# DISCOVERY FARMS MINNESOTA

# 2017 WORK PLAN

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# 1.0 Purpose

This Work Plan proposes monitoring activities to be conducted by the Minnesota Department of Agriculture (MDA) Monitoring and Assessment Unit (MAU). All related work will be for the Discovery Farms Minnesota (DFM) program created in the fall of 2009 by the Minnesota Agricultural Water Resources Center (MAWRC). The 2017 monitoring season will be the seventh year of data collection for three core DFM farms (BE1, GO1, ST1), sixth year for two farms (RE1, WR1), fifth year for three farms (DO1, NO1, WI1) and fourth year for one farm (RO1). In fall 2016, the Chisago County farm (CH1) was graduated from the program.

The purpose of this Work Plan is to provide a framework for the water monitoring activities and procedures of the MAU DFM staff for the 2017 monitoring season. The planning process is essential in prioritizing and optimizing the monitoring resources. All data collected from DFM locations will be worked up by MDA and referred to MAWRC and the DFM Steering Committee for further review and assessment.

Intensive water quality monitoring will be carried out to evaluate runoff from varying commercial farms across Minnesota. Each Discovery Farm will generally be monitored for five to seven years or longer if deemed necessary. The first phase of the project (up to four years or more) will serve to establish baseline relationships between current land use and water quality as well as the underlying mechanisms that dictate the observed water quality. After the first phase, an assessment period will be used to evaluate opportunities for alternative practices based on the initial results from the first phase. If changes are made, the third phase will begin and monitoring will continue for another two to four years. All DFM sites will continue in the first phase of monitoring and evaluation through the 2017 growing season.

# 2.0 Program Objectives

The goal of DFM is to generate water quality data at the farm scale under real world conditions. It is also to create an opportunity for producers to learn from each other about the relationship between agriculture and water quality and improve communication among the agricultural community, consumers, researchers, and policy-makers. MDA is committed to providing support for the collection and distribution of high quality, technically defensible, scientific data.

To achieve this goal, the following objectives have been identified that MDA will be responsible for (objectives are also available in Table 1):

**Table 1:** 2017 Discovery Farms Minnesota objectives.

| Project Objectives | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Equipment Selection and Purchasing | X | | | | | | | | | | | |
| 2. Monitoring Location Assessment | | | | | | X | X | | | | | |
| 3. Equipment Installation | | X | X | | | | | | | | | |
| 4. SOP Development and Revisions | | | | | X | X | | | | | | |
| 5. Water Quality & Field Data Management | X | X | X | X | X | X | X | X | X | X | X | X |
| 6. Flow and Load Quantification | | | | | | | | | X | X | X | X |
| 7. Site Maintenance | X | X | X | X | X | X | X | X | X | X | X | X |
| 8. Annual Report Development | | X | X | X | X | | | | | | | |
| 9. EQuIS Water Quality Database Submittal | | | | | | | | | | | X | |
| 10. Local Partner Training | | X | X | | | | | | | | | |

### Objective 1: Equipment Selection and Purchasing

MDA will be responsible for the selection of appropriate monitoring equipment and associated platforms such as data storage, monitoring sensors, communication, power supply and sample collection. MDA staff will research equipment, obtain quotes, track equipment/supply budgets and assure purchase orders have been completed.

The goal will be to maintain equipment consistency across each Discovery Farm. The exception to this rule will be for *temporary* sites or sites with borrowed or donated equipment. Refer to Table 4 for a list of equipment.

New equipment purchased for 2017 will include the following:

- Solinst Levelogger Junior Edge (Datalogger/Pressure Transducer) – these will be installed at sites with subsurface tile monitoring to serve as a backup-standalone stage sensor for the tile data record.
- Miscellaneous supplies such as cleaning solution, cables and backup/repaired equipment as the budget allows.

Details on the purpose and location of these instruments is included under objective 3.

### *Objective 2: Monitoring Location Assessment*

Two new farms (three monitoring sites) will be added to the DFM program in water year 2017. MDA will be responsible for the identification of appropriate locations for monitoring equipment within a selected Discovery Farm. Selection criteria will include:

- Access for equipment installation and data collection.
- Ability for flow monitoring to be free from backwater conditions.
- Having a watershed that can be accurately delineated.
- Ability to obtain accurate subsurface drainage infrastructure maps.
- To isolate the particular field and/or practices with minimal contribution from adjacent fields with varying land use or management.

### *Objective 3: Equipment Installation*

MDA will be responsible for the programming and installation of all monitoring equipment at Discovery Farms including:

- H flume, plywood wingwalls, soil berms (with assistance from MAWRC)
- Equipment enclosure boxes
- AgriDrain for subsurface drainage monitoring (with assistance from MAWRC)
- Data storage peripherals, stage sensors, weather/soil sensors, automated water samplers, power supplies (batteries, solar panels).
- Time-lapse cameras and photo documentation.

Miscellaneous work may be carried out through MAWRC and may include AC power connection to a site, or field modifications including subsurface drainage alterations.

Equipment installations planned for 2017 include the following:

Installation of a Solinst Levelogger Junior Edge in each of the Agri Drain structures (DO1, MC1, RE1, RW1N, RW1S, ST1, WR1). These will serve as a backup stage sensor for the subsurface tile in the event of a power or equipment failure.

The DFM steering committee directed discontinuation of monitoring activities at site CH1 after six years of monitoring. The steering committee felt that the farmer was doing a good job and there weren't any practices they could recommend for best management practices. We have likely learned everything we can from this particular farm (a corn-soybean rotation with modified no-till) and the equipment could be used to learn more at a new farm. The flume, shelters and all instrumentation will be removed in October 2016 (water year 2017) after the crop has been harvested. This equipment will be transported to the new Discovery Farm in McLeod County.

Complete equipment installs at the new Discovery Farms sites in McLeod and Redwood Counties. All three monitoring stations will monitor both surface runoff and subsurface tile drainage. Tile work and Agri Drain installation will be completed by MAWRC, as well as any earth-work and berms. The MDA will be responsible for installing the monitoring shelters and equipment, along with programming the dataloggers and training the local partners.

