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Upper Missouri River Basin

UMRB – Plains Snow and Soil Moisture Monitoring Network

Background

Updated: 16 December 2025

After the historic 2011 Flood, and in response to one of the six recommendations from the Independent Review Team, the U.S. Army Corps of Engineers (Corps) and various basin agencies developed a framework (2013 Recommendation) for the establishment of an Upper Missouri River Basin Soil Moisture and Plains Snow and Soil Moisture Monitoring Network (UMRB Monitoring Network). The Corps is collaborating with federal, state, and tribal partners to implement the 2013 recommendation.

Description

The Corps uses plains snowpack and soil moisture data in its runoff forecasting for reservoir operations. The Corps and other federal agencies have found limitations in this data. For example, the independent technical review panel, which assessed the Corps operation of the Missouri River mainstem reservoir system during the 2011 flood, found that modeled information on snow water equivalent is available, but observational data is sparse and not always representative of basin-wide conditions. The Water Resources Reform and Development Act (WRRDA) of 2014 included a requirement that the Secretary of the Army, in coordination with other specified agencies, carry out snowpack and soil moisture monitoring in the Upper Missouri Basin. The Water Infrastructure Improvements for the Nation Act (WIIN) of 2016 Section 1179(b) designated the Corps as the lead agency for this effort. The Water Resources Development Act (WRDA) of 2020 provides additional authorization to coordinate with specified agencies and continue to enter into agreements with the state Mesonet programs.

Value to the Corps and the Upper Missouri River Basin

The data obtained from the network will be available for all federal, state and local agencies to improve existing products and/or the development of new products (e.g., NWS river forecasts and flood outlooks, National Drought Mitigation Center drought monitor and outlooks, U.S. Bureau of Reclamation (USBR) and U.S. Department of Agriculture's (USDA) National Resource Conservation Service (NRCS) water supply forecasts, various federal and state fire hazard reports). Specifically for the Corps, the data (temperature, precipitation, snow depth, and other physical elements) are used by the National Weather Service's (NWS) National Operational Hydrologic Remote Sensing Center (NOHRSC) to improve the Snow Data Assimilation System (SNODAS) model to provide more accurate Snow Water Equivalent estimates. That model is a direct input into the river and runoff models used by the NWS and the Corps. Those river and runoff models also use soil moisture data to model the impacts of melted plains snow and rainfall to estimate the inflows in the Corps' reservoir projects.

Total Number of Monitoring Stations – 540

The plains area of the UMRB (above Sioux City, IA) in the U.S. totals 270,000 square miles. Ongoing discussions with the soil moisture experts (NRCS and USDA-National Soils Lab) and plains snow and river forecasting experts at the NOHRSC and NWS's Missouri Basin River Forecast Center (MBRFC) has revealed that a soil moisture and plains snow monitoring station should be installed (see Figure 2) at a density of 1 in every 500 square miles (540 monitoring stations total). A monitoring station includes all sensors – soil moisture and temperature, snow depth, wind speed and direction, solar radiation, relative humidity, precipitation, and air temperature. In addition, during the December-March period, onsite weekly snow depth and snow water equivalent measurements should be collected at each station and conveyed to the Corps, NOHRSC and MBRFC for integration into their respective models.

Existing (172) and New (368) Monitoring Stations

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There are approximately 172 existing soil moisture (NOTE: these do NOT include plains snow monitoring equipment) sites in the upper basin. Of these 172 sites, 148 are owned and operated by three state Mesonet offices (MT, ND, and SD); the other 24 are owned and operated by the USBR (AgriMet). The Corps is actively working with the state Mesonet offices to modify approximately 89 of their existing sites to be part of the UMRB Monitoring Network. To complete the 540-site network, approximately 451 new sites will be installed by five state Mesonet offices (MT, ND, NE, SD, and WY).

Typical Station Configuration

Stations include instrumentation to measure wind, air temperature, humidity, solar radiation, precipitation, snow depth, pressure, and underground sensors at 5 depths to measure soil temperature and moisture. There are also cameras to take images of on-the-ground conditions.

