

# Canal Lining Demonstration Project – Year 25 Durability Report

Condition and performance update of 24 test sections installed in Central Oregon as part of a Reclamation canal lining demonstration project

Research Bulletin  
Science and Technology Program

## S&T Project 1743

This research study showed that concrete over geomembrane liners offer the best combination of reliable performance, long term durability, and effectiveness.

## Mission Issue

The outcome of the study is valuable data and information that can be used as a canal lining selection guide for future Reclamation projects, as well as for the broader geosynthetics industry.

## Principal Investigator

Brian Baumgarten  
Materials Engineer  
Materials and Corrosion Laboratory  
Technical Service Center  
bbaumgarten@usbr.gov

## Research Office Contact

Erin Foraker  
Renewable Energy and Infrastructure  
Research Coordinator  
Research and Development Office  
eforaker@usbr.gov

Bobbi Jo Merten  
S&T Water Infrastructure Research  
Coordinator  
eforaker@usbr.gov

## Problem

Between 1991 and 2001, a total of 34 test sections were installed in 4 different states as part of a canal-lining demonstration project led by two Bureau of Reclamation engineers (Jay Swihart and Jack Haynes). At the time of the study, common canal-lining materials included compacted clay and unreinforced or reinforced concrete. In many instances, these traditional lining methods were not a viable option.

The goal of the study was to evaluate specialized lining technologies that would perform well over difficult subgrades, in situations where traditional lining methods are less desirable.

The Upper Deschutes River Basin in Central Oregon was chosen as the location of the original study because of its volcanic geology. Canals in the area consist of highly permeable rocky side slopes and fractured basalt inverts. These geologic characteristics not only make excavation difficult, but also promote high seepage rates (35% to 50%).

## Solution

This research presents the condition and performance of 24 test sections installed in the Arnold, North Unit, and Ochoco canals in Central Oregon after up to 25 years of service. Of the 24 test sections, 7 have since been removed. This research evaluates the condition of the 17 remaining test sections, including a failure analysis of the removed test sections, visual inspections, coupon testing, and a benefit/cost analysis aimed at determining the most cost-effective lining systems.



Concrete over geomembrane liner in test section A-2.

***“Liner selection will become increasingly important, particularly as the value of water resources continues to rise.”***

Brian Baumgarten  
Materials Engineer  
Reclamation

### **Collaborators**

Geosynthetic Research Institute

### **More Information**

<https://www.usbr.gov/research/projects/detail.cfm?id=1743>

## **Application and Results**

Three canal lining types (concrete, concrete over geomembrane, and exposed geomembrane) were evaluated in this research. The main parameter used to assess the value of each test section was the benefit/cost ratio. The B/C ratio represents the cost effectiveness of each lining system. Below is a B/C ratio range, a summary of the advantages and disadvantages, and conclusions for each of the three lining types.

- Concrete (B/C = 3.0 to 3.3)
  - Advantages - excellent durability, low initial maintenance costs, prevents soil migration, and maintains canal capacity.
  - Disadvantages - provides the lowest effectiveness of any liner type evaluated in the study (70%).
- Concrete over geomembrane (B/C = 3.5 to 3.7)
  - Advantages - favorable durability, effectiveness, and maintenance costs; prevents soil migration, liner uplift, and maintains canal capacity.
  - Disadvantages - most expensive lining type.
- Exposed geomembrane (B/C = 2.2 to 3.8)
  - Advantages - low initial construction costs, high effectiveness and in certain cases can deliver long service lives (25+ years).
  - Disadvantages - performance highly dependent on service conditions; subject to soil migration, liner wrinkles, liner uplift, damage from ice, and capacity reductions; maintenance can be difficult and expensive for field crews.

Concrete liners should be considered in controlled seepage applications where limiting groundwater losses to communities bordering the canal is the main priority. In applications where seepage control is the main priority, other lining options will provide better performance and be more cost effective. Exposed geomembrane liners resulted in the highest B/C ratio, lowest B/C ratio, and the largest range. Although these liner types can perform very well, ultimately, service conditions will play the largest role in their performance, creating a certain level of risk when used. Concrete over geomembrane liners offer the best combination of reliable performance, long term durability, and effectiveness.

## **Future Plans**

Recommended future work includes seepage studies for the highest-performing test sections. Liner selection will become increasingly important, particularly as the value of water resources continues to rise. A seepage study would provide valuable real-world data that could be combined with condition assessments and coupon sample testing to improve accuracy of the Benefit/Cost ratio. This would allow the Bureau of Reclamation, and the geosynthetics industry, to make more informed decisions on future canal lining projects.