5.8 Gate Automation

Applicability

This best management practice (BMP) is applicable to gravity fed and partially pressurized pipeline agriculture surface water irrigation systems and other water conveyance systems. The requirements and applicability of gate automation varies between specific geographic regions and political subdivisions throughout Texas.

Description

Gate automation with supervisory control and data acquisition (SCADA) programming provides irrigation districts and other water districts with water savings by minimizing spills, identifying obstructions quickly, and remotely managing data on water levels and flow rates within the delivery system. The extent of remote management can vary depending on the capability of the system. There are two major aspects of this best management practice: the physical gate construction and equipment as well as telemetry installation and programming.

1. Gate Construction and Equipment:
   The specific size and structure of the gate leaf and frame can vary depending on geographic needs and the conveyance system. There are five main components:
   - The gate structure – a barrier across the width of a canal defining upstream and downstream control sections
   - The gate – an aluminum/steel/ plate that can slide within an aluminum/steel frame imbedded in the gate structure which can be prefabricated or custom fabricated in-house if expertise and machinery are available
   - The actuator – the mechanism that moves the gate up and down
   - The control panel - an enclosure that contains the internal circuitry for gate control, water level instrumentation control, and telemetry
   - Energy source –12 volts of direct current (vdc) solar power system (solar panel, battery, and charge controller)

2. Telemetry and SCADA:
   This is the monitoring and remote-control system that allows for better management of canal water levels, pumping, metering, and data collection. This system includes:
   - Telemetry System – the communications system that relays data to and from the gate controller to a data acquisition system. This could be a proprietary radio network system “900 megahertz (MHz), 2.4 gigahertz (GHz)” or a local broadband cellular provider connected back to a central acquisition system, either to a stand-alone server or a cloud-based platform.
   - Site Controller

  - Each site has a main controller or Remote Terminal Unit (RTU) that controls the gate actuator or monitors the water level instrumentation.
- Central Data Acquisition System
  - The data acquisition system also can be programmed to receive data from other downstream locations or maintain a set water level at each location by sending data from the site through the telemetry system.
  - The Data acquisition system will send out alerts to operational staff and will display the data on a user interface. From here data can also be shared to other systems such as a billing system or long-term data storage system.

Implementation

For implementation of this BMP, it is important to understand that each conveyance system requires distinct gate measurements and design. Engineering experts should be consulted to determine structure design and type of control system. Typically, it is not necessary to automate every gate structure within the system. To help decide what structures need to be automated the following information should be gathered: elevation change from the beginning to end of a canal line, number of gate structures per mile, flow rates at each structure, typical head pressure difference between structures, historical pumping data, and information from canal operators regarding the frequency of adjustments normally necessary at each structure. This information can be used to prioritize structures to automate first, estimate anticipated water savings, and potentially skip automation on structures that do not need to be adjusted often. This is particularly relevant for a large canal system where acreage fluctuates substantially from one year to the next and/or acreage served is significantly lower and more scattered geographically than when the canal system was built.

Gate automation could include building new gates and structures or motorizing the actuators on existing gates. If retrofitting existing actuators is under consideration, building a pilot installation to test the concept is recommended.

Existing internal and external communication and control systems, the expected longevity and replacement costs of those systems, security requirements, the type of data acquisition system and desired data retention timeframe should all be considered when deciding how to integrate telemetry and SCADA systems. Planning for simple integration of additional structures and any anticipated supply chain issues should also be considered upfront. Canal water levels can be controlled using either downstream control (feedforward) or upstream (feedback) control. If downstream canal level control is implemented, it is possible to manage river diversion pumping volumes based on downstream demand.

Scope and Schedule

This BMP can be implemented by irrigation districts and other water management districts or entities managing irrigation delivery systems with multiple landowners. Gate automation with SCADA is a management tool specifically for water conveyance systems. The gate size, frame, and design can vary depending on geography, the size of the canal system and the number of canal systems operated by a political subdivision. Telemetry and SCADA generally correlate with gate structures, but monitoring can be conducted at other parts along the canal, particularly at the end of a canal line to quantify spills.

For the construction of gates including SCADA implementation and programming, a 10-12 site project can take roughly 6 months, typically with construction completed outside of the irrigation season. For the whole project, including engineering design (structural, electrical, and communications), procurement, and post-installation testing, a rough estimate of one year is anticipated.

Measuring Implementation and Determining Water Savings

Water savings can vary based on geography, pre-existing water use efficiency, canal structure, and other factors. The main ways this BMP saves water is by prevention of spills during weather-related shutdowns and timely identification of canal system operational issues. Remote access to flow settings from secure laptops and highwater level alerts sent to mobile devices are key features that can maximize potential savings. Improved water level control also increases the accuracy of water volume delivery. The telemetry and SCADA systems are key components of realizing reliable water savings through the remote monitoring of water levels and controlling optimal storing capacity, which in turn increases the efficiency of the system. Implementing gate automation without SCADA system integration is not recommended as many of the water and labor savings benefits will not be realized with only local control. Savings estimates range from 3 to 5 percent of annual diversions, assuming a project with full SCADA integration and at least 90 percent of the water flow controlled through automated gates.

Documentation

The irrigation district, water management district, or other entity that manages the conveyance system should collect and document data regarding water usage, water flow, and water loss. Projects should include automated water level monitoring at the ends of canal lines to quantify reduction in spills, and baseline data should ideally be collected prior to project implementation. Savings can also be quantified through regression savings analyses over several seasons; however, savings estimates using these types of models tend to have large ranges, so data indicating reduction in spills is useful to corroborate these analyses. A side benefit of gate automation projects is the ability to conduct ponding tests easily on canal segments between automated gates. This can be done annually at the end of the irrigation season when irrigation demand is low, but the canal system is still fully charged.

Cost-Effectiveness Considerations

The costs associated with this BMP can vary significantly depending on the number of gates, the location, the gate size/design, and historical/environmental/geographical context of the conveyance system. Some sources cite one to three gates with SCADA integration costing between $25,000 and $35,000 per gate structure. This does not include the initial set-up cost of a SCADA system (including a radio telemetry system), or the cost of a complete structure rebuild if it is not possible to use the existing structure. The Lower Colorado River Authority's Garwood and Gulf Coast projects and the Harlingen Irrigation District's projects all incorporated large-scale improvements to their conveyance systems. The complete Gulf Coast system, which cost approximately two million dollars, was completed in phases between 2010 and 2018 at a unit cost of approximately $30 per acre foot per year. Multiple studies have shown that improvements to conveyance/delivery systems are the most cost-effective way to save water in the surface water delivered irrigation sector.

References for Additional Information

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