Grant Application

73-19L-1 Canal Lining Project, Colorado River Irrigation Project

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1. TECHNICAL PROJECT DESCRIPTION AND EVALUATION CRITERIA

1.1 Executive Summary

On this date, September 17, 2020, the Colorado River Indian Tribes (CRIT) are pleased to submit this proposal: "73-19L-1 Canal Lining Project, Colorado River Irrigation Project" to the United States Bureau of Reclamation Water and Energy Efficiency Grants (WEEG) Program under FOA No. BOR-DO-21-F001 Funding Group I. CRIT believes that there is a clear need to take a prominent role in managing the water resources that sustain their culture and livelihoods. The project's goal is to line a 3,985 ft-long canal reach for The Colorado River Irrigation Project's lateral, 73-19L-1, that has so far been documented as having the highest seepage rate of all 232 miles of canals in the Colorado River Irrigation Project (CRIP). The lining method of the proposed project is a progressive approach in that it will be lined with a geosynthetic membrane followed by a shotcrete cover that will improve the overall lifetime and drastically reduce yearly maintenance. The proposed project is expected to result in a total water savings of 267 AFY. The total cost for the proposed project is estimated to be $443,229, of which, $209,182 is requested in federal funding. This project is expected to be completed within 2 years of award as required under FOA No. BOR-DO-21-F001 Funding Group I. The CRIP is an 80,000-acre irrigation project in the Lower Colorado River Valley in Arizona near the town of Poston in La Paz County and it is owned and operated by the US Bureau of Indian Affairs (BIA) in trust for CRIT.

1.2 Background

The Colorado River Indian Reservation was established March 3, 1865 by the Federal Government for the Indian Tribes of the Colorado River and its tributaries. The Tribes include the Mohave, whose aboriginal territory includes the Reservation lands along the River, the Chemehuevi who were displaced when Parker Dam was constructed, and Navajo and Hopi who were relocated to the Reservation. The Mohave, Chemehuevi, Hopi, and Navajo Tribes, are collectively, the Colorado River Indian Tribes.

The Colorado River Indian Reservation lies entirely within the Lower Colorado River Valley (LCRV) which is the largest, hottest, and driest subdivision of the Sonora and Mohave Deserts (University of Arizona, 2008). The Reservation encompasses a total of 432 square miles (1,119 square kilometers), the majority of which is in the Parker Valley of Arizona (Colorado River Indian Reservation, 2009). The Colorado River Runs through the Reservation delineating its Arizona and California land areas. Most of the Reservation is in the western La Paz County in Arizona. Parts of the Reservation also lie in southeastern San Bernardino County, California, and northeastern Riverside County, California. However, the project area only falls within La Paz County, Arizona.

Tribal government was established under authority of the Indian Reorganization Act (48 Stat. 984) 1934. The Tribes are governed by a 9-member council including a Chair and Vice Chair. Council Members serve 4-year terms. All Council Members represent the entire Reservation.

1.2.1 Hydrology

The Colorado River is a significant and, in general, the only source of water for the Reservation providing for agriculture in an arid environment as well as for recreation and tourism (University of Arizona, 2008).

The Reservation is located in an area characterized as an arid climate with hot, dry summers, and mild winters. Maximum daily average air temperature is around 105 ^{o}F in July and August. Daily maximum air temperatures of 115-120 ^{o}F in July and August are not uncommon. Daily average minimum air temperatures are around 36-37 ^{o}F during the winter months of December and January. Total annual grass reference evapotranspiration (*ETo*) is estimated at 77.89 inches per year. Total annual precipitation is very low, averaging 3.12 inches per year.

Historically, and currently, surface water diversions from the Colorado River make up the primary source of irrigation water supply for the Reservation. The US Bureau of Reclamation (USBR) prepares annual water accounting reports to provide final records of diversions of water from the mainstream of the Colorado River, return flows to the mainstream, and the consumptive use of such water within the Lower Colorado River Basin States of Arizona, California, and Nevada. The accounting reports document quantities of water drawn by surface diversion from the mainstream of the Colorado River, pumped directly from the mainstream, or pumped from wells in the alluvial flood plain.

Diversions for the Colorado River Indian Reservation are reported for both Arizona and California in the USBR decree accounting reports. Diversions to Reservation land served by the CRIP are made at Headgate Rock Dam and are measured using the USGS gage: 09428500 Colorado River Indian Reservation Main Canal near Parker, Arizona. Other diversions to Reservation lands in Arizona not served by CRIP are also reported for decree accounting purposes. Groundwater development in the basin is small as a consequence of the availability of surface water for irrigation and the low population in the basin. There currently is no diversion and use of groundwater supply water for irrigation on the Reservation.

