



Understanding Minnesota's Watershed and Environmental Health

State of Minnesota – Minnesota IT Services

CATEGORY:

Data Management, Analytics & Visualization

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Executive Summary

The Watershed Health Assessment Framework (WHAF) is a structured, science-based approach to help resource professionals and citizens work together and grow our common understanding of Minnesota's complex natural resource systems.

The WHAF includes an interactive web-map application (WHAF 2.0) created by the Minnesota Department of Natural Resources (DNR) and Minnesota IT Services (MNIT), which brings together current data and scientific analysis and allows users to generate information about Minnesota's watersheds. These products are delivered in a transparent and repeatable framework to foster robust conversations and innovative approaches for improving the health of Minnesota's watersheds and communities.

The Minnesota Clean Water Council (created through the Clean Water Legacy Act) and Clean Water Fund partners have endorsed the WHAF 2.0 as a tool to be used by their staff for outreach and planning. In addition, there are nearly 3,000 WHAF newsletter subscribers, which indicates a strong user base of individuals that are interested in learning and understanding more about our lands and waters and in using this tool to drive action.

Idea

What problem or opportunity does the project address?

It is extremely difficult for natural resource professionals and the public to explore the relationships between the environmental and human factors that influence watershed health and water quality. The WHAF supports an integrated strategy to share stewardship responsibility with Minnesotans and conservation partners to manage natural resources for multiple interests.

Minnesota has placed a strong emphasis on improving water quality and watershed health, and water is a focus for the DNR's Ecological and Water Resource (EWR) Division. As more and more data are collected, the challenge is to create tools that allow resource professionals to explore that data and use it to deliver meaningful and actionable information for resource managers and community leaders. The first WHAF application (WHAF 1.0) launched in early 2014.

After WHAF 1.0 launched, the DNR's Ecological and Water Resource division needed to measure success towards its mission of healthy lands and waters not just by hitting various program targets, but in terms of overall gains in watershed health. They set out to answer the question, "Did this program effort improve ecological health?" To do that, they needed a new way to track that health over time and to visualize and share data with others.

The second WHAF application (WHAF 2.0) launched in February 2018 and has been the subject of continuous improvement since then, with the project completed by December 2020. WHAF 2.0 addressed the structural architecture of the original application that was limiting scalability. The adoption of a more rigorous and

modular development approach allowed new features to be added without negative ramifications to the existing system. WHAF 2.0 also addressed the DNR's goals to make applications accessible, and it was one of the first applications in the state to implement new accessibility guidelines for online web-map applications.

Other changes included the addition of new analysis and analytical tools for natural resource professionals such as: geomorphology triage, ecological health score matrix, land cover analysis, and climate summary reports.

Why does it matter?

The WHAF web-map applications makes a large volume of data sources more accessible to managers, stakeholders, and constituents through an intuitive web-map interface. It enables the interpretation of data as health scores, charts, reports, and data summaries to build a shared understanding of Minnesota's landscapes. It also incorporates historic climate data to help resource managers address climate impacts and adaptation strategies in resource management actions.

What makes it different?

- **Interactive Web Mapping Application:** The interface fosters curiosity to explore a variety of spatial data and enables deeper learning. Data updates, charts, and analytics have unique workflows that are supported by PostgreSQL, Flask, and Python on the server.
- **Watershed-based visualization:** Using natural watershed boundaries to spatially organize data instead of political boundaries helps viewers visualize natural patterns. The WHAF helps users implement a 5-component framework (hydrology, geomorphology, biology, connectivity, and water quality) to conceptually organize the information. Watershed delineations of upstream/downstream relationships create scalable watershed boundaries that can be used to show a visual representation of important spatial relationships.
- **Inter-agency collaboration:** The wide variety of geographic information system (GIS) data delivered in the WHAF has required new relationships with agencies such as Minnesota Department of Health (MDH) and Minnesota Pollution Control Agency (MPCA), as well as University of Minnesota (U of M).

What makes it universal?

Watersheds frame our stories by placing people together with their landscape. Watershed science builds our understanding of the ways we are all connected. Using those connections, we can find the best ways to live in our communities and to responsibly use our natural resources.

While the WHAF team is small, its impact is large. Team members collaborated with a broad set of stakeholders to serve a range of needs for agency partners, educators, local governments, and non-profits. Data access, training and outreach, advanced analysis collaborations: WHAF staff respond to a range of requests as they seek to build a better understanding of watershed science, and help others put that knowledge into action.

The WHAF application supports the NASCIO CIO Priority of data management and analytics by helping the user better understand the data. It is designed to:

- Provide a structured, science-based approach and tool for understanding watersheds and watershed science.
- Help resource professionals and citizens work together using an accessible online platform.
- Grow our common understanding of Minnesota's complex natural resource systems by helping people interpret data with maps, reports, and statistical summaries.

Implementation

What was the roadmap?

WHAF 2.0, launched an initial release to the public in February 2018, with ongoing feature additions and improvements through December 2020. Throughout development, MNIT and the DNR focused on providing:

- Better and more accessible user experience.
- Faster, more stable infrastructure.
- Scalable, modular architecture.
- Increased capacity for future linkages and enhancements.
- Innovation for other DNR mapping applications.

Who was involved?