### *Objective 4: SOP Development*

MDA was responsible for the development of all procedures for site maintenance, sample collection, processing and data analysis. A detailed Standard Operating Procedure (SOP) manual was completed in the spring of 2011. Over the years, additional equipment and updated procedures have been adopted. The current SOP document will be revised to include program updates specific to 2017 and beyond. Once finalized, it will be reposted on the MDA's website, available from:
http://www.mda.state.mn.us/protecting/cleanwaterfund/onfarmprojects/discoveryfarmsmn.aspx

### *Objective 5: WQ and Field Data Management*

MDA will be responsible for data management of all analytical laboratory water chemistry data and site specific data collected from remote data collection platforms (dataloggers). Water chemistry data will be compiled into a spreadsheet as results are returned throughout the year and thoroughly reviewed and saved on an MDA server (as well as submitted to the EQuIS database, see Objective 9). Continuous time series data from the dataloggers will be managed, corrected and finalized by MDA and stored on an MDA server.

### *Objective 6: Flow and Load Quantification*

MDA will be responsible for the quantification of annual and event specific runoff volumes and losses of sediment, nutrients and other selected constituents through the calculation of loads, flow-weighted mean concentrations and yields. Data will be summarized on a water year annual basis, as well as by month and individual events. MDA loading calculation guidelines will be followed for consistency across all MDA edge-of-field monitoring sites.

### *Objective 7: Site Maintenance*

MDA will be responsible to ensure data integrity, accuracy and transparency at each Discovery Farm. Raw data will be available through cellular modems and StreamTrac software. Data will be reviewed on a regular basis to assure that all equipment and sensors are reading properly. If outlying or missing values are present, MDA staff will investigate and troubleshoot to assure the situation is resolved as soon as possible. This could include replacing equipment or reprogramming if necessary.

Miscellaneous needs will arise throughout the year for each site. Flume and Field time lapse cameras will need to be installed or downloaded, backup Levelogger sensors will need to be downloaded, flumes may need to be leveled and crest stage gauges will need to be surveyed into the flume staff gauge. Periodic trips will also be planned for collection of field quality control (QC) samples such as equipment blanks to assure that the equipment is not introducing contamination during the sampling process.

### *Objective 8: Annual Report Development*

MDA will be responsible for development of a DFM Annual Report. Each report will build on available and finalized data from previous years. Once completed and approved, the annual report will be posted on the MDA and Discovery Farms Minnesota websites as well as distributed to the MAWRC and our local partners.

### *Objective 9: EQuIS Water Quality Database Submittals*

MDA will be responsible for the annual submittal of water quality data into the EQuIS database. At the culmination of the water year monitoring season, the raw water chemistry results and associated metadata will be thoroughly reviewed and submitted to the Minnesota Pollution Control Agency's EQuIS database. These data will not be available for public extraction (though data will be readily available from MDA staff by request). Submittal will include all water chemistry results for each Discovery Farm (see Table 3).

### *Objective 10: Local Partner Training*

MDA will be responsible for training of local partners on sample collection and processing procedures. Local partner training will occur on an as-needed basis when new Discovery Farms are installed or when questions arise throughout the monitoring season.

With new farms in McLeod and Redwood County, new partners (Hawk Creek Watershed Partnership and Redwood-Cottonwood Rivers Control Areas) will be trained in on all sampling and site maintenance standard operating procedures in spring 2017.

# 3.0 2017 Discovery Farms

In total, eleven Core Farms will be monitored in 2017 (Table 2). Two additional farms are also being monitored as Special Projects which are not overseen by the MDA (Table 3).

Site BE2 (monitored in 2011 and 2012) was discontinued from the program in December 2012 based on a vote by the DFM Steering Committee after monitoring and observational data indicated the site was prone to runoff from an adjacent field after large rain events. Corrective measures taken in 2011-2012 were not sufficient to minimize the risk of off-site contribution.

Site NO1E (monitored from 2013-2015) was similarly discontinued in March 2016 following a vote by the DFM Steering Committee. The site experienced many site and equipment issues, including several flume blowouts, power issues and instrument malfunctions. In addition, snowmelt monitoring was not possible due to difficult site access and significant snow drifts at the site.

Site CH1 (monitored 2011-2016) was discontinued after WY2016 following graduation from the DFM program.

**Table 2:** 2017 DFM site descriptions for Core Farms.

| Discovery Farm ID | County | Major Watershed (HUC 8) | Major Basin (HUC 4) | Drainage Area (acres) | Dominant Soil Texture and Drainage | Nearest Town | Station Type |
|---|---|---|---|---|---|---|---|
| **BE1** | Blue Earth | Le Sueur | Minnesota | 14.3 S*<br>26.2 T** | Poorly drained silty clay loam | Mankato | Surface and Subsurface |
| **DO1** | Dodge | Zumbro | Lower Mississippi | 13.9 T<br>13.9 S | Somewhat poorly drained silt loam | Kasson | Surface and Subsurface |
| **GO1** | Goodhue | Mississippi, Lake Pepin | Lower Mississippi | 6.3 S | Well drained silty loam | Goodhue | Surface |
| **MC1** | McLeod | South Fork of the Crow | Minnesota | 60.6 T<br>60.6 S | Poorly drained clay loam, well drained loam | Brownton | Surface and Subsurface |
| **NO1W** | Norman | Wild Rice | Red River of the North | 570.8 T | Moderately well drained fine sandy loam | Gary | Subsurface (2) |
| **RE1** | Renville | Middle Minnesota | Minnesota | 81.0 T | Poorly drained clay loam | Fairfax | Subsurface w/surface inlets |
| **RO1** | Rock | Lower Big Sioux | Missouri | 25.5 S | Well drained silty clay loam | Beaver Creek | Surface |
| **RW1N** | Redwood | Redwood | Minnesota | 12.5 T<br>12.5 S | Well drained loam | Seaforth | Surface and Subsurface |
| **RW1S** | Redwood | Redwood | Minnesota | 10.2 T<br>10.2 S | Well drained loam | Seaforth | Surface and Subsurface |
| **ST1** | Stearns | Sauk | Upper Mississippi | 28.2 S<br>24.2 T | Poorly drained loam soils | Sauk Centre | Surface and Subsurface |
| **WI1** | Wilkin | Upper Red River of the North | Red River of the North | 160.0 T | Poorly drained very fine sandy loam | Rothsay | Subsurface |
| **WR1** | Wright | Crow | Mississippi Headwaters | 23.9 S<br>23.9 T | Poorly drained clay loam to well drained loam | Howard Lake | Surface and Subsurface |