Return flows of water to the mainstem of the Colorado River are categorized as measured and unmeasured. Measured returns have historically been recorded at the following spill and wasteway gaging station operated by the USGS:

- USGS Gage 09428505: Gardner Later Spill Near Parker, AZ
- USGS Gage 09428508: CRIR Upper Main Drain Near Poston, AZ
- USGS Gage 09428510: Poston Wasteway Near Poston, AZ
- USGS Gage 09429030: Palo Verde Drain Near Parker, AZ

- USGS Gage 09429060: CRIR Lower Main Drain Near Parker, AZ
- USGS Gage 09429070: CRIR Lower Main Drain Below Tyson Wasteway Near Ehrenberg, AZ

USGS Gage 09428510 replaced USGS Gage 09428508 CRIR Upper Main Drain near Poston in WY2010. USGS Gage 09429070 replaced USGS Gage 09429060 CRIR Lower Main Drain near Parker in WY2010.

1.2.2 Water Rights

The Colorado River Indian Tribes have Colorado River water rights decreed by the United States Supreme Court in the case: Arizona v. California, 547 U.S. 150 (2006), also known as the 2006 Consolidated Decree. CRIT's Colorado River water rights are the lesser of: 719,248 acre-feet of diversions from the mainstream, or, the quantity of mainstream water needed to supply the consumptive use required for irrigation of 107,903 acres of land and satisfaction of related uses. The rights are "present perfected rights" meaning they are considered to be in existence prior to the effective date of the Boulder Canyon Project Act, and that with respect to Federal reserved water rights they are rights to use of water on Federal reserved lands under Federal law whether or not the water has been applied to beneficial use (Arizona v. California, 2006).

Reservation land is located in both the States of Arizona and California, and the water rights are accordingly partitioned for use in the two States. Priority dates are associated with the dates that CRIT land was reserved under Executive Order, CRIT has the right to divert the lesser of 662,402 acre-feet of water from the mainstream, or, the quantity of mainstream water needed to supply the consumptive use required for irrigation of 99,375 acres of land and satisfaction of related uses in Arizona; and, the right to divert the lesser of 56,846 acre-feet of water from the mainstream, or, the quantity of mainstream water needed to supply the consumptive use required for irrigation of 8,528 acres of land and satisfaction of related uses in California. A unit diversion quantity of 6.67 ac-ft/ac applies in both states.

1.2.3 Colorado River Irrigation Project

The primary economic activity on the Reservation has traditionally been dominated by irrigated agriculture. The main crops produced are alfalfa, wheat and other small grains, cotton, Bermuda grass hay, Sudan, and miscellaneous vegetable and other crops (onions, garlic, broccoli, potato, flowers). The CRIP was initiated under the 1867 Appropriations Act, which included funding for the construction of canals from the Colorado River to serve the Indians on the Reservation. Additional appropriations were made in 1868 and 1872. Special appropriations for irrigation structures continued in the early 20th century.

Major Expansion was completed in the 1940's to supply irrigation water to the Japanese internment camp on the Reservation at Poston. This included construction of Headgate Rock

Dam in 1942. The Project is a federal irrigation project governed by 25 USC §381 et seq and 25 CFR Part 171. It is operated by the U.S. Department of Interior Bureau of Indian Affairs (BIA) for the benefit of CRIT. The CRIP is managed by the BIA and serves approximately 80,000 acres of land that are assessed an annual fee for irrigation system operation and maintenance.

The primary diversion for the CRIP occurs at Headgate Rock Dam near the City of Parker. Headgate Rock Dam forms Lake Moovalya on the Colorado River. Water is diverted at the Dam into the Main Canal, which has a capacity of approximately 2,000 cfs (SFC, 1992). The Main Canal serves several lower order canals for conveyance and distribution of irrigation water throughout the CRIP service area. Several in-line structures are placed along the canals to adjust and maintain water levels throughout the system in order to provide relatively stable upstream head conditions at lateral inlets and farm gate turnouts. Farm irrigation operations take control of water delivery at the farm gate turnout and are responsible for irrigation water conveyance and distribution to the individual farm fields served by the turnout. The drainage network consists of approximately 50 spills to wasteways or open surface drains from supply canal overflow points or endpoints (BIA, 2002). CRIP drains collect spill and surface and subsurface return flow and convey this water to the Colorado River at several points located throughout the Project.

Approximately 232 miles of supply canals, which consist of the Main Canal, laterals, sublaterals, and sub-sublaterals, are used to convey water under gravity flow conditions from Headgate Rock Dam to Project farms (BIA, 2002). Of the 232 miles of supply canals, 90 miles are concrete-lined, and 142 miles are unlined earthen channels. The Main Canal is 18 miles long, 15 miles of which are concrete-lined. There are eight principal lateral canal offtakes from the Main Canal (19R, 19L, 27R, 27L, 42L, 46R, 73 and 90), not including smaller laterals, which are considered to reflect the function of lower order “sublateral” canals. Lateral canals comprise a total of 65 miles of channel, 36 miles of which are concrete-lined. In addition, there are 149 miles of lower order supply canals, of which 39 miles are concrete-lined.

There are six principal drains in the CRIP with additional feeder drains and wasteway ditches, comprising a total of 133 miles of drainage channels (BIA, 2002). Principal drains include the East Drain, Upper and Lower Main Drains, Mesa Drain, Tyson Wasteway, Palo Verde Drain, and the Pump Drain.

