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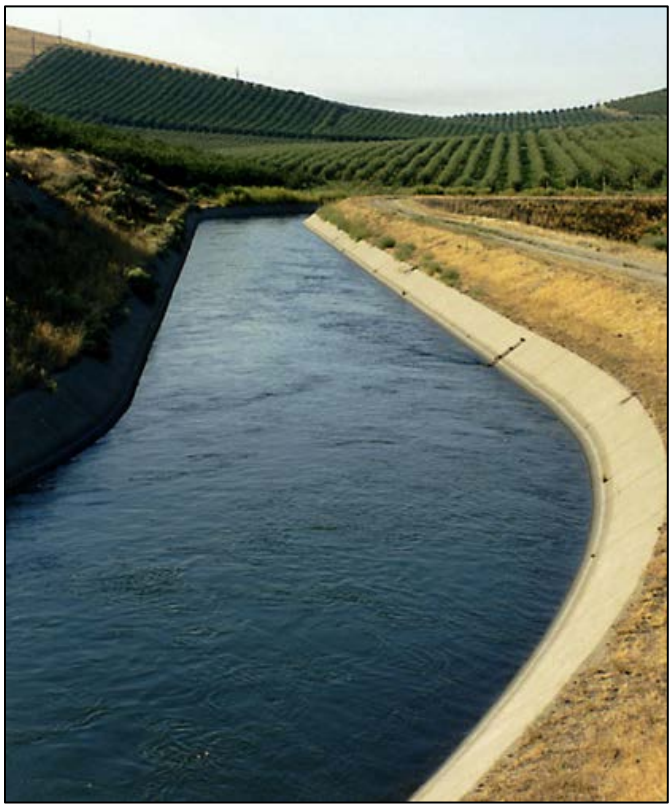
Managing Water in the West

Scoping Methods for Evaluating the Secondary Effects of Canal Lining to Ecosystems and Groundwater

Research and Development Office
Science and Technology Program
Final Report ST-2017-1723-01



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Bureau of Reclamation

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14. ABSTRACT *(Maximum 200 words)* Reclamation and its customers maintain thousands of miles of canals. Canal lining, which involves installing a combination of concrete or geomembrane materials in the bottom and sides of earthen canal channels, is a commonly used water conservation tool to reduce seepage and/or reduce annual maintenance. Canal lining projects potentially decrease the amount of water that		

was previously available from seepage to other uses, such as ecological systems and groundwater return flows. These effects are typically not evaluated because legal water rights have not been established for groundwater or ecosystem uses. This scoping-level study had two objectives: 1) conduct a literature review of how Reclamation addresses effects of canal lining, and 2) develop a conducting-level study to submit for FY18. The literature review examined how National Environmental Protection Act (NEPA) documents for Reclamation canal lining projects analyzed the effects of seepage reduction. Results showed a range of analysis of groundwater and ecological systems, from quantifying changes in water levels to areas where the impacts were not deemed significant enough to mention. A conducting proposal was submitted for FY18 to the Science and Technology Program to quantify the effects of canal lining on groundwater sources using groundwater models and well data analysis in two case study areas in the Pacific Northwest Region.

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Scoping Methods for Evaluating the Secondary Effects of Canal Lining to Ecosystems and Groundwater

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Executive Summary

The United States Bureau of Reclamation (Reclamation) and its customers maintain thousands of miles of canals. Canal lining, which involves installing a combination of concrete or geomembrane materials in the bottom and sides of earthen canal channels, is a commonly used water conservation tool as part of maintenance programs to reduce seepage and/or reduce annual maintenance. In certain cases, canal lining projects that reduce seepage have the potential to decrease the amount of water that was previously available to other uses such as ecosystems and groundwater return flows, the latter which provide river base flows or drain flows relied upon by surface water users. These effects are not typically evaluated because legal water rights have not been set aside for groundwater or ecosystem uses.

