RECLAMATION

Managing Water in the West

Funding Opportunity No. R22AS00023

WaterSMART:

Water and Energy Efficiency Grants for FY 20220

Phase 8 Upper Willard Canal Lining Construction Project

Submitted By:
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U.S. Department of Interior
Bureau of Reclamation

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Phase 8 Willard Canal Lining Construction Project"

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Applicant Info

Date: November 1, 2021

Applicant Name: Weber Basin Water Conservancy District (WBWCD)

City, County, State: Layton City, Davis County, Utah

Project Manager:

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Project Funding Request: Funding Group II, $2,000,000; Total Project Cost, $4,000,000

Project Summary

A one paragraph project summary that specifies the work proposed, including how funds will be used to accomplish specific project activities and briefly identifies how the proposed project contributes to accomplishing the goals of this FOA.

The Weber Basin Project (Project), which was aimed at developing and effectively utilizing the available water resources within the Weber River Basin Drainage, was constructed by the United States Bureau of Reclamation (Reclamation), and is currently administered, operated, and maintained by the Weber Basin Water Conservancy District. Through collaborative efforts in conducting a System Optimization Review (SOR) of all Project Facilities, the District and Reclamation identified the Willard Canal as a source of potential significant water loss due to canal seepage. With the canal seepage losses in the upper 5,000 to 7,000 linear feet (LF) of the Willard Canal estimated to be as high as 15,600 acre-feet (AF) per year, mitigating these losses is now a top priority. Accordingly, the District is pleased to submit this application for the ***Phase 8 Upper Willard Canal Lining Construction Project*** to Reclamation in response to *Fiscal Year 2022 Funding Opportunity Announcement (FOA) No. R22AS00023: WaterSMART – Water and Energy Efficiency Grants*. The proposed project will result in 2,500 LF of the Willard Canal being lined with reinforced concrete. With an estimated total cost of $4,000,000 for environmental compliance and construction, and a projected water savings of 3,750 AF per year, the cost effectiveness of the proposed *Phase 8 Upper Willard Canal Lining Construction Project* equates to $1,066.67 per acre-foot, which is 82% less costly than current District rates for developing irrigation water. The project also includes installing a 30 kW solar array on the Weber South Water Treatment Plant (WTP) that will generate 58,000 kW-hr annually.

At the time of award, WBWCD will initiate conversation with Rocky Mountain Power on the construction of a 30 kW solar array at the Weber South WTP. However, construction on the solar array will also not begin prior to July 2022.

Length of Time and Estimated Completion Date

State the length of time and estimated completion date for the proposed project.

This project is ready to move forward as soon as it is awarded. An environmental document will be prepared as part of the project, and it is anticipated that a Categorical Exclusion will be approved based on the fact that the project will take place in previously disturbed areas. The environmental document will take two to six months. The installation of the lining will take 12 to 24 months and will take place during watering off season. It is expected to start October 2023 – April 2024 and again October 2024 - April 2025. The project will be completed within the required three-year time frame.

Federal Facility

Whether or not the project is located on a Federal facility.

In 1949, the Unites States Congress authorized the Weber Basin Project (Project), which was a U.S. Bureau of Reclamation (Reclamation) project aimed at developing and effectively utilizing the available water resources within the Weber River Basin Drainage. The Weber Basin Water Conservancy District was subsequently created in June of 1950 by a decree of the Second District Court of Utah and under the guidelines of the Utah Water Conservancy Act. The District is the operating agency for the Weber Basin Project and is responsible for the sale and delivery of project water, operation and maintenance of project facilities and is contracted with the U.S. Government for repayment of reimbursable costs of the Project.

Background Data

In 1949, the Unites States Congress authorized the Weber Basin Project (Project), which was a U.S. Bureau of Reclamation (Reclamation) project aimed at developing and effectively utilizing the available water resources within the Weber River Basin Drainage. The Weber Basin Water Conservancy District (District) was subsequently created in June of 1950 by a decree of the Second District Court of Utah and under the guidelines of the Utah Water Conservancy Act. The District was established as the legal agency representing the people of the five-county area within the Weber River Basin Drainage, including Davis, Morgan, Summit, Weber, and (a portion of) Box Elder counties. The District entered into a repayment contract with the United States in 1952 to repay all Weber Basin Project costs, and to administer the sale and delivery of Project water and to operate and maintain Project facilities, which it continues to do today.

The Project was planned to conserve and utilize available flows from the natural drainage of the Weber River, including those from the Ogden River, its principal tributary. Although Reclamation-owned Project water rights also include both groundwater rights and surface water rights on many of the smaller streams along the Wasatch Front, the vast majority of water made available through Project water rights and facilities is from excess flows on the Weber and Ogden Rivers, and the subsequent storage of those flows in storage reservoirs. A map depicting the extent of the District's service area and Weber Basin Drainage can be seen in Figure 1.

Figure 1. Geographic Extent of the Weber Basin Water Conservancy District

In October of 2008, the District received partial funding through collaboration with Reclamation to perform a System Optimization Review (SOR). The scope of the SOR entailed examining the District's entire water distribution system for the purpose of identifying water distribution efficiency and water marketing opportunities. As a result of conducting this SOR, the Willard

Canal was identified as a high priority project due to the estimated amount of water being lost through seepage in the canal each year.

The estimated water loss was calculated by performing field investigations, sampling, and laboratory testing of the Willard Canal to determine the type and condition of the existing clay liner, material permeability rates, stratigraphic data, etc., to ultimately determine seepage rates. Empirical data from several published sources, including Reclamation reports, were then used to estimate water losses based on the observed findings of the field investigations. A summary of these analyses is given in Attachment A.

Through these analyses, it was determined that "…a disproportionate 54-62% of the total (water) volume lost is lost within the first 10-14% (5,000-7,000 feet) of the canal length". Based on these findings, the District is pleased to submit this proposal for the Phase 8 Upper Willard Canal Lining Construction Project.

Project Location

Geographic Location

The Phase 8 Willard Canal Lining Construction Project is located in Weber County in Utah, approximately 3 miles northwest of Ogden. The project latitude and longitude are -112.016, 41.277 degrees. The proposed project is illustrated in the figure below.

The Weber South WTP is located in Ogden, Utah at 41.176, -111.944.

Figure 2. Willard Canal Lining Projects and Proposed Design

Technical Project Description

Describe the work in detail, including specific activities that will be accomplished. This description shall have sufficient detail to permit a comprehensive evaluation of the proposal.

Project Scope of Work

The District has not yet generated final construction drawings for the project. These documents will include design for concrete lining of the upper Willard Canal beginning at the end of the 7th phase at 1275 North in Farr West, Utah and extending approximately 300 feet under I-15 to 2000 West and an additional 600 feet west of 2000 West in Farr West, Utah (**See Figure 2**). This design will include the following design components:

- Reestablishment of the canal's trapezoidal geometry using existing material on site as well as import material as needed in select areas;
- Installation of 6-inch minus granular material for subgrade stabilization as required;
- Installation of free draining 1-inch minus drain rock, non-woven filter fabric, and perforated HDPE pipe all utilized to augment existing underdrains and prevent increased water pressures that result from natural fluctuations in the groundwater table, or resulting ice, from heaving the concrete liner;
- Canal Liner consisting of 6-inch reinforced concrete along the cross section of the canal prism. Freeboard has been as per Reclamation Standards for the design flow. Construction and expansion joints will include water stops.

The following scope of work outlines the tasks that will be provided for Phase 8 of the Willard Canal Lining Project.

Project Tasks

The following scope of work outlines the tasks that will be provided for the proposed project.

Schedule: October 2022-February 2023

Task 1: Final Design of the Phase 8 Willard Canal Lining. The District will retain a professional engineering consulting firm to assist the District in preparing the final design and construction documents for the construction portion of the project.

Task 2: Bidding and Contractor Selection. The District, with assistance from the Consulting Engineer, will prequalify General Contractors, provide only those Contractors that are approved to perform the work with bid documents, and solicit bids from them for all construction services associated with installation of the concrete liner and ancillary equipment.

Task 3: Construction of Concrete Liner. This task will include installation of a new steel reinforced 6" thick concrete liner on the Willard Canal from the termination of the Phase 7 Project at 1275 North in Farr West. This segment comprises approximately 2,500 LF, or approximately 5% of the entire Willard Canal.

Incorporated as part of this project is the construction of a 30 kW solar array at WBWCD's Weber South Water Treatment Plant (WSWTP). The proposed solar array will provide approximately 58,000 kW-hr of energy per year.

Project Approach

The District intends to work with consultants that have been utilized on past phases to cost effectively move this project forward. To date the District has completed six phases of lining projects in the upper sections of the Willard Canal (approximately 15,400 feet), with an additional phase scheduled to be completed in 2022. As a result of these efforts the District has already established relationships with design consultants that understand the complexities and requirements associated with this project. This relationship provides both a cost and time efficiency that would not be available without the past projects. This phase is not expected to differ significantly from past phases and by utilizing the knowledge already obtained in past projects this phase is anticipated to be very cost effective.

E.1. Technical Proposal: Evaluation Criteria

E.1.1. Evaluation Criterion A – Quantifiable Water Savings (30 Points)

Quantifiable Water Savings

Describe the amount of estimated water savings. For projects that conserve water, please state the estimated amount of water expected to be conserved (in acre-feet per year) as a direct result of this project.

Based on the results of a seepage analysis, up to 15,600 AF of water is lost through seepage in the uppermost 5,000 to 7,000 LF of the Willard Canal. Through installation of a 6" thick steel reinforced concrete liner, the *Phase 8 Upper Willard Canal Lining Project* will result in a water savings of 3,750 AF/yr.

Describe current losses. Explain where the water that will be conserved is currently going (e.g., back to the stream, spilled at the end of the ditch, seeping into the ground).

It has been assumed that the average annual water savings resulting from the proposed project will be equal to the current canal seepage losses of 2.0 AF/LF of canal, (refer to calculation in the District's response to the FOA question pertaining to how seepage losses are determined below, and supporting Attachment A). The proposed project will comprise a total of 2,500 LF.

Therefore, the water loss for this stretch of the canal can be calculated to be 2,500 LF x 2.0 AF/LF = 5,000 AF per year.

Describe the support/documentation of estimated water savings. Provide sufficient detail supporting how the estimate was determined, including all supporting calculations.

It has been assumed that the average annual water savings resulting from the proposed project will be equal to the current canal seepage losses of 2.0 AF/LF of canal, (refer to calculation in the District's response to the FOA question pertaining to how seepage losses are determined below, and supporting Attachment A), multiplied by the effectiveness of the newly installed concrete liner. The proposed project will comprise a total of 2,500 LF. Therefore, the water loss for this stretch of the canal can be calculated to be 2,500 LF x 2.0 AF/LF = 5,000 AF per year. Conservatively assuming a liner effectiveness of only 75% (refer to the District's response to the FOA question pertaining to post–project seepage losses below, and supporting Attachment C), the estimated average annual water savings resulting from the *Phase 8 Upper Willard Canal Lining Project* will be:

5,000 AF/year x 75% liner effectiveness = 3,750 AF per year

Canal Lining/Piping

a. How has the estimated average annual water savings that will result from the project been determined? Please provide all relevant calculations, assumptions, and supporting data.

It has been assumed that the average annual water savings resulting from the proposed project will be equal to the current canal seepage losses of 2.0 AF/LF of canal, (refer to calculation in the District's response to the FOA question pertaining to how seepage losses are determined below, and supporting Attachment A), multiplied by the effectiveness of the newly installed concrete liner. The proposed project will comprise a total of 2,500 LF. Therefore, the water loss for this stretch of the canal can be calculated to be 2,500 LF x 2.0 AF/LF = 5,000 AF per year. Conservatively assuming a liner effectiveness of only 75% (refer to the District's response to the FOA question pertaining to post–project seepage losses below, and supporting Attachment C), the estimated average annual water savings resulting from the *Phase 8 Upper Willard Canal Lining Project* will be:

5,000 AF/year x 75% liner effectiveness = 3,750 AF per year

b. How have average annual canal seepage loses been determined? Have ponding and/or inflow/outflow tests been conducted to determine seepage rates under varying conditions? If so, please provide detailed descriptions of testing methods and all results. All estimates should be supported with multiple sets of data/measurements from representative sections of canals.

