Appendix B

Objectives/Tasks Accomplishments

By J. Kjaersgaard, South Dakota State University.

Objective 1: Manage the demonstration site using common agricultural practices and monitor runoff quantity and quality.

Task 1: Manage the watersheds and monitor runoff volumes and nutrient, sediment and *E.coli* export from the three watersheds.

Product 1: Manage the watersheds using normal agricultural practices and monitor the runoff volumes.

Status: On schedule.

Progress on Product 1: We applied the manure on March 10 2013. On the south watershed, manure was applied to the one-half of the watershed located highest in the terrain. On the north watershed, manure was applied to the one-half of the watershed located lowest in the terrain. No manure was applied to the third watershed (control). An outline of where the manure application location within the watersheds is shown in Figure 1. The application rate was calculated using the Fertilizer Recommendations Guide (2005) based on the phosphorus requirement of the succeeding soybean crop, soil phosphorus content and the phosphorus content of the manure. We used a yield goal of 60 bu/acre for the soybean crop. The median soil phosphorus content based on 40 soil samples collected at 0-6 inch depth in the fall of 2012 was 7 ppm (Olsen). The calculated manure application rate was 7 tons/acre, and the actual application rate was approximately 7.4 tons/acre. The uniformity of the application was checked using cross-track calibration. The nutrient content of the manure from the feedlot supplying the manure is shown in Table 1. Pictures from the manure application are shown in Figure 2. The Cattle Feeders Council of the South Dakota Cattlemen’s Association provided and covered the costs associated with manure procurement, truck and loader rental and diesel fuel.

<table>
<thead>
<tr>
<th>Feedlot name</th>
<th>Weight of manure per load, tons</th>
<th>Tot N lb/t</th>
<th>NH₄-N lb/t</th>
<th>P₂O₅ lb/t</th>
<th>K₂O lb/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redder</td>
<td>6.25</td>
<td>12.6</td>
<td>1.9</td>
<td>4.9</td>
<td>18.3</td>
</tr>
</tbody>
</table>
Figure 1. Location of manure application zones and monitoring stations within the three watersheds. Manure was applied to the one-half of the watershed located highest in the terrain in the south watershed. On the north watershed, manure was applied to the one-half of the watershed located lowest in the terrain. No manure was applied to the east watershed (control).

Figure 2. Manure spreading on March 10 2013 (left) and the manure appearance (right).

Pictures from the March 14 2013 runoff event are shown in Figure 3. The runoff hydrographs from the watersheds during March 26-28 2013 are shown in figure 4. We will continue collecting
runoff information for the duration of the project period to support the development of Best Management Practices.

Figure 3. Surface runoff on March 14 2013.

Figure 4. Hydrograph from the runoff recorded during the period March 26 – March 28 2013.

The flumes were maintained throughout the project period, including removal of ice-buildup during the spring snowmelt events, installation and maintenance of stage recorders and automated water samplers and general maintenance around the flumes including removal of vegetation at the flume inlet, keeping the flume outlet clear from debris and similar.
**Product 2:** Collect water samples and analyze runoff for nutrient, sediment and *E. coli* export from the three watersheds.

**Status:** On schedule.

**Progress on Product 2:** A total of 20 water samples were collected during 5 snow melt runoff events. We have not recorded any other runoff during the reporting period. The runoff events occurred as follows:

- March 9 2013. We had a warming for several days prior to March 9, which resulted in snow compaction and produced a small amount of runoff prior to manure spreading on March 10.
- March 26, 27 and 28. Remaining snow melted.

The ranges of nutrient and sediment content in the runoff water collected during the snowmelt events in 2011, 2012 and 2103 as well as during the runoff events in July 2011 and May 2012 are shown in Table 3.

### Table 3. Runoff effluent concentrations of Total Kjeldahl Nitrogen, Ammonia, Nitrate, Total Phosphorous, Total Dissolved Phosphorous and Total Suspended Sediment during the 2011, 2012 and 2013 snowmelt runoff and the runoff events in July 2011 and May 2012.

