

Dam Monitoring Moderization

Using Digital Twins to Improve Operations

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A growing number of dams are approaching their design service life. This situation leaves dam safety engineers trying to mitigate the risks with safety, aging infrastructure, labor shortages, rising maintenance costs, and climate change.

A modern approach to dam monitoring and maintenance practices can help dam owners and operators with digital twin technology. By efficiently consolidating engineering and operational data in a single view, it is visible to all parties in real time, enabling organizations to make timely and risk-informed decisions and receive alerts with early warning systems for dam and levee protection.

**Dams Worldwide Are
Approaching the End of
Their Design Service Life**

58,000+

Large Dams Worldwide

60 Years

Average Age of Large Dams

Most of Humanity

Will Live Downstream
of Large Dams Built in the
20th Century by 2050

*Large dams: a category largely defined
by structures taller than 15 meters, or 49 feet.

Source: https://www.icold-cigb.org/GB/world_register/general_synthesis.asp

Aging Dam Infrastructure Poses Significant Risks

There are over 91,000 dams in the United States, with an average age of 57 years. And, over the last 20 years, the number of high-hazard-potential dams has more than doubled as development steadily encroaches on once-rural dams and reservoirs.

By 2030, seven out of ten dams in the United States will be over 50 years old. Therefore, the majority of dams will not have been built to current standards, let alone incorporate newer standards that improve their resilience and reduce the risk to downstream areas.

Dam failures not only put the public at risk, they can also cost our economy billions of dollars in damages. Failure includes more than damage to the dam but can negatively impact many other infrastructure systems, such as roads, bridges, and water systems.

**A growing number of dams are subject to increasing hazard creep
as climate change alters weather patterns.**

Data Challenges

Government agencies, the largest segment of dam owners and operators, struggle to modernize their dam operations. While there are many reasons for this struggle, data presents one of the biggest obstacles. With modern technology comes newer data types and models. Legacy systems are often not equipped to handle modern data, preventing dam operators from leveraging advancements that would improve their monitoring and management of dam infrastructure.

Limited or No Support for Data Types

Older systems may only support specific types of data or have restrictions on the variety of data that they can process, including newer types of data.

Siloed Data

Legacy systems often store data in silos, making it difficult to access and integrate information from different sources. This fragmentation limits the ability to get a comprehensive view of the dam's health.

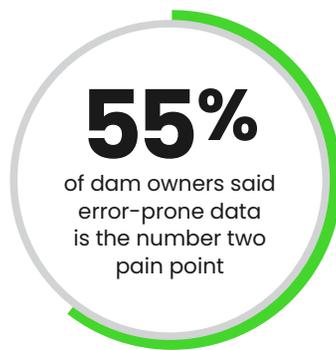
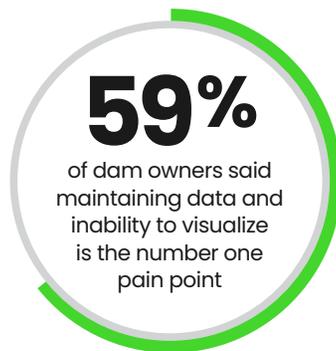
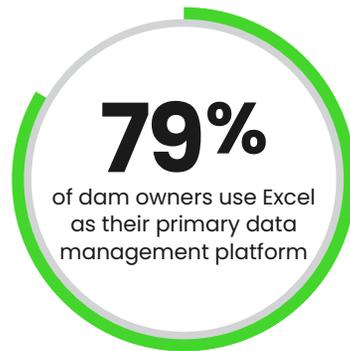
Complex Data

Analyzing large datasets manually can be challenging, limiting the depth of analysis and inhibiting timely and accurate decision-making.

**Dam Operators Face
Numerous Issues to
Effectively Manage
Their Monitoring
Programs**

**Not Enough Data
Siloed Data
Complex Data**

Manual data management
and analysis does not help.



Manual Data Management and Analysis

Manual data management and analysis do not help. Legacy systems used for dam monitoring often involve manual data management and analysis processes. In fact, 79% of dam owners use Excel as their primary data management platform.

Manual processes present several challenges. The number one pain point for dam owners is maintaining data and the inability to visualize real-time insights. The second-biggest pain point is human error, which causes inaccuracies in data collection or transcription and can compromise the reliability of the data used to monitor dam health.

Technology Can Help, But Where to Start?

Dam owners should move from monitoring processes that are human dependent with intermittent assessments to automated, ongoing surveillance of the dam's health and performance.

There's a New Approach...

74% of dam owners have identified the need to use technology to solve those challenges, but do not know where to start.

Make the Move to Modern Dam Monitoring

Dam owners face critical challenges with existing manual processes. The inability to visualize real-time insights and inaccuracies caused by human error presents major risks. However, you can enhance your entire dam safety and operations through digital twin technology.

Bentley's dam monitoring solution leverages digital twins to consolidate engineering and operational data into a unified view. This process provides timely insights to stakeholders and reliable data used to monitor dam health.

