// USCID

U.S. Committee on Irrigation and Drainage

The U.S. Society for Irrigation and Drainage Professionals

USCID

U.S. Committee on Irrigation and Drainage

The U.S. Society for Irrigation and Drainage Professionals

President's Message

Dear USCID Members,

I am thrilled to announce the upcoming USCID Annual Conference, scheduled to take place from October 21-24, 2025, in Reno, Nevada. This year's conference will focus on the critical issues surrounding water supply and demand management. As we face increasing challenges due to regulatory constraints, over allocated basins, conjunctive management, and competing water needs, it is imperative that we come together to share innovative solutions and strategies.

Please mark your calendars and save the date for this important event. The conference will feature a half-day workshop on canal lining and seepage brought to you by the Irrigation Training & Research Center (ITRC) at California Polytechnic, plenary sessions on technical and policy considerations, invited speakers from the Bureau of Reclamation, NOAA, and the Great Salt Lake Commission, and a concluding tour in the Walker River Basin. It will provide an excellent opportunity for networking and learning from experts in the field.

The conference presentations will include topics on basin water management, competing agricultural and urban uses, water planning, supply and demand management, water transfers, conjunctive use of groundwater and surface water, and the latest technologies in irrigation and drainage.

Continued on page 2

2025 USCID Conference

October 21-24 in Reno, Nevada

Join us this fall! As details become available, we will post them on the USCID website - www.uscid.org/events. We hope you can join us in Reno for conference activities that offer time for networking and reconnecting with colleagues!

The **Call for Papers** announcement is attached at the end of this newsletter and posted at www.uscid.org/events.

Spring 2025
Issue No. 1007

Continued from page 1

NOTE: The “Call for Papers and Presentations” deadline has been extended to May 30, 2025. See the link below for more information.

Click Here to Learn More About the Conference and the Call for Papers

Additionally, we are seeking volunteers to join our conference planning committee. Your involvement will be crucial in ensuring the success of the event. If you are interested in contributing your time and expertise, please contact Megan at megan@agamsi.com.

We look forward to your participation and contributions to make this conference a success.

Best regards,
Therese A. Ure Stix
President, USCID

Visit us online!

Register to attend, or sponsor events
Renew your membership online
Find past newsletters and conference proceedings

www.uscid.org

In This Issue...

USCID Newsletter Advertisers
Spring 2025

We would like to thank our advertisers for making this edition of the USCID newsletter possible!

2025 USCID Annual Conference
October 21-24, 2025
Reno, NV

The 2025 USCID Annual Conference, organized by the United States Committee on Irrigation and Drainage (USCID), will be held in Reno, Nevada, from October 21–24, 2025. The event offers a vital forum for collaboration and innovation in the irrigation and drainage community. The conference aims to address the pressing challenges related to water supply and demand in the United States, particularly in light of climate change, urban growth, regulatory constraints, and increasing competition among agricultural, urban, and environmental water users. Emphasizing sustainable basin water management, the event will explore infrastructure improvements, policy changes, and innovative technologies required to support effective and equitable water resource management.

Water professionals such as irrigation and water district managers, consultants, academics, and agency staff are invited to participate and share their experiences and solutions. The conference will feature a study workshop on canal lining and seepage, plenary sessions, technical and policy presentations, networking opportunities, and a field tour. A call for papers invites 250 to 300-word abstracts for oral presentations and potential inclusion in the conference proceedings, with a submittal deadline of May 1, 2025. Submissions should focus on one of twelve key topic areas, such as groundwater and surface water integration, water policy, basin governance, technology, economic impacts, and more.

Why Attend the USCID Conference?

Attending the 2025 USCID Annual Conference is important for anyone involved in water resources, irrigation, or environmental management because it offers a unique opportunity to engage with the most current challenges and solutions in sustainable water use. With growing pressure from climate change, drought, population growth, and competing demands for water, professionals need innovative tools, strategies, and policies to adapt. This conference brings together leading experts, practitioners, and policymakers to share real-world experiences, case studies, and cutting-edge research across a wide range of water-related topics. It’s a chance to learn from diverse perspectives, build valuable professional networks, and gain insights into governance, infrastructure, technology, and economic considerations that impact water planning at the basin level. For those presenting, it's also an opportunity to contribute to the broader conversation, gain recognition, and influence how water resources are managed in the future.

Workshops are BACK!
October 21, 2025 at the USCID conference

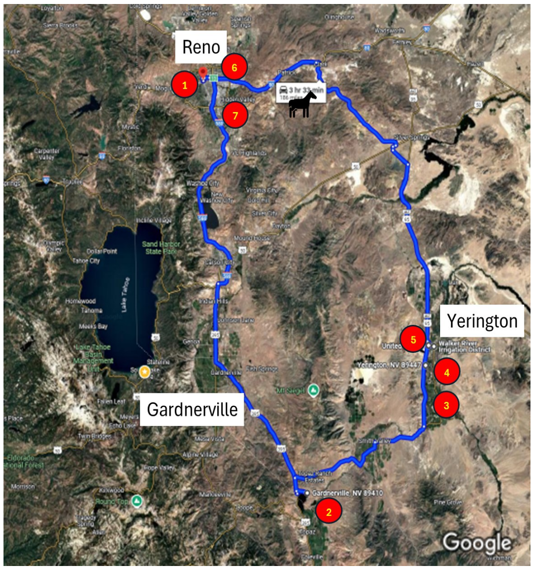
8:30am-11:30am WORKSHOP: LINING AND SEEPAGE REDUCTION (separate registration required)

Presented by Charles Burt and Dan Howes, Cal Poly ITRC

This workshop will include presentations on:

- Justifications for lining, including bank stability, less hydraulic resistance, less maintenance, and seepage reduction
- Options and details of vibratory compaction without liners, simple geomembrane liners with no geotextile or concrete, geomembranes with concrete cover, concrete only, shotcrete, concrete canvas, and treated soil
- Differences between geotextiles and geomembranes; woven and non-woven geotextiles
- ASTM specs for geomembranes and various geotextiles
- Results of studies regarding longevity of various linings under various situations
- How to deal with situations involving seepage reductions with different variables
- Installation hints and tricks

USCID FIELD TOUR AGENDA
Friday, October 24, 2025



USCID Tour - Friday, 24 October 2025

	Location	Desc.	Arrive	Depart	Pin
1	El Dorado Reno	Hotel		7:30am	39.5291432633, -119.814452759
2	Topaz Dam	Dam	9:00am	9:30am	38.6935638634, -119.514869717
3	Spragg Headworks	Modernized Headworks	11:00am	11:30am	38.6935638634, -119.514869717
4	WRID Main Office	Headquaters and Lunch	12:00pm	1:15pm	38.9933875431, -119.162622420
5	Campbell Headworks	Modernized Headworks	1:30pm	1:45pm	38.9962932081, -119.178028581
6	Jensen Precast	Precast Concrete	3:00pm	3:15pm	39.5296571978, -119.738651952
7	El Dorado Reno	Airport - Hotel	3:30pm		39.5291432633, -119.814452759

Sites along the Trail

Gardnerville, Topaz Reservoir, Center Pivots, West Walker River, East Walker River, Yerington, USA Parkway Mustangs

APPLICATION OF GEOMEMBRANE BACKED GEOSYNTHETIC CEMENTITIOUS COMPOSITE MATS (GCCMS) TO MITIGATE WATER SEEPAGE OF EARTHEN IRRIGATION CANALS

Nathan Ivy[1], Alejandro Paolini[2] and Simon Lester[3]

ABSTRACT
As water conservation becomes a higher priority for irrigation districts across the western states for environmental and financial reasons, this paper reviews the application of Geosynthetic Cementitious Composite Mats (GCCMs) as a low permeability liner of irrigation canals to mitigate water seepage. GCCMs are a well-established material technology within storm-water drainage but are relatively new in their use for lining irrigation canals. They are defined by ASTM D4439–20 'Standard Terminology for Geosynthetics' as factory-assembled geosynthetic composites consisting of a cementitious material contained within a layer or layers of geosynthetic materials that becomes hardened when hydrated. This paper explores key material characteristics of GCCMs pertinent to the lining of irrigation canals including the accommodation of differential ground movement, the importance of conformance to ASTM standards and the determination of permeability to liquids of three jointing techniques applicable to GCCMs. Specifically, this paper provides analysis of seepage data obtained from ponding tests before and following the installation of CCX© GCCM which was used to line a 1,440' reach of the Duni ditch operated by Henry Miller Reclamation District No. 2131 (HMRD) in Dos Palos, California. It also covers aspects of the general installation processes of the GCCMs versus traditional membrane and concrete solutions and an indication of the financial gains that irrigation districts can attract from the re-sale of saved irrigation water losses through seepage.