The District has conducted a detailed seepage analysis of the Willard Canal, which can be found in the District's SOR and is enclosed in Attachment A. The methods used to estimate canal water losses were as follows:

i. Research was conducted to ascertain canal lining techniques used by other Districts in the Western United States;
ii. Canal system design and maintenance information was reviewed and analyzed by a Geotechnical firm with experience in canal design;
iii. Borings were placed along the entire alignment of the Willard Canal;
iv. Piezometers were installed at aforementioned boring locations to determine water table levels and fluctuations with respect to canal water levels;
v. Samples of canal lining materials were taken along the entire alignment of the canal;
vi. Data collected were analyzed and compared to published reports; and
vii. Operational measurements from existing system operations records were considered.

From this analysis, it is estimated that anywhere from 12,880 AF to 15,600 AF per year is lost to seepage through the southernmost 5,000-7,000 LF of the Willard Canal. Using an average value of 14,240 AF per year through 7,000 LF of canal, it can be inferred that:

Seepage Loss = 14,240 AF/7,000 LF = 2.0 AF/LF of canal

c. What are the expected post-project seepage/leakage losses and how were these estimates determined? (e.g., can data specific to the type of material being used in the project be provided)?

The District has utilized the results of Reclamation Project "R-00-01: CANAL LINING DEMONSTRATION PROJECT 2000 SUPPLEMENTAL REPORT" to derive post project leakage estimates. A portion of this report up to and including the Executive Summary and relative conclusions, can be found in Attachment C.

This report states for the project area studied that a complete prism concrete lining method should be 70% to 85% effective. A conservative value of 75% effectiveness is used to reduce the water savings estimates in the seepage analysis contained in Attachment A.

d. What are the anticipated annual transit loss reductions in terms of acre-feet per mile for the overall project and for each section of canal included in the project?

Transit losses generally consist of seepage, spillage, and evaporation. Seepage losses have already been estimated as described above, using a conservative 75% effectiveness rating for the new concrete liner. Spillage and evaporation will not be greatly impacted by the project, as the original geometry of the existing unlined canal will be utilized. Although the canal may operate at a reduced depth due to increased hydraulic efficiency, and the area of atmospheric

exposure will therefore be reduced slightly, evaporation will not be reduced significantly from what it has historically been. Additionally, there are no turnouts or other diversions in the stretch proposed to be lined that would be improved substantially which would contribute to reduce spillage. Therefore, with the exception of the aforementioned reduction in seepage, there will be no significant change in transit losses that would translate into additional water loss (or savings).

e. How will actual canal loss seepage reductions be verified?

Actual losses will be measured as outlined in the Technical Project Description (Section 1.C, paragraph 2). Specifically, flow measurements will be collected and recorded by the District at each end of the proposed project, both before and after installation of the concrete liner. This will be accomplished using a portable ADCP meter as manufactured by Teledyne Instruments for their StreamPro Meter (which the District has already acquired for the Phase 1 and Phase 2 Upper Willard Canal Lining and Water Marketing Projects). The resulting data will allow the District to accurately document actual canal leakage for both the current condition and the post-lining condition. In this way, accurate measures of water savings will be determined and documented. Actual measured water savings will then be available for water marketing.

f. Include a detailed description of the materials being used.

The project will use materials consistent with previous canal lining projects that the District has already completed or are underway, which were partially funded through previously received WaterSMART Grants. Specifically:

i. The Willard Canal will be thoroughly cleaned and restored to a trapezoidal geometry using mostly in-situ material, with some infill possibly needed in selected areas;

ii. Granular 6” minus material may be used for subgrade stabilization as required. Free draining 1” minus drain rock, non-woven filter fabric, and perforated HDPE pipe will be used to augment underdrains and prevent pore water pressures resulting from natural fluctuations in the groundwater table, or resulting ice, from heaving concrete liner; and

iii. The canal liner will consist of reinforced concrete, with a thickness of 6” along the cross section of the canal prism. Freeboard will be as per Reclamation Standards for the design flow. Construction and expansion joints will include water stops. Construction cost estimate data can be found in Attachment D. Please note that the District used the *average* of construction bids received for the Phase 1 Upper Willard Canal Lining and Water Marketing Project, and the most recent cost for Consulting Engineering design and construction services, which was received for the Phase 2 Upper Willard Canal Lining and Water Marketing Project (2012).

- **Subcriterion No. A.2 – Percentage of Total Supply:** Using the formula found in the FOA:

$$\textbf{\textit{Percentage of Total Supply}} = \frac{\mathbf{3,750\ \textit{AF/yr saved}}}{\mathbf{277,265\ \textit{AF/yr available}}} = \mathbf{1.4\%}$$

The water savings achieved by the proposed *Phase 8 Upper Willard Canal Lining Project* amount to savings of approximately 1.4% of the total water supply across the entire five-county area served by the District. However, it should also be noted that the water savings is a much greater percentage of the total amount of water conveyed by the Willard Canal in an average year.

- **Subcriteria No. A.3 – Reasonableness of Costs:** Using the formula found in the FOA:

$$\textbf{\textit{Cost Resonableness}} = \frac{\mathbf{\$4,000,000}}{\mathbf{3,750\ \textit{AF/yr}}} = \frac{\mathbf{\$1,066.67}}{\textbf{\textit{AF/yr}}}$$

From the most recent water rate analysis, the District estimates the cost per acre-foot to develop untreated water is $5,902.78. Compared to this rate for untreated water; the proposed *Phase 8 Upper Willard Canal Lining Project* is extremely cost effective.

E.1.2. Evaluation Criterion B – Renewable Energy (20 Points)

The extent to which the project increases the use of renewable energy or otherwise results in increased energy efficiency and reduced greenhouse gas emissions:

E.1.2.2 Subcriterion No. B.2: Increasing Energy Efficiency in Water Management

- *Describe any efficiencies that are expected to result from implementation of the water conservation or water efficiency project.*
  - *If quantifiable energy savings is expected to result from the project, please provide sufficient details and supporting calculations. If quantifying energy savings, please state the estimated amount in kilowatt hours per year.*

    The proposed project includes the construction of a 30 kW solar array at WBWCD's Weber South Water Treatment Plant (WSWTP). The proposed solar array will provide approximately 58,000 kW-hr of energy per year. This power will be used to offset energy demand that is used to operate various equipment at the WSWTP that is used to treat surface water to EPA drinking water standards.

  - *How will the energy efficiency improvement combat/offset the impacts of climate change, including an expected reduction in greenhouse gas emissions?*

    The ability for the District to utilize power less often will help mitigate climate pollution in as much as energy costs would be reduced.

- *If the project will result in reduced pumping, please describe the current pumping requirements and the types of pumps (e.g., size) currently being used. How would the proposed project impact the current pumping requirements and energy usage?*
  Not applicable.

- *Please indicate whether your energy savings estimate originates from the point of diversion, or whether the estimate is based upon an alternate site of origin.*
  The energy savings originates at the point of origin.

- *Does the calculation include any energy required to treat the water, if applicable?*
  Not applicable.

- *Will the project result in reduced vehicle miles driven, in turn reducing greenhouse gas emissions? Please provide supporting details and calculations.*
  The project will not result in reduced vehicle miles driven.

- *Describe any renewable energy components that will result in minimal energy savings/production (e.g., installing small-scale solar as part of a SCADA system).*
  The proposed solar array will operate year round and will provide approximately 58,000 kW-hr of energy annually.

E.1.3. Evaluation Criterion C – Sustainability Benefits (20 Points)

Address a specific water and/or energy sustainability concerns, including enhancing drought resilience, addressing the current and future impacts of climate change, and resolving water related conflicts in the region. In addition, this criterion is focused on the benefits associated with the project, including benefits to tribes, ecosystem benefits, and other benefits to water and/or energy supply sustainability.

Enhancing Drought Resiliency

- *Does the project seek to improve ecological resiliency to climate change?*
  Planning for the impacts to our water supply and water demand as a result of a changing climate is critical to ensuring sustainability and resiliency. Studies completed specific to WBWCD's service area show that the impacts of the changing climate will reduce streamflow, shift runoff timing, and increase demand for water. Precipitation patterns in Utah are shifting towards more rain and less snow. Temperatures have increased steadily over the last 50 years.

  Conservation can help stretch existing supply sources and improve the ability to meet water needs as the climate changes. The water savings identified as a result of the lining the canal, substantiate this project's ability to stretch the existing water supplies of our drainage and facilitate greater mitigation measures as the impacts of a changing climate are realized.

- *Will water remain in the system for longer periods of time? If so, please provide details on current/future durations and any expected resulting benefits (e.g., maintaining water temperatures or water levels).*
  Reduced water loss will have immediate impacts on the source volumes within WBWCD's service area. These sources include several large reservoirs and wells that act to supply the region with its water needs as well as meet environmental obligations in the form of instream flows and deliveries to wildlife refuges.

- *Will the project benefit species (e.g., federally threatened or endangered, a federally recognized candidate species, a state listed species, or a species of particular recreational or economic importance)? Please describe the relationship of the species to the water supply, and whether the species is adversely affected by a Reclamation project or is subject to a recovery plan or conservation plan under the Endangered Species Act (ESA).*
  The water conserved from lining the canal leaves more water in the local streams and rivers to support the wildlife and habitats. The threatened species that are in the area, that will also benefit from having more water in the streams within the Weber Basin watershed are the Ute Ladies-tresses and Canada lynx.

- *Please describe any other ecosystem benefits as a direct result of the project.*
  Within the Weber River Watershed Plan of 2014, it says that "The goal of this plan is to recognize both the human and ecological values that the watershed provides and develop strategies to protect and enhance those values." Allowing for more water to remain in the Weber River, Echo, East Canyon and other reservoirs, recreational opportunities will be benefited, water quality will be improved, recreation fishing will be sustainable, and economic development will continue.

  In addition, WBWCD has completed a Drought Contingency Plan which identifies lining the Willard canal as a strategy to mitigate the impacts of drought. Lining the canal expands the capacity of the canal and makes more water available during drought years.

- *Will the project directly result in more efficient management of the water supply? For example, will the project provide greater flexibility to water managers, resulting in a more efficient use of water supplies?*
  Lining the next phase of the Willard Canal will allow for better water management to nearly 675,000 people. The water savings will provide greater flexibility to water managers allowing them to be more efficient in the use of the water supply.

Projects that are intended to improve streamflows or aquatic habit, and are requesting $500,000 or more in Federal funding, must include information about plans to monitor the benefits of the project. Please describe the plan to monitor improved streamflows or aquatic habit benefits over a five-year period once the project has been completed. Provide detail on the steps to be taken to carry out the plan.

The proposed project's primary goal is not to improve stream flows or aquatic habitat. Consequently, there are no plans to monitor the associated benefits in this nature. However, the water savings realized as a result of secondary meters being installed will be assessed on an annual basis similar to analysis' that have been performed on the 1,097 meters referenced in the Uintah Bench.

Addressing a specific water and/or energy sustainability concerns.

- *Explain and provide detail of the specific issues in the area that is impacting water sustainability, such as shortages due to drought and/or climate change, increased demand, or reduced deliveries.*

  Utah is the second driest state in the United States. As such, drought relief planning is an essential component of the Weber Basin Water Conservancy District's planning efforts.

  All of the water saved through this project may be used to meet rapidly increasing demands for water, particularly in western Weber County. This has never been more apparent than in 2021, when following one of the driest winters and then the hottest summer on record, decreed water rights on the Weber River system were cut to 1862 and earlier priority in July of 2021. This was the second time cuts of this magnitude have been made in the last 10 years, indicating an over-allocation of existing water within the basin and/or increased climate variability leading to drought conditions.

  The Phase 8 Upper Willard Canal Lining Project will address several water sustainability issues that have been identified as a high priority in the District's Master Plan. Through development of a water marketing mechanism for the additional 3,750 AF/yr or water to be saved, the District will be able to provide more water to wholesale customers in its five-county service area. Many of these customers are municipalities that have limited or no ability to develop new water sources themselves.

  In addition, the Phase 8 Upper Willard Canal Lining Project will also reduce the potential for water related conflict. The District serves one of the fastest growing regions in the Western United States, with the population of the region (and thereby the demand for water) expected to increase by 20-30% by 2025. Due to this rapid growth, there is an increasingly volatile balance between the demand for irrigation water, and the rapidly increasing demand for additional municipal and industrial (M&I) water, particularly in years of drought. By conserving an additional 3,750 AF per year, the Phase 8 Upper

Willard Canal Lining Project will contribute substantially to the District's conservation efforts and will help to alleviate potential future conflicts.

