OAK RIDGE NATIONAL LABORATORY

Building Intelligent Watersheds

Watersheds across the United States are under increasing strain. Hydropower operations must balance energy production with growing demands for water supply, flood control, agriculture, and ecosystem health. Yet many of the tools and data streams used to manage these decisions are disconnected—scattered across agencies, locked in incompatible systems, or misaligned with on-the-ground realities. This disconnection—and the subsequent lack of clear communication between watershed systems—leads to lost opportunities, inefficient operations, and delayed action in the face of increasingly complex challenges.

A Smarter Approach

Researchers at Oak Ridge National Laboratory and Pacific Northwest National Laboratory, in collaboration with the Internet of Water Coalition, have developed a blueprint for what comes next: Intelligent Watersheds (IWs).

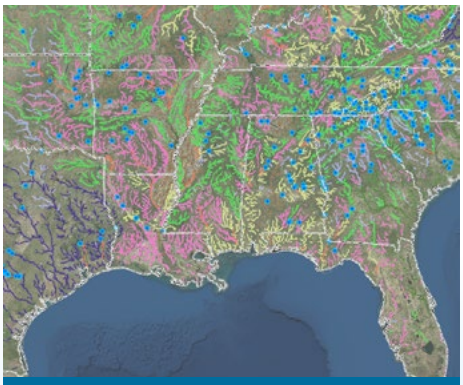
IWs are advanced resource management systems that connect data, modeling, and decision-making across agencies, infrastructure, and landscapes. They don't replace people, they empower them—providing shared access to tools and information that make coordinated action easier, faster, and more effective.

This work draws from a nationwide research effort involving dozens of expert interviews, collaborative workshops, and a real-world case study in the Upper Colorado River Basin. The result is a clear set of stakeholder-and SME-informed priorities and actionable recommendations to drive future investment, innovation, and implementation.



Key Stakeholder Priorities

- Focus on community-centered solutions to build trust and engagement
- Data-driven tools must be informed by sociological, economic, and environmental context



Key Technical Priorities

- Standardized data and decision-support tools are essential for broad adoption of IW systems
- IW efforts will benefit more from coordinated implementation than new technologies



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Recommendations: Building Blocks for an Intelligent Watershed

- **Smart Sensing, Strategically Deployed**
  Expand and integrate sensing systems to track and collate more information, including streamflow, snowpack, water quality, and more. Combine remote sensing with targeted ground-based tools to cover more ground with fewer resources.

- **Shared Data and Common Standards**
  Break down information silos by aligning data platforms and formats across agencies. Apply FAIR data principles (Findable, Accessible, Interoperable, Reusable) to make it easier to find and use information.

- **Next-Generation Modeling Tools**
  Support collaborative, user-driven modeling that incorporates real-time data, human behavior, and regulatory context. Improve forecasting with flexible, transparent models built to inform real decisions.

- **AI and Machine Learning**
  Use AI to accelerate workflows like data discovery, processing, and visualization. Prioritize transparency and validation to build trust—and include users early to ensure tools meet real-world needs.

- **Real-World Testbeds**
  Invest in pilot sites where tools and techniques can be tested under operational conditions. Field-testing builds practitioner confidence and smooths the path from research to implementation.

- **Communities of Practice**
  Create spaces—both virtual and in-person—for practitioners, researchers, and decision-makers to share tools, compare outcomes, and strengthen trust. Shared tools and information provide a common foundation for more effective collaboration.

- **Smarter Funding Models**
  Enable cross-agency, long-term investment in shared data and tools. Move beyond short-term projects to support the durable infrastructure Intelligent Watersheds require.

Implications for Watershed Management

These seven building blocks represent a practical, actionable vision for transforming U.S. watershed management. Targeted investments in technology, coordination, and capacity building will reduce inefficiencies and enable faster decision-making with improved outcomes. The roadmap developed by ORNL, PNNL, and their collaborators offers a national strategy for modernizing how to manage one of our nation's most vital resources in the 21st century.

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