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June 9, 2015

The Honorable James M. Inhofe
Chairman
The Honorable Barbara Boxer
Ranking Member
Committee on Environment and Public Works
United States Senate

The Honorable Bill Shuster
Chairman
The Honorable Peter A. DeFazio
Ranking Member
Committee on Transportation and Infrastructure
House of Representatives

Missouri River Basin: Agencies' Progress Improving Water Monitoring Is Limited

The Missouri River is a critical national resource, stretching 2,341 miles from western Montana to its mouth near St. Louis, Missouri, and flowing through or forming a border for seven states (see fig. 1). Between 1933 and 1964, the U.S. Army Corps of Engineers (Corps) built six dams and reservoirs on the mainstem¹ of the Missouri River. The Corps manages these dams and reservoirs for eight authorized purposes, including flood control.² In 2011, large amounts of snow and extreme rains along the Missouri River led to the greatest volume of runoff³ since 1898, when recordkeeping began. That prompted the Corps to release a record volume of water from the dams to prevent the dams from being overtopped, which otherwise could have caused catastrophic dam failure. The high runoff levels and large water releases caused significant flooding and damage along the river from Montana to Missouri that affected farms, homes, businesses, industries, public infrastructure, and transportation networks.

¹ The mainstem is the primary downstream segment of a river, as contrasted to its tributaries.

² The eight authorized purposes for which the Corps manages the dams and reservoirs are: navigation, flood control, irrigation, hydropower, municipal and industrial water supply, water quality, recreation, and fish and wildlife habitat. See Flood Control Act of 1944, Pub. L. No. 78-534, § 9, 58 Stat. 887 (1944); H. R. Doc. No. 475, 78th Cong., 2d Sess. 28-29 (1944); S. Doc. No. 191, 78th Cong., 2d Sess. (1944); S. Doc. No. 247, 78th Cong., 2d Sess. 2-5 (1944); *South Dakota v. Ubbelohde*, 330 F.3d 1014, 1019-20 (8th Cir. 2003).

³ Runoff flows over the land surface, going downhill into rivers and streams. Runoff into the mainstem reservoirs along the Missouri River generally comes from three sources: snowfall in the mountains of Montana and Wyoming; snowfall in plains states, including Montana, North Dakota, South Dakota, and Nebraska; and rainfall throughout the Missouri River basin.

Figure 1: Missouri River Basin and the Six Mainstem Dams and Reservoirs



Sources: GAO; Map Resources (map). | GAO-15-558R

Following the flood, the Corps appointed a panel composed of an academic and officials from federal agencies with missions in water data and studies to conduct an independent technical review of the Corps' operations during the flood. The resulting December 2011 report stated that the Corps substantially underestimated the wet soil conditions in the plains and the plains snowpack in its water supply forecasts leading up to the flood.⁴ The report made recommendations on how the Corps could improve forecasting, including by improving data on soil moisture and snowpack in the upper Missouri River basin. The report also stated that while these advancements could help improve future forecasting, having these data in 2011 would not have prevented the 2011 flood due to the extreme volume of runoff.

In response to this report, several federal agencies and states coordinated to develop a set of interagency recommendations to improve snowpack and soil moisture monitoring in the upper Missouri River basin, specifically in the states of Montana, North Dakota, South Dakota, and

⁴ Independent Technical Review Panel, *Review of the Regulation of the Missouri River Mainstem Reservoir System During the Flood of 2011*, (December 2011).

Wyoming. The recommendations were outlined in a February 2013 report titled “Upper Missouri River Basin Monitoring Committee: Snow Sampling and Instrumentation Recommendations.” The recommendations included, among other things, adding new snowpack and soil moisture monitoring stations in the upper Missouri River basin. According to the February 2013 report, the area in the upper Missouri River basin that should receive this additional monitoring is more than 268,000 square miles.