* S = Surface | ** T = Subsurface Tile

**Table 3:** 2017 DFM site descriptions for Special Project Farms.

| Discovery Farm ID | County | Major Watershed (HUC 8) | Major Basin (HUC 4) | Drainage Area (acres) | Dominant Soil Texture and Drainage | Nearest Town | Station Type |
|---|---|---|---|---|---|---|---|
| **BT1*** | Benton | Platte-Spunk, Mississippi | Mississippi Headwaters | unknown | Excessively drained loamy sand | Royalton | Suction-cup lysimeters |
| **KA1*** | Kandiyohi | South Fork of the Crow River | Mississippi Headwaters | multiple plots, unknown | Poorly drained loam soils | Willmar | Subsurface Tile |

* KA1 and BT1 are considered a Special Project Discovery Farms, which are not the responsibility of the Minnesota Department of Agriculture. They are maintained by the Minnesota Agricultural Water Resources Center and University of Minnesota Extension offices. For more information, see mawrc.org

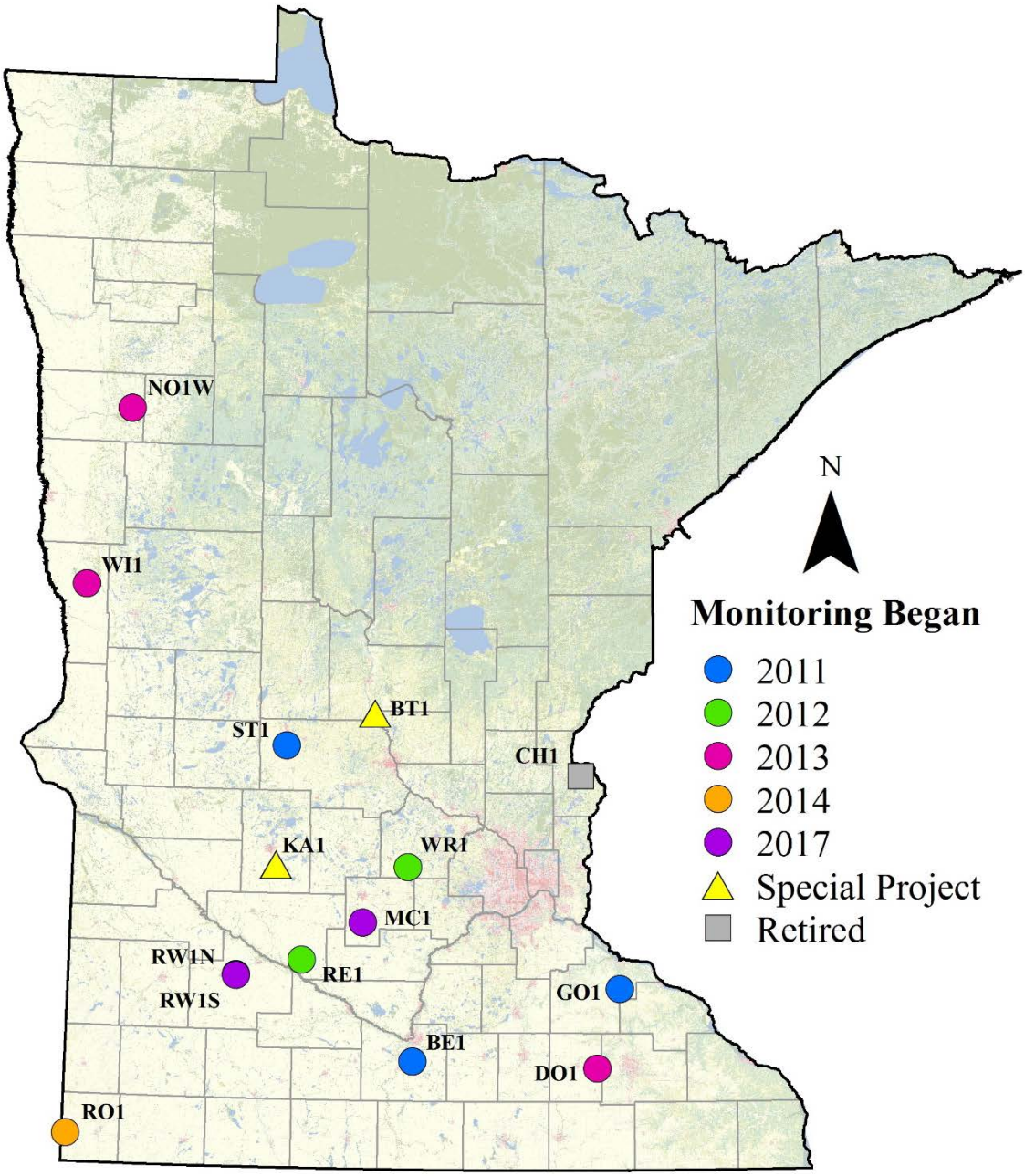


**Figure 1:** 2017 Discovery Farms Minnesota locations.

# 4.0 Proposed 2017 Sampling

Sampling for 2017 will be driven by weather conditions and intensity of storm events received by each region. As a general rule, the goal will be to characterize all measureable runoff year-round at each Discovery Farm. There will not be a set limit on the number of samples collected for each site. It can be expected that sites will have anywhere from five to up to fourty-five runoff events in a given water year (October 1st of previous year through September 30th of the current year) with anywhere from 10-80 samples per autosampler configuration. The number of events could fall outside of that range with a very dry or wet year. Flow-based composite subsurface tile samples will be collected for as long as tile flow is occurring.

A more detailed procedure for sample collection, processing and site maintenance can be found in the Discovery Farms Minnesota Standard Operating Procedures (SOP) manual, available at http://www.mda.state.mn.us/protecting/cleanwaterfund/onfarmprojects/discoveryfarmsmn.aspx

## 4.1 Sample Collection

The automated sampler configuration will consist of four polyethylene one gallon bottles. Samples will be collected on an equal-flow increment (EFI) composite basis. Once the flume or tile system reaches a predetermined level, flow will begin accumulating.

In spring 2016, the sampler programming was modified to better capture the frequent small runoff events. The flow accumulation threshold for all flume sites will be equal to 0.01 inches of runoff, meaning the threshold is based on the contributing watershed size. When the flow accumulation threshold is reached, the datalogger will trigger the automated sampler to collect one pulse of 600 mL into the first one gallon ISCO bottle. The datalogger will be programmed to immediately collect the first sample pulse after stage in the flume reaches 0.04 feet and five to ten cubic feet of flow have accumulated. This insures that even during the smallest runoff events, adequate sample volume will be collected to analyze all analytical constituents. The low activation threshold also ensures that even the smallest runoff events are sampled. The first ISCO bottle will be configured for six pulses, totaling 3.6 liters (0.95 gallons).