- *Explain and provide detail of the specific issues in the area that is impacting energy sustainability, such as reliance on fossil fuels, pollution, or interruptions in service.*
  The largest issue impacting energy sustainability is interruptions in service. The majority of the distribution system was completed in the 1950s and 1960s. Providing funding for this project will allow WBWCD to better afford its goal to conserve water as well as maintain and update their distribution system.

- *Please describe how the project will directly address the concerns stated above. For example, if experiencing shortages due to drought or climate change, how will the project directly address and confront the shortages?*
  Water supply will always be a limited source, and as such, it is vital that this resource is utilized efficiently. In the event of a drought, water conservation is of the upmost importance and lining the Willard canal allows WBWCD to make sure there is no wasted water through seepage.

- *Please address where any conserved water as a result of the project will go and how it will be used, including whether the conserved water will be used to offset groundwater pumping, used to reduce diversions, used to address shortages that impact diversions or reduce deliveries, made available for transfer, left in the river system, or used to meet another intended use.*
  The District will create a flexible water marketing legal structure which will allow this conserved water to be marketed. All of the water saved by constructing the proposed project can be marketed.

- *Provide a description of the mechanism that will be used, if necessary, to put the conserved water to the intended use.*
  Based on the results of water marketing investigations conducted thus far, as a component of the District's SOR, no limitations exist with regard to which types of users the water may be marketed to. Water saved as a result of this project will most likely be marketed using the existing legal structure in place for many of the District's secondary water customers, via water lease petitions. Other mechanisms, such as transfer agreements, will also be considered to identify the best approach to achieve water conservation objectives in the District's Water Conservation Plan.

- *Indicate the quantity of conserved water that will be used for the intended purposes.*
  For this project, the amount of estimated water savings is 3,750 acre-feet/year. This project will continue the lining process along the Willard Canal.

Other project benefits.

- *Please provide specific details and examples on how the project will address the impacts of climate change and help combat the climate crisis.*

  Planning for the impacts to our water supply and water demand as a result of a changing climate is critical to ensuring sustainability and resiliency. Studies completed specific to WBWCD's service area show that the impacts of the changing climate will reduce streamflow, shift runoff timing, and increase demand for water. Precipitation patterns in Utah are shifting towards more rain and less snow. Temperatures have increased steadily over the last 50 years.

  Conservation can help stretch existing supply sources and improve the ability to meet water needs as the climate changes. The water savings identified as a result of the lining the Willard Canal, substantiates this project's ability to stretch the existing water supplies of our drainage and facilitate greater mitigation measures as the impacts of a changing climate are realized.

- *Does the proposed project strengthen water supply sustainability to increase resiliency to climate change?*

  The large amount of water saved, estimated at 3,750 af/yr greatly strengthens water supply sustainability and allows for increased resiliency to climate change. This water savings will be most noted in years of drought, which the District has been in for the last 15 of 20 years (according to drought.gov).

- *Will the proposed project establish and utilize a renewable energy source?*

  The proposed project does establish a renewable energy source in the solar array that will be installed at the WSWTP. The solar array will produce 58,000 kW-hr of energy annually.

- *Will the project result in lower greenhouse gas emissions?*

  The proposed project will not result in lower greenhouse gas emissions.

Disadvantaged or Underserved Communities.

- *Does the proposed project directly serve and/or benefit a disadvantaged or historically underserved community?*

  No, the project will not serve a disadvantaged or historically underserved community.

- *If the proposed project is providing benefits to a disadvantaged community, provide sufficient information to demonstrate that the community meets the disadvantaged community definition, or the applicable state criteria for determining disadvantaged status.*

  Not applicable.

- *If the proposed project is providing benefits to an underserved community, provide sufficient information to demonstrate that the community meets the underserved definition.*
  Not applicable.

Tribal Benefits.

- *Does the proposed project directly serve and/or benefit a Tribe? Will the project increase water supply sustainability for an Indian Tribe? Will the project provide renewable energy for an Indian Tribe?*
  The project does not directly serve or benefit a Tribe.

- *Does the proposed project directly support tribal resilience to climate change and drought impacts or provide other tribal benefits such as improved public health and safety through water quality improvements, new water supplies, or economic growth opportunities?*
  The project does not directly support tribal resilience to climate change or drought.

Other Benefits.

- *Will the project assist States and water users in complying with interstate compacts?*
  No, the proposed project does not assist States in complying with interstate compacts.

- *Will the project benefit multiple sectors and/or users (e.g., agriculture, municipal and industrial, environmental, recreation, or others)?*
  Yes, lining Willard Canal will benefit the multiple sectors served by WBWCD. WBWCD serves a geographic are over 2,500 square miles that includes District-administered water contracts from primarily municipal, to industrial (M&I), to agriculture. Municipal use includes lawns and gardens, and agriculture use includes irrigation of row crops and pastures. WBWCD supplies residential customers with irrigation water in Davis and Weber counties via approximately 484 miles of pipelines, and also delivers irrigation water to many irrigators and farmers in Box Elder, Davis, Morgan, Summit, and Weber Counties. Considering its large service area, WBWCD supplies irrigation water to multiple environmental and recreation sectors, such as city parks, gardens, and other recreational and educational centers.

- *Will the project benefit a larger initiative to address sustainability?*
  Within the Weber River Watershed Plan of 2014, it says that "The goal of this plan is to recognize both the human and ecological values that the watershed provides and develop strategies to protect and enhance those values." Allowing for more water to remain in the Weber River, Echo, East Canyon and other reservoirs, recreational opportunities will be benefited, water quality will be improved, recreation fishing will be sustainable, and economic development will continue.

  In addition, WBWCD has completed a Drought Contingency Plan which identifies lining the Willard Canal as a strategy to mitigate the impacts of drought.

- *Will the project help to prevent water-related crisis or conflict? Is there frequently tension or litigation over water in the basin?*

  The proposed project will reduce the potential for water-related conflict. WBWCD serves one of the fastest growing regions in the Western United States, with the population of the region (and thereby the demand for water) expected to increase significantly by 2025. Due to this rapid growth, there is an increasingly volatile balance between the demand for irrigation water, and the rapidly increasing demand for additional municipal and industrial (M&I) water. Particularly in years of drought, the proposed project will substantially contribute to WBWCD's conservation efforts and will help to alleviate potential future conflicts.

E.1.4. Evaluation Criterion D – Complementing On-Farm Irrigation Improvements (10 Points)

If the proposed project will complement an on-farm improvement eligible for NRCS assistance, please address the following:

No, the proposed project does not compliment an on-farm improvement.

E.1.5. Evaluation Criterion E – Planning and Implementation (8 Points)

E.1.5.1 Subcriterion No. E.1: Project Planning

- *Does the applicant have a Water Conservation Plan and/or System Optimization Review (SOR) in place? Does the project address an adaptation strategy identified in a completed WaterSMART Basin Study?*

  Weber Basin Water Conservancy District has a water conservation plan that has been implemented, updated and submitted in 2018 to the Utah State Division of Water Resources as well as the Bureau of Reclamation (Provo Area Office). The District has also completed a System Optimization Review (SOR) for an overall planning and projecting of future water needs and demands. In addition, the WBWCD recently prepared a Drought Contingency Plan funded by Reclamation. This plan allows them to develop better understanding of the impact of drought and strategies to plan for sustainable water demands and water supplies as they continue to change. Within the Drought Contingency Plan, water conservation is an important action in mitigating the effects of future droughts.

- *Identify any district-wide, or system-wide, planning that provides support for the proposed project. This could include a Water Conservation Plan, SOR, Drought Contingency Plan or other planning efforts done to determine the priority of this project in relation to other potential projects.*

  The District SOR has identified canal lining and metering projects as the top two priorities. This application addresses canal lining projects. The District has also developed a water conservation plan that was most recently updated in 2018. Canal lining is one of the priority items listed in the District's water conservation plan. With

the development of the Drought Contingency Plan, WBWCD will be able to continue their goals of the SOR and water conservation plan and help them meet other goals of the State.

- *Describe how the project conforms to and meets the goals of any applicable planning efforts and identify any aspect of the project that implements a feature of an existing water plan.*

  The proposed project will assist WBWCD in meeting its conservation goal, which is also the State of Utah's goal of a 25 percent reduction in per capita use by 2025. Furthermore, WBWCD plans to meet 35 percent conservation by 2050. Conservation can be thought of as a future supply, because it delays the need for more costly water development projects.

  Prepare60, a center established by the four largest water conservancy districts, including WBWCD, focuses on protecting what Utah has, using it wisely, and providing for the future:

  Protect what we have
  - Repair and replacement of existing infrastructure
  - Watershed and water source protection

  Use it wisely
  - Water conservation – efficient use of a precious resource

  Provide for the future
  - New water sources and development of new infrastructure

  WBWCD strives to focus first and foremost on the "Use it wisely" initiative because it is the most effective and least costly way to create and maintain a safe, reliable, and sustainable water supply. In WBWCD's area, with current unmetered secondary water, the greatest potential for conservation comes with accountability and end user knowledge of how much they use. Data that is presented in the proposal also shows the conservation savings that will be achieved to benefit WBWCD and to benefit surrounding areas and other water purveyors to meet water conservation goals, environmental improvement goals, and energy reduction goals by reduced pumping costs.

- *If applicable, provide a detailed description of how a project is addressing an adaptation strategy specifically identified in a completed WaterSMART Basin Study or Water Management Options Pilot (e.g., strategy to mitigate the impacts of water shortages resulting from climate change, drought, increased demands, or other causes).*

  Within the Weber River Watershed Plan of 2014, it says that "The goal of this plan is to recognize both the human and ecological values that the watershed provides and

develop strategies to protect and enhance those values." Allowing for more water to remain in the Weber River, Echo, East Canyon and other reservoirs, recreational opportunities will be benefited, water quality will be improved, recreation fishing will be sustainable, and economic development will continue.

In addition, WBWCD has completed a Drought Contingency Plan which identifies lining Willard Canal as a strategy to mitigate the impacts of drought.

E.1.5.2 Subcriterion No. E.2: Readiness to Proceed

- *Identify and provide a summary description of the major tasks necessary to complete the project.*

  The project is ready to move forward as soon as it is awarded but will not begin prior to July 2022. The District is prepared to proceed with the Phase 8 Upper Willard Canal Lining Project immediately upon funding by Reclamation. The work plan as presented above in the Technical Project Description, Project Tasks, will be implemented.

- *Describe any permits that will be required, along with the process for obtaining such permits.*

  The project will be constructed entirely upon property that is owned in fee-simple title by Reclamation, and all improvements will remain in United States ownership. For this reason, there are no permits or approvals needed.

- *Identify and describe any engineering or design work performed specifically in support of the proposed project.*

  The District has performed thorough evaluations of the condition of the liner in the Willard Canal and used this information to estimate canal seepage rates. This information can be found in Attachment A.

- *Describe any new policies or administrative actions required to implement the project.*

  No new policies will be required to implement this project.

- *Please also include an estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates. Milestones may include, but are not limited to, the following: complete environmental and cultural compliance; mobilization; begin construction/installation; construction/installation 50% complete; construction/installation 100% complete.*

  The District is prepared to proceed with the Phase 8 Upper Willard Canal Lining Project immediately upon funding by Reclamation. The work plan as presented above in the Technical Project Description, Project Tasks, will be implemented. The installation of the solar array will take place within the first year of construction, between October 2023 and April 2024.

E.1.6. Evaluation Criterion F – Collaboration (6 Points)

Please describe how the project promotes and encourages collaboration. Consider the following:

- *Is there widespread support for the project? Please provide specific details regarding any support and/or partners involved in the project. What is the extent of their involvement in the process?*

  WBWCD and the cities in the proposed project area are in support of the project because it will promote conservation of water, decrease seepage into the ground and free up capacity in the Davis Aqueduct needed to meet peak demands.

  The proposed project will help move the state of Utah and WBWCD closer to their goal of 25 percent in reduced water use by 2025. A letter of support for WBWCD project includes Weber County, and can be found in Attachment E – Letter of Support.