In June 2014, Congress passed the Water Resources Reform and Development Act (WRRDA) which directs the Corps to, among other things, implement the recommendations from the February 2013 report in coordination with other federal agencies, including the National Oceanic and Atmospheric Administration (NOAA), Natural Resources Conservation Service (NRCS), United States Geological Survey (USGS), and Bureau of Reclamation (BoR).⁵ WRRDA also included a provision for GAO to examine the agencies’ implementation of recommendations in the February 2013 report. This report addresses (1) the extent to which federal agencies have made progress implementing the recommendations in the February 2013 report and (2) challenges federal and state officials reported that they face in implementing the recommendations in the February 2013 report.

To address our objectives, we reviewed the WRRDA and the February 2013 report and interviewed officials at the Corps, NOAA, NRCS, USGS, and BoR to discuss their progress in implementing the February 2013 report recommendations and any challenges they face in doing so. We also interviewed officials, such as state climatologists or water officials, from the states identified in the February 2013 report—Montana, North Dakota, South Dakota, and Wyoming—to discuss any challenges states face in implementing the recommendations in the February 2013 report. We selected officials from these states based on their involvement in Missouri River basin issues, including the development of the February 2013 report. Included among the federal and state officials we interviewed were four of the five authors of the February 2013 report.

We conducted this performance audit from November 2014 to June 2015 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Results in Brief

Federal agencies have made limited progress implementing recommendations to improve snowpack and soil moisture monitoring outlined in a February 2013 interagency report. According to officials from the Corps, although it has not established a time frame for doing so, the Corps plans to develop a document that will describe the mandate from the WRRDA that directs implementation of the February 2013 recommendations. Within this document, the Corps plans to include an assessment of whether it is more appropriate for the Corps or other federal agencies to implement the mandate and to describe the priority the Corps has assigned to this effort with respect to its other programs. Corps officials plan to make the document publicly available. Officials from the four other federal agencies identified in the WRRDA—NOAA,

⁵ Pub. L. No. 113-121, § 4003(a)(1), 128 Stat. 1311 (2014).

NRCS, USGS, and BoR—told us that they had not taken actions to implement the recommendations in the February 2013 report. Officials from NOAA and NRCS also told GAO that they are waiting for the Corps' decision as to whether it intends to undertake the lead agency role before making any further decisions about what role their agencies would have in implementing the recommendations.

Federal and state officials reported facing several challenges to implementing the February 2013 report recommendations. Specifically, officials from several federal agencies and states that were involved in developing the report said that the February 2013 report was intended to be a starting point for discussions. They said that, while it contains specific recommendations, it does not contain the details needed to implement those recommendations, such as where new climate stations would be located. Therefore, some federal officials said that additional work and detailed engineering and other studies would need to be completed before implementation of the recommendations could occur. In addition, numerous federal and state officials also mentioned uncertainty about the availability of resources as a challenge to implementing the recommendations in the February 2013 report, including funding for equipment, personnel, and ongoing operation and maintenance.

Background

The February 2013 report describes existing federal and state data collection networks in the upper Missouri River basin that provide some information about soil moisture or snowpack. The main federal agencies that currently collect soil moisture or snow data are NRCS and NOAA. For example, NRCS manages the Soil Climate Analysis Network, which has 10 sites in the upper Missouri River basin that collect soil moisture data. Similarly, NOAA's National Operational Hydrologic Remote Sensing Center (NOHRSC) uses a combination of airborne surveys, satellite observations, and on-the-ground field measurements to produce a map of snow conditions in the United States daily, including in parts of the Missouri River basin. NOAA's U.S. Climate Reference Network also collects soil moisture data, among other weather and climate parameters, at 114 climate stations nationwide, including 15 in the Missouri River basin.

In addition, the February 2013 report describes other federal and state data collection networks in the basin that do not currently collect information about soil moisture or snowpack but that could be modified to do so. For example, the February 2013 report suggests adding snowpack monitoring to NOAA's U.S. Climate Reference Network. Similarly, both North Dakota and South Dakota operate weather monitoring networks that could, with new equipment and data management, be modified to collect information about soil moisture in those states, according to the February 2013 report. USGS does not collect soil moisture or snowpack data but does manage a streamgauge network that tracks the amount of water in rivers and streams throughout the United States.⁶

According to Corps and BoR officials, the Corps and BoR use information from the aforementioned existing federal and state data collection networks in the upper Missouri River basin to forecast how much water will be entering their reservoirs along the Missouri River and

⁶ According to a USGS official, USGS also has one soil moisture monitoring site in the upper Missouri River basin, which is used for research purposes.

its tributaries. These agencies also use the USGS streamgauge network to track the amount of water currently in the Missouri River and its tributaries on an ongoing basis. The Corps and BoR make decisions about how much water to release from their reservoirs based, in part, on current information from streamgages and their forecasts.