INTRODUCTION

As water usage rates continue to increase, and rainfall continues to drop – especially in populus

[1] B.Sc., Texas A & M University, Concrete Canvas USA Inc, 1350 E NASA Pkwy, Suite 120, Houston, TX 77058, United States
[2] Henry Miller Reclamation District No. 2131, 11704 W. Henry Miller Ave., Dos Palos, CA 93620, United States
[3] Concrete Canvas Ltd, Cowbridge Rd, Talbot Green, Pontyclun, CF72 8HL, United Kingdom

Continued on next page

arid regions such as California – the need to preserve water resources becomes increasingly important. Water is a vital natural resource required for growing crops, raising livestock and for human existence within any environment. Historically, irrigation canals have played an important role in maintaining and transporting water through arid regions. Largely, these canals have been unlined, earthen canals. Some have been lined with geomembrane or concrete or both in an effort to extend the life cycle and improve efficiency in both preserving and transporting water through the canal. Both products are effective – at least initially – in protecting water resources, but both are susceptible to damage and seepage losses – especially when used independently of each other. About 5 years ago, the USBR published the results of their 25-year durability report1. The study concludes that a geomembrane overlain by concrete provides the longest lasting protection. This paper discusses geomembrane backed GCCMs that impart both a geomembrane and a high strength concrete layer into a single product to provide an estimated lifespan in excess of 50 years when designed and installed properly. It will provide a brief history of the current ASTM standards that are available for specifying GCCM and will focus on a case study of a canal over ¼ mile long where it was successfully installed and greatly reduced water losses at a cost less than many competing technologies.

HISTORY OF GCCMs

The newest geosynthetics class, now known as GCCMs, were first developed in the UK in 2005. Their initial use was emergency shelters that could be rapidly installed for humanitarian aid projects. As the manufacturing process evolved, mass production began in 2009 for use in erosion control applications. Because they are a new class of geosynthetics, many existing ASTM test standards were not appropriate to test material that, as installed, is pliable, but ends up hardened after it is hydrated and cured. Much work has been done since those early days to develop test standards to support specifying this material. ASTM D8364 “Standard Specification for Geosynthetic Cementitious Composite Mat (GCCM) Materials” is the overarching test standard (Table 1). The standard defines 3 types of GCCM, Type I, II and III. They vary by thickness and required values for prescriptive test properties. The application (weed suppression, erosion control, water conveyance) and site-specific conditions (soil type, slope angle, water velocity) determine the best type of material to use for a specific project. Each type of GCCM is further defined by compressive strength, flexural strength and tensile strength among other important characteristics. Currently this is the only recognized test standard for specifying GCCM so it is important to ensure any GCCM used on a project meets or exceeds all of these requirements. Because it is new class of geosynthetics, ASTM D8173 “Standard Guide for Site Preparation, Layout, Installation and Hydration of GCCMs” is also available to guide first time specifiers in how to ensure a quality installation. Additionally, there are various training resources online from a variety of manufacturers.

TABLE 1. ASTM D8364 Requirements[2]

Property	Test Method	State of GCCM	Minimum Values		
			Type I	Type II	Type III
Thickness	D5199	uncured	4.5 mm	7.0 mm	
Mass per Area	D5993	uncured	6.5 kg/m^2	10.5 kg/m^2	
Density	D5993	uncured	1250 kg/m^3		
Flexural Strength (cured 24 hr)	D8058	initial load	625 N/m	1500 N/m	3450 N/m
		initial flex strength	3.5 MPa		
		final flex strength	4.0 MPa		
Compressive strength	D8329	cured 28 days	40 MPa	50 MPa	60 MPa
Pyramid Puncture	D5494	cured 28 days	2 kN	3.5 kN	4.5 kN
Abrasion	C1353	cured 28 days	0.3 mm		
Tensile Strength	D4885	uncured	8 kN/m		
		cured 28 days	3.5 kN/m	6.5 kN/m	9 kN/m
		cured 28 days	10 kN/m	19 kN/m	
Freeze-Thaw	C1185	cured 28 days	>80%		

JOINTING METHODS

There are 3 different ways to join panels of GCCM. The best method depends on the project application and expectations. Far and away, the most common method is using stainless steel screws at 4-8” centers to join the seams. This joint is not meant to be impermeable but is used for slope protection applications or for water conveyance applications where water is expected to be present only when flowing during storm events, for example. The water will be flowing over the seam and not back up into the seam – at least to any degree that would be meaningful for these applications. This method is also useful in areas of high hydrostatic uplift. In locations with high water tables, this approach allows seepage through the joints without exerting pressure on the joints which

Continued on next page

could cause damage to the joints or the material itself. This method also allows recharge by allowing water to seep from the channel back into the ground if that is desired.

There are two other methods available when a lower permeability seam is required. This is particularly important in applications such as irrigation, standing water or potentially contaminated water. One of these methods requires that an acceptable sealant first be applied to the seam and the screws installed through the bead of sealant. The downside is that the sealant becomes an additional consumable – driving up the installation cost – and can be messy. The anticipated design life may also be impacted by the design life of the sealant which is typically less than the GCCM. The other installation method to decrease permeability is to thermally bond the bottom of the top layer to the top of the bottom layer. This can be performed with standard thermal bonding equipment used for other types of geosynthetics. Although GCCMs are innovative, their installation and specification is similar to other conventional geosynthetics. The same stainless-steel screws are then used at 4" centers to account for any drying shrinkage and to provide the strongest, lowest permeability joint available.

HENRY MILLER RECLAMATION DISTRICT NO. 2131 (HMRD) CASE STUDY

Henry Miller Reclamation District No. 2131 was formed in FY2000. It works in conjunction with San Luis Canal Company (SLCC) to deliver the irrigation water and provide drainage to the company's customers. The vast majority of the delivery facilities are now either owned by HMRD or have permanent easement. HMRD is in charge of operating and maintaining the canals and drains.

As a member of the San Joaquin River Exchange Contractors, SLCC has an annual right of 163,600 AF in a "normal" year, HMRD currently manages water services for 45,000 acres of farmland mostly in Merced County, CA. They are contractually required to deliver 163,000 acre-feet (53,000,000,000) gallons of water annually for irrigation of surrounding crops. Because this region is arid, agriculture would be very difficult without the water supplied by the irrigation district. Much of their existing canal infrastructure consists of earthen canals or concrete lined canals. The earthen canals demonstrate problems with seepage and erosion – as would be expected, but many of the concrete lined canals are decades old and in disrepair. For this particular project, the existing concrete was installed less than 20 years ago – in 2004. Much of the existing concrete was cracked, bulging or missing resulting in significant seepage losses (Figure 1). The objective of this project was to mitigate seepage losses in the irrigation canal such that water could be sold to farmers rather than lost. Prior to remediation efforts, this ¼ mile section of canal was losing 46 gallons per minute to seepage or more than 2,400,000 gallons of water per year based on 36 operation days per year.

Many options were considered for remediation of the existing concrete lined canals. Among the options considered were replacement of concrete, a combination of geomembrane and shotcrete or GCCM. The District could not afford to shut down the canal for more than two to three weeks as they needed to supply water during the irrigation season. Ultimately, a Type II GCCM was chosen for the rehabilitation of the existing canal. The GCCM offered many advantages over the other options. The material was more cost effective than other alternatives, in part, because the district personnel could install the material themselves without the need for outside contractors. Using outside contractors would have added a level of complexity for scheduling, which meant the GCCM solution could be installed on a much tighter timeline and return the canal to operation more quickly. Unlike concrete, the GCCM that was chosen is able to withstand differential settlement of 12% or more without compromising the integrity of the containment solution – the 12 mil LLDPE geomembrane which provided the impermeability – would not be impacted by this level of settlement.

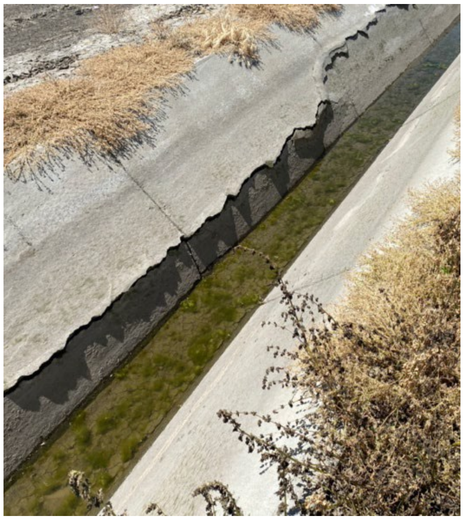


Figure 1. Typical condition of the existing concrete canal installed in 2004 prior to remediation efforts.

Continued on page 10


3035 T
Inter-Drain


DEERE

The graphs below (Figure 2) show tension versus strain for CCX-M. Immediately after the final crack, the top fabric ruptures exposing the underlying LLDPE geomembrane.