Currently, there are no irrigation water storage facilities on the CRIP, but that will soon change after Funding Opportunity Announcement No. BOR-LC-19-F002 FY 2019 awarded CRIT funds to design a re-regulating reservoir on the project. This project is expected to be completed within 15 months after receiving that specific award from USBR.

The CRIP has a Supervisory Control and Data Acquisition (SCADA) system (described in more detail below) which is operated by the BIA for remote monitoring of flow rates and water levels, and remote control of regulation structures. The CRIT Water Resources Department (WRD) is contracted by the BIA to manage SCADA sites and other continuous flow measurement sites on the Project through an Indian Self-Determination and Education Assistance Act, as amended, P.L., 93-638, 25 USC 450 et. seq. contract. The purpose is to support irrigation project operations. The purpose of these sites is to facilitate operational management and water delivery accounting. This includes continuous recording at the Main Canal and major lateral headings, inflow and outflow on 4 sublaterals serving 4 large leases, and at two primary high-volume spill locations.

Periodic manual measurements at over 40 lateral and sub-lateral spill sites (generally to wasteways or open drains) is also contracted by the BIA through the WRD. The purpose of these measurements is an attempt to improve accounting of operational waste on the CRIP.

1.2.4 Water Management Planning and System Optimization

In early 2015, CRIT Tribal Council contracted Natural Resources Consulting Engineers, Inc. (NRCE) and Cascade Economics, LLC (CE) to conduct several water use studies on the Reservation with objectives of assessing water use efficiency, gaining an understanding of opportunities for both conserving water and improving beneficial use of CRIT's water resources, and evaluating the economic returns of various Tribal water uses, while preserving and protecting CRIT's Colorado River water rights. CRIT has expressed a desire to improve the economic return on its Colorado River water allocation as well as to improve irrigation efficiency to result in water conservation. CRIT in keenly aware of water shortage conditions in the Lower Colorado River Basin and is interested in making conserved water available under different mechanisms to forestall system shortages or to make water available for other system users who may be at risk if shortages are declared. Over the period 2015-2017, the NRCE/CE team implemented and completed three studies for CRIT Tribal Council which effectively serve the purposes of a Water Conservation Plan.

- *Agricultural Resource Management Plan: Phase I—Irrigated Agriculture Inventory and Issues* (NRCE, 2016). The primary focus of the study was to collect baseline information and data on water supply and use on the CRIP. Information and data over the period 1996-2015 were collected and summarized—weather and climate, soil and land resources, total cropped area, cropping patterns/crop mix, sources and characterization of water supply quantity and quality, CRIP water delivery and distribution system infrastructure, water deliver operations and management, flow distribution and control, methods of water ordering, water rates and allocation, and preliminary identification of potential structural and operational issues. On-farm irrigation methods and practices were characterized. Irrigation water requirements for the crops and cropped areas of the CRIP and water balance analyses of: (1) the Project inflows, return flows and consumptive use, and, (2) the Colorado River reach from below Parker dam to below the Palo Verde diversion dam were performed to develop estimates of Project level agricultural water use efficiency.

- *Water Measurement Inventory, Colorado River Irrigation Project* (NRCE, 2017a). The purpose of this study was to locate and describe all water measurement sites that are on, or, are related to the Project. A technical assessment of each water measurement site was performed to develop estimates of the accuracy and reliability of the measured flow rate data, describe any issues/deficiencies of the site (physical infrastructure, measurement location, type of measurement, rating equation used for conversion to flow rate, etc.), and recommend corrective measures. The water measurement data management system—data storage, archival, backup, processing, reporting, etc,--where do the collected raw data reside, what data QA/QC processes are used, who has access, how what standard data processing and reporting is in place was evaluated. Water measurement site operation and maintenance procedures were reviewed. Locations on the Project where additional water measurements are needed were identified.

- *Agricultural Resource Management Plan: Phase II—Efficiency Analyses and Potential Water Conservation, Colorado River Irrigation Project* (NRCE, 2017b). This study assessed the conditions and operations of the Colorado River Irrigation Project and identified potential mechanisms to improve efficiency, with a goal of conserving water to allow expansion of irrigation acreage and/or make water available for alternate uses. Appraisal level estimates of costs and water savings for conveyance and farm level improvements across the Project were developed. Of the total average annual Project diversion of 610,000 AFY, an estimated 300,000 AFY spills, seeps, or evaporates as non-beneficial use. Multiple system infrastructure rehabilitation needs were identified as first priority for improvements to improve system functionality. System modernization and other upgrades, including expansion of flow measurement and SCADA operations on the Project, construction and automation of re-regulation reservoirs, canal lining, and drain water capture for re-use are recommended. Improvements on-farm level to address significant water losses and improve crop production are also needed.

