

METEOROLOGICAL AND SOIL CONDITION MONITORING

Sites are instrumented with several devices that measure weather and soil conditions. Data are automatically recorded to a datalogger at 15 minute intervals. Weather measurements include precipitation, air temperature, relative humidity, wind speed & direction, and solar radiation. Soil temperature at four depths (2 inches, 4 inches, 12 inches, 24 inches) and soil moisture level are also measured at each site.



DATA COMPILATION

Flow and water quality data are compiled and combined to calculate total runoff, constituent loads, yields and flow-weighted mean concentrations. All of these parameters are tabulated annually, monthly and by individual storm events.

- **Runoff:** Defined as the total volume of water that leaves the monitored watershed divided by the total watershed area. Conceptually, one inch of runoff would equate to one inch of water spread across the surface of the watershed. Runoff is often compared to precipitation as a percentage or runoff ratio. Runoff is useful when comparing different size watersheds, as it normalizes results based on area.
- **Load:** The total mass (pounds) of the constituent (sediment, phosphorous, nitrogen) that moves from the site, over a predetermined period of time. Loads are calculated by multiplying the sample concentrations by the flow volume.
- **Yield:** The total load divided by the area of the watershed (pounds per acre). Yield values are useful when comparing different size watersheds, as it normalizes results based on area.
- **Flow-Weighted Mean Concentrations (FWMC):** The total load divided by the total water volume. This measurement provides an average concentration over a predetermined period of time (milligrams per liter (mg/L)).

QUALITY CONTROL AND EQUIPMENT CALIBRATION

To ensure quality control the Discovery Farms Minnesota Program has developed a standard operating procedures (SOP) manual that is provided to all organizations assisting with monitoring activities. This document describes procedures for site inspection and field notes, sample collection and processing, site maintenance and equipment calibrations and collection of quality control samples.



OBTAINING DATA FROM DISCOVERY FARMS MINNESOTA

Flow and weather data can be viewed or downloaded at www.discoveryfarmsmn.org/weatherstations. The website provides raw (uncorrected) flow and weather data at 15 minute intervals and is updated hourly. Information on annual results (precipitation, runoff, loads, yields and flow-weighted mean concentrations), descriptions of the farms and other materials can be accessed by clicking on the "Resources" tab. To obtain more specific and finalized information on the sites, a data request process can be initiated by contacting Discovery Farms Minnesota staff.

DATA SUMMARIES

Annual Year-In-Review summaries are available at www.discoveryfarmsmn.org, under the Resources tab. Data summaries for each individual Discovery Farm will be completed at the end of their participation in the program (5-7 years).

VALUE OF DISCOVERY FARMS DATA

Data provided by edge-of-field monitoring are unique and not otherwise available. These data are absolutely critical when deciding which conservation practices to implement and where to place them on the landscape. It complements research from the experimental stations as well as larger, watershed scale monitoring efforts.

These sites provide credible, site-specific information on typical farm practices that farmers and crop consultants can use to inform management decisions. Also, these data are being used to calibrate computer models used by various agencies to better predict agricultural impact on water resources.

FOR MORE INFORMATION, PLEASE CONTACT

Tim Radatz	George Rehm	Scott Matteson
(608) 443-6587	(507) 263-9127	(507) 344-3201
radatz@mawrc.org	rehmx001@umn.edu	scott.matteson@state.mn.us

WWW.DISCOVERYFARMSMN.ORG



*In accordance with the Americans With Disabilities Act,
an alternative form of communication is available upon request. TDD: 1-800-627-3529.
The MDA is an equal opportunity employer and provider.*



EQUIPMENT Equipment used at Discovery Farm sites in Minnesota



PROGRAM OVERVIEW

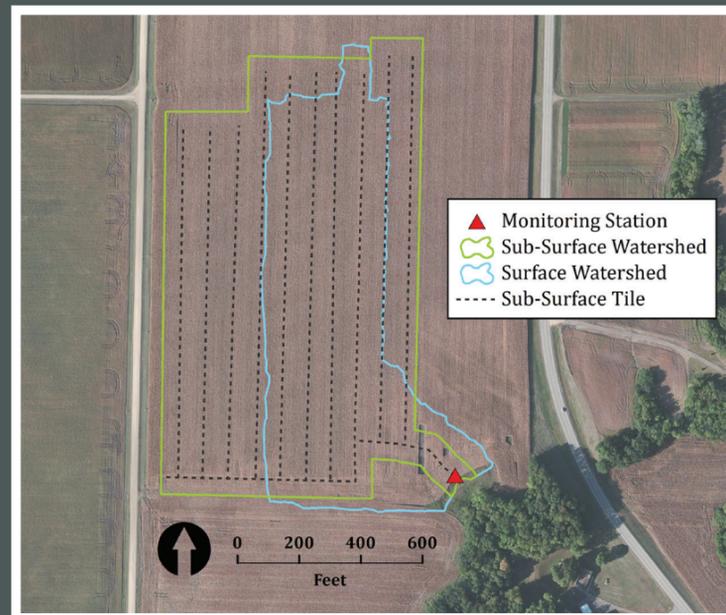
Discovery Farms Minnesota is a farmer led effort to gather water quality information from different types of farming systems, in landscapes all across Minnesota. The mission of the program is to collect water quality information under real-world conditions and provide practical, credible, and site-specific information to support better farm management decisions.