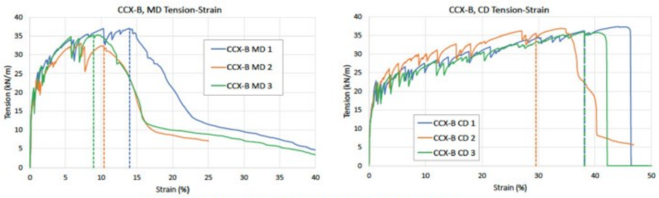


Figure 2. Tension Versus Strain for CCX-M

Table 2, is a summary of observed strain and tensile strength for CCX. When the layers above the LLDPE backing rupture, this indicates the point at which the LLDPE backing is compromised.

Product Type	Direction	Mean Geomembrane Failure Indicators	
		Final Failure Strain (%)	Ultimate Strength (lbf/in)
CCX-M™	MD	12.8	200
	CD	15	130

Table 2. Average strain and tensile strength for CCX-M.

As mentioned earlier, the USBR study indicated that a geomembrane overlain by concrete is the best solution for lining canals. This product offered a 2-in-1 solution – geomembrane and concrete. Another important consideration was the design life. While the existing concrete had failed in less than 20 years, the expected design life of the GCCM that was chosen is in excess of 50 years.
Because the existing concrete was in such disrepair the existing material was removed and the canal was reprofiled. The rolls were deployed across the invert of the canal with a spreader bar and cut to length. The canal structure involved gates, valves, and existing concrete all of which required mechanical attachments and sealant in order to minimize seepage at these connections (Figure 3).

Figure 3. Reprofiling existing canal, deployment of GCCM and gates/valves.

The material was thermally bonded, and the seams screwed together with stainless steel screws. At the end of each day, the material that had been installed was fully hydrated. This is an important step in installing GCCM. It prevents partial pre-hydration resulting from unexpected rainfall or even heavy dew. If this were to occur, the upper most part of the concrete layer would cure, leaving concrete powder between the cured layer and the underlying geomembrane. While the entire layer would eventually cure, during that time, the GCCM would not exhibit the strength or durability of a fully hydrated and cured GCCM that was expected. The installation of 28,000 sf of GCCM on this ¼ mile section (1,440') of canal took 3.5 days (Figure 4).

SEEPAGE TESTING
After installation was complete, the District undertook seepage testing to measure water loss in the canal. As mentioned previously, the seepage before remediation was 46 gallons per minute (gpm). The test took place over a 4-day period shortly after installation was complete. To perform this testing, they first shut all of the vales within the section to isolate it. They estimated evaporative losses using the California Irrigation management Information System (CIMIS) summary of the hourly evapotranspiration (ETo) value for the duration of the test. Lastly, they factored in the addition of water due to rain events (Figure 5). During the test, they measured how much water had to be supplied to maintain a constant water level within the canal (Figure 6).

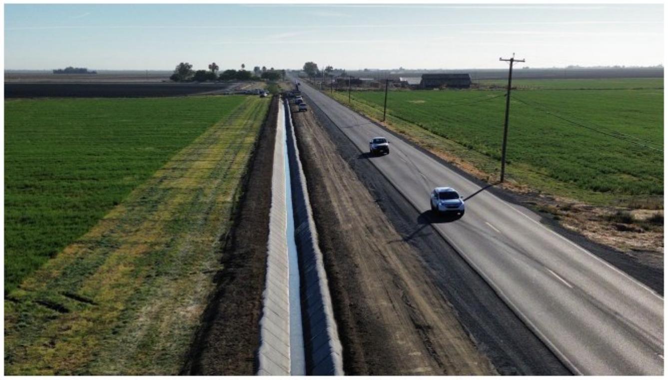


Figure 4. Completed canal section

Continued on next page

Total Volume of Losses Due to Seepage

Total Seepage Losses = Total Volume added (ac-ft) + Net change in water level (ac-ft) - Volume Evaporated (ac-ft)

Total volume added (ac-ft)	0.019	1 AF = 325,851 gallons
Net change (ac-ft)	0.0252	
Volume Evaporated (ac-ft)	0.0070	
Rain (ft)	0.0058	
Total Seepage Losses (ac-ft)	**0.0315**	

Seepage Rate Calculation

Seepage Rate (gpm) = Total seepage volume (gal) / Total time elapsed (min)

Total Seepage Losses (ac-ft)	0.0315
Seepage Losses (ft^3)	1374
Seepage Losses (gal)	10276
Total Elapsed Time (min)	5880

Seepage Rate (gpm)	**1.75**
Seepage Rate (ac-ft/day)	**0.008**
Seepage Rate (ac-ft/Year)	**0.28**

Considering 36 days of operation

Figure 5. Volume losses due to seepage factoring in evaporation and rainfall.

Net Change in Water Level

Net change (ac-ft) = (average net change in water level) x (Total water surface area of test pool)
Difference in water level (ft) = FINAL Reading - INITIAL Reading

Initial Reading (ft)	ITRC 24439	2.2395	
Final Reading (ft)	ITRC 24439	2.1210	
	Difference in water level (ft)	**-0.1185**	(Drop in water level)
Initial Reading (ft)	ITRC 23824	2.6569	
Final Reading (ft)	ITRC 23824	2.5469	
	Difference in water level (ft)	**-0.1100**	(Drop in water level)

Average Δ in water level (ft) **-0.1143** (Drop in water level)

NOTE: Based on the average of the two pressure transducers, the net DROP in water level was **0.1143 feet** in 98 **hours.**

Net DROP in water level (ft)	0.1143
Net change (ac-ft)	**0.0252**

Total Volume of Water Added during Testing

Initial totalizer reading	5466517	gallons
Final totalizer reading	5472741	gallons
Total volume added	**6224**	**gallons**

Figure 6. Calculation of water needed to maintain constant water level.

RESULTS AND DISCUSSION

The test results indicate that seepage rate was reduced from 46 gpm to 1.75 gpm – a reduction of more than 96%. If these results were replicated widely throughout irrigation systems, millions of gallons of water – now lost to seepage – could be saved, sold and used to grown crops.

CONCLUSIONS

The District was faced with a problem of dilapidated concrete lined canals which were losing water due to seepage losses. This lost water represents lost revenue that could be gained from selling this water. They researched many available options to remediate the structure. They were constrained by cost, ease of installation and time required to return the canals to service. After exploring all options, they settled on the relatively new technology of a geomembrane backed GCCM. This solution provided both the durability of a concrete surface and the impermeability of a geomembrane backing. The USBR decided a long time ago that a combination of geomembrane and concrete is the best long-term solution for canal lining – one that provides the longest life, the lowest seepage and the best protection for water conveyance. Key wins to securing federal grants are solutions to address water scarcity and preventing saline waterlogging. The lining of USCID 2024 Conference 97 canal assets maximizes the value of expenditure towards other irrigation systems such as pump and dosing stations.

ACKNOWLEDGEMENTS

We appreciate the support of Alejandro Paolini, Water Conservation Specialist for Henry Miller Reclamation District No 2121. He was instrumental in bringing this project to fruition and for performing the seepage testing to demonstrate the efficacy of a geomembrane backed GCCM for use in water conveyance applications.

REFERENCES

[1] Baumgarten, B. (2019). Canal Lining Demonstration Project – Year 25 Durability Report. US Department of the Interior Bureau of Reclamation

[2] ASTM D8364-21, "Standard Specification for Geosynthetic Cementitious Composite Mat (GCCM) Materials", American Society of Testing and Materials

50 Year Celebration in 2024

Therese Ure Stix and Larry Stephens

Brian Wahlin and Larry Stephens

Blast From The Past

Remember this article from **2010?**

Synthetic Canal Lining Evaluation Project

Eric Leigh[1], Askar Karimov[2], Guy Fipps, Ph.D., P.E.[3]

ABSTRACT

Irrigation districts in the Lower Rio Grande Valley of Texas have been experimenting with an assortment of synthetic canal lining materials, looking for more cost-effective methods for rehabilitating old, deteriorating canals. The synthetic canal lining materials are showing promise, but little information exists on the relative performance between different products. In 2005, we initiated a program to track the long-term effectiveness and durability of these lining projects and to document the damage caused by such factors as UV damage, animal traffic, intentional and unintentional vandalism. A summary of our results from the first four years of inspections are presented. Inspections for the linings are currently being updated for 2009-2010. Additionally, this paper provides documentation on canal lining installation and maintenance procedures, along with suggested considerations when planning a lining project. This paper also discusses future collaborative efforts underway for the testing and evaluation of synthetic canal liners.