Bottles two through four will be set to sample 125 mL per pulse, with 24 pulses totaling three liters (0.80 gallons). Sampling will continue until the fourth bottle is full or flow subsides. A complete sampler program would result in approximately 0.78 inches of runoff being characterized.

For subsurface tile monitoring sites, there was a switch in early 2014 to continuous sampling whenever subsurface drainage is occurring. This eliminated the need for collecting baseflow grab samples and defining periods for storm event sample concentration extrapolations. No major program modifications will be made to the tile monitoring sites in 2017.

Upon collection, samples will immediately be shipped on ice to Minnesota Valley Testing Laboratory (MVTL) in New Ulm, Minnesota. MVTL will be used for consistency for all monitoring sites related to the DFM program. A chain of custody will be filled out with site IDs, sample start/end dates and times and submitted to the lab along with the samples. All samples will be analyzed for the same suite of parameters listed in Table 4. Total Suspended Volatile Solids analyses were added in 2013, but eliminated for the 2014 water year due to insignificant variability.

**Table 4:** Laboratory analytes, holding times, minimum detection levels, analytical method numbers and accuracy for DFM parameters.

| Analyte | Holding Time | Minimum Detection Level | Method # | Accuracy |
|---|---|---|---|---|
| Total Suspended Solids (TSS) | 7 days | 2 mg/L | USGS 1-3765-85 | +/- 0.1135 mg/L |
| Ammonia-N ($NH_3$) | 28 days | 0.16 mg/L | SM 4500NH3, B, E | +/- 0.0209 mg/L |
| Nitrate+Nitrite ($NO_2$+$NO_3$) | 28 days | 0.2 mg/L | EPA 353.2 | +/- 0.0640 mg/L |
| Total Kjeldahl Nitrogen (TKN) | 28 days | 0.2 mg/L | SM 4500NorgB, NH3, E | +/- 0.0128 mg/L |
| Total Phosphorus (TP) | 28 days | 0.005 mg/L | EPA 365.1 | +/- 0.0338 mg/L |
| Dissolved Orthophosphorus (DOP) | 48 hours | 0.005 mg/L | EPA 365.1 | +/- 0.0629 mg/L |
| Chloride (Cl-) | 28 days | 3 mg/L | SM 4500 Cl, E | +/- 0.0426 mg/L |

### 4.2 Site Inspections and Data Collection

Detailed field notes are to be collected during *every* site visit whether the visit was made for collection of a runoff event, base flow water quality sampling or for site maintenance. A site inspection worksheet has been created specifically for DFM stations, which outlines and guides the user through the necessary data collection criteria. Local partners are required to scan their field notes and send to MDA within 2-3 business days of the field visit rather than batch sending them at the end of the water year monitoring season.

Detailed notes and observations will be collected on the following:

- Field measurements (t-tube readings, site photos)
- Measured stage readings & comparisons against stage sensors
- Water appearance
- Flow/channel conditions
- Soil, field and crop conditions
- Equipment observations
- Maintenance needs
- Sampling details

### 4.3 Photo Documentation

Time lapse field cameras will be installed at each farm and will be programmed to take a photo every three hours during daylight. Although equipped with a small solar power source, the internal camera batteries will be checked and replaced periodically throughout the monitoring season. 8GB memory cards will be downloaded as needed to ensure proper backup of photos. All DFM photos will be housed in an online photo database (Dropbox). If access to the online Dropbox website cannot be obtained, the camera SD cards should be mailed to an MDA staff member to download periodically.

A second time lapse camera was installed in 2014 and aimed at the flume staff gage at sites that monitor surface runoff. These cameras will better equip MDA staff in correcting the raw data at the end of the year by providing verification of runoff during the freeze-thaw time period.

## 4.4 Quality Assurance and Quality Control

### *Field Duplicates*

Field duplicates will be collected simultaneously with a sample from the same source under identical conditions, into separate sample containers. Duplicates will assess if the autosampler bottles are being properly mixed prior to pouring off into laboratory bottles and is also a quality control measure with the laboratory. As a general guideline, a goal of 10 percent of samples submitted to MVTL will be duplicates.

### *Equipment Blanks*

Equipment blanks will be collected to evaluate whether contaminants have been introduced into the samples during the sampling process via the sampler tubing and collection bottles. MDA staff will be responsible for collection of equipment blanks. There will be a goal that five percent of samples submitted to MVTL will be equipment blanks, or at least one blank per automated sampler configuration (15 samples total).

## 4.5 Site Maintenance

### *Measured Stage*

Measured stage readings are important for providing accurate instantaneous stage measurement corrections and are used to verify equipment and sensors are accurately recording data. If necessary, changes can be made on site if the difference between the measured stage and what the equipment is reading is greater than 0.02 feet. Measured stage readings for subsurface tile instrumentation and within the flume will be recorded during each site visit (regardless if for a runoff event or for site maintenance).

### *Bottle Cleaning*

Bottle sanitization is a necessary step to eliminate sampling bias, reduce sample variability and to produce comparable data. All one gallon autosampler bottles will be properly cleaned and sanitized (with a phosphate free detergent) after every runoff event or when the integrity of the bottles are in question. Clean 500 mL and 1 liter sanitized bottles will be provided by MVTL for shipment of sample water to the lab.

### *Flume Cleaning and Winter Maintenance*

After a runoff event, sediment and/or debris will likely remain on the floor of the flume. Residual sediment and debris will be properly cleaned to prevent contamination of sample water during the *next* runoff event and plugging of the sampler and bubbler lines.

Sites will be monitored 365 days of the year. If winter temperature conditions show the potential for runoff, staff will schedule visits to prepare the site including removing and/or chipping out any ice and snow within the flume as well as upstream and downstream channels.

***Miscellaneous Site Maintenance***

Because of its high importance in flow calculation accuracy, flume levelness will be checked with each site visit. Steps will be taken as soon as possible to correct an un-level flume.

Desiccant and autosampler pump tubing will be replaced on an as-needed basis (typically once per site, per year).

Thick vegetation could cause backwater conditions and interfere with free flow velocities. Obstructive vegetation upstream and/or downstream from the flume will be removed from the site so free flow conditions can be maintained. In addition, vegetation can obscure the view of the time lapse camera and produce unusable images. Vegetation between the cameras and their targets must also be removed.