There were two objectives of this scoping-level study: 1) conduct a literature review of how Reclamation currently addresses secondary effects of canal lining and 2) develop a conducting study furthering research based on the literature review to submit for FY18 funding. The literature review examined how effects of seepage reduction through canal lining on the overall water supply and ecological systems are evaluated and acknowledged in National Environmental Protection Act (NEPA) documents for Reclamation canal lining projects. Results showed a range of ways that groundwater and ecological systems were addressed and discussed, from quantifying water levels to areas where the impacts were not deemed significant enough over the project life to mention.

A conducting proposal was submitted for fiscal year 2018 to the Science and Technology Program to quantify the effects of canal lining on groundwater sources. The research proposed would use groundwater models and analysis of well data in two case study areas in the Pacific Northwest Region, the locations of which must be kept private at this time. Groundwater models for the two case study areas are already created and are in current use in Reclamation.

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Introduction

Background

The United States Bureau of Reclamation (Reclamation) and its customers maintain thousands of miles of canals. Depending on the conditions, it is possible for a canal to seep over 50 percent of its conveying water. Canal lining, which involves installing a combination of concrete or geomembrane materials in the bottom and sides of earthen canal channels, is a commonly used water conservation tool to reduce seepage.

Canal lining has many benefits in addition to water conservation. Irrigation districts can often reduce maintenance time and costs by reducing the amount of erosion that causes siltation in canal beds, reducing the population of aquatic species, and reducing the animal burrowing that increases the safety risk of a canal. Reducing or eliminating seepage can reduce issues near the canal of water logging of crops and other nearby land. A lined channel can have flow velocities 1.5 to 2 times faster than an unlined canal, which allows for a smaller canal (FAO 1993). Canal lining can be an effective tool for Reclamation and irrigation districts to address a host of issues.

Irrigation districts are typically the primary beneficiary of these benefits, but canal lining may cause unquantified negative impacts to others. Canal seepage may contribute to groundwater, wetlands, or river returns, and some of that water may be a source for other users (Reclamation 2002). Canal lining projects that reduce seepage potentially decrease or eliminate the amount of water that was previously available to other uses, such as groundwater return flows, that support base flows. These river flows contribute greatly to some ecosystem uses, such as providing a water source of wetlands; increasing habitat; and providing cooler, cleaner water; or to drain flows, which support surface water uses as a source of water. In areas where surface water and groundwater are managed jointly, canal lining may be counterproductive, as the canal seepage may be depended upon to help recharge the groundwater. These effects are not typically evaluated because the interaction may not be significant enough over the project life to require evaluation, or in situations where interactions are significant, legal water rights have not been set aside for groundwater or ecosystem uses.

Objective

There are two objectives of this scoping-level study: 1) conduct a literature review of how Reclamation currently addresses secondary effects of canal lining, and 2) develop a conducting-level study proposal furthering research based on the literature review to be submitted to Reclamation’s Science and Technology Program for FY18 funding.

Literature Review of Previous Investigations

Internal Reclamation Investigation of Canal Lining Effects

Reclamation follows National Environmental Policy Act (NEPA) and its own guidance to

address possible effects from lining canals. If the canal-lining project is using Federal funds, being constructed by a Federal agency, or is located on Federal property, NEPA compliance is required. In addition, Reclamation policy guidance suggests that the beneficiaries of seepage and potential legal water right holders to the seeped water should be assessed prior to canal lining. Identifying the beneficiaries of seepage and potential legal water rights holders to the seeped water should be assessed prior to canal lining (Reclamation 2002).

NEPA documents for lining projects throughout Reclamation were evaluated for this scoping effort. Environmental Assessments (EAs) and Categorical Exclusions (CEs) are common NEPA documents filed for canal lining projects to record the investigation into the effect of a project on the environment. Projects for which the EA identifies significant impacts must then be further analyzed in an Environmental Impact Statement (EIS). Because CEs are checklists providing no project detail, all reviewed documents are either EAs or EISs. These documents were reviewed to understand the level of analysis that had been conducted on the possible effects of lining canals. There are 10 documents available through online, publically available sources that were either solely for or involved canal lining.