The best performers were the two types of synthetic liners (PVC and polyester) with a protective barrier of shotcrete, which have shown no problems to date. The noticeable difference between the two types of liners was the ability of the polyester to hold the shotcrete in place on the canal sidewalls. The PVC liner required an additional support system using a wire mesh

1 Extension Associate, Department of Biological and Agricultural Engineering, 2117 Texas A&M University, College Station, Texas 77843-2117; eleigh@tamu.edu
2 Extension Associate, Department of Biological and Agricultural Engineering, 2117 Texas A&M University, College Station, Texas 77843-2117; akarimov@ag.tamu.edu
3 Professor and Extension Agricultural Engineer, Department of Biological and Agricultural Engineering, 2117 Texas A&M University, College Station, Texas 77843-2117; g-fipps@tamu.edu

Continued on next page

overlay serving as the attachment between the material and the shotcrete.

The performance of synthetic liners without a protective barrier varied dramatically. One important factor was the location of the project. Liners located in high traffic areas (people and animals) showed significantly more damage than those installed in remote areas. The PVC alloy is the toughest of the 4 liners installed without a protective barrier, is more difficult to cut and less likely to be damaged by unintentional vandalism. We also observed that liners carelessly or improperly installed were more susceptible to intentional and/or unintentional damage.

INTRODUCTION

Water Losses from irrigation canals can be significant, and water districts are looking for more cost-effective methods for rehabilitating old, deteriorating canals other than relining with concrete or replacement with pipelines. Synthetic canal lining materials are showing promise as an alternative to more costly methods, but little information exists on the relative performance between different products, or on installation and maintenance procedures needed to ensure long life.

Since 1999, irrigation districts in the Lower Rio Grande Valley of Texas have been experimenting with an assortment of canal lining materials. In 2005, we initiated a program to track the long-term effectiveness and durability of these materials and to document installation and maintenance procedures which will help ensure good performance. Each lining project was inspected multiple times to document the effects of such factors as UV damage, animal traffic, intentional and unintentional vandalism, and normal irrigation district operational and maintenance activities. A summary of the results from the first four years of inspections are presented in this report.

MATERIALS AND METHODS

<u>Lining Materials</u>

Six different lining materials have been installed in seven irrigation districts of the Lower Rio Grande Valley of Texas. Table 1 provides a list of material types and generic descriptions of each. Unlike the other materials, the polyurethane was manufactured onsite during installation using specialized equipment. The locations of the lining projects are shown in Figure 1. In 1999, Hidalgo County Irrigation District No. 1 initiated a program that included four types of liners installed in 27 segments.

Table 1. Description of each lining material's composition.

Material	Description
Polyester with protective barrier	A geocomposite consisting of two layers (top and bottom) of 8 oz/yd^2 nonwoven polyester bonded to an olefinic copolymer geomembrane, 20 mil thick. The protective barrier consists of 2-3 inches of shotcrete.
PVC with protective barrier	Non-reinforced Poly Vinyl Chloride (PVC). The protective barrier consists of a wire mesh with 2.5 inches of shotcrete.
Polypropylene	A reinforced polyester scrim 16 oz/yd^2 between polypropylene layers, 24 mil thick.
PVC Alloy	A polyvinylchloride blend, reinforced with a polyester scrim, 40 mil thick.
EPDM Rubber	A non-reinforced EPDM (ethylene propylene diene monomer), 45 mil thick.
Polyurethane	Two layers of 3-oz/yd^2, heat-bonded, non-woven geotextile saturated with liquid polyurethane, 40 mil thick.

<u>Evaluations and Site Inspections</u>

During each site inspection, projects were given a condition rating ranging from "excellent" to "serious problems" as defined in Table 2, and photographs and other information were collected to document observed problems. Our original plan was to conduct inspections every six months. However, little change was observed over this time period, and succeeding inspections took place annually as follows:

- February 2005
- September 2005
- September 2006
- December 2007

Conducting inspections during the winter months when water levels tend to be the lowest have proved to be the most effective.

Table 2. General performance ratings for canal liners.

Rating	Definition
Excellent	0%: no damage and no maintenance required
Good	0 – 5%: mild damage to top anchor and canal interior 1 to 2 significant repairs needed per year
Fair	5 – 20%: mild damage to top anchor and canal interior 3 to 5 significant repairs needed per year
Poor	20 – 50%: mild damage to top anchor and canal interior 6 to 10 significant repairs needed per year
Serious Problems	50 – 100%: mild damage to top anchor and canal interior 10 > significant repairs needed per year

Note: Percentages are based on the linear length of the lining project

<u>Seepage Loss Tests</u>

Before and after seepage loss tests were conducted for Project #5 in Figure 1 using the ponding test method. In this method, earthen dams are constructed at either end of the test segment. The

Continued on next page

test segment is then filled with water, and the rate and total water losses are measured over a 24–48 hour period (Leigh and Fipps, 2009). The time-line for these tests was as follows:

- pre-lining test - September 2002
- lining project completed - October 2004
- first post-lining test—November 2004
- second post-lining test—July 2005.

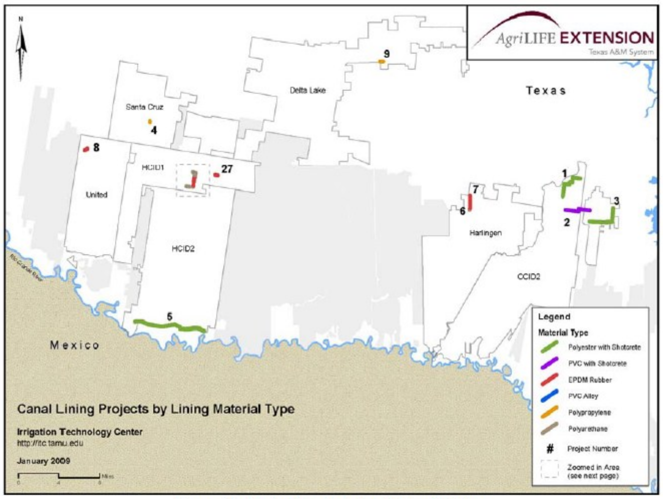


Figure 1. Lining Projects by Material Type

RESULTS AND DISCUSSION

The results of our evaluations are summarized in Table 3. Projects are grouped into lining projects *with a protective barrier* and projects *without a protective barrier*. Without question, liners with a protective barrier performed the best and have required no maintenance, while the performance of the liners without a protective barrier has varied significantly.

Table 3. Range of the performance rating results by lining material

Material	No. of Projects	Total Miles	Rating
with a protective barrier			
Polyester with	4	14.47	Excellent
PVC with shotcrete	1	2.61	Excellent
without a protective barrier			
Polypropylene	2	0.36	Excellent to Good
PVC Alloy	3	0.05	Excellent to Good
EPDM Rubber	8	2.04	Excellent to Serious
Polyurethane	9	1.42	Excellent to Serious

<u>Liners with a Protective Barrier</u>
The best performers were the synthetic liners with a layer of shotcrete. This system is effective as the liner reduces seepage losses dramatically, while the layer of shotcrete prevents damage to the liner. Five projects extending over about 17 miles were implemented using this system with two different liners: polyester and PVC. The protective barrier consisted of 2 - 3 inches of shotcrete as shown in Figure 2.

To-date, these projects show no evidence of problems and have required no maintenance. No difference in performance was observed between the two types of liners. Hairline cracks developed in the shotcrete on a small stretch of Project #5, but no related problems have been observed.


Figure 2. Polyester canal liner with a 3-inch protective barrier

An important consideration with this system is the ability of the shotcrete to adhere to the liner. The polyester liner has a rough surface to which the shotcrete readily adheres to, while surface of the PVC liner is slick, and a wire mesh must be used.

In seepage loss tests, we found that this lining system reduced seepage losses by 94% after eight months (Leigh and Fipps, 2006). Details are as follows:

- before lining, loss rate = 1.36 gal/ft2/day (134 ac-ft/mi/yr)
- one (1) month after installation, loss rate = 0.27 gal/ft2/day (24 ac-ft/mi/yr)
- eight (8) months after installation, loss rate = 0.09 gal/ft2/day (8 ac-ft/mi/yr)

<u>Liners without a Protective Barrier</u>
The performance of the liners without a protective barrier has varied significantly. Exposed liners are obviously more susceptible to damage caused by UV light, animals, and vandalism, as well as damage

Continued on next page

caused by the districts' mowers and maintenance activities. However, the amount of damage varied by the location of the project. Liners in remote areas have performed much better than those in urban or high traffic areas.

Installation and maintenance of the liners also appears to explain some of the variation in performance of these projects as discussed below. Another consideration with exposed liners is the potential damage that machinery can cause during normal district mowing operations and while cleaning out aquatic vegetation and sedimentation (Figure 3).

Figure 3. Aquatic vegetation and sedimentation clogging a farm outlet pipe

In general, of the four types of materials, the polypropylene and PVC alloy liners have been more durable and have experienced less damage. The performance of the other two liners, EPDM rubber and polyurethane varied significantly. While some projects are still in excellent condition, others have serious problems or have failed completely. Details are discussed below by type of liner.

