

## Western Water and Power Solution Bulletin

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### Evaluation of River-Spanning Rock Weir Performance

*Design Guidelines Will Improve Performance and Reduce Repairs and Replacement Costs*

#### What Is The Problem?

Rock weirs are being used more and more as alternatives to conventional concrete and steel structures in river engineering projects. Rock weirs can provide bank protection, channel profile stability, improved aquatic habitat, recreational opportunities and fish passage. Current design methods, however, rely mostly on professional experience and anecdotal information. As a result of poor design, many rock weirs do not function as intended and are in need of repairs or replacement.

Investigations of 127 rock weirs found that downstream scouring is the most common cause for failure. Other failure modes include piping or erosion of fine material beneath the structure and burying from high sediment loads.

#### What Is The Solution?

Reclamation is combining field investigations, physical modeling, and computer simulations to develop design guidelines and countermeasures for river-spanning rock weir structures. Use of the design guidelines and countermeasures will result in more robust structure design or retrofits based upon predictable engineering and hydraulic performance criteria.



Physical and numerical models are being used to better understand the scouring processes and other failure modes observed. Physical scale models are tested in the hydraulics laboratory at Colorado State University using various channel and weir configurations, channel bed material sizes and flow conditions. Two- and three-dimensional numerical models developed by Reclamation (SRH-2D and U<sup>2</sup>RANS) are used to test large ranges of design parameters and conditions to identify how variations in structure geometry affect the local hydraulics and resulting scour development.

The results of laboratory tests and numerical modeling show that scour depths below rock weirs are significantly deeper than predicted by methods used for conventional structures. Empirical methods for accurate prediction of scour are being

developed. Also, design techniques to minimize scouring and other undesirable conditions are being tested with the physical and numerical models. These techniques include deep foundations to protect against scour, grouted weir crests, using multiple structures in series, and using interlocking and block-shaped rocks.

#### Who Can Benefit?

Natural resource managers with a need for aesthetic river structures from natural materials for diversion, fish passage, channel stabilization, etc. will benefit from the results of this research. The river-spanning rock weir design guidelines and countermeasures will be used by river project designers and engineers to construct long-lasting rock weir structures that perform as intended.

#### Where Have We Applied This Solution?

The findings of this research thus far have been applied to develop plans for repairs and retrofits of rock weir diversion structures on the Lemhi River in Salmon, ID, Beaver Creek near Twisp, WA, and Entiat River near Entiat, WA. Repairs/retrofits of these structures incorporated design guidelines and countermeasures to protect the structure against common failure mechanisms.

#### Future Development Plans

The rock weir research is part of a larger effort to evaluate the use of natural materials in many types of water engineering projects. Future research will include similar evaluations of other structures including: roughened channels, boulder clusters, rock ramps and diversion (check) dams.

#### More Information

Additional information on River-Spanning Structures Research and associated numerical computer modeling and the Qualitative Evaluation of Rock Weir Field Performance and Failure Mechanisms report are available at:

<http://www.usbr.gov/pmts/sediment/kb/SpanStructs/index.html>

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#### Collaborators

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