Introducing the Bentley Dam Monitoring Solution

Bentley's dam monitoring solution implements cloud-based infrastructure that provides a centralized data hub. Dam owners can visualize and analyze engineering and operational data. Visual real-time monitoring improves the understanding of underlying causal factors and risk drivers.

iTwin® Capture provides an immersive and intuitive visualization of the dam. Capture in a photorealistic and geo-referenced 3D reality mesh to serve as context for automated condition monitoring, inspection, and identification of defects or condition change and facilitate any redesign processes.

iTwin IoT provides actionable insights incorporating all sources of dam surveillance to identify early signs of changing behaviors that pose a risk to structural performance and integrity. Alerts and reporting support collaboration and emergency action plans.

iTwin Experience enhances engagement and collaboration for improved decision-making. Make fast and informed decisions to improve response time to adverse events in hard-to-reach areas. Dam safety monitoring is essential to maintaining safety and reducing risk in your dam portfolio.

Together, these products provide a connected, scalable digital twin environment purpose-built for dam safety and risk mitigation.

Move From Manual to Automated and Continuous Condition Monitoring

Bentley's dam monitoring solution utilizes digital twins to consolidate engineering and operational data into a single view to inform stakeholders in a timely manner.

The Benefits

Bentley's dam monitoring solution provides four major benefits:

- ◆ Risk Mitigation: Identifying issues early for proactive safety measures.
- ◆ Improved Data Quality: Reliable data for better insights into dam conditions.
- ◆ Faster Decision-making: Real-time analytics for faster, accurate responses.
- ◆ Streamlined Collaboration: Centralized platform for effective sharing and coordination among stakeholders.





Image Courtesy of Yuba Water Agency

How Yuba Water Agency Automates Dam Monitoring

Yuba Water Agency

Using Bentley's iTwin Applications for Situational Intelligence Significantly Improves Risk Assessment

Situated in the Yuba County foothills along the edge of Tahoe National Forest on the North Yuba River, New Bullards Bar Dam is a 645-foot-tall concrete arch dam. It is the second-tallest dam in California and the fifth-tallest in the United States.

Owned and operated by Yuba Water Agency, the New Bullards Bar Dam was constructed in 1970 as part of the Yuba River Development project, which was aimed at reducing flood risk, generating clean hydropower, and ensuring a reliable water supply for county residents and the environment. Committed to dam safety and efficient, reliable infrastructure operations, Yuba Water sought to modernize the dam monitoring system by collecting continuous, real-time operational data. This data collection is especially critical when dealing with inclement weather and seismic events.

Yuba Water implemented a digital automated survey and monitoring system to better understand the entire performance of New Bullards Bar Dam, ensuring safe, reliable operations.

Addressing Site, Survey, Security, and Safety Risks

The dam's previous monitoring system posed safety hazards, requiring time-consuming, costly, and hazardous manual data collection that spanned only a portion of the dam.

Implementing the new monitoring system involved performing drone surveys and installing automated survey equipment for detecting 3D deflection, as well as monitoring any propagation or deformation of the dam structure.

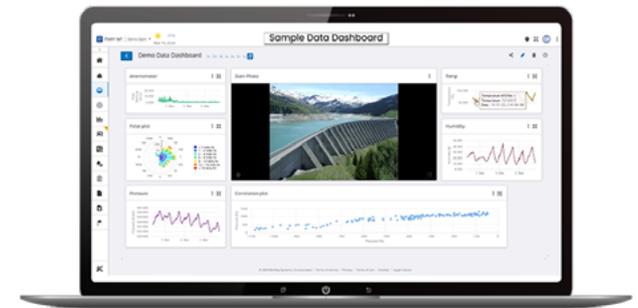
The project team experienced several challenges, including securing permitting and approvals for drilling and installing devices directly to the dam, as well as the engineering and construction activities necessary to build a dedicated enclosure for survey equipment at a location with visibility of the entire downstream dam face. Compounding these issues was the steep terrain around the dam, accessible only via a narrow, restricted road.

To reduce personnel safety risks, Yuba Water wanted to implement a more cost-efficient, safe, and comprehensive automated monitoring system, eliminating manual surveys.

Leverage iTwin Capture and iTwin IoT to Automate Dam Monitoring

Yuba Water implemented a digital automated survey and monitoring system to better understand the performance of New Bullards Bar Dam and ensure safe, reliable operations.

Yuba Water worked with iTwin Ventures portfolio company Niricson to capture and process a 3D reality mesh, then leveraged iTwin IoT to collect, monitor, and visualize the dam data and its components in the digital twin. The project provides a cloud-based platform to visually track the stability of the structure and effectively communicate with the team to address any potential damages.



Digital Twin Optimizes Dam Operations

The original legacy system took approximately one week to get a data point from a target. It was USD 5,000 for each manually collected data event.

The new cloud-based system can collect a data point from over 80 prisms twice a day and make it immediately accessible to authorized users. It has saved hours every week and improved workflows and productivity, all while eliminating risky on-site visits.

Using iTwin IoT, the dam can be monitored more closely and quickly during heavy rainfall and seismic events and protecting the surrounding environment.

Make Risk-informed Decisions

Contact us to learn how you can leverage digital twins in your dam safety program.

[Learn How](#)

[Visit Bentley.com](#)



For Yuba Water Agency, there is nothing more important than public safety. Investing in a real-time, automated monitoring solution at New Bullards Bar Dam with iTwin technology significantly improves our monitoring capabilities and is a testament to our continued commitment to public safety and infrastructure resilience.

Tim Truong, Chief Dam Safety Engineer, Yuba Water Agency

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Image Courtesy of Yuba Water Agency