Polypropylene In two lining projects, polypropylene was applied on existing concrete canals. To-date, these two lining projects are in excellent condition, with no visual damage. Yet, for one of these projects, we have concerns with the large amount of wrinkles which occurred during installation. Wrinkles can reduce water flow, accelerate sedimentation, and provide loose material that can easily be damaged.

For the project shown in Figure 4, concrete sections approximately 1-foot wide were poured on top of the liner at a spacing of 500 feet. The rational is that the concrete sections will help keep the liner in place and provide access points for sediment removal. Our conclusion is that long-term evaluation is needed to determine if such sections are useful for these purposes.

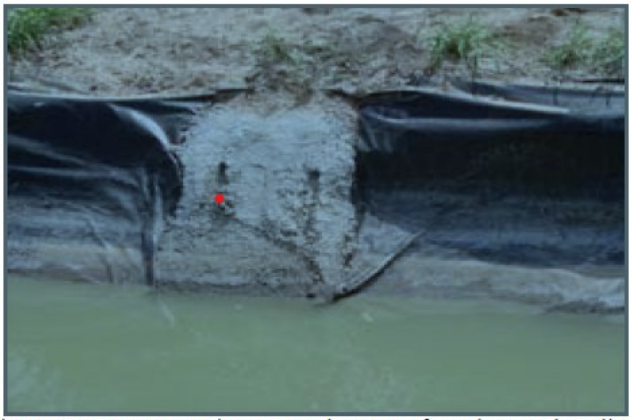


Figure 4. Concrete sections poured on top of a polypropylene liner

PVC Alloy Three short sections of PVC alloy were installed in 1999, ranging in length from 38 to 148 ft. This material has performed well, requiring little maintenance, with no major damage observed. However, cuts and tears have occurred in the exposed area of the liner (Figure 5) which could develop into larger problems if not taken care of in a timely manner. The overall performances for these small test segments are excellent to good.

Figure 5. PVC Alloy liner damaged on the exposed area

EPDM Rubber The performance of the eight projects using EPDM rubber has varied significantly. Two projects are in good to excellent condition, while the remaining six ranges from fair condition to serious problems, with one totally failing. EPDM rubber is very susceptible to vandalism and punctures caused by animals. It also appears that many cuts and tears

Continued on next page

initially occurred on the exposed areas where there is the most human and animal traffic (Figure 6). Unless repaired in a timely manner, these tears may lead to increasing amounts of damage (Figure 7).

Figure 6. Cuts/tears in a rubber liner

Figure 7. A rubber liner damaged possibly due to vandalism

Polyurethane During 1999 - 2000, nine short sections were lined with polyurethane, totaling 1.42 miles. The current condition of these projects varies from excellent to serious problems, with one section a total failure. Observed problems include the liner falling off the canal walls which was likely caused by a combination of severe UV damage (Figure 8), material defects, and vandalism. In some segments, the top layer of the material has peeled off, while in others, the entire liner has worn off (Figure 9).

Unlike the other liners, the polyurethane was manufactured on-site by specialized machinery, and requires that the chemicals used to be properly handled. Several problems occurred during its manufacture and installation, including inconsistency in product thickness, which may account for the large variation in performance. In addition, little to no maintenance has occurred since installation. The location of the section does not appear to be a factor. For example, projects 17, 18, 20, and 21 are all continuing test segments; while projects 17 and 21 are in excellent shape, projects 18 and 20 have serious problems.

Figure 8. Polyurethane liner is shown hanging off the canal wall.

Figure 9. Residue left from a deteriorated polyurethane liner

CONSIDERATION WHEN PLANNING NEW LINING PROJECTS

The installation procedures and equipment requirements vary from material to material, with details available from each manufacturer. Proper installation and maintenance is necessary for avoiding or reducing problems that may contribute to accelerated deterioration of the material.

Lining Installation
Important installation considerations include:

- the methods used to overlap and mend/seam the layers of lining material together

Continued on page 19

- the methods used for attaching the material to the canal walls, around structures, and to the top of the levee (top anchor)
- the total width of the liner and extension on top of the levee in relation to the normal and maximum operating depth of the canals

Liners need to be properly installed and stretched in order to prevent wrinkles. Wrinkles not only look unprofessional, but make the liner more susceptible to damage. Glues, liquid rubbers resin, tar and types of metal pins are used to secure the material around the structures and at the joints (Figures 10).

Figure 10. Glues being applied to the joints of a polyester liner.

In one of early lining projects, the liner size was not planned properly to overlap and extend onto the top of the levee (Figure 11). As seen in Figure 12, the operating depth of the canal was higher than the top of the liner. The water eventually got underneath this liner and caused it to float.

Figure 11. Canal liner installed too low on the levee

Figure 12. Water level higher than the canal liner installed

Most damage has occurred on the exposed areas of the liner and top side walls of the canal. Figure 13 shows a cut made with a sharp object (probably intentional vandalism) verses Figure 14 could have been a case of unintentional vandalism. In areas where kids are playing, swimming in the canals, or being mischievous, intentional and unintentional vandalism will occur. Vultures have been reported to pick at the seams on the EPDM Rubber; animal hoofs can cut some liners.

Figure 13. Horizontal cuts likely due to vandalism on the canal sidewall

Continued on next page

Figure 14. Vertical cut or tear on canal side wall caused unintentionally

Use of a Protective Barrier

While the initial costs of a lining project using a use of a protective barrier such as shotcrete are higher, these costs may be offset by the reduction in costs of maintenance and repairs over the life of the project. An important consideration is the ability shotcrete to adhere to the liner. The polyester material has small fibers (similar to the harden side of Velcro) to which the shotcrete will stick when sprayed on to the liner (Figure 15). On the other hand, the PVC liner has a smooth texture to which the shotcrete will not stick, and a wire mesh needs to be used on the top of the liner to provide grip and added reinforcement. This application also increases labor and cost.

Figure 15. Shotcrete being sprayed onto the fibrous polyester liner

Maintenance

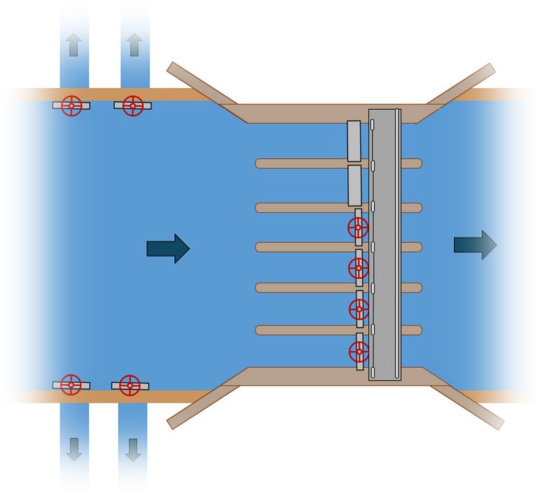
A regular inspection and maintenance program is important so that repairs can be completed on a time basis. Once a tear or cut starts, it will tend to expand or be susceptible to further damage until it is repaired. Districts should consider having their personnel trained to performed the repair and maintenance which sometimes requires specialized equipment, and similar glues and adhesives used during the installation process (Figures 16 and 17). Removing sediment from lined canals may be more difficult due to the limitations of using heavy machinery, and may require increased manual labor (Figure 18).

Figure 16. A district maintenance crew repairing a damage section of lining

Figure 17. Repair of the liner joints around a structure with glue

Figure 18. Sedimentation at the bottom of a lined canal

Continued on page 22



NEW Comprehensive Irrigation Structure Control Package

FLUID

Advanced automation for gate control and flow management

Developed and implemented by:
Cal Poly SLO Irrigation Training & Research Center (ITRC)

Sponsored by:
USBR California-Great Basin Region

What is FLUID?

FLUID is a new comprehensive control package for canal gate structures. It was built for the Schneider Electric SCADAPack RemoteConnect platform and can control:

- Up to 6 main check structure gates
    - Undershot Gates (radial gates, sluice gates)
    - Overshot Gates (tilt, Langemann)
- Up to 4 lateral gates

FLUID includes various control modes, which can be changed on-the-fly via the site OIT or HMI:

- Remote Manual
    - Gate position control
- Automated
    - Upstream water level control
    - Downstream water level control
    - Flow control without level overrides
    - Flow control with level overrides
    - Lateral flow control

Why use FLUID?