The following summarizes how the 10 documents addressed effects to groundwater:

- Four had no mention of groundwater.
- Four had groundwater that was so contaminated that seeped water was of no use once it entered the ground. One of the four mentioned using some of the water to increase groundwater levels in specific recharge areas.
- One stated that the groundwater quality levels would immediately go down after lining, but there was little to no long-term effect on groundwater levels due to lining. Return flows to the river or nearby lake were not discussed.
- One quantified potential reduction in groundwater levels over a period of time for the local aquifer. This document also acknowledged that groundwater pumping could be affected.

The following summarizes how the 10 documents addressed effects to wetland and riparian resources:

- Two had no mention of wetlands or riparian resources.
- One stated that there were no wetlands within the existing canal prism.
- One stated there were no wetlands supporting species of interest.
- Three stated that no wetlands were in the proposed area.
- Two stated that there was no effect to wetlands.
- One quantified the acreages of potentially affected wetlands

As this study showed, there is a wide range of analysis for the effects of canal lining projects with respect to their effects on ecosystems and groundwater. Analysis ranges from quantifying a

radius of affected aquifer and affected wetland acreage to no mention because impacts were not deemed significant enough. In areas where groundwater effects are significant enough to mention, there is a need to uniformly evaluate those effects.

External Investigation of Canal Lining Effects

A variety of works have been published on the broad and specific effects of lining canals and ditches. There are few publications that address the qualitative or quantitative effects of canal lining related to seepage reduction. Burt (2011) stated that lining is not a guaranteed water conservation practice, and actual conservation is dependent on physical and political boundaries: local water tables, management system, and water rights. The issues related to canal lining can be complicated and multifaceted. While there are some quantitative studies of the impacts of canal seepage or lining, they are limited (Harvey and Sibray 2001). Nofziger et al. (1979) into the issue found that canal seepage affects to the local water table. The research often points out that irrigation canals specifically used for groundwater recharge can have positive economic benefits for farmers (Kumar et al. 2013).

In a study of lining a canal in western Nebraska, Harvey and Sibray (2001) monitored wells near the canal during different times of the year: when the canal was filled (start of irrigation season), drained (mid-summer), and refilled (late summer) from 1992 to 1995. While local precipitation had minimal impact on groundwater levels, the local groundwater levels increased when the canal was running and decreased when the canal was dry. The potential decrease in shallow groundwater due to canal lining likely would impact wetlands negatively along the canal and shallow wells nearby for livestock and irrigation. The study concluded by stating that a better understanding of the effects on canal seepage on local groundwater requires more data, as well as an examination of water quality (Harvey and Sibray 2001).

Fernald and Guldan (2006) studied the effects of seepage from an unlined irrigation ditch on shallow groundwater in New Mexico. The study found that surface water was the source for shallow groundwater. The study also found that benefits of canal seepage include improving water quality of the shallow groundwater through dilution, recharging shallow groundwater, and delaying stream return flows after peak runoff. In a further study of the last point, Fernald et al. (2010) found that reduced canal seepage can result in higher spring runoff and lower fall and winter river flow. Fernald and Guldan (2006) identify a need to determine the long-term hydrologic impacts of lining irrigation ditches.

Proposed Work for Conducting Study

Findings from this literature review highlight the importance of further studying the secondary effects of canal lining on ecosystems and groundwater in locations where the interaction of groundwater and surface water has the potential to impact project benefits. Reclamation has, and continues to, invest money and support in assisting water purveyors with canal lining. Through the WaterSMART program alone, Reclamation has contributed more than $15 million since 2010 for projects that have a lining component to improve water delivery efficiency in the

western United States. A conducting proposal was submitted to the Science and Technology Program for fiscal year 2018 to further investigate the effects of canal lining on groundwater. This 3-year conducting-study research would provide Reclamation insight as to the effects of lining projects and provide a platform to educate Reclamation staff about how to quantify these effects.

Quantifying the effects of eliminating seepage through canal lining on groundwater supports Reclamation's ability to manage water and resources more effectively. This research will use existing groundwater models and support the development of a well data analysis tool in two case study locations in the Pacific Northwest Region to improve the understanding of canal lining impacts on groundwater. The methods developed through this research will increase the understanding of surface water-groundwater interaction and can be applied to evaluate current or future projects. Data results can be used as examples of canal lining effects to increase awareness of the impacts of potential projects.