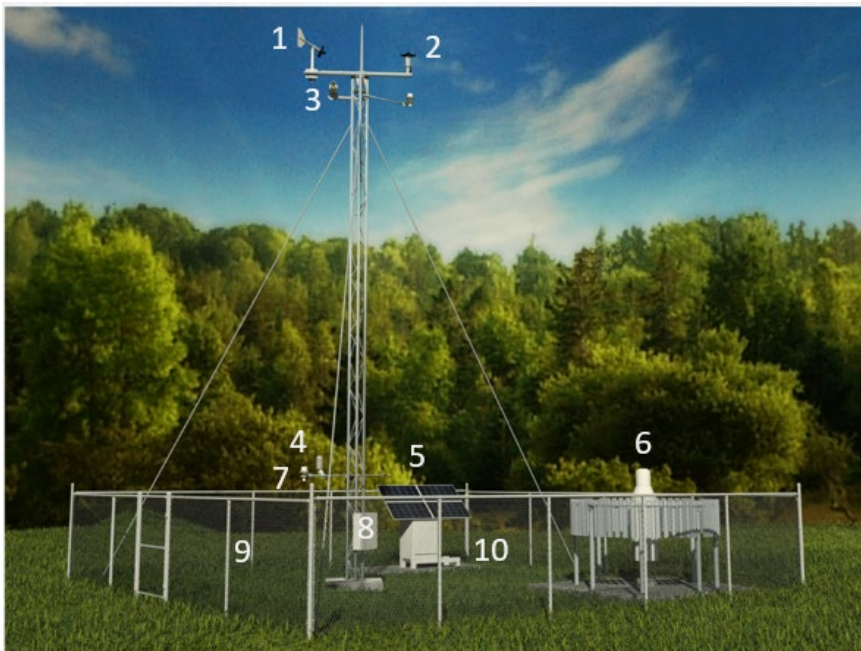


Figure 1. Typical station components

Sensors
1 - Wind measurement on 10-m tower
2 - Camera to measure snow depth
3 - Air temp. on 10 – m tower
4 - Air temp and humidity (at 6 ft)
5 – Solar radiation
6 – Precipitation
7 – Snow depth
8 – Pressure
9 – Base soil temperature @ 4"
10 – Soil moisture and temp. @ 5 depths (2/4/8/20/40")

Work Completed through FY25

The Corps has completed the following actions to build out the network:

- South Dakota State University (SDSU) was funded for an instrumentation study that was completed in August 2019.
- Awarded a purchase order in 2019 for three “pilot” stations in Montana, Wyoming, and South Dakota to better understand the requirements and processes.
- Awarded five Single Award Task Order Contracts (SATOCs) with the following universities: University of Montana (UM), University of Wyoming (UW), North Dakota State University (NDSU), SDSU, and University of Nebraska-Lincoln (UNL). The contracts provide known costs for installation and operation and maintenance (O&M) over a five-year period. Other costs provided include site identification and tribal coordination.
- Contracted with the UM’s Center for Integrated Research on the Environment (CIRE) for Mesonet Coordination Services. CIRE developed the site selection methodology for new stations, a GIS-based database, and provides



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continuous coordination among the numerous basin stakeholders including the state Mesonet.

- Funded NRCS through an Economy Act Order to complete soil sampling and characterization for each station.
- At the end of FY25, 368 stations will be complete (including the three pilot stations). Ten were awarded on a task order pending installation in FY26.
- North Dakota completed their project requirement of 85 stations under their SATOC.
- New Mesonet Coordination Services contract to be awarded late FY25 or early FY26.

FY26 Funded Efforts

Approximately 110 candidates submitted so far will undergo 106/NEPA clearance for planned FY26 and FY27 installs.