WHAF 2.0 was developed with a cross-agency team of data experts, developers, GIS experts, and subject matter experts from state government, local government, and nonprofit partners. Development included collaboration between:

- **MNIT:** Worked with partners to interview WHAF users to understand use cases and functionality needs. Developed application with expertise in GIS, coding, and data management. Resources included:
 - GIS servers, Geospatial Water Resource Team, Python users, web team, and the cross-agency accessible map collaboration team.
- **University of Minnesota:** Provided Water Quality Management WHAF-based consultants and users from the University of Minnesota Extension, Watershed coursework.
- **Board of Water and Soil Resources:** Coordinated input from Soil and Water Conservation Districts (SWCDs), counties, townships, and watershed districts.
- **Minnesota Department of Natural Resources:** Provided internal resource to develop user requirements and test the application. Made use of this application integral to the work of staff in DNR Lands and Minerals, Forestry, and Fish and Wildlife divisions.
- **MDH:** Helped integrate groundwater and drinking water data.
- **MPCA:** Integrated datasets into WHAF, including nutrient studies, water stressor indicators, Minnesota One Watershed One Plan (1W1P) data, and data from MPCAs Watershed Restoration and Protection Strategy (WRAPS).
- Other partners such as local government staff, local watershed groups, and nonprofits.

The level of participation and involvement from partnering agencies, local government, and other stakeholders reflects the extent to which the WHAF program' framework and application has been adopted by the broader community. The DNR communicates about WHAF 2.0 to these groups and many other end users through newsletters, trainings, and presentations to different audiences.

How did you do it?

The development of WHAF 2.0 took roughly 5 years of full-time employee (FTE) technical (IT) staff effort, not including the contribution of DNR scientists on the team or other partners.

To make the new application more user-friendly, the team interviewed users of WHAF 1.0 to interact with demos of WHAF 2.0. This resulted in changes that improved user experience. Four of the biggest efforts included:

- End user adding their own GIS services to the map interface.
- Confirming the importance of using the latest accessibility guidance for designing web-map applications.
- Creating an API to house the database for easier maintenance.
- Using training opportunities to test out new functionalities and receive user feedback.

Continuous improvement since launch in 2018 has resulted in other new features, such as being able to download results tables, set watershed scale properties, add custom base maps, manage data layers in the map environment, use a robust search tool, find watershed health guides more easily, and share maps and analysis in a comprehensive way by simply copying and pasting a URL representing the app's current state and sending it to a colleague.

Impact

What did the project make better?

- **Resource Management:** The WHAF 5-component framework (Biology, Connectivity, Geomorphology, Hydrology, and Water Quality) has been adopted and applied to the Minnesota Legacy Clean Water Fund work by both the DNR and Minnesota Pollution Control Agency. It will continue to help organize and deliver a wide range of work products that are funded by Minnesota's Legacy Amendment.
- **Decision Making:** WHAF is delivering information that supports our resource management workflows in a way that integrates systems understanding.
- **GIS Online Mapping:** WHAF delivers complex analytics tools together with spatial data. The web interface and tools can also be leveraged for deployment in other projects.

How do you know?

The Minnesota Clean Water Council (created through the Clean Water Legacy Act) and Clean Water Fund partners have endorsed the WHAF 2.0 as a tool to be used by their staff for outreach and planning. In addition, there are nearly 3,000 WHAF newsletter subscribers, which indicates a strong user base of

individuals that are interested in learning and understanding more about our lands and waters and using this tool to drive action.

DNR continues to enhance the information that is delivered by the WHAF program and through the application. Through partnerships and collaborative development, the WHAF team this year delivered several new products and features to users. For example, DNR responded to requests to deliver new data layers in the WHAF Map while also making it easier to find the data.

DNR also added watershed climate summaries, bringing insight to climate change issues affecting water quality. Collaborating with DNR Climatology staff, a WHAF data analyst leveraged DNR's investment in statewide historic climate data to create several watershed-based summaries. This collaboration led to three climate data products; the [Watershed Climate Summary reports](#), [climate change data layers in the WHAF Map](#), and statewide animations of change in [precipitation](#) and [temperature](#).

WHAF products also improve efficiency. Collaborations have led to a range of shared data and analysis products that meet multiple needs and improve overall efficiency of staff from across agencies. The WHAF map and data summaries also provide a platform for discussion and further coordination. Here are some recent examples.

Supporting the Clean Water Fund

- Stream Protection Priorities for watershed restoration and protection strategy (WRAPS)
 - Product: Analysis, annual updates, data delivery
 - Outcome: Access to accurate, current data for reports and planning
 - Partners served: MPCA, Local Government, DNR
- Drinking Water Grant Application
 - Product: Drinking water data delivered in WHAF map
 - Outcome: Easy public access to materials needed for timely grant applications
 - Partners served: MDH and BWSR

Consult on Watershed Science

- Stream Geomorphology Triage
 - Product: Target Tool added to WHAF map, training and use guide
 - Outcome: Consistent watershed review for prioritizing streams
 - Partners served: DNR-EWR Division
- Lakes of Phosphorus Sensitivity, Lakes of Biological Significance
 - Product: GIS data layers added to WHAF Map
 - Outcome: Additional lakes-related data and metrics (in development)
 - Partners served: DNR-EWR/DFW Divisions

Share the Science with Education and Outreach

- WHAF Training for MPCA
 - Product: Full day in-person computer training session

- Outcome: Enhanced use of WHAF for Stressor ID work
- Partners served: MPCA-Brainerd Staff
- University of Minnesota Water Quality Course
 - Product: Annual presentation/consultation for WHAF based curriculum
 - Outcome: Watershed science applied in the classroom using WHAF tools
 - Partners served: University staff, grad/undergrad students

What now?

WHAF is a program that is funded through the Clean Water Land and Legacy Amendment and recognized as one of the data resource tools that is essential for helping to get funding to the right projects. With climate change, the need to study Minnesota's watershed has only increased, showing the need for sustained programming. DNR will continue to coordinate with the State Climatology Office to incorporate more climate change-based data into the system. The team is also conducting more user outreach to ensure that the system is accessible to a wider audience.

With the recent addition of the time-series component, users can reveal new patterns, showing that the use case of the WHAF extends far into the future.