- *What is the significance of the collaboration/support?*

  The District delivers water to private irrigation districts and individuals through the Willard Canal, and they are interested in the District's efforts to improve the efficiency of the infrastructure that delivers the water. The District has placed emphasis on water savings through improvement projects such as these and places a high priority on the accountability of water at the user level. Lining Willard Canal will support the efforts of the District and surrounding irrigation districts as they strive to be water-wise.

- *Will this project increase the possibility/likelihood or future water conservation improvements by other water users?*

  As is seen in the letter of support (Attachment E), other water users like Weber County, recognize the importance of water conservation. The water saved through these improvement projects will provide benefit to water users and the regional environment. Therefore, there is the possibility of future water conservation from other water users as they continue to observe the positive benefits from completing these improvement projects.

- *Please attach any relevant supporting documents (e.g., letters of support or memorandum of understanding).*

  A letter of support for WBWCD project includes Weber County, which can be found in Attachment E – Letter of Support.

E.1.8. Evaluation Criterion G – Additional Non-Federal Funding (4 Points)

State the percentage of non-federal funding provided using the following calculation: Non-Federal Funding divided by Total Project Cost.

$$\frac{Non-Federal\ Funding}{Total\ Project\ Cost} = \frac{\$2{,}000{,}000}{\$4{,}000{,}000} = \mathbf{50\%}$$

E.1.7. Evaluation Criterion H – Nexus to Reclamation Project Activities (4 Points)

Describe the nexus between the proposed project and a Reclamation project or Reclamation activity. Please consider the following:

- *Does the applicant have a water service, repayment, or O&M contract with Reclamation?*
  No. The District's repayment plan was completed in 2017.

- *If the applicant is not a Reclamation contractor, does the applicant receive Reclamation water through a Reclamation contractor or by any other contractual means?*
  The Weber Basin Water Conservancy District was created in June of 1950 by a decree of the Second District Court of Utah and under the guidelines of the Utah Water Conservancy Act. The District is the operating agency for the Weber Basin Project and is responsible for the sale and delivery of project water, operation and maintenance of project facilities and is contracted with the U.S. Government for repayment of reimbursable costs of the Project, as orchestrated by the Bureau of Reclamation.

- *Will the proposed work benefit a Reclamation project area or activity?*
  The proposed project is directly related to Reclamation activities, since the water supplying the project service area is part of the Weber Basin Project. Much of the infrastructure, pumping, and other activities are connected to Reclamation-owned land, facilities, and infrastructure that the District operates to provide the water where needed.

- *Is the applicant a Tribe?*
  No.

Performance Measures

Provide a brief summary describing the performance measure that will be used to quantify actual benefits upon completion of the project (e.g., water saved or better managed, energy generated or saved).

Actual losses will be measured as outlined in the Technical Project Description. Specifically, flow measurements will be collected and recorded by the District at each end of the proposed project, both before and after installation of the concrete liner. This will be accomplished using a portable ADCP meter, which the District has already acquired for previous projects. The resulting data will allow the District to accurately document actual canal leakage for both the current condition and the post-lining condition. In this way, accurate measures of water savings will be determined and documented. Actual measured water savings will then be available for water marketing.

The energy produced by the solar array will be metered. The metered output will be recorded monthly and compared to the estimation of power generated in this application.

Project Budget

Funding Plan and Letters of Commitment

Describe how the non-Federal share of project costs will be obtained.

Identify the sources of the non-Federal cost share contribution for the project, including:

- *Any monetary contribution by the applicant towards the cost-share requirement and source of funds (e.g., reserve account, tax revenue, and/or assessments)*

  The District will fund the project through a combination of proceeds from bonds and current operating revenues.

- *Any costs that will be contributed by the applicant*

  N/A

- *Any third-party in-kind costs (i.e., goods and services provided by a third party)*

  N/A

- *Any cash requested or received from other non-Federal entities*

  N/A

- *Any pending funding requests (i.e. grants or loans) that have not yet been approved, and explain how the project will be affected if such funding is denied*

  N/A

In addition, identify whether the budget proposal includes any project costs that have been or may be incurred prior to award. For each cost, describe:

- *The project expenditure and amount*

  N/A

- *The date of cost incurrence*

  N/A

- *How the expenditure benefits the Project*

  N/A

Budget Proposal

Table 1 - Total Project Cost Table

Source	Amount
Costs to be reimbursed with the requested Federal funding	$2,000,000
Costs to be paid by the applicant	$2,000,000
Value of third party contributions	$0.00
Total Project Cost	**$4,000,000**

Table 2 - Budget Proposal

Budget Item Description	Computation		Quantity Type	Total Cost
	$/Unit	Quantity		
Salaries and Wages				**$0.00**
Fringe Benefits				**$0.00**
Equipment				**$0.00**
Supplies and Materials				**$0.00**
Contractual /Construction				**$4,000,000**
Engineering & Construction Services	$3,900,000	1	LS	$3,900,000
Solar Array at WSWTP	$60,000	1	LS	$60,000
Environmental and Regulatory Compliance (1% of total)	$40,000	1	EA	$40,000
Third-Party In-Kind Contributions				**$0.00**
Other				**$0.00**
Total Direct Costs				**$4,000,000**
Indirect Costs				**$0.00**
Type of rate	Percentage	$base		$0.00
Total Estimated Project Costs				**$4,000,000**

Budget Narrative

Phase 6A in the Willard Canal Lining Project has been completed and the construction bid tabulation was used as the basis for determining the cost estimate for constructing Phase 8. The construction bid tabulation can be seen in Attachment D. Phase 6A was for the installation of 2,000 feet of canal. This results in a cost of $900.62/foot. Current estimates for Phase 7 place the cost per foot around $1,300, which is a 44% cost increase. Construction for Phase 7 is scheduled to take place in the fall of 2022. Therefore, in addition to the final costs in Phase 6A, Phase 8 includes a 29% inflation (to account for the 2018 construction for Phase 6A and the

2023 construction for Phase 8) and a 44% cost increase, resulting in an additional 73% to account for the inflation rates and other construction and materials expenses.

$900.62/ft x (1 + 73%) = $1,560

$1,560/ft x 2,500 ft = $3,900,000

Salaries and Wages

No WBWCD Salaries or Wages will be included. All services will be contracted. WBWCD's staff time will be over and above the cost of the project and will not be counted toward the project cost.

Fringe Benefits

No fringe benefits will be required.

Travel

No travel will be required.

Equipment

There will be no new equipment purchased for the proposed project. The District already has acquired or will acquire the necessary equipment through previous projects. As such, this equipment is not reimbursable under the currently proposed project.

Materials and Supplies

Itemizations of construction by major category, unit price, quantity, and purpose, such as whether the items are needed for office use, research, or construction is provided in Attachment D. The District is not asking for reimbursement of any office supplies.

Contractual

The total project design and construction budget is $4,000,000.

Third-Party In-Kind Contributions

No third-party in-kind contributions will be part of the project.

Environmental and Regulatory Compliance Costs

Environmental costs are expected to be very minimal, as all work is done in the existing canal right of way in the immediate vicinity and/or directly in the location of the existing canal. However, as instructed in Paragraph IV.D.4 of the FOA, a cost of no less than 1% of the total project budget is allocated for environmental and regulatory compliance costs.

Although this is the amount that will be budgeted for in the financial assistance agreement between Reclamation and the District, it is anticipated that if any portion of the funds budgeted for environmental and regulatory compliance are not required for compliance activities, such funds may be reallocated to the project, if appropriate.

Other Expenses

No other expenses will be part of the project.

Indirect Costs

No indirect costs will be part of the project.

Total Costs

WBWCD Portion: $2,000,000 Fed Portion: $2,000,000 Total: $4,000,000

Environmental and Cultural Resources Compliance

Will the proposed project impact the surrounding environment (e.g., soil [dust], air, water [quality and quantity], animal habitat)? Briefly describe all earth-disturbing work and any work that will affect the air, water, or animal habitat in the project area. Explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.

The project will require a moderate level of earth work. However, this entire earthwork is within the existing canal right of way. Animal habitats will not be negatively impacted.

Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area? If so, would they be affected by any activities associated with the proposed project?

WBWCD is not aware of any impacts concerning threatened or endangered species in this area.

Are there wetlands or other surface waters inside the project boundaries that potentially fall under CWA jurisdiction as "Waters of the United States?" If so, please describe and estimate any impacts the proposed project may have.

No wetlands are in the project boundaries.

When was the water delivery system constructed?

The original District/Reclamation Project began in the late 1950s and continued over several year periods in the early 1960s. Since then, additional infrastructure with conveyance canals and pipes have been added to meet the growing population water needs.

Will the proposed project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously.

Yes, the primary modifications will be canal lining. No other modifications or effects thereof are anticipated. The 30 kW solar array will be located on an existing building at the Weber South Water Treatment Plant.

Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.

WBWCD is not aware of any building, structures or features that would be impacted or would qualify. A cultural resource inventory will be completed as part of the submitted environmental document.

Are there any known archeological sites in the proposed project area?

WBWCD is not aware of any impacts to any archeological sites. An archeological resource inventory will be completed as part of the submitted environmental document.

Will the proposed project have a disproportionately high and adverse effect on low income or minority populations?

The project will not require a right-of-way or relocations from adjacent properties and will have no impact on residential uses within the study area.

Will the proposed project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands?

No.

Will the proposed project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?

No.

Required Permits or Approvals

Applicants must state in the application whether any permits or approvals are required and explain the plan for obtaining such permits or approvals.

The project will be constructed entirely upon property that is owned in fee-simple title by Reclamation, and all improvements will remain in United States ownership. For this reason, there are no permits or approvals needed.

Rocky Mountain Power will need to approve the proposed solar array at the WSWTP. A building permit may be required for the installation. WBWCD will work with Ogden City to obtain all necessary approvals and permits.

Letters of Project Support

Include letters from interested stakeholders supporting the proposed project.

Letters of support from the following entities are included in Attachment E – Letter of Support:

» Weber County – Gary Myers, County Engineer

Official Resolution

Include an official resolution adopted by the applicant's board of directors or governing body. The official resolution may be submitted up to 30 days after the application deadline.

This resolution has been approved by the District's Board of Trustees and is included at the end of this application in Attachment F.

Attachment A – Willard Canal Leakage Analysis

February 15, 2011

Mr. John Masek
Weber Basin Water Conservatory District
2837 East Highway 193
Layton, UT 84040

Phase 2 Canal Seepage Assessment
Willard Canal
Weber and Box Elder Counties, Utah

Mr. Masek:

Intermountain GeoEnvironmental Services, Inc. (IGES) has performed additional field investigation, sampling, laboratory testing and seepage assessment for the 10 mile stretch of the Willard Canal maintained and operated by the Weber Basin Water Conservancy District (District). This work was intended to supplement the findings of our 2009 subsurface investigation and liner sampling of the canal in order to better quantify the performance of the canal liner. Our liner sampling was performed at an additional 12 locations within the partially empty canal (see Figure A-1). Sample locations were selected to fill in gaps between the 10 locations sampled in 2009. The locations were spaced along the entire length of open canal starting at the Slaterville Diversion Dam and ending near Willard Bay in Box Elder County. Our field services and analysis were performed in accordance with our proposal dated January 27, 2010. This letter provides a summation of field work, laboratory testing, and seepage modeling.

CANAL OBSERVATIONS

Sampling and observation of the canal liner in 2009 was complicated by the presence of approximately 7-8 feet of water in the canal during our field investigation. Under the circumstances sample quality was relatively good, but an accurate representation of the existing channel cross section was not available or easily obtainable.

For a period of time in early February 2010 flow was not actively diverted into the Willard Canal from either the Weber River or Willard Bay. Our field investigation was scheduled and performed between February 3rd and 5th, 2010. Due to the relatively flat bottom slope of the canal, ponded water (up to 3 feet deep) and some ice (up to 1.5 feet thick) was encountered at sampling locations throughout the canal. These conditions limited measurement/documentation of canal bottom conditions. For most of the northern portions of the canal (10-6 through 10-12) snow was also present (up to 0.5 feet deep) on top of ice and on the canal side slopes limiting observation of liner conditions on the side slopes of the channel as well.