1.3 Project Location

This 3,985-feet long proposed canal lining project at CRIP’s 73-19L-1 sublateral is located at 39°57’58.70”N and 114°23’40.67”W, approximately 1.7 miles south of Poston, AZ. Figure (1) gives a general map of the proposed project area with reference to the entire Colorado River Irrigation Project, and Figure (2) displays a detailed map of the 3,985-feet long reach proposed for lining along with its service area boundary. This project’s service area includes a maximum irrigated acreage of 720 acres, of which an average of 692 acres are irrigated in a given year based on the crop patterns from the past six years. Maximum flow for this canal reach is limited to 45 cfs according to BIA Irrigation Supervisor, Gary Colvin.

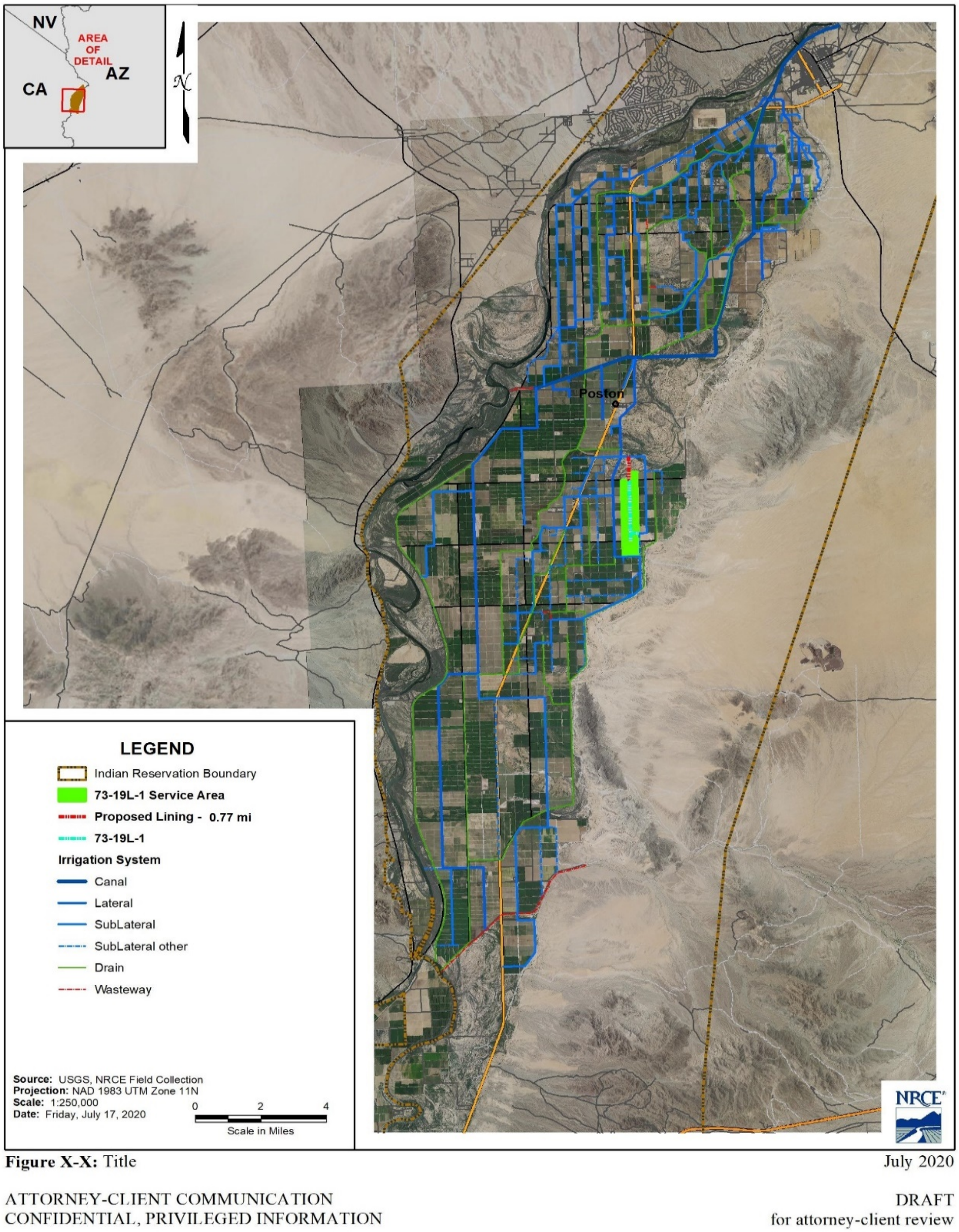

Figure 1. Project location with reference to the entire Colorado River Irrigation Project (CRIP)