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<tbody>
<tr>
<td>Total Kjeldahl Nitrogen</td>
<td>40-130</td>
<td>1-12</td>
<td>3-11</td>
<td>2-7</td>
<td>14-16</td>
</tr>
<tr>
<td>Ammonia-Nitrogen</td>
<td>30-60</td>
<td>0.5-3.5</td>
<td>1-3.7</td>
<td>0.25-2</td>
<td>0.8-0.9</td>
</tr>
<tr>
<td>Nitrate-Nitrogen</td>
<td>5-8</td>
<td>0.25-11</td>
<td>1.1-5</td>
<td>0.5-2</td>
<td>4-14</td>
</tr>
<tr>
<td>Total Phosphorous</td>
<td>6-18</td>
<td>0.1-0.8</td>
<td>0.1-1.7</td>
<td>NA</td>
<td>0.5-0.6</td>
</tr>
<tr>
<td>Total Dissolved Phosphorous</td>
<td>5-17</td>
<td>0.1-0.8</td>
<td>0.1-2.0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>30-190</td>
<td>15-36</td>
<td>7-275</td>
<td>50-300</td>
<td>1800-3300</td>
</tr>
</tbody>
</table>

The flumes were maintained throughout the project period, including removal of ice-buildup during the spring snowmelt events, installation and maintenance of stage recorders and automated water samplers and general maintenance around the flumes including removal of vegetation at the flume inlet, keeping the flume outlet clear from debris and similar.

**Objective 2:** Compare in-field placement of manure during winter spreading to determine which practice that minimizes the impact on water quality and develop BMPs.

**Task 2:** Quantify water quality impacts from winter manure spreading.

**Product 3:** Quantify water quality impacts from winter manure spreading.

**Status:** On schedule.
**Progress on product 3:** A number of best management practices related to manure spreading have been suggested in the literature. Many of those practices are region-specific and may therefore not be fully transferable from one region to another. Based on a literature review, a preliminary computer modeling effort using WEPP, and the field data collected during this project several best management practices have tentatively been suggested. Most of these BMPs are based on the literature review and WEPP modeling because the data collection from this project is not complete and conclusive, and we need to collect more information for a complete analysis. For these reasons we are only able to discuss appropriate BMPs and not draw conclusion at this time.

The literature and field observations suggest that manure should be spread on soil that is least likely to produce runoff, including soil with high infiltration rates and on fields located away from streams. As confirmed using WEPP, soil texture regulates runoff losses more than the slope of the field. Runoff losses will likely occur on clay soils compared to silty or sandy soils. Therefore soil texture might need to be considered before slope. Fall tillage can increase surface storage which can increase infiltration and runoff loss. Long term no-till management operations have also been known to increase infiltration.

From the literature review, manure should not be applied to melting snow or directly before a large rain event. Large runoff losses are likely to occur along with large nutrient and sediment losses. This BMP is difficult to practice because of variable climate and weather conditions.

**Product 4:** Set up and run an appropriate model to simulate runoff and sediment transport in the watersheds.

**Status:** Ahead of schedule.

**Progress on Product 4:** We conducted a preliminary computer simulation study using the WEPP model utilizing three common South Dakota soil types representing fine (Promise), medium (Houdek) and coarse (Maddock) textured soils. All model runs were completed using weather data collected at the field site, i.e. the climate conditions were the same for all three soils. The objectives of the modeling exercise were to quantify the impacts from a) soil type, and b) slope on runoff and sediment yield.

The average annual runoff (fig. 5) and average annual sediment yield (fig. 6) were generated after simulating changes in slope and soil texture with the WEPP model. For the Houdek soil series the average annual runoff event varied from 24 to 36 mm, and the average annual sediment yield varied from 1000 to 50000 kg ha\(^{-1}\). The annual runoff varied from 61 to 88 mm for the Promise soil series, and the annual sediment yield varied from 3700 to 132000 kg ha\(^{-1}\). The Maddock soil series varied from 3 to 5 mm for the annual runoff and 0 to 40 kg ha\(^{-1}\) for the annual sediment yield.
According to the WEPP simulations different soil textures influence runoff and sediment yield more than changes of slope. Current regulations identify manure should only be applied to land with less than 4% slopes in South Dakota. Model results from WEPP do not support this conclusion. The results from the Houdek, Promise, and Maddock soil series greatly differ compared to changes of slope between each soil series. Coarse textured soils lose very little runoff each year, so almost no sediment was lost. Fine textured soils lose the most runoff each year. This causes sediment loss to increase exponentially with an increase in slope. Medium textured soils results fall between the other two soil types. Runoff loss occurs, but sediment loss
only increases linearly when the slope increases. Although it is too early to draw conclusions, these preliminary results suggests that best management practices should depend more on soil type and less on slope.

**Objective 3:** Assess climatic risk factors using frequency of soil frost and rainfall events impacting runoff and water quality and monitor changes in soil nutrient levels.

**Task 3:** Mine historical meteorological information and merge it with weather information collected during the project in a database. Build database of soil nutrient levels.