# 5.0 Equipment Configuration and Data Logging

## Equipment Configuration

Typical overland monitoring station setups will consist of a standard H flume, automated sampler, datalogger, weather station (electronic tipping bucket rain gage, air temperature and relative humidity sensor, solar radiation sensor and wind speed/direction sensor), bubbler stage sensor, back-up ultrasonic stage sensor, soil moisture probe, soil temperature probe, 12 volt marine batteries and solar panels. Farms where subsurface tile is also monitored will have an additional automated sampler and either an area velocity flow module or transit time flow meter for stage and flow measurements. Access to the subsurface drainage will occur with the installation of an Agri Drain structure typically used for conservation drainage. Details of equipment configurations by site can be found in Table 5.

### *Data Logging*

For typical parameters (water level, flow, velocity, weather/site conditions), the datalogger will be programmed to log in 15 minute intervals when there is no runoff occurring. When runoff occurs through the flume, datalogging will increase to a one minute interval for stage and flow. In addition, precipitation will record for every minute that rainfall is occurring. See Tables 5-7 for site specific data logging configurations.

**Table 5:** Discovery Farms Minnesota 2017 Equipment Configuration, by site.

| TYPE | EQUIPMENT | BE1 | DO1 | GO1 | MC1 | NO1W | RE1 | RO1 | RW1N | RW1S | ST1 | WI1 | WR1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Data Logging** | FTS H2 axiom datalogger | X | X | X | X | X | X | X | X | X | X | X | X |
| | FTS AM Analog Module | X | X | X | X | X | X | X | X | X | X | X | X |
| | SDI12 ISCO Interface Cable | X | X | X | X | X | X | X | X | X | X | X | X |
| **Level Measurement** | OTT CBS High accuracy bubbler | X | X | X | X | | X | X | X | X | X | | X |
| | APG 5413 Ultrasonic Transducer | X | X | X | X | | | X | X | X | X | | X |
| | GE Transit Time Flow Meter | | | | | X | | | | | | X | |
| | Solinst Levelogger Junior Edge | X | X | X | X | | X | X | X | X | X | | X |
| | ISCO Area Velocity Flow Module | X | X | | X | | | | X | X | X | | X |
| **Sample Collection** | ISCO 6712 Automated Sampler (4 bottle configuration) | X | X | X | X | X | X | X | X | X | X | X | X |
| | ISCO Avalanche Refrigerated Sampler (4 bottle configuration) | | | | | | | | | | | | |
| **Site/Weather Conditions** | FTS Rain Gage (RG-T) | X | X | X | X | X | X | X | X | X | X | X | X |
| | CS215 – Air temperature, Relative humidity sensor | X | X | X | X | X | X | X | X | X | X | X | X |
| | CS300 Pyranometer – Solar radiation sensor | X | X | X | X | X | X | X | X | X | X | X | X |
| | Windsonic – wind sensor | X | X | X | X | X | X | X | X | X | X | X | X |
| | CS650 Soil Reflectometer | X | X | X | X | X | X | X | X | X | X | X | X |
| | Stevens HydraProbe II | X | X | X | X | X | X | X | X | X | X | X | X |
| | Microcom Soil Temperature probe | X | X | X | | | X | | | | | X | |
| **Power** | 12v solar panel, 15-80 watt | X | X | X | X | | X | X | X | X | X | | X |
| | 100 amp hour, 12 volt deep cycle battery (2) | X | X | X | X | X | X | X | X | X | X | X | X |
| | AC Power | | | X | | X | | | | | X | X | |
| **Photo Documentation** | Wingscapes BirdCamPro | X | X | X | X | X | X | X | X | X | X | X | X |
| **Communication** | AirLink Cellular Modem, RAVEN XTV | X | X | X | X | X | X | X | X | X | X | X | X |

**Table 6:** Discovery Farms Minnesota 2017 Data Logging, by site.

| Variable | Description | BE1 | DO1 | GO1 | MC1 | NO1W | RE1 | RO1 | RW1N | RW1S | ST1 | WI1 | WR1 | Logging Interval |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar1 | One minute total solar radiation | X | X | X | X | X | X | X | X | X | X | X | X | 1 min (total) |
| Rn_min | Rainfall (inches) | X | X | X | X | X | X | X | X | X | X | X | X | 1 min \| 15 min* |
| F_flow | Flow (cfs) - Flume | X | X | X | X | | | X | X | X | X | | X | 1 min \| 15 min* |
| Fflw_acc | Accumulated Flow for Pulse | X | X | X | X | X | X | X | X | X | X | X | X | 1 min \| 15 min* |
| Fisco_cnt | Flume Pulse Count | X | X | X | X | X | X | X | X | X | X | X | X | 1 min \| 15 min* |
| Head_APG | APG (ultrasonic) level (ft) | X | X | X | X | | | X | X | X | X | | X | 1 min \| 15 min* |
| Head_Ft | OTT CBS bubbler level (ft) | X | X | X | X | | | X | X | X | X | | X | 1 min \| 15 min* |
| T_flow | Tile Flow (cfs) | X | X | | X | X | X | | X | X | X | X | X | 1 min \| 15 min* |
| Tflw_acc | Accumulated Flow for Pulse | X | X | | X | X | X | | X | X | X | X | X | 1 min \| 15 min* |
| Tisco_cnt | Tile Pulse Count | X | X | | X | X | X | | X | X | X | X | X | 1 min \| 15 min* |
| Rn_15 min | Total 15 minute rainfall (in) | X | X | X | X | X | X | X | X | X | X | X | X | 15 min (total) |
| AHum | Air Humidity (%) | X | X | X | X | X | X | X | X | X | X | X | X | 15 min |
| ATemp | Air Temperature (degF) | X | X | X | X | X | X | X | X | X | X | X | X | 15 min |
| F_Btl | Flume Autosampler Bottle # | X | X | X | X | | | X | X | X | X | | X | 15 min |
| Vbatt | Battery Voltage (volts) | X | X | X | X | X | X | X | X | X | X | X | X | 15 min |
| Wtemp | Tile Water Temperature (degF) | X | X | | X | X | | | X | X | X | X | X | 15 min |
| T_Btl | Tile Autosampler Bottle # | X | X | | X | X | X | | X | X | X | X | X | 15 min |
| STemp5 | Soil temperature at 5 cm depth | X | X | X | | | X | | | | | X | | 15 min |
| STemp10 | Soil temperature at 10 cm depth | X | X | X | | | X | | | | | X | | 15 min |
| STemp30 | Soil temperature at 30 cm depth | X | X | X | | | X | | | | | X | | 15 min |
| STemp60 | Soil temperature at 60 cm depth | X | X | X | | | X | | | | | X | | 15 min |
| STemp6in | Soil temperature at 6 in depth | X | X | X | X | X | X | X | X | X | X | X | X | 15 min |
| STemp24in | Soil temperature at 24 in depth | X | X | X | X | X | X | X | X | X | X | X | X | 15 min |
| SMoist6in | Soil moisture at 6 in depth | X | X | X | X | X | X | X | X | X | X | X | X | 15 min |
| SMoist24in | Soil moisture at 6 in depth | X | X | X | X | X | X | X | X | X | X | X | X | 15 min |
| Solar15 | Total 15 minute solar radiation | X | X | X | X | X | X | X | X | X | X | X | X | 15 min (total) |
| WindSpd | Wind speed (mph) | X | X | X | X | X | X | X | X | X | X | X | X | 15 min |
| WindDir | Wind direction (degrees) | X | X | X | X | X | X | X | X | X | X | X | X | 15 min |
| AT_avg | Daily Avg Air Temperature (degF) | X | X | X | X | X | X | X | X | X | X | X | X | 24 hour avg |
| WT_avg | Daily Avg. Water Temp (degF) | X | X | | X | X | | | X | X | X | X | X | 24 hour avg |
| Rn_day | Total Daily Rainfall (in) | X | X | X | X | X | X | X | X | X | X | X | X | 24 hour total |
| F_hgt | Height of Flume (ft) | X | X | X | X | | | X | X | X | X | | X | 24 hr-reference |
| F_trig | Trigger Value for Flume (ft) | X | X | X | X | | | X | X | X | X | | X | 24 hr-reference |
| Fflow_sel | Select OTT or APG | X | X | X | X | | | X | X | X | X | | X | 24 hr-reference |
| Fstg_min | Minimum Level to Cal. Fflow (ft) | X | X | X | X | | | X | X | X | X | | X | 24 hr-reference |
| T_trig | Tile Trigger Level (ft) | X | X | | X | X | X | | X | X | X | X | X | 24 hr-reference |
| Tstg_min | Minimum Level to Cal. Tflow (ft) | X | X | | X | X | X | | X | X | X | X | X | 24 hr-reference |