- Developed from decades of ITRC research and field experience with canal control.
- Multiple control modes that can be changed on-the-fly via the site OIT or HMI
- Integrate with a new or existing SCADA systems
- Provide accurate flow totalization
- Comprehensive alarm suite (power monitoring, site intrusion, failure and sensor parameter alarming)
- Role-based access for operators and supervisors

Flow &
Level
Universal
Irrigation
Dashboard

Implementation Process

- Modernization Plan/Rapid Appraisal
- Survey & analysis
- ITRC optimization routines for control constants
- Streamline code
- Coordinate with implementation team
- Site commissioning
- Maintenance support (long-term)

What's Next?

- A separate, future control package will include pump control. Look for that package in late 2025 or early 2026.

01/29/2025

Contact

Dr. Stuart Styles, P.E., Director
Irrigation Training & Research Center
California Polytechnic State University
San Luis Obispo, California 93407
(805) 748-9036
sstyles@calpoly.edu
www.itrc.org

LEARN BY DOING
CAL POLY
Irrigation Training
& Research Center

Synthetic Canal Lining Evaluation Project

(Continued)

CONCLUSIONS

The best performers were the two types of synthetic liners (PVC and polyester) with a protective barrier of shotcrete, which have shown no problems to-date. All five projects using a protective barrier were rated with a score of excellent since installation. The use of a protective barrier can extend the life of the lining project by preventing inadvertent damage and discouraging vandalism. The noticeable difference between the two types of liners was the ability of the polyester to hold the shotcrete in place on the canal sidewalls. The PVC liner required an additional support system using a wire mesh overlay serving as the attachment between the material and the shotcrete.

The performance of the synthetic liners without a protective barrier varied dramatically, ranging from excellent to having serious problems. Some were found to be more susceptible to such factors as installation problems, unintentional damage and vandalism.

Most of the damage to the synthetic liners occurred around the exposed areas of the liner near the top anchor attachments and top side walls of the canal. If the damage is not repaired in a timely manner, small tears can grow into larger ones. In general, exposed synthetic liners need more frequent inspections and regular maintenance.

In conclusion, the initial costs of a canal lining project will vary depending on the type of material and whether a protective barrier is used. For that reason, when planning a project, especially in areas of high traffic (animals and pedestrians), the district should consider if the short-term costs of adding a protective barrier will be more cost-effective compared to the long-term costs that will be incurred due to maintenance and repairs from the lining being damaged.

FUTURE COLLABORATIVE EFFORTS

Collaborative efforts are underway to assess more geosynthetic canal lining materials. Texas AgriLife Extension engineers and the Specialty Products division of Firestone are demonstrating three reinforced geomembranes with Adams Garden Irrigation District. The three lining materials included: 300 feet of Green TPO-R 0.060", 110 feet of Black Reinforced EPDM 0.045", and 160 feet of Black Reinforced fpp-R 0.045". During installation, the Extension engineers monitored and evaluated the installation techniques and materials used. The joining methods of the materials and sections were done using the overlap method and TPO QuickPrime tape along with a six inch wide standard unsupported QuickSeam Coverstrip. Further testing methods are being assessed such as tear and puncture testing methods used in the geosynthetic market today.

ACKNOWLEDGEMENTS

This material is based upon work supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under Agreement No. 2008-45049-04328 and Agreement No. 2008-34461-19061. For program information, see http://riogrande.tamu.edu.

REFERENCES

Martin Barroso Jr., GIS Specialist.

Leigh, E., and Fipps, G. (2009, January). *Measuring Seepage Losses from Canals Using the Ponding Test Method* (Publication B-6218). College Station: Texas AgriLife Extension Service.

Leigh, E., and Fipps, G. (2006, February). *Water Loss Test Results for Lateral A Before and After Lining Hidalgo County Irrigation District No.2* (TWRI Report No. TR-328, 2008). College Station: Texas AgriLife Extension Service, Texas

CANAL SEEPAGE REDUCTION BY SOIL COMPACTION

Charles M. Burt[1], Marcus Cardenas[2] and Mohamed Grissa[3]

Abstract
Large-scale tests were conducted of in-place compaction of irrigation district earthen canal bottoms and sides. Five canal pools with sandy loam soils were compacted. Seepage reduction of about 86% was obtained when the sides and bottoms were compacted; reductions of 12 – 31% were obtained when only sides were compacted.

Introduction

Irrigation districts that rely upon long, open canals share a common problem: canal seepage. Canal seepage can create difficulties including:

- Reduced water deliveries to farmers
- Increased pumping costs if the water in the canals is lifted by pumps
- Increased drainage problems, possibly causing crop yield and health problems
- Loss of water supply in a basin if the seepage goes to a salty aquifer or into the ocean
- Increased diversion from rivers, resulting in decreased in-stream flows

The two most common solutions for reducing seepage are lining canals or replacing them with pipes. These options bring along with them additional benefits, such as stabilization of banks (canal lining) or reduced need for access and fewer drownings (pipelines). However, these solutions are expensive. A typical piping cost in California for an irrigation district is in the neighborhood of $120 - $200/foot for pipe sizes in the 4' – 5' range (flows in the 20 – 30 CFS range). Canal lining costs are often in the neighborhood of $1 million per mile, which is prohibitive for most irrigation districts.

Therefore, the Irrigation Training and Research Center (ITRC), with support from CALFED and the California Agricultural Research Initiative, has experimented with an uncommon method of seepage reduction – in-place compaction of canal banks and canal bottoms.

Concepts of Soil Compaction

The general concepts of soil compaction for seepage reduction and soil consolidation are well documented in civil engineering, under the category of "soil mechanics". Everyone is familiar with compaction of soils for roadways, even if they do not understand the technical details. Additionally, many people are aware that two of the major dams in California (Oroville Dam and San Luis Dam) are earth-filled dams rather than concrete structures.

Soil laboratory tests for compaction (Proctor and Modified Proctor) have specified procedures by ASTM. Samples of soil are compacted by specified layer thicknesses, by specified weights dropped a specified number of times from a specified height. In a compaction test, this is typically done with a number of samples, each of a different moisture content. A graph such as Figure 1 is developed, illustrating what the moisture content should be during construction.

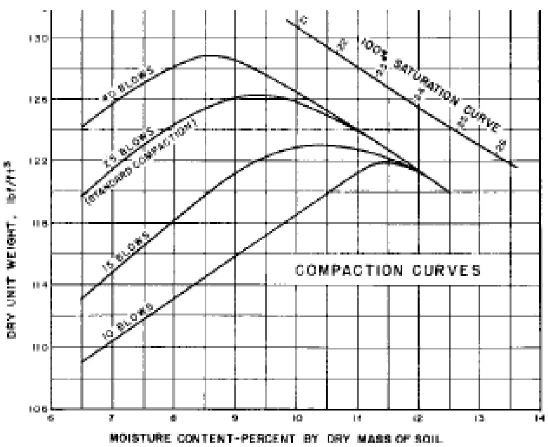


Figure 1. Compaction curves (USBR, 1998)

It is relatively common knowledge that some soils compact better than others and that as the level of compaction increases, the soil hydraulic conductivity (seepage rate) decreases. Optimum compaction will also depend upon the moisture content during compaction. If the soil is too moist or too dry, it will not achieve the "optimum bulk density". Different compaction techniques are suited for one soil or another, as shown in Table 1.

[1] BioResource and Agricultural Engr. Dept.; Founder, Irrigation Training and Research Center (ITRC), California Polytechnic State Univ., San Luis Obispo, CA 93407 charlesmburt@gmail.com
[2] Former Irrigation Specialist, ITRC
[3] Former Irrigation Engineer, ITRC

Continued on page 25

Canal Seepage Reduction by Soil Compaction

(Continued)

Table 1. Compaction equipment (Bader, 2001)

Effect of Soil Type on Equipment selection				
		Vibrating Sheepsfoot Rammer	**Static Sheepsfoot Smooth Roller**	**Vibrating Plate Vibrating Roller**
	Lift Thickness	*Impact*	*Pressure*	*Vibration*
Gravel	12 in.	Poor	No	Good
Sand	10 in.	Poor	No	Excellent
Silt	6 in.	Good	Good	Poor
Clay	6 in.	Excellent	Very Good	No

Additionally, the optimum moisture content for high bulk density does not necessarily translate to the optimum moisture content for reduced seepage. There are differences between laboratory and field activities and results. Some engineers believe that a slightly-moister-than-“optimum” soil in the field provides the best seepage reduction.

Soil Compaction for Sealing Canals

Perhaps the best source for information on earth lining of canals is a publication by ANCID (Australian National Committee on Irrigation and Drainage, 2001) entitled “Open Channel Seepage and Control”. This publication, as well as others, focuses on bringing soil material to the site one layer at a time and compacting each layer. The publication does mention “in situ” compaction – which is in-place compaction of existing canal banks and bottoms. The senior author has talked to engineers from dozens of irrigation districts in California about this, and has not encountered anyone who has tried it before this experiment.

