application of manure on frozen ground to impacts on surface water quality.

The overall project goal is to evaluate the environmental risk of spreading manure during winter conditions and develop BMPs for winter manure spreading that minimize water quality impacts. The goal will be attained by completing activities designed to reach four objectives:

1. Assess the impact on surface water quality following spreading manure on frozen soils.
2. Compare winter manure spreading practices related to location, timing and placement within a field to minimize water quality impacts and develop BMPs.
3. Develop a climatic risk factor using frequency of soil frost and rainfall events, and
4. Provide education on winter manure spreading BMPs to livestock producers, extension educators, and resource managers.

The project is funded through a SD DENR EPA 319 grant.

Contact the project PI's for more information:
Nathan Brandenburg, graduate assistant
Jesse Kiensasara, assistant professor
Best Management Practices

• Final conclusions can not accurately be determined until more years of runoff and data occurs. Two years with limited runoff data not enough to firmly determine BMPs.
Project continuation

• We think it is necessary to **continue the monitoring** to collect meaningful information.
• Continuing the project will utilize the field installation and monitoring equipment already in place.
• The land owner is willing to continue.
• We will continue working with current project partners.
• Community support
Questions
TKN Data

2011

2012

Total Kjeldahl Nitrogen (mg/L)

Date


Total Kjeldahl Nitrogen (ppm)

No Data

Date

7/10/2011 7/14/2011
NO$_3^-$ Data

2011

2012

Date

Nitrate-Nitrogen (ppm)

Nitrte-Nitrogen (mg L$^{-1}$)

North WS  South WS  East WS  No Data


7/10/2011  7/14/2011

5/5/2012  5/6/2012

North WS  South WS  East WS  No Data
TP Data

2011

2012
TDP Data
TSS Data

2011

2012

2011

2012

2011

2012