* If stage is >0.04 feet values will record in 1 minute intervals. If stage is <0.04 feet, values will record in 15 minute intervals.

**Table 7:** Discovery Farms Minnesota 2017 autosampler trigger values, by site.

| SITE ID | FLUME HEIGHT | FLUME FLOW TRIGGER VALUE | FLUME THRESHOLD ($ft^3$)* | TILE DIAMETER (at outlet) | TILE FLOW TRIGGER VALUE | TILE THRESHOLD ($ft^3$)* |
|---|---|---|---|---|---|---|
| **BE1** | 1.5 ft | >0.04 ft | 520 $ft^3$ | 8 inch | > 0.100 ft | 1,000 $ft^3$ |
| **DO1** | 2.5 ft | >0.04 ft | 510 $ft^3$ | 8 inch | > 0.00 ft | 510 $ft^3$ |
| **GO1** | 2.5 ft | >0.04 ft | 230 $ft^3$ | - | - | - |
| **MC1** | 3.0 ft | >0.04 ft | 2,200 $ft^3$ | 12 inch | > 0.00 ft | 2,200 $ft^3$ |
| **NO1W** | - | - | - | 8 inch | > 0.00 ft | 10,000 $ft^3$ |
| **RE1** | - | - | - | 8 inch | > 0.00 ft | 2,000 $ft^3$ |
| **RO1** | 3.0 ft | >0.04 ft | 925 $ft^3$ | - | - | - |
| **RW1N** | 2.0 ft | >0.04 ft | 455 $ft^3$ | 8 inch | > 0.00 ft | 455 $ft^3$ |
| **RW1S** | 2.0 ft | >0.04 ft | 370 $ft^3$ | 8 inch | > 0.00 ft | 370 $ft^3$ |
| **ST1** | 2.5 ft | >0.04 ft | 1,025 $ft^3$ | 8 inch | > 0.00 ft | 1,000 $ft^3$ |
| **WI1** | - | - | - | 6 inch | > 0.00 ft | 4,000 $ft^3$ |
| **WR1** | 2.5 ft | >0.04 ft | 870 $ft^3$ | 8 inch | > 0.00 ft | 500 $ft^3$ |

* Threshold values listed are current as of 12/28/2016.

# 6.0 Data Management

Upon receiving scanned field notes from project partners, site inspection documents will be immediately reviewed for accuracy, discrepancies and consistency so that any questions regarding field notes can be resolved as soon as possible. PDF copies of field notes will be saved on an MDA network server for backup.

Water quality results from MVTL will be checked for potential lab errors. Retests will be requested for questionable values. Approved laboratory results will be transcribed into an excel spreadsheet. PDF and Excel electronic copies of the laboratory results will be filed for backup. Reviewed and finalized results will be submitted to the EQuIS database for storage.

Each monitoring station will be equipped with a cellular modem which allows for remote acquisition of the logger data. Data will be programmed to download hourly and then pushed to an MDA FTP site where it will be pulled and posted on the Discovery Farms Minnesota webpage.

At the end of the 2017 monitoring season, project staff will review and correct the raw stage data for each of the sites using field notes taken by MDA staff and local partners, as well as site conditions data and time lapse camera images. Raw stage and flow data corrections will be made using Stream Trac software from Forest Technology Systems (FTS). Finalized flow data will be combined with the laboratory data to calculate annual, monthly and event constituent loads, yields and flow-weighted mean concentrations. Load data will be reviewed internally by MDA staff and then submitted to MAWRC for review. Approved water quality, flow and load data will be archived and stored in a MDA database.

During the fall of 2012, the National Weather Service - North Central River Forecast Center (NCRFC) requested access to data from the DFM sites to aid in flood forecasting. To fulfill this request the DFM data logger data is uploaded several times daily to a FTP server where the NCRFC can access it near real-time. The NCRFC uses the data to ground-truth flood forecast model predictions and verify the accuracy of radar data. This protocol will continue through the 2017 season and will be expanded in the future if any new sites are added.