Field Experiments in California

ITRC contacted four irrigation districts in the San Joaquin Valley of California who were experiencing seepage problems:

- Panoche WD
- Chowchilla WD
- San Luis Canal Co (also known as Henry Miller Reclamation District)
- James ID

Seepage tests were conducted on two Panoche WD canals, and it was determined that the seepage rates were very low. Plus, the soil was a heavy silty clay loam and it would have been impossible to dry the soil out enough for compaction without just making mud.

The other three districts had sandier soil, so compaction trials were conducted there. The results of one canal compaction effort in Chowchilla cannot be reported because the well that would have supplied the water for post-compaction seepage tests failed and was not repaired.

All the compaction work was “in-situ”, meaning that there was no addition of soil, and no over-excavation and replacement of compacted soil layers. The compaction was performed on the soil surface “as-is” with the exception of some smoothing of canal banks.

<u>Seepage Tests</u>. Prior to, and after compaction, ponding tests were conducted to determine the seepage rates. The ponding tests involved the following:

- The entire canal pool that was compacted was filled with water to the normal operating depth.
- The ends of the pool were sealed to prevent water from entering or leaving the pool.
- Weather data was recorded from the nearest CIMIS station, to estimate evaporation losses.
- Redundant water level sensors were installed to measure the change in water depth versus time.
- The water was replenished occasionally with a metered supply to maintain a fairly constant water level.
- Water temperatures were measured, to correct for different viscosities in pre- and post-compaction tests.
- Measurements began after water had been standing in the pool for several days, and continued for 1-3 days.

Figure 2. James ID Main Canal during pre-compaction seepage test.

Figure 3. James ID Main Canal during side compaction

Continued on next page

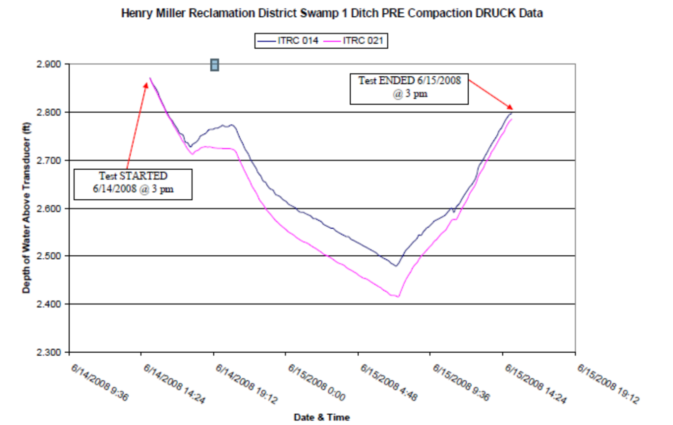


Figure 4. Pressure transducer data for ponding test – San Luis Canal Co (Henry Miller RD)

Soil Preparation. During the first compaction work at Lateral H in James ID, it was learned that if the canal banks were smoothed off, the compactor could operate much more quickly. Subsequent locations were therefore lightly smoothed off. There was no opportunity to obtain the "optimum" moisture content for compaction. Field conditions and availability required that the compactor begin work as soon as the canal had dried down enough to use the equipment without making mud. Certainly, moisture contents were different at various depths in the bands and bottom.

Laboratory Tests. Soil samples were taken in the field for a number of reasons. In some cases, undisturbed core samples were taken to measure bulk density before and after compaction. Texture samples (about 20 per canal section) were taken at various depths. Laboratory experiments were run with the modified Proctor test to determine optimum moisture contents for compaction, and the effects on hydraulic conductivity. Those laboratory results and their correlations with the field results have not yet been completed.

Equipment and Costs. The soil was compacted using a 45-thousand pound Kobelco excavator with an MBW 36-inch roller attached to the end of the boom. Installed immediately between the UVW-36 roller and the end of the excavator boom was a UV-10K exciter. This exciter is a hydraulically driven vibration mechanism. Since the vibratory exciter was hydraulically driven, the excavator operator could engage and disengage the exciter when he felt it was necessary.

The compaction accessories cost about $25,000 (not including the cost of the excavator) installed. An experienced operator was able to compact the sides of 1 mile of canal (both sides, meaning 2 miles total) in about 8 days. The cost for the operator, transport of the excavator, and the excavator rental was about $1.20/foot of canal, with about 10 feet of compaction on each side of the canal (cost = $1200 for 1000' long pool).

Figure 5. MBW 36" vibratory roller attached to the end of an excavator arm.

Figure 6. Compacting the sides and bottom of Lateral H at James ID

Figure 7. Compacting the canal banks on the James ID main canal with an MBW vibratory roller

Results

Table 2 shows the results of the in-situ compaction. Seepage reduction varied from 12% to 89%. Clearly, the three sites at which the canal bottom was compacted had much better results than the two sites at which only the sides were compacted. The seepage differences were probably due to additional factors, but this appears to be one possible explanation.

Table 2. Compaction results

Irrigation District	Location	Compaction		Cost, $	L, ft	Canal width, ft	Texture	Pre-Seepage, GPM	Post-Seepage, GPM	% Seepage Reduction
		Sides	Bottom							
Chowchilla WD	Site #2 – Ash Main Canal, between roads 11-12	Y	N	4,845	4,240	27	Loamy Sand	143	126	12*
James ID	Lateral H, from Main Canal to TO	Y	Y	3,240	1,010	15	Sandy Loam	86	12	86
James ID	Main Canal	Y	N	15,800	10,238	58	Sandy Loam	252	173	31
San Luis Canal Co.	Swamp 1 Ditch, between Turner Island & Deep Well	Y	Y	1,945	1,730	27	Sandy Loam	130	14	89
San Luis Canal Co.	East Delta Canal	Y	Y – with ride-on	3,100	3,020	19	Loam	80	8	90

*The Chowchilla WD site had sections of rip-rap along the canal banks that could not be compacted, resulting in a lower % seepage reduction

Continued on next page

Canal Seepage Reduction by Soil Compaction
(Continued)

Conclusion

For sandy loam soils, in-situ compaction with a vibratory roller reduced seepage. The seepage reduction was significant (86 – 89%) when both the sides and bottom were compacted. The compaction extended to a depth of about 2 feet, so it is suspected that the seepage reduction will withstand normal maintenance activities from year to year.

References

ANCID. 2001. Open Channel Seepage and Control, Vol. 2.1. Australian National Committee on Irrigation and Drainage. March 2001

Bader, C.D. 2001. Soil compaction: Modern solutions to an age-old need. Forester Media, Inc. http://www.forester.net/gx_0101_compaction.html. <Verified 9/30/2008>

USBR. 1998. Earth Manual – Part I. 3rd Edition. United States Department of the Interior, Bureau of Reclamation. Earth Sciences and Research Laboratory – Geotechnical Research Technical Service Center, Denver, CO. Also at http://www.usbr.gov/pmts/writing/earth/earth.pdf

CAL POLY
Irrigation Training & Research Center

Professional Education Opportunities at ITRC

2025-2026

www.itrc.org

Winter 2026

ITRC

Flow Measurement – January 2026
February 2026
(8 am - 5 pm)

Sponsor: USBR California-Great Basin Region

ITRC is providing several training and educational opportunities for staff, engineers, and water operators of agricultural irrigation districts. These classes utilize the excellent indoor and outdoor facilities at ITRC.

Chico

Flow Measurement – ***February 2026***
(9 am - 4 pm)

Sponsor: USBR California-Great Basin Region

Provided in cooperation with Chico Farm, this annual flow measurement and canal operation training covers topics including: flow measurement details such as how to properly use a meter gate, how to get more water through various structures, and an introduction to SCADA.

ITRC

Pumps (for Irrigation Districts) – February 2026
(8 am – 5 pm)

Sponsor: USBR California-Great Basin Region

Pumps topics covered include types; terms; curves; pumps in series and parallel; system curves; TDH computations; efficiency; WHP, BHP, input HP; pump selection; common pump questions and answers.

ITRC

SCADA (for Irrigation Districts) – 2026
(8 am - 5 pm)

Sponsor: USBR California-Great Basin Region

This course provides an overview of SCADA systems, starting with electric and electronic fundamentals and moving on to typical technician role and responsibilities.

Spring and Summer 2025

ITRC

Certified Irrigator Program
Training for ITRC Certified Irrigator
(8 am - 5 pm)

Sponsor: CDFA WETA

Certified Irrigator I
Focuses on the basics of irrigation.

Certified Irrigator I (English and Spanish)
August 2025
Winter 2026

Certified Irrigator II
Covers basic pipeline hydraulics, irrigation efficiency, salinity management for drip/micro and drainage and freeze protection.

Certified Irrigator II (English and Spanish)
August 2025
Winter 2026

Exam administered after class.