The proposed project relates to multiple areas of research need within Reclamation. Based on the *Science and Technology Program: Science Strategy FY2018-FY2021* document, this research addresses two main Research Areas:

1) The Water Infrastructure Canals (WI2) category, by advancing work to improve repair and maintenance, reliability, and efficiency of canals; and
2) The Developing Water Supplies Groundwater Supplies (WS2) category, by developing and improving solutions and tools that advance and optimize groundwater storage and conjunctive storage and use.

The research also addresses the Areas 2.02 (high urgency) and 2.04 (medium urgency) detailed in the draft of *Ongoing Research Needs: Groundwater-Surface Water Interaction* (Johnson 2016). Area 2.02 calls for an improvement of methods for quantifying regional recharge for use in groundwater or rainfall-runoff models. This research will quantify changes in recharge due to canal lining in a localized area. Area 2.04 focuses on improving simulation processes for canal-aquifer exchange. Both the groundwater model and the to-be-created well-level analysis tool will address this need. Though this research does not specifically address climate change, the results and methods could be used to help address the issue Brekke et al. (2011) list as a priority gap 4.05 relating climate change and its impacts to groundwater recharge and surface water-groundwater supply interaction.

The major tasks of the proposed work are: 1) identify input data for models and well analysis, 2) prepare models and create the well analysis tool, 3) collect data for models and groundwater well data, 4) analyze groundwater well data, 5) run groundwater models, 6) quantify effects on groundwater, and 7) prepare outreach materials and provide workshops. This effort is supported by two key persons from the Pacific Northwest Regional Office and partnerships with the Mid-Pacific Regional Office, Policy and Administration, and Texas A&M AgriLife Research.

NEPA and Policy groups can use the results to evaluate how their programs address this surface water-groundwater interaction. Workshop materials will be created as part of this research to share results. Projects considering lining as part of their water management strategy will include

case studies of how canal lining affected groundwater. The results will also be shared with other researchers conducing canal research projects and other interested groups.

Available Information and Data

The groundwater models, one developed by a state agency and the other by the U.S. Geological Survey, for the two case study areas are in use, so there is little to no risk in obtaining and using the groundwater models. Reclamation modeling staff have used these models and are already familiar with their operation. The data for the well analysis tool will come from the respective state sources for monitoring and production wells.

There is a risk of not having a long enough dataset after the canal lining to capture the full effect of the lining or appear in the well data analysis; this is one reason that long-term modeling is part of the total analysis. These two case study areas were selected partially due to their geology supporting fast-moving water that will minimize the chance of not including enough time to see the effect.

Estimated seepage rates provided by the water purveyor as justification for the canal lining will be used as inputs to the models.

Further Work

While the proposed research will help increase understanding of the surface water-groundwater effects of canal lining, there are many other research questions related to canal lining. The proposed research does not address the gaps in either understanding or describing the effects on ecological systems and wetland areas. Two topics that are outside of the scope of this research but are closely related are the change in the water quality of groundwater or return flows and canal recharge through seepage versus managed recharge sites.

Conclusions

This scoping literature review shows that additional research is needed to uniformly evaluate, communicate, and describe the secondary effects of canal lining to ecosystems and groundwater. In areas where the impacts are significant, there is a need for studies that quantify the effects of canal lining projects that reduce or eliminate seepage that provides water for ecosystems and groundwater recharge. Quantifying the effects of eliminating seepage through canal lining on groundwater supports Reclamation’s ability to manage water and resources more effectively. Reclamation is an agency whose evolving role includes managing a variety of water resources and the environmental impacts of those management decisions, and as such, the benefits of conservation may need to be balanced with potential impacts to the groundwater resource more so than in the past. This research will use modeling and other analytic tools in two case study locations in the Pacific Northwest Region to improve the understanding of canal lining impacts to groundwater.

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