# 7.0 Annual Report

An annual report will be compiled that builds upon an existing report with updated results. The report will include graphic and tabular summaries of the following:

- Average runoff, sediment and nutrient yields and flow-weighted mean concentrations for all available data, by site and across all sites.
- Water year annual precipitation compared with 30 year normals (for the nearest station)
- Monthly precipitation compared with 30 year normals
- Water year annual and monthly runoff (inches)
- Water year annual and monthly yields and flow-weighted mean concentrations
    - Total Suspended Solids
    - Total Phosphorus
    - Dissolved Orthophosphorus
    - Particulate Phosphorus
    - Nitrate+Nitrite Nitrogen
    - Total Kjeldahl Nitrogen
    - Ammonia
    - Organic Nitrogen
    - Total Nitrogen
    - Chloride

All water chemistry, raw and finalized data collected as part of the Discovery Farms Minnesota program are considered public data. Due to the growing number of monitored farms over the past few years and multiple years' worth of data, there is an immense amount of data. The annual reports will serve as a summary of results to date, but more detailed and site specific information is available upon request.

# 8.0 Project Partners

Project Partners are critical to the success of Discovery Farms Minnesota and make monitoring and collection of data feasible. Partners will be responsible for water quality data collection, observations and sample submittal. Partners will typically involve county Soil and Water Conservation Districts (SWCD) or watershed districts that will reside in close proximity to Discovery Farms. 2017 Project Partners are listed in Table 8.

**Table 8:** 2017 Project Partners.

| DISCOVERY FARM | AGENCY | ADDRESS | CONTACT INFORMATION |
|---|---|---|---|
| **BE1** | **Minnesota Department of Agriculture** | **Scott Matteson**<br>Hydrologist<br>422 Belgrade Avenue, Suite 104<br>North Mankato, MN 56003 | **Office**: 507.344.3201<br>**Cell**: 507.340.4048<br>**Email**: scott.matteson@state.mn.us |
| **DO1** | **Dodge County SWCD** | **Blaine Delzer, Jim Hruska, Tom Johnston**<br>916 2nd Street SE<br>Dodge Center, MN 55927 | **Office:** 507.374.6364 ext 3<br>**Email:** blaine.delzer@mn.nacdnet.net<br>jim.hruska@mn.nacdnet.net<br>tom.johnston@mn.nacdnet.net |
| **GO1** | **Goodhue County SWCD** | **Beau Kennedy**<br>Water Planner/Wetland Adm<br>104 E 3rd Ave, PO Box 335<br>Goodhue, MN 55027 | **Office**: 651.923.5286<br>**Email**: bkennedy@goodhueswcd.org |
| **MC1** | **Hawk Creek Watershed Project** | **Jordan Austin**<br>Hawk Creek Watershed Project<br>Renville County Courthouse<br>500 East DePue Avenue<br>Olivia, MN 56277 | **Office:** 320.523.3666<br>**Email:** jordan@hawkcreedwatershed.org |
| **NO1** | **Norman County SWCD** | **Mark Christianson \| Lori Thronson**<br>District Technician \| Assist. Manager<br>100 Main Avenue East<br>Twin Valley, MN 56584 | **Office:** 218.584.5169<br>**Email:** markc@arvig.net<br>lorit@arvig.net |
| **RE1** | **Hawk Creek Watershed Project** | **Jordan Austin**<br>Hawk Creek Watershed Project<br>Renville County Courthouse<br>500 East DePue Avenue<br>Olivia, MN 56277 | **Office:** 320.523.3666<br>**Email:** jordan@hawkcreedwatershed.org |
| **RO1** | **Rock County SWCD** | **Arlyn Gehrke \| Mark Jensen**<br>Engineering Technician<br>311 W. Gabrielson Road<br>Luverne, MN 56156 | **Office:** 507.283.8862 ext 4<br>**Email:** arlyn.gehrke@co.rock.mn.us<br>mark.jensen@co.rock.mn.us |
| **RW1N, RW1S** | **Redwood-Cottonwood Rivers Control Area** | **Shawn Wohnoutka**<br>Watershed Technician<br>1424 E. College Drive, Suite 300<br>Marshall, MN 56258 | **Office:** 507.532.1325<br>**Email:** shawn.wohnoutka@rcrca.com |
| **ST1** | **Sauk River Watershed District** | **Sarah Jo Schmitz**<br>Monitoring Coordinator<br>524 Fourth Street South<br>Sauk Centre, MN 56378 | **Office**: 320.352.2231<br>**Email**: sarah@srwdmn.org |
| **WI1** | **Wilkin County SWCD** | **Don Bajumpaa \| Kim Melton**<br>District Manager \| District Technician<br>1150 Highway 75 North<br>Breckenridge, MN 56520 | **Office:** 218-643-2933<br>**Email:** donald.bajumpaa@mn.nacdnet.net<br>kimberly.melton@mn.nacdnet.net |

| DISCOVERY FARM | AGENCY | ADDRESS | CONTACT INFORMATION |
|---|---|---|---|
| **WR1** | **Wright County SWCD** | **Alicia O'Hare**<br>Water Resource Specialist<br>311 Brighton Avenue S, Suite C<br>Buffalo, MN 55313 | **Office:** 763.682.1970<br>**Email:** alicia.ohare@mn.nacdnet.net |

# 9.0 Organizational Responsibilities

DFM is mainly comprised of four groups; farmers, MAWRC, MDA and the local monitoring project partners that support sample and data collection. A general overview of organization responsibilities can be found in Table 9.

**Table 9:** Organizational responsibilities for Discovery Farms Minnesota.

| | |
|---|---|
| **FARMERS** | • The farmers involved in Discovery Farms are the backbone of the project.<br>• Provide access to selected monitoring location(s) on their farm.<br>• Provide knowledge and understanding on their specific farming systems and the local landscape.<br>• Participating farmers provide detailed management records on practices that occur each year on the monitored field.<br>• Host field days and provide input on why they were interested in being involved with the Discovery Farms program. |
| **MAWRC** | • Support from the 15 major farm organizations in Minnesota<br>• Organize and lead Discovery Farms effort<br>• Organize Steering Committee<br>• Create/organize application process for future Discovery Farms |
| **MDA** | • Site selection among a selected Discovery Farm for the most suitable monitoring station setup.<br>• Researching, ordering, programming appropriate equipment for Discovery Farm locations.<br>• Installation and maintenance of all field equipment.<br>• Ensure protocols and Standard Operating Procedures are being effectively carried out throughout the monitoring season.<br>• Site Maintenance.<br>• Assist outreach activities<br>• Maintain raw field data and notes.<br>• Quantify flows and loads. |
| **PROJECT PARTNERS** | • Sample collection and processing<br>• Site Maintenance, as necessary |

# 10.0 Communication and Outreach

Multiple communication strategies will be used to present DFM as a proactive initiative. MDA and MAWRC will develop factsheets, brochures, presentations and display boards and work with other media outlets to develop and disseminate newspaper articles, promotional videos and interviews. Additionally, project partners will host field days, bus tours and informational sessions. The overall intent is to raise awareness about the program and the value of the data collected and to be viewed by stakeholders as a reliable and accurate water monitoring program.