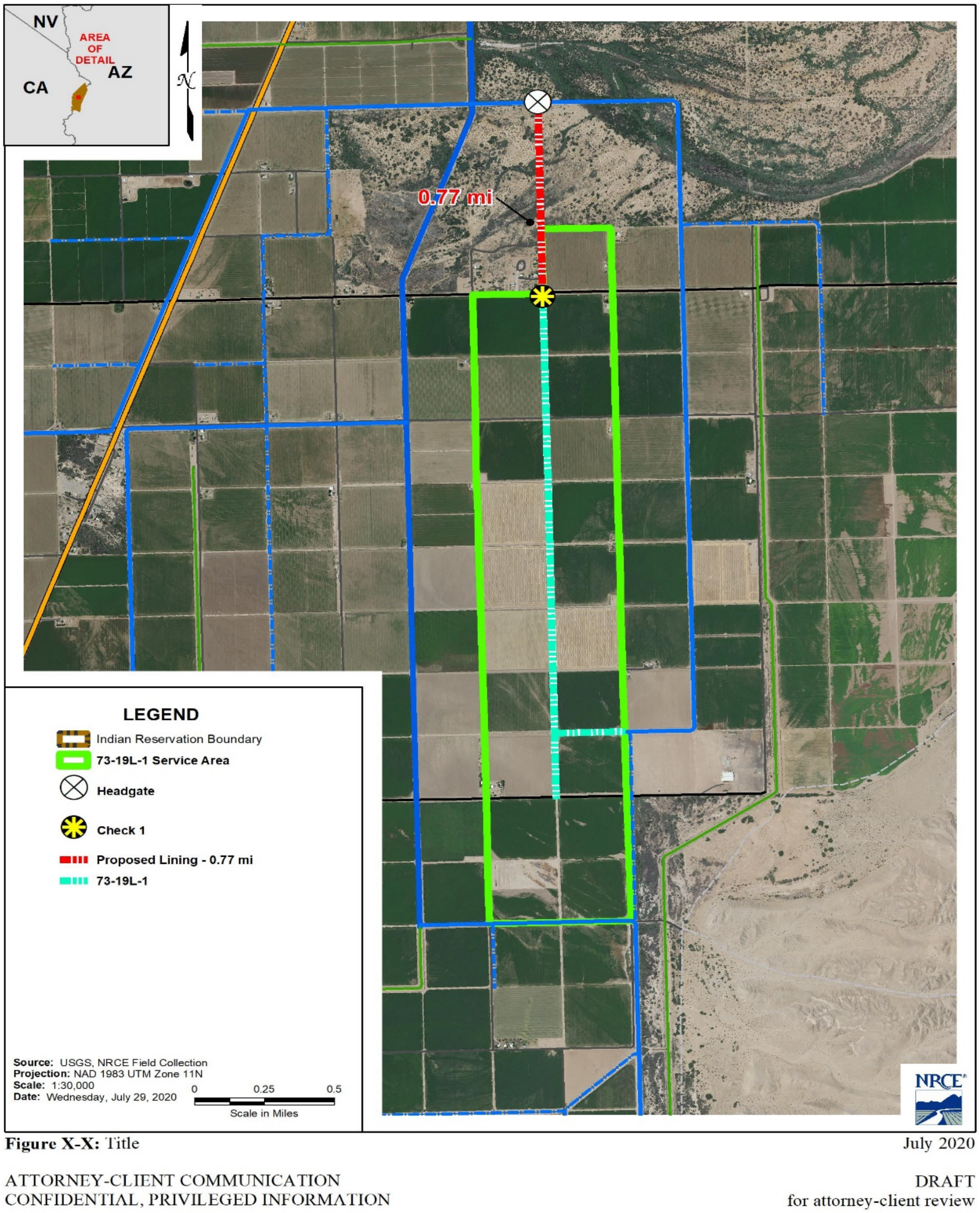

Figure 2. 73-19L-1 Service Area

1.4 Technical Project Description

1.4.1 Need for Assistance and Problem Statement

The CRIP is a very large project capable of irrigating approximately 80,000 acres each year and has senior perfected Federal reserved Colorado River water rights to divert 662,402 AFY. The CRIP has an estimated project-wide efficiency of 53.5% (NRCE, 2017b). Operational losses are estimated as 31% of the total diversion at Headgate Rock Dam and come in the form of evaporation (1% of diversion), seepage (11% of diversion), and operational spills (19% of diversion), (NRCE, 2017b).

A main goal of the Tribes is to maximize the amount of water available at each farmers' turnout. To accomplish this, operational spills and seepage losses need to be minimized. A project to reduce spills by means of a re-regulating reservoir will soon commence with the recently finalized assistance agreement between CRIT and Reclamation (Agreement No. R20AP00317). Additionally, the Tribes were awarded funding for SCADA System Modernization of the CRIP and are currently working to finalize the assistance agreement (R19AP00137). This project proposes to improve existing and add additional flow monitoring and control sites to better track water distribution and help to reduce spills. The subject project of this proposal would reduce operational losses from seepage by lining a section of earthen canal that has been found to have high seepage rates.

1.4.2 Proposal Statement

CRIT proposes to implement a canal-lining project at CRIP's lateral *73-19L-1* from its Heading to Check 1, totaling 3,985 linear feet, with funding assistance from USBR's WaterSMART Water and Energy Efficiency Grant program. This canal lining is estimated to result in the conservation of 267 AFY by reducing canal seepage.