The February 2013 report recommended a number of improvements to existing data collection efforts, including the following:

- enhance existing climate stations with snowpack and soil moisture sensors;
- install new climate stations in the basin to enhance existing coverage;
- enhance NOHRSC airborne surveys;
- identify and train volunteer or part-time hires to conduct manual snow sampling; and
- fund state coordinator positions in Montana, Nebraska, North Dakota, South Dakota, and Wyoming to coordinate snow surveys and other snow data networks at a state level.

The February 2013 report estimated costs for implementing these recommendations as \$6.2 million in up-front investment and \$1.5 million in annual operations costs.

Agencies Have Made Limited Progress Implementing the February 2013 Report Recommendations

Agencies have made limited progress implementing the recommendations outlined in the February 2013 report. According to Corps officials, the Corps plans to develop a document that will describe the mandate from WRRDA. Corps officials said that writing such a document for each of the individual mandates included in WRRDA is the standard first step after a new law is passed. Corps officials said that they do not have a time frame for developing the document for the Missouri River monitoring mandate; however, they have begun to write similar documents for other mandates in WRRDA. Corps officials said that the document for the Missouri River monitoring mandate will include an assessment of whether it is most appropriate for other federal agencies to implement the mandate or whether the Corps should work to implement it directly. The document will also describe the priority the Corps has assigned to this effort with respect to its other programs. The Corps makes such completed documents publicly available on its website. If the Corps decides to implement the mandate directly, it will assess current funding available for the mandate and, if needed, make an additional budget request. Corps officials said that the earliest they could submit a budget request for implementing the February 2013 report is for fiscal year 2017. Officials from the four other federal agencies identified in the WRRDA told us that they had not taken actions to implement the recommendations in the February 2013 report.⁷

⁷ A NOAA official indicated that the agency has increased the total, nationwide, number of aircraft flight hours related to the NOHRSC program, some of which could be allocated to the Missouri River basin. However, this official said that the improvements to date fall short of addressing the February 2013 report recommendations because, among other things, they are nationwide in scope and do not necessarily increase dedicated flight hours in the Upper Missouri basin.

Federal and State Officials Reported Several Challenges to Implementing the February 2013 Report Recommendations

Federal and state officials reported facing several challenges to implementing the February 2013 report recommendations, including that this report was intended as a starting point for discussions, as well as uncertainty about availability of resources for equipment installation, personnel, and ongoing operation and maintenance.

Officials from several federal agencies and states that were involved in developing the report said that the February 2013 report was intended to be a starting point for discussions. Several federal officials said that, while it contains specific recommendations, it does not contain the details needed to implement those recommendations. For example, several officials said that while the February 2013 report recommends installing new climate stations, the report does not have specific details of where those stations should be located. Officials from NOAA we interviewed also gave examples of issues that would require additional discussion before a work plan could be developed. For example, one part of the February 2013 report suggests adding snowpack monitoring equipment to certain stations within NOAA's U.S. Climate Reference Network. However, officials who manage that network noted that adding new equipment to only a few stations in the nationwide network is not consistent with the network's mission to provide consistent, high-quality data throughout the United States. These officials said that a key tenet of the Climate Reference Network is to provide consistent measurements by ensuring that each station is collecting the same information in the same way, allowing for comparisons among stations and providing a consistent historical record. Officials conducted an evaluation of the proposed changes to the Climate Reference Network and determined that the impact would be significant. These officials said that more detailed engineering and integration studies are needed to determine whether the proposed changes are feasible and how impacts to the U.S. Climate Reference Network can be managed. Similarly, a NOAA official from the NOHRSC program said that NOHRSC currently allocates aircraft hours in the airborne survey program to regions based on a nationwide prioritization and that the number of hours recommended by the February 2013 report cannot be dedicated to the upper Missouri River basin except at the expense of other regions with greater need.