In order to be successful, clear goals and objectives have been identified.

**Goals for Communications and Outreach:**

- To promote visibility, differentiation and support for DFM within the farm community.
- To ensure DFM is viewed as an accurate and reliable source of science based information by researchers, local, state and federal agencies, producers, and the public.
- To ensure that DFM's data and participants are a critical part of the water policy discussion and are well known and respected within the water policy community.

**Objectives for Communications and Outreach*:***

- Build awareness, comprehension, and support for the DFM program among producers and producers groups.
- Communicate DFM findings to key stakeholders (farmers, ag professionals, conservation groups, state agencies, etc).
- Build awareness about DFM in the non-agricultural community and identify outreach opportunities.

**2017 Outreach Tasks**

- DFM Website: Provide near real-time weather and flow monitoring data. Post updated documents. The Discovery Farms website will be getting an overhaul in spring 2017. Specifically, the page for viewing real-time data will be updated to showcase fields in a more user-friendly manner. Graphing will also be available with selectable parameters.
- Brochures: Update the Discovery Farms Overview brochure which was last updated in 2013. The map and list of sites needs to be revised. Develop brochures for the two new Discovery Farms in McLeod and Redwood counties.
- Discovery Farms logo: Use the DFM logo on clothing, publications and work equipment. Clothing will be available for field staff and project partners. This logo should be used to brand the program.
- Metal signs: Install metal descriptive signs at each Discovery Farm with a short overview of practices.
- Fact Sheets: Past fact sheets have described farm, site and study design and equipment procedures and sampling. MDA will support the MAWRC with creating new fact sheets focused on the monitoring data.
- Field Tour: Plan field days to provide legislatures, commissioners, area producers and interested parties an opportunity to see how a Discovery Farm operates.
- Farm Fest: Have a Discovery Farm presence (and informative table) at the 2017 Farm Fest.

- Presentations: Conduct various presentations on the DFM program to any interested parties, producers groups or watershed groups. A Power Point presentation is available for anyone who is invited to present on the program.
- Earned Media: Engage local, regional and statewide media to write articles and conduct interviews about the DFM program.

# Appendix:

## A. Work To Be Completed In 2017

| SITE ID | TYPE OF WORK |
|---|---|
| **BE1** | • Collect equipment blank for surface and subsurface auto samplers.<br>• Install Stevens Hydraprobe at 6 inch depth.<br>• Replace ISCO 2150 area velocity probe used to measure tile flow. |
| **DO1** | • Collect equipment blank for surface and subsurface auto samplers.<br>• Move timelapse camera to better capture field conditions.<br>• Install a Solinst Levelogger in the AgriDrain to serve as a backup tile stage sensor. |
| **GO1** | • Collect equipment blank from autosampler.<br>• Troubleshoot or replace 6 and 24" Stevens HydraProbes.<br>• Troubleshoot autosampler issues and refrigerator. |
| **MC1** | • Collect equipment blank from autosampler.<br>• Install shelters, Agri Drain structure, H flume and berms.<br>• Install all monitoring peripherals – datalogger, stage sensors, auto samplers, weather/soil equipment.<br>• Train local monitoring partners on sampling standard operating procedures. |
| **NO1W** | • Collect equipment blanks from subsurface auto samplers. |
| **RE1** | • Collect equipment blank from autosampler. |
| **RO1** | • Collect equipment blank from autosampler. |
| **ST1** | • Collect equipment blank for surface and subsurface auto samplers.<br>• Install a Solinst Levelogger in the AgriDrain to serve as a backup tile stage sensor.<br>• Troubleshoot or replace 6 Stevens HydraProbe.<br>• Troubleshoot Windsonic sensor. |
| **RW1N** | • Collect equipment blanks from subsurface auto samplers.<br>• Install shelters, Agri Drain structure, H flume and berms.<br>• Install all monitoring peripherals – datalogger, stage sensors, auto samplers, weather/soil equipment.<br>• Train local monitoring partners on sampling standard operating procedures. |
| **RW1S** | • Collect equipment blanks from subsurface auto samplers.<br>• Install shelters, Agri Drain structure, H flume and berms.<br>• Install all monitoring peripherals – datalogger, stage sensors, auto samplers, weather/soil equipment.<br>• Train local monitoring partners on sampling standard operating procedures. |
| **WI1** | • Collect equipment blank from autosampler.<br>• Replace electronic tipping bucket rain gage. |
| **WR1** | • Collect equipment blank for surface and subsurface auto samplers.<br>• Move timelapse camera to better capture field conditions.<br>• Install a Solinst Levelogger in the AgriDrain to serve as a backup tile stage sensor. |

# B. Discovery Farms Contact Information

**Table 10:** Minnesota Department of Agriculture Staff.

| Staff | Address | Contact Information |
|---|---|---|
| **Scott Matteson**, Hydrologist | MN Dept. of Agriculture<br>422 Belgrade Avenue, Ste.104<br>North Mankato, MN 56002 | **Office**: 507.344.3201<br>**Cell**: 507.340.4048<br>**Email**: scott.matteson@state.mn.us |
| **Katie Rassmussen**, Hydrologist | MN Dept. of Agriculture<br>625 Robert Street North<br>St. Paul, MN 55155 | **Office**: 651.201.6331<br>**Cell**: 218.343.4159<br>**Email**: katie.rassmussen@state.mn.us |

**Table 11:** Minnesota Agricultural Water Resources Center Staff.

| Staff | Address | Contact Information |
|---|---|---|
| **Tim Radatz,** Discovery Farms Coordinator | MAWRC<br>3080 Eagandale Place<br>Eagan, MN 55121 | **Office**: 715.694.3418<br>**Cell**: 608.443.6587<br>**Email**: radatz@mawrc.org |
| **Jerome Lensing,** Advanced Nutrient Management Specialist | MAWRC<br>3080 Eagandale Place<br>Eagan, MN 55121 | **Cell**: 507-251-9101<br>**Email**: jlensing@mawrc.org |
| **Warren Formo,** MAWRC Executive Director | MAWRC<br>3080 Eagandale Place<br>Eagan, MN 55121 | **Office**: 651.768.2106<br>**Email**: warren@mawrc.org |