The proposed method of lining is to utilize geosynthetic membrane lining that has been observed as having great success for many irrigation districts. In addition to the geosynthetic membrane, CRIT proposes to cover the membrane with 1.5-inch thick shotcrete for added protection. Use of the geosynthetic membrane is becoming more common as they are much cheaper and reduce more seepage than concrete because of the water-tightness and low permeability properties the geosynthetic membrane material has. Because geosynthetic membranes are more prone to wear-and-tear from nature's elements than concrete, whether that be by direct sunlight, rock punctures, or punctures from maintenance operators, the combination of a geosynthetic membrane with a shotcrete cover was determined as the best option for CRIT to reduce more seepage while maintaining a long-term product.

Figure (3) displays the proposed cross section of CRIP's 73-19L-1. The lateral's cross-sectional dimensions were surveyed every 300 feet along the entire reach. Layers of the proposed cross section include a prepared earthen base, followed by a geosynthetic membrane, which would then be followed by the 1.5-inch-thich shotcrete cover for lasting protection of the geosynthetic membrane and earthen channel. The total amount of geosynthetic material required is estimated as 144,288 ft^2, and the total amount of shotcrete required is estimated as 477 yd^3 based on the 1.5-inch thickness.

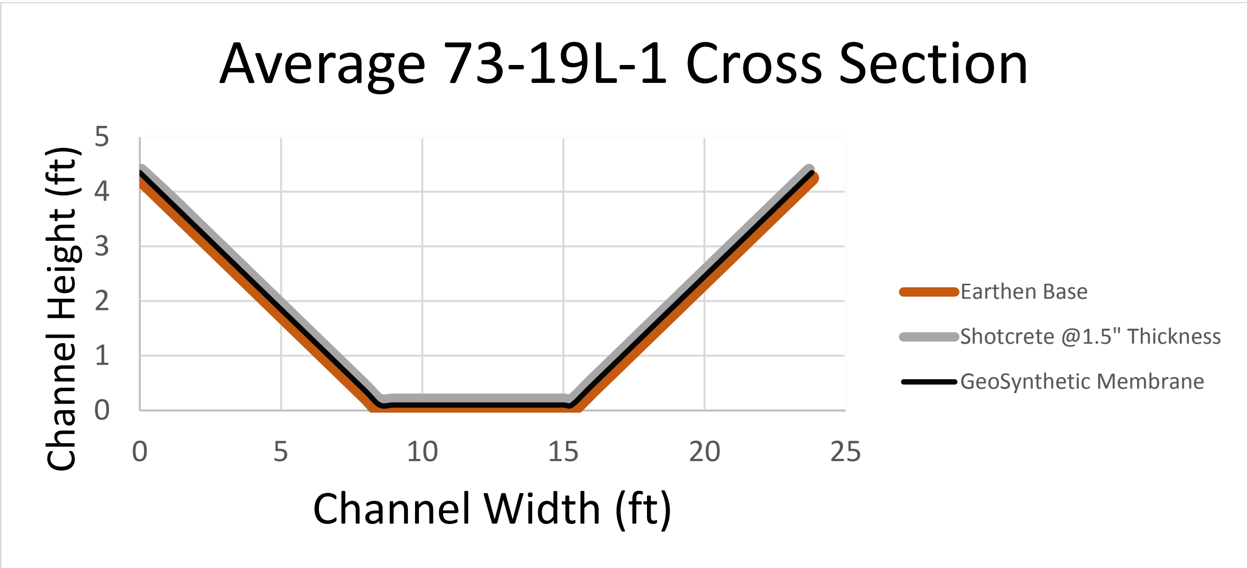

Figure 3. Proposed cross section of 73-19L-1

1.5 Evaluation Criteria

1.5.1 Evaluation Criterion A—Quantifiable Water Savings

1.5.1.1 Describe the amount of estimated water savings.

The water savings resulting from this project is expected to be 267 AFY.

1.5.1.2 Describe current losses.

The projected water savings will result from the reduction of canal seepage. These losses to seepage enter the alluvial aquifer and eventually return to the Colorado River. Currently, CRIT does not pump groundwater for irrigation purposes and 100% of canal seepage losses return to the river and are not put to beneficial use by the Tribes.

1.5.1.3 *Documentation to Support Estimated Water Savings (Seepage Tests)*

The CRIP is a very large irrigation project. With 232 miles of canals, 142 miles of which are unlined, the process of selecting 73-19L-1 as CRIT's most optimal canal-lining project was conducted using several steps. For example, CRIT, BIA, and NRCE worked collectively on seepage tests along five different canal reaches throughout the CRIP from December 2017-February 2018. These five canal segments were selected based on known soil types throughout the CRIP system, proximity to drains, and anecdotal information regarding canal segments or reaches thought to have high seepage loss rates. The method used for the seepage tests was the *ponding method*, where canal segments were bounded on upstream and downstream ends by plastic sheeting sealing at either: 1) A headgate and check structure, or, 2) Two consecutive check structures; both would result where water could remain ponded in the selected reaches. Figure (4) displays how the plastic sheeting was placed to prevent leakage at one of the test sites. Once the CRIT/BIA/NRCE team managed to raise the water levels in each reach with minimal leakage from turnouts or the check gate structure, the seepage rate could then be monitored. The seepage rates were determined by monitoring the rate of water-level depletion with pressure transducers. With measured channel dimensions, a seepage rate with a unit measure of $ft^3/ft^2/day$ was determined for each test reach.