The following table shows the tasks identified for execution in FY26:

Task	Execution Strategy
Omaha District Labor	In-house execution
Soil Characterization	Economy Act Order with NRCS
Cultural Resource Surveys/ NEPA reviews	In-house execution
Mesonet Coordination Services	Programmatic coordinator contract
Station Installation	SATOC Task Orders

New SATOCs for SDSU, UM and UW will be pursued for award in Q2. Additional soil characterization and coordination services will also be funded. The bulk of the remaining candidate sites should be submitted by the Mesonets early Q2 and will undergo 106/NEPA coordination for FY27 installs. At the end of FY26, Nebraska will have completed their project requirement of 35 stations under their SATOC.

FY27 Efforts

FY27 is the final planned installation year for this project. Carryover funds after this year will be used for closeout and final year of O&M management cost.

Funding and Capability

The following table identifies the funding capability, funds received, and description of work based on the funding capability for each fiscal year. Funding for the first year of O&M is included in the cost estimates and station installation. The first year of O&M includes station commissioning and equipment validation, as well as data collection. Long-term O&M funding will be needed after the first year of installation for each of the stations.



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FY	Funding Capability*	Funding Appropriated	Funding Obligated***	Description of Work
18	\$100,000	\$100,000	\$100,000	Initiate the planning process and contract with SDSU for the equipment test bed (completed).
19	\$1.5M	\$1.5M	\$1.5M	Purchase and install equipment at 3 existing Mesonet stations for “proof of concept”, finish NEPA documentation, fund the Mesonet coordination contract (year 1 of 5), and awarded SATOCs and Task Orders purchase equipment for approximately 45 existing Mesonet stations. Purchase and install equipment at additional existing and new stations, additional soil sampling by NRCS, and Section 106/NEPA for future stations to complete build out of 540 total stations within the network. This also includes the programmatic coordination services contract.
20	\$3.0M	\$3.0M	\$3.0M	
21	\$3.4M	\$5M	\$3.4M	
22	\$7.3M	\$20.0M	\$7.3M	
23	\$8.6M	\$10.0M	\$8.6M	
24	\$12.0M	\$16.0M	\$5.1M	
25	\$17.5M	\$0M	\$10M	
26**	\$15.5M	\$0M	TBD	
27	\$TBD	\$0M	TBD	
Total		\$55.6M	\$39M	Any carryover beyond FY27 to be used for closeout and final year of O&M management cost.

*Capabilities were re-baselined in FY23 Q4 to align with NOAA transition requirements.

**Includes estimated Y6/7 pricing but needs to be finalized on new SATOCs for MT, SD, and WY.

***Includes SATOC awards, USACE labor, NRCS soil analysis, CIRE, etc. and funds that may need to be deobligated.

Real Estate

Real estate access was obtained for the existing stations by the Mesonets. The Mesonets will acquire the needed real estate instruments to ensure access for installation and for new stations.

Issues

- The monitoring stations currently measure snow depth and use related data to estimate snow water equivalent (SWE). SWE instrumentation is considered emerging technology and is currently being field-tested by various research entities to determine accuracy, reliability, and durability. USACE is conducting market research to determine what instruments are available and may fund additional studies in the future.
- Factors like late submission of candidate sites, candidate sites needing to be replaced and needing new 106/NEPA coordination, and Mesonets not providing land use in a timely manner delays the award of installation task orders and put the project budget and timeline at risk.
- Ensuring continued funding and operation of the network after federal funding for O&M lapses.
- Escalation of project costs not anticipated at beginning of project (ex. site identification, tribal coordination, etc.) put the budget at risk.

Current Status



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The status of operational, in-progress, and planned stations is available on the Corps Northwestern Division (NWD) Missouri River Basin Water Management (MRBWM) web page at:

https://www.nwd-mr.usace.army.mil/rcc/reports/pdfs/umb_mon_network_update.pdf.

A completed programmatic environmental assessment can be found at:

<https://usace.contentdm.oclc.org/utis/getfile/collection/p16021coll7/id/14447>.

