RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Research Update

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Bottom Line

This scoping-level research project report investigated practical methods for canal inspections.

Better, Faster, Cheaper

Finding the most effective ways to inspect canals will help detect problems early, thus avoiding costly repairs and ensuring that Reclamation's canals continue to deliver water efficiently and effectively.

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Inspecting Reclamation Canals in New Ways

Accurately predicting canal seepage

Problem

Reclamation is particularly concerned with identifying canals which have possible voids or active seepage that can potentially pose risks to urbanized areas. Some voids and seepage from canals can be detected by regular visual inspections, but methodologies are being researched that allow for identification and inspection of voids and seepage that cannot be detected by visual means alone.

Example of a canal of concern, highlighting that some of Reclamation's canals are above urbanized populations.

Solution

This Reclamation Science and Technology Program research project conducted a literature search to assemble and assess existing knowledge about void and seepage detection methods applied to canal channels. This compiles available field investigation methods useful for canal seepage and void detection and evaluation, including various geophysical survey techniques, and visual and other nondestructive inspection techniques. The techniques were evaluated for cost effectiveness, accuracy, practicality for large-scale use, and other factors.

Results

Methods to inspect canals and detect leaks or other potential problems include:

- **Traditional field seepage tests.** These tests help measure field seepage. Ponding and dye tracer tests are limited to small sections of canals and are best suited for situations when possible seepage locations have been identified and need to be further evaluated. Inflow-outflow tests help determine if a longer reach of a canal is losing or gaining water and are best suited to long sections of channel that contain apparent seepage.

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- **Geologic and hydrogeologic characterizations.** Using existing data (e.g., maps, well logs, and water levels) and drilling new wells can provide an understanding of the groundwater conditions near a canal. Data collected over time can be used to determine if elevated groundwater conditions are a result of canal seepage or other recharge sources.
- **Remote sensing.** Thermal imaging to measure heat, self potential to measure electrical potential, ground-penetrating radar to measure soil water content, electrical resistivity to measure how well the soil conducts electricity, and microwave radiometry to measure moist soil areas are all remote tools that can help paint a picture of water seepage and loss. Primary limitations include the presence of other structures or utilities that might interfere with readings. Further, most of these only note the presence of water and do not determine flow patterns.
- **Hydrochemical tracers.** Isotope and tracer investigations can be used in detailed studies to assess canal seepage. The difficulty with this method is that canal flows limit the time available for sufficient volumes of dosed water to seep into the aquifer and be detected. Another major disadvantage of this method can be the high costs of artificial isotopes and specialized expertise needed for application and evaluation, so this is generally not a practical solution for seepage location identification.
- **Fiber optic sensors.** These sensors detect leaks by monitoring temperature changes. A distributed sensor network supported by fiber optics is useful in harsh environments or along structures that span long distances. However, given the high costs of installation and assembly of a fiber optic thermal monitoring system, placing this technology on existing canals is likely to be limited to those reaches that may present potential flood hazards if breached.

All of these methods should be considered to be a set of tools, which can be selectively applied on a case-by-case basis for individual canal sections.

Future Plans

Methods and techniques that are cost effective, practical, and have not previously been demonstrated in the field will be field-tested at a critical reach of a Reclamation-owned canal. The plan will include scope of effort, preliminary design, cost estimates, any required regulatory requirements (i.e., National Environmental Policy Act [NEPA] and Endangered Species Act [ESA]). The plan may include additional laboratory-scale testing or modeling if the selected alternatives require further evaluation.

The ultimate objective of this research is to develop a practical and cost-effective single method or suite of methods to improve detection and evaluation of canal seepage sources and paths. Any method that is identified should be practicable for implementation by regional, area, and field office staff or their respective contractors.

"Determining the best methods to find and quantify the extent of seepage to ensure a breach does not occur on Reclamation's canals is a significant priority, with broader potential applicability to all canals."

Nathaniel Gee
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More information

www.usbr.gov/research/projects/detail.cfm?id=4861

Photographs below show the electrical resistivity test method being applied (mentioned under the remote sensing bullet above). The test is applied on the outer side of the embankment; the canal is at left. Stainless steel pins are pounded into the embankment at even spacings. The cable is connected to each pin and to the instrumentation to apply the method, which is further processed to provide a two-dimensional slice of the embankment's electrical resistivity.

For printable version see: www.usbr.gov/research/docs/updates/2015-06-canals.pdf