Figure 4. Plastic sheeting sealing off a turnout on 73-19L-1 for seepage test via ponding method.

None of these seepage tests interfered with farmers' irrigation schedules, as CRIT/BIA/NRCE were able to conduct each test during each reach's corresponding 1-3 week dry-up, which is when the BIA shuts water off to conduct yearly maintenance throughout the CRIP.

Each test lasted an average of 3 days, and the corresponding seepage rate from each day was averaged for a total seepage rate for each test reach. Results from all 5 selected test reaches are summarized below in Table (1).

Table 1. Average seepage rates for five selected test reaches on the CRIP.

Average Seepage Rate ($ft^3/ft^2/day$)					
Test Reach	19L Check 3-4	19R-10 Heading to Check 1	27L Check 3-4	73-19R Check 2-3	73-19L-1 Heading to Check 1
Average Seepage Rate	0.580	0.374	0.468	0.494	0.684

Of all five test reaches, test reach 73-19L-1 (Heading to Check 1) was determined to have the highest average seepage rate of all five test reaches (0.684 $ft^3/ft^2/day$). However, this higher unit measure did not necessarily mean that 73-19L-1's test reach is the best candidate for lining. For example, higher flows in other canals may lead to higher annual seepage losses due to a larger averaged wetted perimeter. Also, another canal may have a higher benefit/cost ratio due to smaller channel dimensions. The steps that were taken to optimize CRIT's selection included determining average nonstop flowrates, annual seepage, and an estimated water savings in acre-feet per lined square foot ratio for all five test reaches.

A detailed description of the five seepage tests' results, along with the justification for selecting 73-19L-1 as CRIT's most optimal canal-lining candidate are included in a separate report (NRCE, 2020) and are summarized below in this section.

Reach Flow Rates

The first step in determining the best candidate for lining was to estimate an average annual flowrate for each reach based on typical crop water requirements and system efficiencies. This step was necessary to estimate the average wetted perimeter through which seepage occurs. The canals do not flow year-round, but with little flow data available, estimating operation schedules and flow rates would come with a very high level of uncertainty.

Not all test reaches have reliable water accounting data, so crop net consumptive use requirements were determined for each test reach based on average cropping patterns from 2014 through 2019. The method used was the (single mean) crop coefficient-reference evapotranspiration approach. Reference evapotranspiration was computed using the ASCE Standardized Reference Evapotranspiration Equation for short crop (ASCE, 2005) using weather data from the AZMET Parker #1 and Parker #2 weather stations. Crop coefficients were taken from the USBR Lower Colorado River Accounting System (LCRAS) as developed and reported in Jensen (1998, 2003). Reduction or stress coefficients for non-ideal conditions were applied as well. Effective precipitation, the fraction of total precipitation consumed by crop evapotranspiration, was also computed according to methods used for the Lower Colorado River Accounting System (Jensen, 1993). The annual diversion requirement for each reach was estimated assuming the project-wide efficiency of 53.5%. For the purpose of these seepage estimates, it was assumed that the annual diversion requirement is met at a constant flow rate throughout the entire year. Table (2) displays the results using the methods described above.

Table 2. Average annual crop consumptive use, annual diversion requirement given a 53.5% project-wide efficiency, and associated average flowrate for each test reach

Canal Reach	Crop Consumptive Use (AFY)	Total Diversion (AFY)	AVG Flowrate (cfs)
19L CH 3-4	4,357	8,143	11.25
19R-10 HDG-CH 1	1,403	2,623	3.62
27L CH 3-4	2,345	4,384	6.06
73-19R CH 2-3	3,514	6,568	9.07
73-19L-1 HDG-CH 1	2,657	4,966	6.86

Further Seepage Analyses

Higher flow rates are a leading factor in determining seepage, but the main factor affecting total seepage in this study was the *wetted perimeter* because a higher wetted perimeter results in more area for the water to seep into. The estimated average annual flow rates were used to determine the average annual wetted perimeter for each test reach using Manning's Equation. Use of Manning's Equation allowed for the determination of a "normal depth," given the average annual flow rates in Table 2. The normal depth was then used to calculate the wetted perimeter, which was enough information to accurately estimate annual seepage losses for all test reaches. These annual seepage losses are located in Table (3) (NRCE, 2020).

Table 3. Displays the average flow, channel dimensions, flow depth, wetted perimeter, and annual seepage losses from each of the five test reaches.