CROSS-SECTION SURVEY

In order to document the existing ground surface profile, IGES retained the services of a professional land surveyor. A surveyed cross section (ground surface or top of ice) was obtained at seven of the twelve sampling locations. The remaining five were not surveyed because of a scheduling conflict which prevented the surveyors from returning to the site prior to the canal being charged on February 5th. This survey data was combined with field measurements of ice thickness, water depth, liner thickness, laboratory measured permeability rates and previously obtained subsurface stratigraphic data (IGES, 2009) to create seepage models for each canal cross section. The estimated water level (7-8 feet) for the canal cross section(s) carrying 1,150 cfs corresponded with the liner deformation (sidewall sloughing) observed and measured by the surveyors.

LINER SAMPLING

Attempts were made to obtain at least one undisturbed sample of liner material at each of the 12 locations explored in this investigation; additional disturbed samples were collected for correlation of permeability testing results based on index testing of both sample types. The existing liner thickness was probed in the vicinity of collected samples using rebar. For simplicity in identifying sample locations at each cross section they have been identified as Left Bank, Center, and Right Bank. The following tables provide a summary of the estimated liner thickness encountered at each section; additional detail and observations about the sections are included in Appendix B.

10-1

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
		Left Bank	Center	Right Bank
4,565,630	415,209	1.17	1.17	1.17

10-2

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
		Left Bank	Center Bank	Right Bank
4,567,655	415,177	1.0	1.0	1.0

10-3

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
		Left Bank	Center	Right Bank
4,569,170	415,118	1.0	1.17-1.5	1.0

10-4

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
		Left Bank	Center	Right Bank
4,570,134	414,751	0.67	1.5 - 2.0	0.67

10-5

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
		Left Bank	Center	Right Bank
4,570,431	414,302	1.0	2.0	1.0

10-6

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
		Left Bank	Center	Right Bank
4,571,011	413,637	0.5	2.0	0.67

10-7

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
		Left Bank	Center	Right Bank
4,569,170	415,118	0.5	2.0	1.0

10-8

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
		Left Bank	Center	Right Bank
4,573,337	413,427	0.5 - 0.67	2.0	0.5 - 0.67

10-9

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
		Left Bank	Center	Right Bank
4,574,664	413,385	0.5 - 0.67	2.0 - 2.5	0.67

10-10

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
4,575,306	413,325	Left Bank	Center	Right Bank
		No Sample	2.5	3.0

10-11

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
4,576,184	413,275	Left Bank	Center	Right Bank
		Rip Rap*	2.0**	Rip Rap*

* unable able to probe through gravel/cobbles (rip-rap) or excavate through frozen soils with hand tools, did not reach top of liner.
** pushed through 2' of soft material, but could not keep in Shelby tube.

10-12

Sampling Location				
Northing (m)	Easting (m)	Approximate Liner Thickness (ft)		
4,577,228	412,331	Left Bank	Center	Right Bank
		1.0	2.0	1.0

Photographs of sampling locations and the conditions encountered are contained in Appendix B.

The photographs show that during our 2010 investigation, while the canal was not under normal operational water levels, it was also not completely drained. Water, ice and snow obscured the canal/liner surface at the majority of our investigation locations. At the two southernmost locations (10-1 & 10-2) most of the canal cross section was visible and showed that liner soils were not uniformly distributed through the canal in these areas. Samples were collected and liner thickness measured from visible liner soils; however, streams flowing around liner "islands" indicated that little or no liner soils were present in portions of the southern reaches of the canal. This corresponds with our 2009 sampling in the southern reaches of the canal (locations 09-1 and 09-2) where respective liner thickness of 0 and 3 inches were measured.

LABORATORY TEST RESULTS

As mentioned previously general index and soil permeability tests were performed on samples collected during our field investigation. The following table provides a summary of the laboratory testing performed.

SAMPLE LOCATION	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE CONTENT %	GRADATION (%)			ATTERBERG LIMITS		PERMEABILITY	
Point No.			Gravel +#4	Sand	Silt and Clay -#200	Liquid Limit	Plasticity Index	(cm/s)	(ft/yr)
10-1 C		32.3	0	85.8	14.2	48	18	2.30E-05	2.38E+01
10-1 R									
10-1 L			0.6	45.1	54.3	34	7		
10-2 C			17.9	31.5	50.6	NP	NP	5.60E-04	5.79E+02
10-2 R					34.3	20	5		
10-2 L									
10-3 C		17.7							
10-3 R									
10-3 L			40.6	32.2	27.2	NP	NP		
10-4 C	91.7	23.9			1	NP	NP		
10-4 R					46.4	25	8		
10-4 L									
10-5 C		23.7	0.6	93.8	5.6	24	7	1.30E-04	1.35E+02
10-5 R									
10-5 L			20.2	38.3	41.5	19	3		
10-6 C	89.9	30.6			33.6	NP	NP		
10-6 R			13.1	38.6	48.3	21	5		
10-6 L									
10-7 C									
10-7 R									
10-7 L		20.1			40.8	21	7		
10-8 C	86	32.7			33.8	NP	NP		
10-8 R			7	50.9	42.1	18	3		
10-8 L									
10-9 C		29.5	-	81.2	18.8	NP	NP	1.20E-04	1.24E+02
10-9 R									
10-9 L					59.7	23	8		
10-10 C	88.4	32.6			32.1	NP	NP		
10-10 R					37.5	NP	NP		
10-10 L									
10-11 C	No sample								
10-11 R			88	10.5	1.5	NP	NP		
10-11 L	No sample								
10-12 C		49.8	-	36.4	63.6	34	12	1.00E-04	1.03E+02
10-12 R									
10-12 L		25.4			54.6	22	6		

Detailed results of the individual tests performed are included in Appendix C.

SEEPAGE LOSSES

A simplistic model was created previously to approximate seepage losses based largely on the design cross section, utilizing an average head (water level in the canal) and average distance to groundwater (arbitrarily set 2.5 feet below the liner). Because the survey performed in February 2010 provided actual surface topography for most of the cross sections, and more accurate measurements of the liner thickness were obtained seepage losses were approximated using the Finite Element Modeling (FEM) capabilities of SLIDE 5.0 by RocScience instead of the simplistic evaluation performed using Darcy's Law in our previous canal assessment (IGES, 2009). Using the FEM method allowed us to accurately account for the variation in driving head along sloped sidewalls of the trapezoidal canal, it also allowed us to more easily model the impacts of groundwater fluctuation on seepage losses. Our 2009 assessment set groundwater 2.5 feet below the bottom of the constructed liner (average distance between bottom/side slopes and the natural groundwater surface); however, piezometer data indicated the water levels within the embankments were above this level. Our revised analysis attempts to quantify the impacts of groundwater fluctuation while also accounting for the variable distance to the water surface on the side slopes of the canal. Assumed values of embankment and native soil permeability were still required to complete the modeling. The same permeability value was assigned to the entire liner thickness at each cross section even though it is possible for the permeability to vary within the liner at that location. Because the canal runs near capacity for the entirety of the irrigation season, a constant water surface elevation (corresponding to 1,150 cfs) was used at each cross section.

As previously discussed, uneven distribution of liner soils was observed in the southern reaches of the canal (locations 10-1, 09-1, 10-2 and 09-2). This was particularly noted in the ~5,000 feet of canal located between the Slaterville Diversion Dam and Willard Pump Station No. 2 where low level flows meandered around liner "islands" on the bottom of the canal (see Figure B-2). We do not know exactly the causes or extent of liner degradation, but have attempted to account for the observed uneven liner distribution in our seepage modeling by removing the liner from 50% of the canal length between the two structures. Combining the removal of liner material with the granular nature of native soils in this area results in a seepage loss rate 33-37 times higher than the same section where a liner is present.

The following table provides a summary of the total annual seepage losses modeled for the entire length of the canal.

Scenario		Total Seepage Loss (acre-ft)
1,150 cfs	GW 2.5 feet below bottom of Liner	
	Simplistic (2009)	28,182
	FEM (2010)	29,126
	GW at levels measured in May 2009	
	FEM (2010)	20,903

With the groundwater modeled below the bottom of the liner for the entire length of the irrigation season (200 days) our modeling showed a 3.3% increase in approximated seepage losses by using the FEM method. Modeling the seepage losses using the May 2009 groundwater levels shows a 25% reduction in losses as compared to our previous modeling. Our modeling results approximate a 4.5-6.5% loss of water to seepage during the irrigation season. Further details of seepage modeling are included with this document in Appendix D.

CONCLUSIONS AND RECOMMENDATIONS

Based on construction drawings provided by WBWCD the canal liner was designed/constructed to be at least 2-feet thick (floor and side slopes) for the majority of the canal alignment, and 3 feet thick in the northernmost reach as it approaches Willard Bay. The liner thickness measured by IGES typically showed a reduced thickness on the side slopes, and sloughing of sidewalls was observed near the normal canal water surface and measured in most surveyed cross sections. Some of the soft material encountered/sampled may be comprised of liner material eroded from other areas of the canal or sediment transported by the Weber River. This hydraulically deposited material may be subject to additional movement during canal operation; altering the seepage rates as it changes location. Liner thickness on side slopes was typically measured to be less than that encountered on the canal "floor." Gravel (rip-rap) and frozen soils limited probing/measurement and sampling of liner material in some locations. It is also possible that the gravel encountered is part of the originally installed "liner" material, depending on the material source. Based on our field/laboratory measurements and computer modeling the canal loses between 4.5 and 6.5 percent of its total annual flow by seepage from the canal. Actual seepage rates will vary depending on surrounding groundwater levels and the depth of water in the canal; the canal may also receive water from surrounding groundwater during other times of the year. Our approximation of seepage from the canal does not include water lost during the initial charging of the canal and filling of voids in the "dry" liner or other surrounding soils. It is possible that some areas of the canal have less liner soils and more free-draining sands and gravels than encountered at the points explored. Our seepage modeling has not attempted to account for every variation in liner/native soil conditions between and beyond the points explored during our investigations. Substantial losses may result from a small area of the canal that

has a more free-draining liner/native soil profile. Other losses such as evaporation, or gains from precipitation should also be taken in to account when evaluating the overall canal performance.

Groundwater fluctuation is one key variable in accurately estimating the seepage losses from the canal. Piezometers have been installed to track the seasonal/operational fluctuations but have not been monitored since shortly after their installation in May 2009. Without data we cannot be certain, but because the canal had been full for a time prior to piezometer installation we assume that groundwater levels measured at that time closely reflect "normal" conditions; the stabilized level of groundwater through the majority of the irrigation season. We recommend that periodic readings be taken over the course of the calendar year in order to better understand the fluctuations.

From the differences seen when varying the groundwater levels, it can be inferred that loss rates will be highest during initial charging of the canal (spring) when surrounding groundwater levels are likely at or near their seasonal lows. The more rapid rate of seepage losses associated with low groundwater could be experienced for a larger portion of the season depending on weather. In a drought cycle where snowpack/runoff and rainfall recharge of groundwater is low, a greater percentage of the total canal flow could be lost. These losses become increasingly problematic because of increased demand during dry weather cycles.

By using a soil liner system in the canal some seepage is inevitable; however, based on our observations and measurements of liner variability we conclude the highest rate of seepage losses occur in the southernmost reaches of the canal where liner distribution was observed to be least uniform. Depending on groundwater levels we estimate the losses in this southern portion to be between 12,880 and 15,600 acre-ft per year. This means that a disproportionate 54-62% of the total volume lost is lost within the first 10-14% (5,000-7,000 feet) of the canal length. Considering the District's proposed Phase 1 lining project, we recommend that rehabilitation efforts be initially focused on the ~5,000 feet between the Slaterville Diversion Dam and Willard Pump Station No. 2. The next priority area should include the 2,000 feet immediately downstream (north) of Pump Station No 2.

We appreciate the opportunity to provide you with our services on this project. If you have any questions, please contact us at your convenience (801-270-9400.

Respectfully Submitted,
IGES, Inc.