Accurate measurements of water volume, sediment, nitrogen, and phosphorus movement through surface runoff and subsurface tile drainage are made using sophisticated monitoring equipment. Data collected are used to gain a better understanding of the relationships between agricultural land management and water quality.

EDGE-OF-FIELD MONITORING

Monitoring at an edge-of-field location is not possible on every field in Minnesota. There are certain features that must be considered, for example, site accessibility. Monitoring equipment must be accessible to staff for maintenance and sample collection 365 days per year, even during the winter months. Staff conduct field work to ensure the equipment is operating properly and free of snow and ice, especially prior to potential snowmelt runoff. At many of the Discovery Farm sites, monitoring equipment is located next to or near a road or driveway.

The size of the watershed is an important consideration. Staff must be able to accurately delineate the size of the watershed (area contributing water to the monitoring station). This is critical for equipment selection and especially for data analysis. It is important that water is not entering the monitored area from an adjacent field. If there is subsurface drainage tile in the field, staff review maps and talk with the cooperating farmers to determine the size of the "tile watershed".



Example of delineated surface watershed (blue) and tile watershed (green) at the Blue Earth County site.

FLOW MONITORING



To measure surface runoff, a fiberglass structure called an H-flume is installed at the low point along the edge of the field (where flow will naturally accumulate). H-flumes were developed in the 1930's by the United States Department of Agriculture for the purpose of monitoring agricultural runoff. Typically, 1.5 to 3 foot tall flumes are used for Discovery Farm monitoring stations. The height of the flume is dependent on the size of the watershed being monitored. The flume is instrumented with two stage measurement devices, an OTT brand compact bubbler sensor (primary) and an APG brand ultrasonic transducer (secondary). Two instruments are used to insure data accuracy, and provide backup in situations where one instrument may be damaged or malfunctioning.

When flow occurs, stage is recorded at one minute intervals and converted to flow using a stage to flow rating equation.

- **Stage:** The height of the surface flow as it passes through the flume.
- **Flow:** The amount of water flowing through a measurement device (flume), per unit of time. Flow is measured in cubic feet per second (ft³/s).
- **Rating equation:** A mathematical equation that is used to convert stage to flow.
- **Dual stage measurement device:**
 - **Compact bubbler sensor (primary):** A bubbler sensor pushes compressed air through a measuring tube into the water flowing through the flume. The pressure created in the measuring tube is proportional to the water column above the opening of the tube. The instrument measures this pressure, along with the barometric pressure. The difference between these two pressure measurements is used to calculate the height of water above the tube opening.
 - **Ultrasonic transducer (secondary):** The sensor emits a high frequency sound wave that bounces off the surface below. The instrument uses the time interval between sending the signal and receiving the echo to determine the distance to an object (water surface).



To measure subsurface tile drainage, Agri Drain water level control structures are installed to interface with the existing drainage tile. They provide access for sample collection and installation of monitoring equipment. An ISCO brand area velocity probe is mounted into the upstream end of the tile. To measure high accuracy flow data, stop logs (boards that can be stacked on top of each other) are inserted down to the center of the structure to keep the upstream tile fully submerged while flow is occurring. The ISCO probe measures the stage of water flowing over the stop logs and the velocity of the flow through the tile. During low and moderate flows, flow is calculated using a rating equation. If the station becomes flooded, or surcharged, flow is calculated using the velocity measurement from the ISCO area velocity probe.

- **Area velocity probe:** An instrument that measures stage and velocity to calculate flow rate in the subsurface tile line.

WATER QUALITY MONITORING

Water samples are collected using automated ISCO brand samplers. The samplers contain four one-gallon containers. The ISCO samplers are setup to automatically collect samples when stage in the H-flume or Agri Drain structure reaches a certain level (referred to as an activation threshold). Once activated, the samplers pump a small pulse of water (125 ml) into the one gallon container at an equal flow interval. Thus, the greater the flow, the more frequent the sampler will pump a sample. Once the sampler has pumped 24 pulses of water, the sampler moves onto the next one gallon container. Each one gallon bottle contains a composite (mixed) sample of the 24 pulses of water.



Following the runoff event the water samples are collected by local monitoring partners (staff from Soil and Water Conservation Districts and Watershed Districts). The one gallon containers are thoroughly mixed and then poured into laboratory testing bottles. Each one gallon container is poured into a separate laboratory testing bottle. The bottles are put in a cooler with ice and shipped to Minnesota Valley Testing Laboratory (MVTL) in New Ulm, Minnesota. To provide consistency among sites, all sample analysis is conducted by MVTL.

Samples are tested for the following constituents at the laboratory:

- Total Suspended Solids
- Total Kjeldahl Nitrogen
- Total Phosphorus
- Chloride
- Phosphate Phosphorus
- Nitrate + Nitrite Nitrogen
- Ammonia Nitrogen