ITRC

Ag Irrigation System Evaluation Short Course 2025
Training for ITRC Certified Evaluator
Sponsor: DWR

ISE I: Theory and Laboratory Practice of Evaluations.
This 2½-day course will be held **June 16-18, 2025.** The class combines classroom (50%) and outdoor laboratory (50%) activities.

ISE II: Field Evaluations of Drip/Micro Systems
This 2½-day class, held on **June 23-25, 2025**, travels to the San Joaquin Valley and performs the entire evaluations on 2 fields.

Exam administered after class.

CHICO

Ag Irrigation System Evaluation
Training for ITRC Certified Evaluator
May 20-22, 2025 *(9 am - 4 pm)*

Sponsor: DWR

This comprehensive 3-day class combines classroom (50%) and outdoor laboratory (50%) activities. The techniques and programs covered are the standard used for DWR-funded evaluation projects throughout California.

ITRC

Designer/Manager School of Irrigation
(8 am - 5 pm)

The Designer/Manger School is a comprehensive educational program offering a variety of classes designed for agricultural irrigation professionals. See http://www.itrc.org/classes/desmgr.htm for details.

Irrigation Scheduling **July 23-25, 2025**
Training for IA Certified Ag Irrigation Specialist
Soil texture and structure, water holding capacity, retention, intake rates, evaporation, transpiration, soil classification, measurement of soil moisture and tension, ETo and crop coefficients. *Exam administered after class.*

Pipeline Hydraulics **July 28-29, 2025**
Pipe material & sizes, energy equation, friction, elevation changes, and basic spreadsheet operations.

Pumps **July 30 – August 1, 2025**
Pumps topics covered include types; terms; curves; pumps in series and parallel; system curves; TDH computations; efficiency; WHP, BHP, input HP; pump selection; trimming impellers; common pump questions and answers.

Row Crop Drip Irrigation **August 5, 2025**
Design layouts, flushing, fittings, how design relates to management, hose installation, retrieval.

Drip/Micro Irrigation Design **August 6-8, 2025**
Training for IA Certified Irrigation Designer
Filtration, step-by-step design procedure of hardware selection and hydraulics, drip/micro system design, SDI for trees and vines, plugging prevention. *Exam administered after class.*

ONLINE

Fertigation
Training for ITRC Certified Fertigator
Online class available now!
Sponsor: CDFA FREP

The class will cover new techniques in the control and application of fertilizers through irrigation systems and strategies to conform with the intent of the new nitrogen regulations in California. Increasing yields per acre-foot of evapotranspiration (ET) through better fertility management, will also be discussed – a key topic for California growers. *Exam administered after class.*

USCID

1521 I Street
Sacramento, CA 95814
(916) 441-1064
www.uscid.org

The United States Committee on Irrigation and Drainage is a National Committee of the International Commission on Irrigation and Drainage.

USCID Meeting

USCID Conference. October 21-24, 2025, Reno, NV.

Mission Statement

The mission of USCID is to promote progressive and sustainable irrigation, drainage and flood control practices in support of food and fiber production and public safety, recognizing that sustainability embodies economic, social and environmental goals.

USCID Newsletter and Membership

The *USCID Newsletter* is published by ITRC for USCID members. News items and technical articles of interest to the irrigation community are invited. Membership information is available on the USCID website www.uscid.org

United States Committee on Irrigation & Drainage

2025 Annual Conference

USCID

October 21-24, 2025
Eldorado Resort Casino
Reno, Nevada

2025 USCID CONFERENCE
SCHEDULE AT A GLANCE (subject to change; please refer to our website for updates)

TUESDAY, OCTOBER 21

7:00am — **CONTINENTAL BREAKFAST (workshop participants only)**

8:00am-11:30am — **WORKSHOP: LINING AND SEEPAGE REDUCTION (separate registration required)**
Presented by Charles Burt, Cal Poly ITRC Founder and Dan Howes, Cal Poly ITRC Chairman
This workshop will include presentations on:

- *Justifications for lining, including bank stability, less hydraulic resistance, less maintenance, and seepage reduction*
- *Options and details of vibratory compaction without liners, simple geomembrane liners with no geotextile or concrete, geomembranes with concrete cover, concrete only, shotcrete, concrete canvas, and treated soil*
- *Differences between geotextiles and geomembranes; woven and non-woven geotextiles*
- *ASTM specs for geomembranes and various geotextiles*
- *Results of studies regarding longevity of various linings under various situations*
- *How to deal with situations involving seepage reductions with different variables*
- *Installation hints and tricks*

12noon-1:15pm — **OPENING LUNCH WITH SPEAKER**

1:30pm-3:00pm — **GENERAL SESSION: Multistate Irrigation District Panel**

3:30pm-5:00pm — **GENERAL SESSION: Competition in Water for Ag, Urban and Environmental Uses**

5:00pm-6:30pm — **WELCOME RECEPTION WITH EXHIBITORS**

WEDNESDAY, OCTOBER 22

7:30am-8:30am — **CONTINENTAL BREAKFAST WITH EXHIBITORS**

8:30am-10:00am — **GENERAL SESSION: Environment and Economics**

10:30am-12noon — **GENERAL SESSION: Water Supply**

12noon-1:15pm — **LUNCH WITH SPEAKER**

1:30pm-3:00pm — **GENERAL SESSION: Water Demand**

3:30pm-5:00pm — **GENERAL SESSION: Challenges in Water Policy, Planning and the Law**

5:00pm-6:30pm — **RECEPTION WITH EXHIBITORS**

THURSDAY, OCTOBER 23

7:30am-8:30am — **CONTINENTAL BREAKFAST WITH EXHIBITORS**

8:30am-10:00am — **GENERAL SESSION: Basin Water Management and Governance**

10:30am-12noon — **GENERAL SESSION: Groundwater Recharge Panel**

12noon-1:15pm — **LUNCH WITH SPEAKER**

1:30pm-3:00pm — **GENERAL SESSION: Water Technology and Remote Sensing**

3:30pm-5:00pm — **GENERAL SESSION: Water Technology and Open ET**

FRIDAY, OCTOBER 24

7:15am-3:30pm — **FIELD TOUR (separate registration required)**
Walker River Irrigation District (Yerington, NV) Irrigation Modernization

CONFERENCE WEBSITE

*Please visit us at **https://www.uscid.org/events** for conference information, up-to-date schedules, hotel information, online registration, and to download registration, exhibitor, and sponsorship information forms. ONLINE REGISTRATION IS AVAILABLE ON OUR WEBSITE.*

CALL FOR PAPERS

*Abstracts of proposed papers/presentations are invited. Information can be found at **https://www.uscid.org/events**. The deadline for abstract submission is May 1, 2025.*

HOTEL INFORMATION & RESERVATIONS

The 2025 United States Committee on Irrigation & Drainage will be held at the Eldorado Hotel & Casino, located at 4th and Virginia Streets in downtown Reno, Nevada. Room rates start at $45 (plus reduced resort fee of $15/day and applicable taxes.

- *Book online at **https://www.uscid.org/events**. Click on the Hotel Information tab.*
- *Call the hotel reservations line at (800)687-8733. Please mention the USCID Conference, group code **SRCID5** to ensure the group rate.*
- *MAKE YOUR RESERVATIONS EARLY!!!!! THE DEADLINE FOR HOTEL RESERVATIONS AT THE SPECIAL RATE IS OCTOBER **6, 2025** **OR** UNTIL OUR ROOM BLOCK IS FILLED.*

CONFERENCE DEADLINES

- *The Eldorado Hotel room reservation deadline is October 6, 2025 OR until our room block fills.*
- *Conference early registration deadline is September 6, 2025. After September 6, registration fees are higher.*

CANCELLATIONS

- *Eldorado Hotel room reservation cancellations must be made directly with the hotel at least 72 hours prior to your scheduled arrival to avoid a cancellation penalty.*
- *Conference registrations cancelled by October 6 will be refunded in full. There will be no refunds for registrations cancelled after October 6 or for "no shows".*

EXHIBITOR INFORMATION

*Exhibitor Receptions will be held Tuesday and Wednesday evenings. In addition, continental breakfasts and breaks will be served in the exhibit area on all days. For details, please refer to the enclosed Exhibitor Information and Application. If you have questions, please call us at (916)206-7186 or email **jane@agamsi.com**. Information and online registration is also available on our website: **https://www.uscid.org/events***

SPONSORSHIP INFORMATION

*A limited number of sponsorship opportunities are available. Please refer to the enclosed Sponsorship Opportunities menu. Information and online registration is also available on our website: **https://www.uscid.org/events***

MARK YOUR CALENDARS

United States Committee on Irrigation & Drainage 2026 Annual Conference
October 20-23, 2026
Eldorado Resort Casino, Reno, NV

QUESTIONS?

*Contact Jane Townsend at (916)206-7186 or **jane@agamsi.com** or Megan Corcoran **megan@agamsi.com***