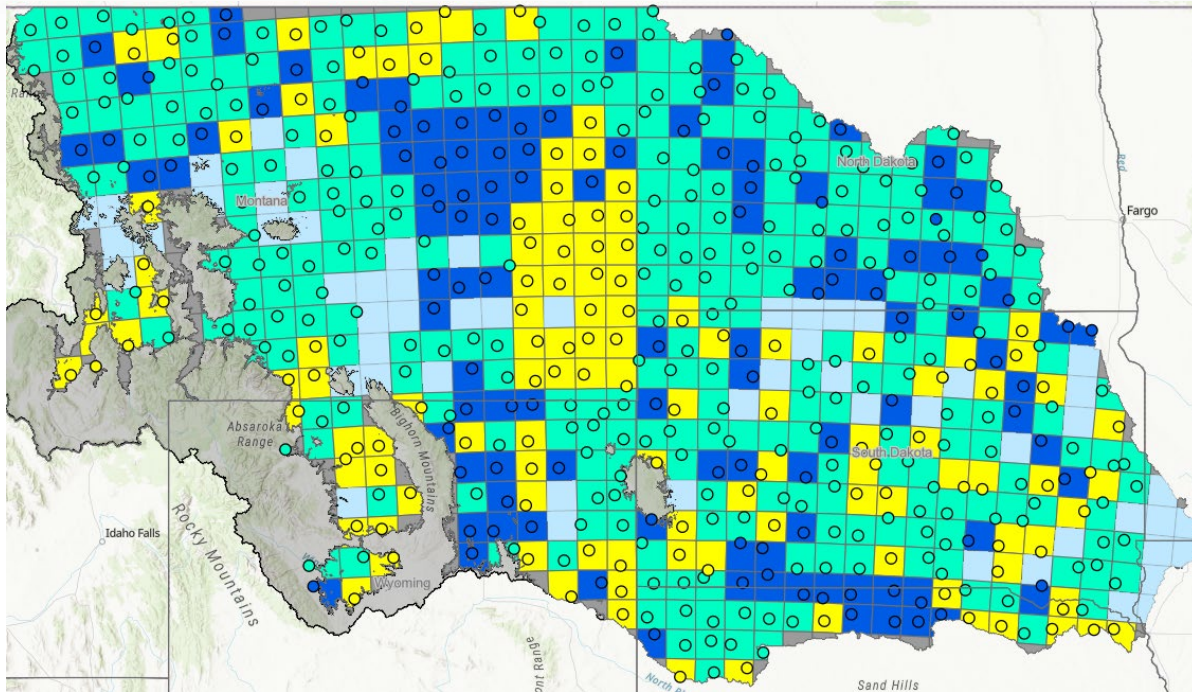
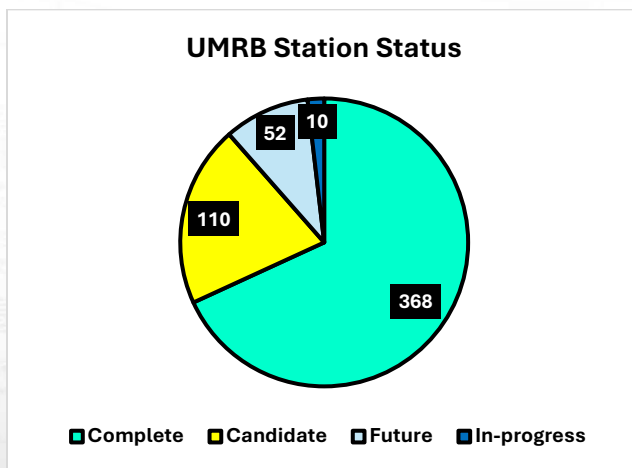


Figure 2. Snowpack status snapshot. The map is updated as stations are completed and transmitting. The “In-progress” cells depict installs for FY25.



UMRB Site Status Categories	Definition
Candidate	New or existing site proposed for installation or retrofit. Cultural/NEPA work is planned or in-progress.
Complete	New site installation or retrofit complete and station data is transmitting.
Future	Site location has not been proposed yet in this cell.
In-progress	New or existing site awarded on Mesonet Task Order and pending installation.

For more information, please contact:

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