Jared Hawes, P.E.
Project Engineer

Brett Miekelson, P.E.
Principal

Attachments

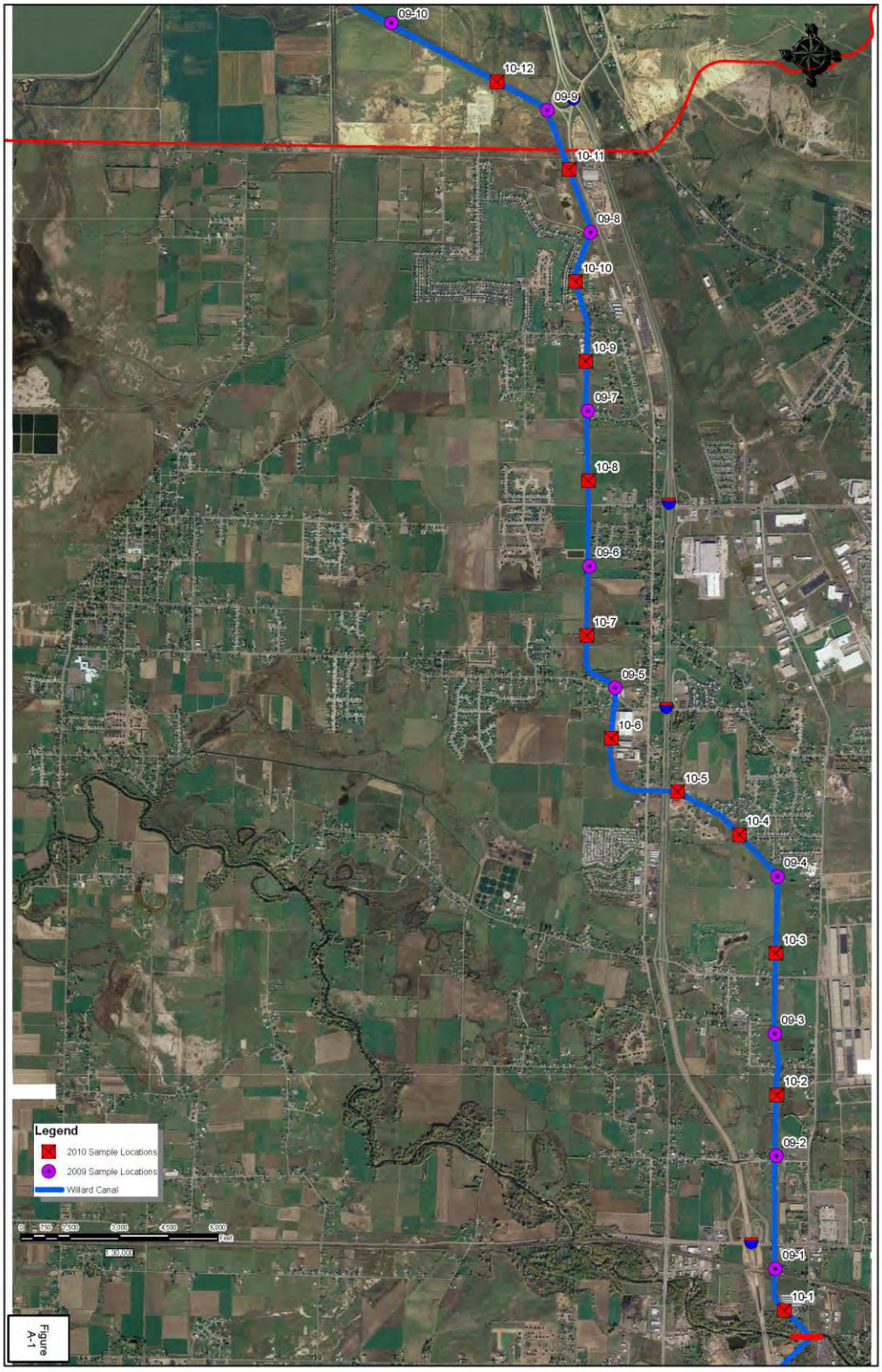
Appendix A
Figure A-1 Site Investigation Location Map

Appendix B
Figures B-1 through B-24 Field Investigation Notes and Photographs

Appendix C
Laboratory Test Results

Appendix D
Seepage Modeling Results

APPENDIX A


09-10
10-12
09-9
10-11
09-8
10-10
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09-7
10-8
09-6
10-7
09-5
10-6
10-5
10-4
09-4
10-3
09-3
10-2
09-2
09-1
10-1
Legend
2010 Sample Locations
2009 Sample Locations
Willard Canal
Figure A-1

APPENDIX B

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/2/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 1**

	Proposed	Actual	
UTM Coordinates:	415,191.0 m E	415,209.0 m E	Install and Label T-post
	4,565,797.7 m N	4,565,630.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 18 soft for 14", unable to probe beyond 14", no visual indication of seepage, bucket sample collected

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 19 1" ice, some water, soft for 14" then stiff to 3' (~3' of fine-grained soils) shelby tube sample

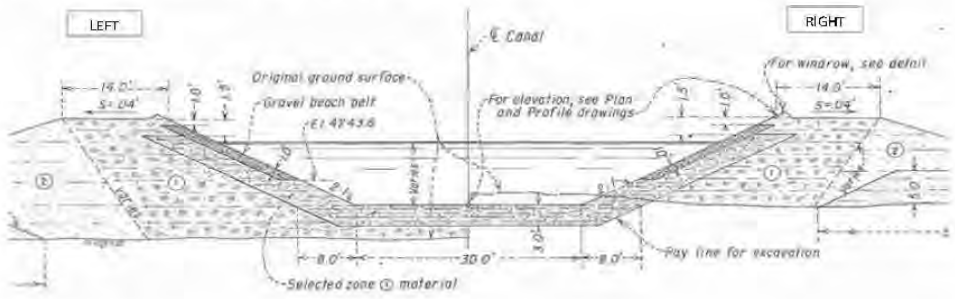
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 20 soft for 14", unable to probe beyond 14", no visual indication of seepage, bucket sample collected

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

Photo 12: Sample Location

Figure B-1

Figure B-2

Site Photos
Section 1

Project Number: 00578-011

IGES

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/2/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 2**

	Proposed	Actual	
UTM Coordinates:	415,122.3 m E	415,177.0 m E	Install and Label T-post
	4,567,808.8 m N	4,657,655.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 22 Rounded gravel rip-rap on surface ~ 6" thick, silty sand - black, organic, liner ~1' thick (bucket sample)

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 23 12" of liner (shelby sample)

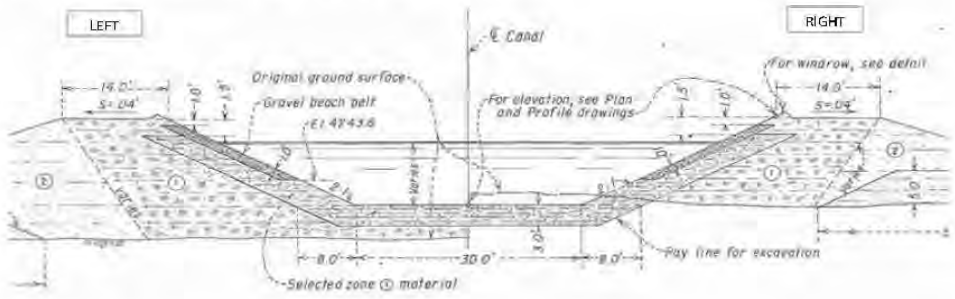
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 24 Rounded gravel rip-rap on surface ~ 6" thick, silty sand - black, organic, liner ~1' thick (bucket sample)

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

Figure B-3

Site Photos
Section 2
Project Number: 00578-011

Figure
B-4

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/3/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 3**

	Proposed	Actual	
UTM Coordinates:	415,113.1 m E	415,118.0 m E	Install and Label T-post
	4,569,131.9 m N	4,569,197.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 25 6" gravel over 1' of liner

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 26 14-18" of liner (shelby sample)

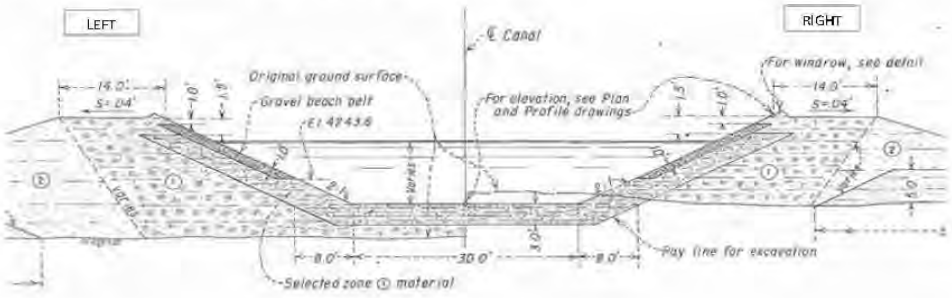
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 27 6" gravel over 1' of liner

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

Photos 30-31:

Figure B-5

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\\Skyserver\company\PROJECTS\00578 WB\WC\011 Willard Canal Phase 2\Photos\IMAG0031.JPG

Site Photos
Section 3

Project Number: 00578-011

Figure
B-6

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/3/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 4**

	Proposed	Actual	
UTM Coordinates:	414,770.7 m E	414,751.0 m E	Install and Label T-post
	4,570,242.3 m N	4,570,134.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 32 3" gravel rip-rap over 8" liner (bucket sample)

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 33 18-24" of liner (shelby sample)

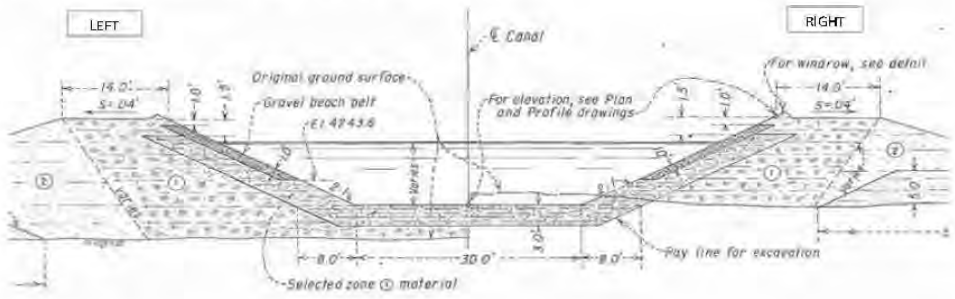
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 34 3" gravel rip-rap over 8" liner (bucket sample)

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

Figure B-7

Figure B-8

Site Photos
Section 4

Project Number: 00578-011

IGES

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/3/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 5**

	Proposed	Actual	
UTM Coordinates:	414,196.3 m E	414,302.0 m E	Install and Label T-post
	4,570,641.8 m N	4,570,431.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 35 3" rip-rap, 12" liner (bucket)

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 36 24" soft (shelby sample)

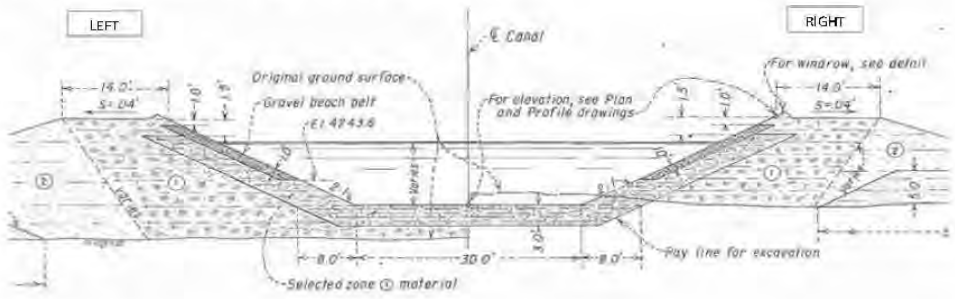
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 37 8" ice

\\Skyserver\company\PROJECTS\0 3" rip rap, 1' liner (bucket sample)

Sketch any observed differences from design cross section shown below



Additional Comments:

Figure B-9

Figure B-10

Site Photos
Section 5

Project Number: 00578-011

IGES

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/3/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 6**

	Proposed	Actual	
UTM Coordinates:	413,577.5 m E	413,637.0 m E	Install and Label T-post
	4,571,139.9 m N	4,571,011.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 38 Ice/snow 12-18" thick, 3" rip-rap, 8" liner- soft (bucket sample)

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 39 8-10" ice, 3" rip-rap, 2' soft clay (shelby sample)