Numerous federal and state officials also mentioned uncertainty about the availability of resources as a challenge to implementing the recommendations in the February 2013 report, including funding for equipment, personnel, and ongoing operation and maintenance. According to these officials, funding is a particular challenge because the installation of new soil moisture and snowpack equipment would constitute an additional requirement for agencies and states that currently operate monitoring equipment in the upper Missouri River basin. For example, the February 2013 report's expansions to the NOHRSC airborne survey program envision the possible acquisition of an additional aircraft to fly the additional flight lines. NOAA officials said that they are not aware of any currently manufactured aircraft that meet NOHRSC's specifications for data collection, so a used aircraft would have to be purchased. These officials said that the market for used aircraft fluctuates significantly, and assumptions made in the February 2013 report about the cost of this aircraft may no longer be valid. Similarly, state officials in North Dakota and South Dakota noted that the February 2013 report recommendations suggested adding equipment to their existing state climate networks. However, these officials noted that their state networks were designed for state-specific purposes, and it would be difficult for the states to justify funding the proposed additional equipment if the equipment will not contribute to the current missions of those networks.

Officials from several agencies and states also emphasized that the costs of implementing new soil moisture and snowpack monitoring are not one-time costs. Officials said that ongoing costs will include equipment maintenance and operation, quality control checks of the data, and data dissemination.

In addition, according to officials from each agency and state we interviewed, they have not yet discussed roles and responsibilities for implementing the recommendations in the February 2013 report. For example, several officials mentioned that there is currently no lead agency to coordinate activities or prioritize next steps. Officials from both NOAA and NRCS indicated that they are waiting to learn whether the Corps intends to undertake this lead agency role before making any decisions about what roles their agencies would have. Our previous work has found practices that can help enhance and sustain collaboration among federal agencies, including that collaborating agencies agree on their respective roles and responsibilities, such as how the collaborative effort will be led.⁸ In doing so, agencies can clarify who will do what, organize their joint and individual efforts, and facilitate decision making. Corps officials said that a determination about whether the Corps intends to undertake the lead agency role would be made when the WRRDA document, as previously discussed, is developed.

We recognize the agencies have not yet started to work on developing a plan of action for implementing the recommendations in the February 2013 report. As they move forward, our previous work has found that considering leading practices in strategic planning when developing a plan of action is important.⁹ These practices include defining the mission and goals; defining strategies that address management challenges and identifying resources needed to achieve goals; communicating key information to decision makers; and developing defined metrics and timelines to measure progress.

Agency Comments

We provided a draft of this report to the Departments of Agriculture, Commerce, Defense, and the Interior for comment. These agencies did not provide formal written comments. In an email received on May 13, 2015, the NOAA audit liaison within the Department of Commerce provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees; the Secretaries of Agriculture, Commerce, Defense, and the Interior; and other interested parties. In addition, this report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or fennella@gao.gov. Contact points for our Offices of Congressional Relations and

⁸GAO, *Results-Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, GAO-06-15 (Washington, D.C.: Oct. 21, 2005).

⁹GAO, *Environmental Justice: EPA Needs to Take Additional Actions to Help Ensure Effective Implementation*, GAO-12-77 (Washington, D.C.: Oct. 6, 2011) and *Reserve Forces: Army Needs to Finalize an Implementation Plan and Funding Strategy for Sustaining an Operational Reserve Force*, GAO-09-898 (Washington, D.C.: Sept. 17, 2009).

Public Affairs may be found on the last page of this report. Key contributors to this report were Vondalee Hunt, Assistant Director; Michelle Cooper; Janice Poling; and Lisa Turner.

A handwritten signature in black ink that reads "Anne-Marie Fennell". The signature is written in a cursive style with a long horizontal line underneath the name.

Anne-Marie Fennell
Director, Natural Resources and Environment