**Product 5:** Build a database of historical meteorological information by mining historical weather data sets. Add current meteorological information, soil temperature and moisture data.

**Status:** On schedule.

**Progress on product 5:** A database of historical climate data has been built. Meteorological information from the field and from nearby weather stations operated by the South Dakota Climate Office are added to the database.

**Product 6:** Collect information about soil temperature and soil moisture and collect soil samples for analysis.

**Status:** On schedule.

**Progress on product 6:** Soil moisture and soil temperature data was collected throughout the project period. Soil sensors are located at 6, 20 and 40 inches at five different locations in the watersheds. The location of the soil sensors are shown in Figure 1.

In addition, 40 soil samples was collected at 0-6 inch depth in mid-November 2012, and three samples were collected mid-January at 6-24 inch depth. The samples were analyzed for nitrate-nitrogen, Olsen P, Organic matter, potassium and pH. This information was used in the WEPP simulations.

**Task 4:** Meteorological data analysis.

**Product 7:** Complete a climate risk assessment of critical meteorological factors impacting the runoff potential of excess surface water.

**Progress on product 7:** A climate risk assessment will be completed once more information has been collected. The climate risk assessment is planned to be undertaken towards the end of the project period as outlined in the PIP.

**Status:** On schedule.

**Objective 4:** Monitor surface runoff and leaching of nitrogen to shallow groundwater from field storage of manure.
**Task 5:** Establish a manure pile and collect surface water and groundwater samples for nitrogen analysis.

**Product 8:** Monitor surface runoff and leaching of nitrogen to shallow groundwater from field storage of manure.

**Status:** On schedule.

**Progress on product 8:** In the fall of 2013 we established two fields of observation wells with three well in each field. The wells are placed around two temporary field manure storage locations; one near Colman, and one near Hudson. No results have been collected form the wells yet.

**Objective 5:** Provide education on winter manure spreading BMPs to livestock producers, extension educators, crop advisers, land managers, water quality experts, state regulators, and other stakeholders.

**Task 6:** Information transfer and outreach

**Product 9:** Maintain the project website and post results, reports, presentations and other pertinent information.

**Status:** On schedule.

**Progress on product 9:** The project website has been developed and continues to be updated as new information is generated. The website address is [http://www.sdstate.edu/abe/wri/research-projects/winter-manure-spreading.cfm](http://www.sdstate.edu/abe/wri/research-projects/winter-manure-spreading.cfm).

**Product 10:** Develop educational brochures, fact sheets and handouts.

**Status:** On schedule.

**Progress on product 10:** A factsheet on nitrate was published in April 2012. The factsheet is available in electronic form from the Water Resources Institute website at [http://www.sdstate.edu/abe/wri/water-quality/upload/NitratePublication_Kjaersgaard_Published.pdf](http://www.sdstate.edu/abe/wri/water-quality/upload/NitratePublication_Kjaersgaard_Published.pdf).
A 10-page factsheet on Watershed Management was been completed in July 2012. The publication is available in electronic form through the Water Resources Institute Website and from e.g. from the South Dakota Legislative Research Council ([http://legis.state.sd.us/interim/2012/documents/WTF09-25-12WatershedManagementSDSU.pdf](http://legis.state.sd.us/interim/2012/documents/WTF09-25-12WatershedManagementSDSU.pdf)). Printed copies are available from the offices of the Water Resources Institute and East Dakota Water Development District.

**Product 11:** Organize or contribute to nine meetings, crop clinics or CAFO training workshops to disseminate information generated during the project.
Status: On schedule.

**Progress on product 11:** Findings from the study were presented at two CAFO training workshops held at the Crossroads Convention Center, Huron SD. The workshops are sponsored by South Dakota State University, South Dakota Department of Environment and Natural Resources and the USDA Natural Resources and Conservation Service. Six soil crop and soil fertility clinics were conducted. We had two meeting for the project advisory board held on December 21 2012 and July 26 in Sioux Falls.

**Task 7:** Project reporting.

**Product 12:** Prepare semi-annual reports for the SD DENR describing project progress and results.

Status: On schedule.

**Progress on product 12:** This report is the first report in the project period.

**Product 13:** Prepare annual reports for the SD DENR describing project progress and results.

Status: On schedule.

**Progress on product 13:** Along with the GRTS reporting form and associated Appendices A and B this is the annual progress report for project year 2013.

**Product 14:** Prepare a project completion report for the SD DENR describing project results and impact.

Status: On schedule.

**Progress on product 14:** The project completion report will be completed at the end of the three-year project period.