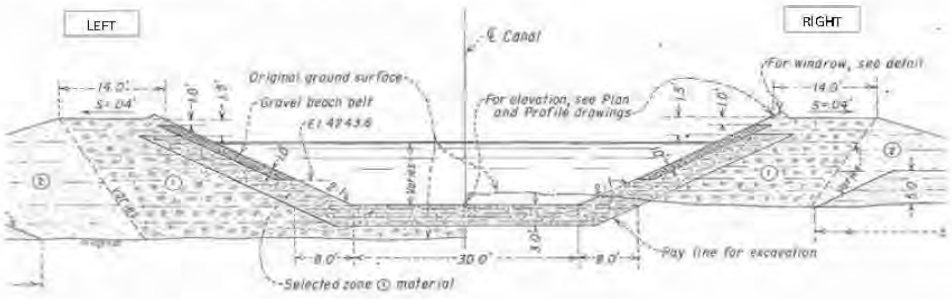
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 40 6" ice, 3" rip-rap, 6" soft, hard below (bucket sample)

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

\\Skyserver\company\PROJECTS\00578\WB\WC\2011 Willard Canal Piece 2\Photos\IMG0041.JPG

Figure B-11

Figure
B-12

Site Photos
Section 6
Project Number: 00578-011

IGES

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/3/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 7**

	Proposed	Actual	
UTM Coordinates:	413,348.1 m E	413,373.0 m E	Install and Label T-post
	4,572,102.5 m N	4,572,361.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 42 Ice ~6" thick, soft to 12" unable to probe/sample below (bucket sample)

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 43 Ice 8-10" thick, 3" gravel rip-rap, soft for 2' below (shelby sample)

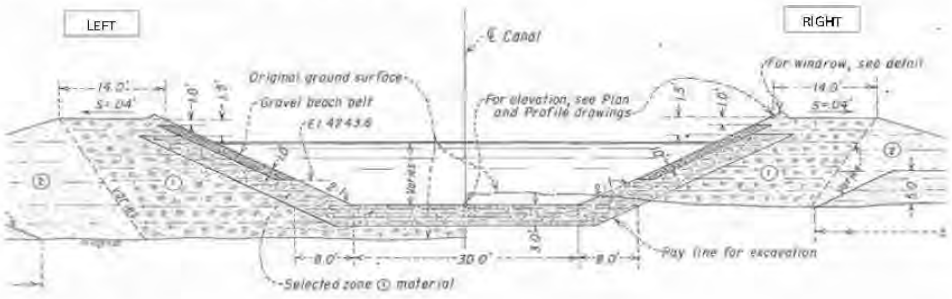
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 44 Ice ~6" thick, 3' rip-rap, soft for 6" unable to probe/sample deeper (bucket sample)

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

\\Skyserver\company\PROJECTS\00578 WBW\CD\011 Willard Canal Phase 2\Photos\IMAG0045.JPG

Photo 45

Figure B-13

Figure B-14

Site Photos
Section 7

Project Number: 00578-011

IGES

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/3/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 8**

	Proposed	Actual	
UTM Coordinates:	413,365.5 m E	413,427.0 m E	Install and Label T-post
	4,573,550.5 m N	4,573,337.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 46 Ice ~ 2" thick, 2 inches of gravel rip-rap over 6-8" soft clay (bucket sample)

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 47 ice 12-15" thick, soft clay liner ~2' thick unable to probe/sample beyond 2' deep (shelby sample)

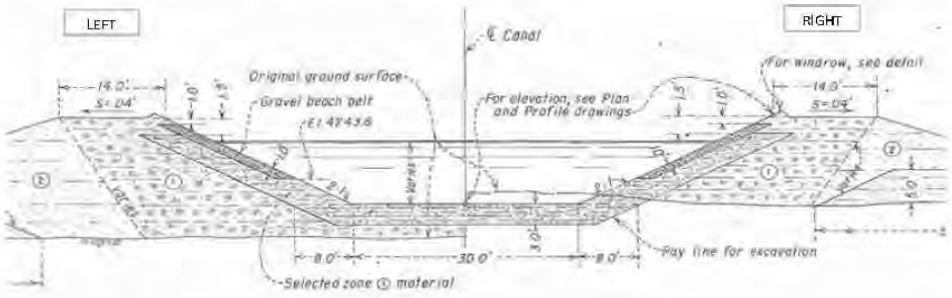
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 48 Ice ~ 2" thick, 2 inches of gravel rip-rap over 6-8" soft clay (bucket sample)

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

Photo #49

\\Skyserver\company\PROJECTS\00578\WRK\C\011 Willard Canal Phase 2\Photos\IMG0049.JPG

Figure B-15

Figure B-16

Site Photos
Section 8

Project Number: 00578-011

IGES

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/4/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 9**

	Proposed	Actual	
UTM Coordinates:	413,342.8 m E	413,385.0 m E	Install and Label T-post
	4,574,664.6 m N	4,574,664.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 50 6" subrounded gravel (rip-rap) 8" soft clay - bucket sample

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 51 2-2.5' of soft clay, ~4-6" organics on top (shelby sample)

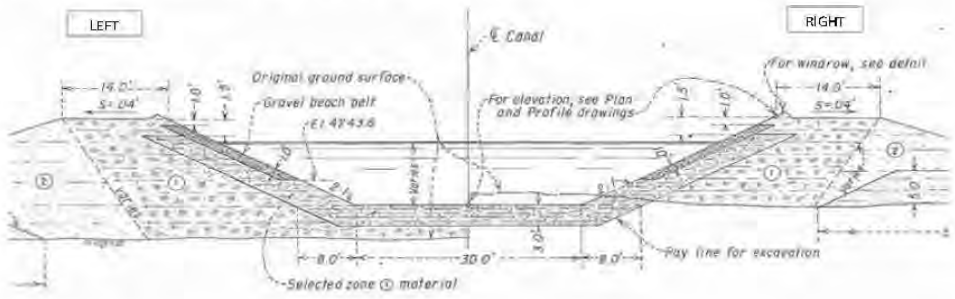
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 52 3 to 6" subrounded gravel rip-rap over 6-8" clay (bucket sample)

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

Figure B-17

Figure B-18

Site Photos
Section 9

Project Number: 00578-011

IGES

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/4/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 10**

	Proposed	Actual	
UTM Coordinates:	413,244.6 m E	413,325.0 m E	Install and Label T-post
	4,575,411.0 m N	4,575,306.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 53 Ice ~3" thick, no gravel, very soft, organic smell in upper 3', grass on slope, no apparent slumping

\\Skyserver\company\PROJECTS\0 (bucket sample)

Center/Bottom

Photo: 54 Ice ~12" thick, some water, very soft to 24-30" below water (shelby sample)

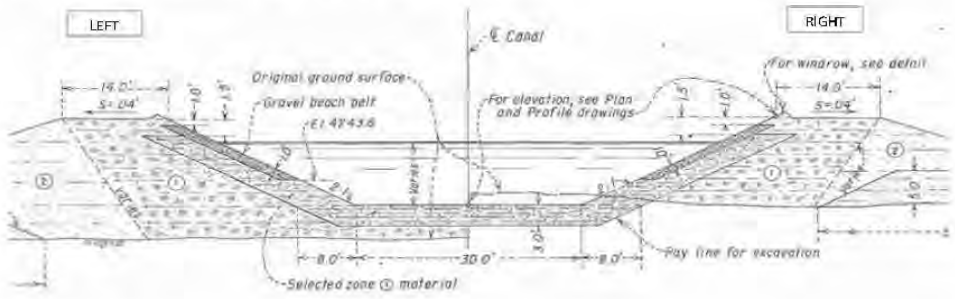
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 55 Upper 3' exposed grass, no apparent slumping, no seeps (did not collect sample)

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

Figure B-19

Figure
B-20

Site Photos
Section 10

Project Number: 00578-011

IGES

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/4/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 11**

	Proposed	Actual	
UTM Coordinates:	413,187.4 m E	413,275.0 m E	Install and Label T-post
	4,576,460.6 m N	4,576,184.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 56 6" of ice, gravel (subrounded to rounded) at least 12 " thick, unable to locate liner (bucket sample)

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 57 Ice up to 18" thick, soft for 2' below, could not keep sample in shelby tube

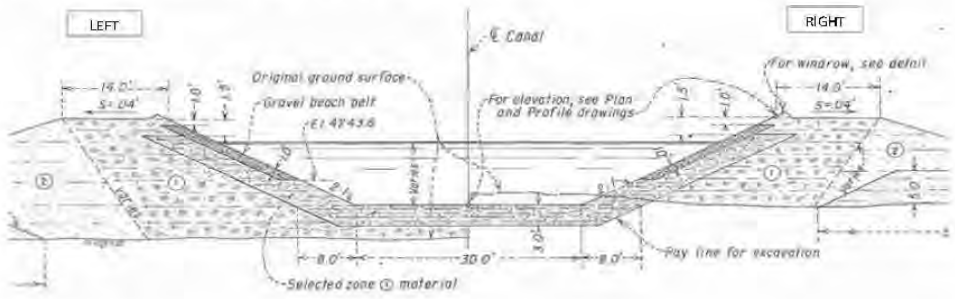
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 58 upper 2'3 feet of slope exposed grass, snow 3-6" thick, ice ~6" thick (no sample)

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

Figure B-21

Figure B-22

Site Photos
Section 11

Project Number: 00578-011

IGES

2010 Willard Canal Assessment

Project #: 00578-011
Date: 2/4/2010
Staff: C. Ege, D. Siebach
Location ID **WC2010 - 12**

	Proposed	Actual	
UTM Coordinates:	412,513.6 m E	412,331.0 m E	Install and Label T-post
	4,577,275.5 m N	4,577,228.0 m N	

Canal Description: include water/snow depth and ice thickness, probe liner thickness (describe location and resistance) Describe type and location of samples; describe vegetation (any indication of seepage)

Right Bank

Photo: 59 Exposed face (gravel and cobbles) gravel ~3" thick, soft for 1' below (liner - bucket sample)

\\Skyserver\company\PROJECTS\0

Center/Bottom

Photo: 60 ice 12-18" thick, water ~3' deep, liner ~2' thick (soft) shelby sample

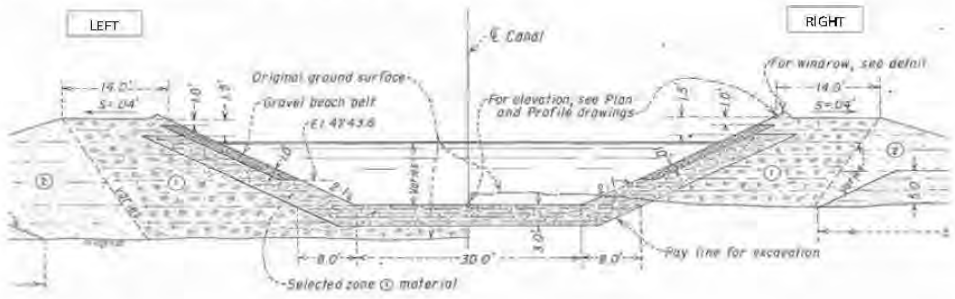
\\Skyserver\company\PROJECTS\0

Left Bank

Photo: 61 Covered with snow and ice, soft (liner) is ~1' thick (liner - bucket sample)

\\Skyserver\company\PROJECTS\0

Sketch any observed differences from design cross section shown below



Additional Comments:

Figure B-23

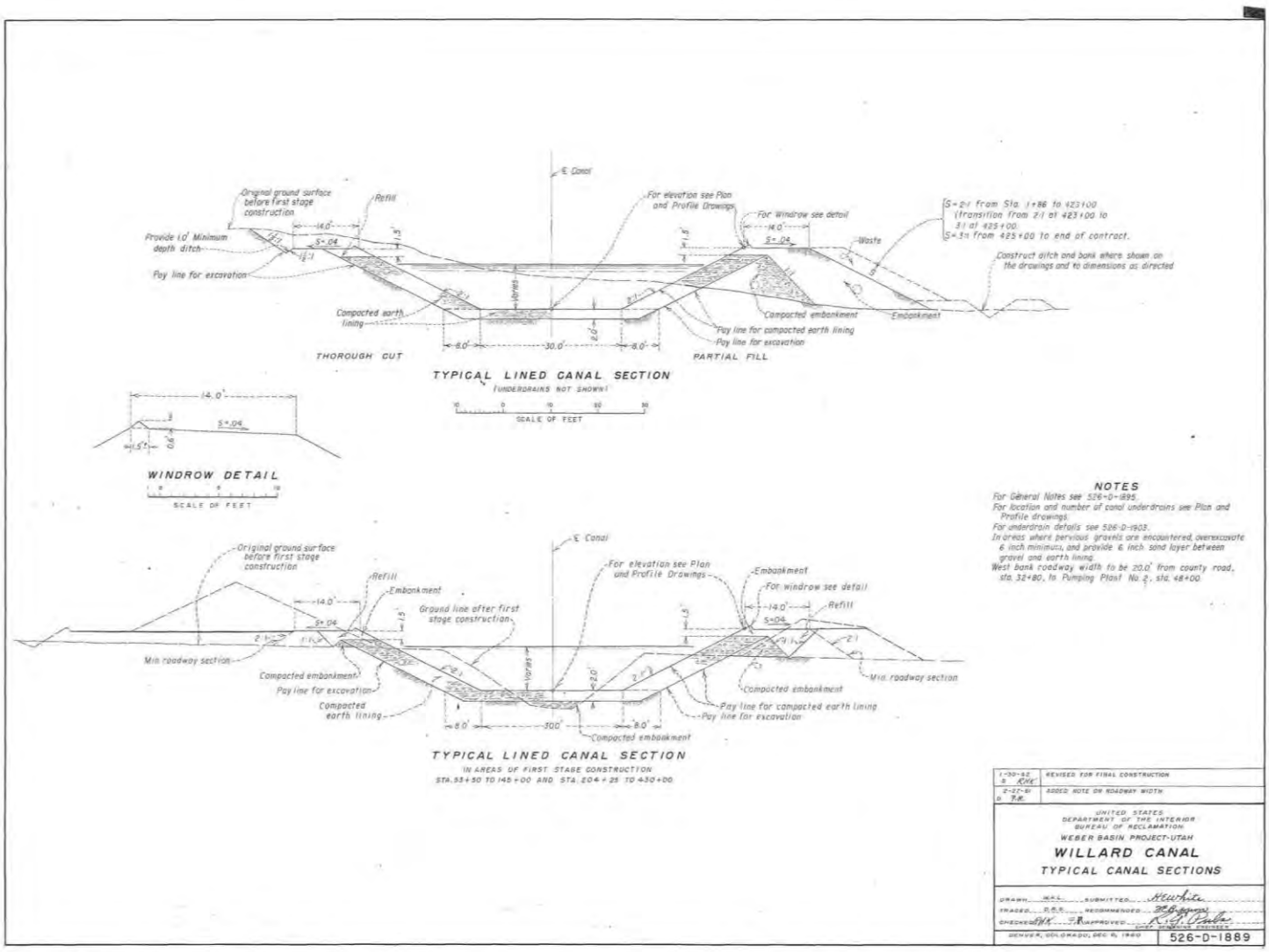
Figure B-24

Site Photos
Section 12

Project Number: 00578-011

IGES

Attachment B – Selected Original Reclamation Drawings



Attachment C – Basis for Post-Project Seepage Loss Estimates

R-00-01

CANAL-LINING DEMONSTRATION PROJECT
2000 SUPPLEMENTAL REPORT

January 2000

U.S. DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

Pacific Northwest Region
Water Conservation Center

Technical Service Center
Civil Engineering Services
Materials Engineering Research Laboratory

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	January 2000	Final

4. TITLE AND SUBTITLE
Canal-Lining Demonstration Project 2000 Supplemental Report

5. FUNDING NUMBERS

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Bureau of Reclamation
Technical Service Center
Civil Engineering Service
Materials Engineering Research Laboratory
Denver, Colorado

Pacific Northwest Region
Water Conservation Center
Boise, Idaho

8. PERFORMING ORGANIZATION REPORT NUMBER
R-00-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Same

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
DIBR

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Available from the National Technical Information Service, Operations Division, 5285 Port Royal Road, Springfield, Virginia 22161

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

The Deschutes Canal-Lining Demonstration Project is a cooperative effort among the Bureau of Reclamation, several irrigation districts, and several geosynthetic lining manufacturers. The purpose of the study is to develop low-cost canal-lining technologies to reduce seepage over severe rocky subgrade conditions. Over the first 7 years, Reclamation constructed 27 alternative canal-lining test sections using combinations of geosynthetics, shotcrete, roller compacted concrete (RCC), grout mattresses, soil, elastomeric coatings, and sprayed-in-place foam. This report documents the construction of two additional test sections using an exposed 45-mil EPDM rubber geomembrane and an exposed 30-mil Linear Low Density Polyethylene (LLDPE) geomembrane. Unit construction costs range from $0.78 to $0.87 per square foot. The test sections will be monitored for maintenance requirements, durability, and effectiveness to calculate Benefit-Cost ratios.

This report also documents seepage studies performed on a RCC-Shotcrete test section. The seepage studies include both full-scale short-term ponding tests and long-term inflow-outflow measurements taken over a 3-year period. The two methods yield similar results, and show that the RCC-Shotcrete lining is 75 to 85 percent effective which agrees well with previous estimates.

14. SUBJECT TERMS
geosynthetic/water conservation/geotextile/geocomposite/geomembrane/ponding tests/Benefit-Cost Analysis/life-cycle costs

15. NUMBER OF PAGES
60

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UL	UL	UL	UL

R-00-01

CANAL-LINING DEMONSTRATION PROJECT
2000 SUPPLEMENTAL REPORT

by

Jay Swihart
Jack Haynes

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Civil Engineering Services
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Denver, Colorado

Pacific Northwest Region
Water Conservation Center
Boise, Idaho

January 2000

UNITED STATES DEPARTMENT OF THE INTERIOR • BUREAU OF RECLAMATION

ACKNOWLEDGMENTS

The authors wish to thank the irrigation districts whose support was essential to the planning and implementation of this project. The Bureau of Reclamation particularly appreciates the support from the boards of directors of the Arnold, North Unit, Tumalo, Ochoco, Juniper Flat, Frenchtown, and Lugert-Altus Irrigation Districts. Water user support consisted of both a financial commitment and the acceptance of the risks involved with using unfamiliar technologies.

The authors wish to acknowledge the various material suppliers and contractors who were willing to participate in the project. In addition to making financial contributions, the participating companies provided invaluable technical support. These companies have also assumed risks by placing their products adjacent to those of their competitors under adverse conditions and often in new applications.

U.S. Department of the Interior
Mission Statement

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to tribes.

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EXECUTIVE SUMMARY

The Deschutes Canal-Lining Demonstration Project is a cooperative effort among the Bureau of Reclamation, several irrigation districts, and several geosynthetic lining manufacturers. The purpose of the study is to develop low-cost canal-lining technologies to reduce seepage over severe rocky subgrade conditions.

Over the first 7 years, Reclamation constructed 27 alternative canal-lining test sections using combinations of geosynthetics, shotcrete, roller compacted concrete (RCC), grout-filled mattresses, elastomeric coatings, and sprayed-in-place foam. This report documents the construction of two additional test sections in November 1999, and additional seepage studies performed in December 1999.

The two new test sections include exposed 45-mil EPDM rubber, and exposed 30-mil EPDM rubber. Construction costs ranged from $0.78 to $0.87 per square foot. These construction costs are at the low end of all the test sections built to date.

The seepage studies were performed on the RCC-Shotcrete test section in the North Unit Main Canal. The seepage studies include both short-term full-scale ponding tests performed over a 1,400-ft reach of canal, and long-term inflow-outflow measurements taken over a 25-mile reach of canal over a 3-year period. The 3 years of inflow-outflow measurements include 1996 (unlined canal), 1998 (canal invert lined with RCC), and 1999 (canal invert lined with RCC, sideslopes lined with shotcrete). The inflow-outflow measurements show:

1. The unlined seepage rate for the North Unit Canal averages 1.1 ft/day which agrees well with our earlier estimate of 1 ft/day *(Year 7 Report)*. The first 12½ miles of canal has a higher unlined seepage rate (1.5 ft/day), with some isolated areas as high as 20 ft/day.

2. The effectiveness of RCC lining of the invert only is about 30 percent, which agrees well with our earlier estimate of 40 percent effectiveness *(Year 7 Report)*.

3. The fully-lined seepage rate is 0.38 ft/day, which agrees reasonably well with the 1999 ponding test result of 0.6 ft/day.

4. The effectiveness of RCC lining of the invert and shotcrete lining of the sideslopes is about 75 percent, which agrees well with our earlier estimate of 70 percent *(Year 7 Report)*. This effectiveness also agrees well with the 1999 ponding test which shows effectiveness of 80 to 85 percent.

All 29 of the test sections will continue to be monitored for maintenance requirements, durability (life expectancy), and effectiveness (seepage reduction) to calculate Benefit-Cost ratios.

Attachment D – Canal Lining Cost Estimate Basis

Project: Phase 6 Willard Canal Lining Project
Engineer: Bowen Collins
Bid Opening Data: 8/23/2018 (2:00 PM)

				BOWEN CONSTRUCTION	
Item No.	**Description**	**Quantity**	**Unit**	**Unit Price**	**Price**
1	Mobilization, demo, temporary facilities, and administrative items (not to exceed 5% of Total Base Bid)	1	LS	$100,000.00	$100,000.00
2	Construction Dewatering	1	LS	$80,000.00	$80,000.00
3	Subgrade Prep.	1	LS	$117,158.00	$117,158.00
4	Foundation Stabilization	1500	CY	$25.00	$37,500.00
5	Underdrain System and Drain Rock Base Layer	1	LS	$432,500.00	$432,500.00
6	Concrete Canal Liner	1	LS	$1,251,574.00	$1,251,574.00
7	Import of Additional Fill Required Along Canal Access Road	4900	CY	$22.00	$107,800.00
8	Materials Testing Services Allowance	1	LS	$25,000.00	$25,000.00
9	Modifications to Existing Irrigation Pipe	1	LS	$7,000.00	$7,000.00
10	Installation of Bollards Adjacent to Existing Access Ramps	21	EA	$750.00	$15,750.00
11	Balance of Work	1	LS	$43,700.00	$43,700.00
TOTAL					**$2,217,982.00**

Attachment E – Letter of Support

WEBER COUNTY

PUBLIC WORKS /ENGINEERING
(801) 399-8374
FAX: (801) 399-8862
Gary Myers, P.E.
County Engineer

November 1, 2021

Tage I. Flint, General Manager/CEO
Weber Basin Water Conservancy District
2837 E Highway 193
Layton, UT 84040

Dear Tage,

Weber County is pleased to write in support of your grant application being submitted to the Bureau of Reclamation Water and Energy Efficiency Grants Program for Phase 8 of the Willard Canal Lining Project. We applaud your efforts to increase the efficiency of your system to conserve valuable water and energy. We understand that this lining project will save significant water loss due to seepage from the earthen canal.

Weber County recognizes the importance of water conservation. The water saved through these improvement projects will provide benefit to water users and the regional environment. Weber Basin continues to be a valuable partner promoting wise water uses in our community.

We strongly support your grant application and appreciate the advancements it will make in water savings and improving water efficiencies in the District boundary of Weber Basin Water Conservancy District.

Sincerely,

Scott Jenkins
Weber County Commissioner

2380 Washington Blvd., Suite 240
Ogden, Utah 84401-1473

Attachment F – Official Resolution

WEBER BASIN WATER CONSERVANCY DISTRICT

2837 East Highway 193 • Layton, Utah 84040 • Phone (801) 771-1677 • SLC (801) 359-4494 • Fax (801) 544-0103

OFFICIAL RESOLUTION

WHEREAS, the Weber Basin Water Conservancy District (District) is committed to the concept of water conservation;

WHEREAS, the District recognizes the need to conserve water and use it more efficiently in order to provide for the needs of the growing population in the District's Boundaries;

WHEREAS, the District strongly supports the Bureau of Reclamation's goals as set forth in the Water and Energy Efficiency Grants;

NOW THEREFORE, BE IT RESOLVED that the Board of Trustees for the Weber Basin Water Conservancy District agrees and authorizes that:

1. The Board has reviewed and supports the proposal submitted;
2. The District will provide up to $2,000,000.00 of funding for the Phase 8 Willard Canal Lining Construction Project; and

If selected for the Phase 8 Willard Canal Lining Construction Project, the District will work with Reclamation to meet established deadlines for entering into a cooperative project.

ATTEST

I, TAGE I. FLINT, Secretary of the Weber Basin Water Conservancy District, hereby certify that the foregoing is a true and correct copy of a resolution adopted in accordance with District Policies approved by the Board of Trustees of the Weber Basin Water Conservancy District.

Dated: 11/01/2021

Tage I. Flint, Secretary

(SEAL)