Canal Reach	AVG Flow rate (cfs)	AVG Flow Depth (ft)	Bottom Width (ft)	Side Slope	Channel Height (ft)	AVG Wetted Perimeter (ft)	Reach Length (ft)	Seepage Losses (AFY)
19L CH 3-4	11.25	1.36	9.5	1.25	6.86	14.6	1,300	92
19R-10 HDG-CH 1	3.62	0.93	6	1	4	9.2	1,860	54
27L CH 3-4	6.06	0.88	10.5	1.38	6.63	13.9	6,420	350
73-19R CH 2-3	9.07	1.43	6.9	1.33	6.77	12.4	1,390	71
73-19L-1 HDG-CH 1	6.86	1.15	6.8	2	4.25	11.9	3,985	273

Optimizing Method for Selection

The annual volume of seepage loss calculated for each test reach varied drastically. It can be observed in Table (3) that even with 73-19L-1 having the highest seepage rate collected from the seepage tests, it does not have the highest annual volumetric seepage loss. The test reach 27L from its Check 2 to Check 3 took the honor of the highest annual seepage loss. However, this is due to 27L Check 2-3 being a much longer reach. A longer reach results in a larger demand for geosynthetic membrane and shotcrete material, which may not be desirable. Therefore, a unit measure similar to a benefit/cost ratio was developed. This unit measure is a ratio of total water savings to total square footage to-be-lined for each reach, which can be expressed in the following equation:

$$Ratio = \frac{Total\ Water\ Savings_{AF}}{ft^2\ to\text{-}be\text{-}lined} * 100$$

Where:

Total Water Savings$_{AF}$ = Total Seepage$_{AF}$ = Value from Table (3)
Area (ft^2) to-be-lined = Lined Perimeter (ft) * Reach Length (ft)

Because material and labor costs are directly related to the square footage of lined canal, this ratio serves the same function as a benefit cost ratio from which the relative merits of lining each canal reach can be inferred. Table (4) displays the averaged cross section parameters, length of test reach, total seepage losses, and the ratio of estimated water savings in acre-feet per square foot of lined canal expressed as a percentage.

Table 4. Each Reach's channel dimensions and corresponding Ratio using above equation

Canal Reach	Bottom Width (ft)	Side Slope	Channel Height	Lined Perimeter (not wetted Perimeter, ft)	Reach Length (ft)	Area to-be-lined (ft^2)	Total Seepage Loss (AFY)	Ratio
19L CH 3-4	9.5	1.25	6.86	35.2	1,300	45,718	92	0.20
19R-10 HDG-CH 1	6	1	4	19.9	1,860	36,933	54	0.15
27L CH 3-4	10.5	1.38	6.63	36.2	6,420	232,482	350	0.15
73-19R CH 2-3	6.9	1.33	6.77	32.8	1,390	45,597	71	0.16
73-19L-1 HDG-CH 1	6.8	2	4.25	25.8	3,985	102,865	273	0.27

Conclusion from Seepage Tests

Canal reach *73-19L-1 Heading to Check 1* was determined to be the best candidate for lining based on the water savings per square foot of lining metric.

Expected Water Savings

The seepage tests conducted did not take evaporation into account. The expected evaporation losses were calculated using the crop coefficient reference ET approach. Using the canal dimensions and normal depth of the average annual flow rate shown above, the canal top width of flow was 11.4 feet and the total canal water surface area was 1.04 acres. The actual expected savings were calculated as 273 AF minus 5.61 AF in evaporation losses, equating to a rounded total expected water savings of 267 AFY upon completion of this project (NRCE, 2020).

Final Quantification of Water Savings

Therefore, the expected water savings upon completion of this project is 267 AFY.

1.5.1.4 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.

As previously described and presented in the previous section, the expected water savings from this project is 267 AFY, or 5.38% of the total diversion of 73-19L-1. According to a conversation with Dave Bos, Manager of Operations at Sunnyside Valley Irrigation District, a seepage reduction of 100% has been observed after implementation of a geosynthetic membrane covered in shotcrete along one of their canal reaches.

1.5.1.5 How have average annual canal seepage losses 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. If not, please provide an explanation of the method(s) used to calculate seepage losses. All estimates should be supported with multiple sets of data/measurements form representative sections of canals.

As previously stated, the method of determining the annual seepage losses from 73-19L-1 was determined by conducting a seepage test using the ponding method. Canal segments for the ponding seepage tests were selected based on known soil types throughout the CRIT system, proximity to drains, and anecdotal information regarding canal segments or reaches thought to have high seepage loss rates. Multiple candidate canal segments were identified and mapped. In general, canal segments were bounded on upstream and downstream ends by either: 1) a headgate and check structure, or, 2) two consecutive check structures.

Raw pressure transducer data recorded at 73-19L-1 for the seepage test from 6 am January 1, 2019 through 3 pm January 6, 2019 is shown in Figure (5). The average seepage rate over the 3 days of the seepage test was found to be 0.684 ft^3/ft^2/day.

The trendline of the test results is relatively linear, including at the point of normal flow depth for the canal (1.15 ft). Therefore, it was assumed that the average seepage rate of 0.684 ft^3/ft^2/day was valid for the seepage analysis discussed in section 1.5.1.3.

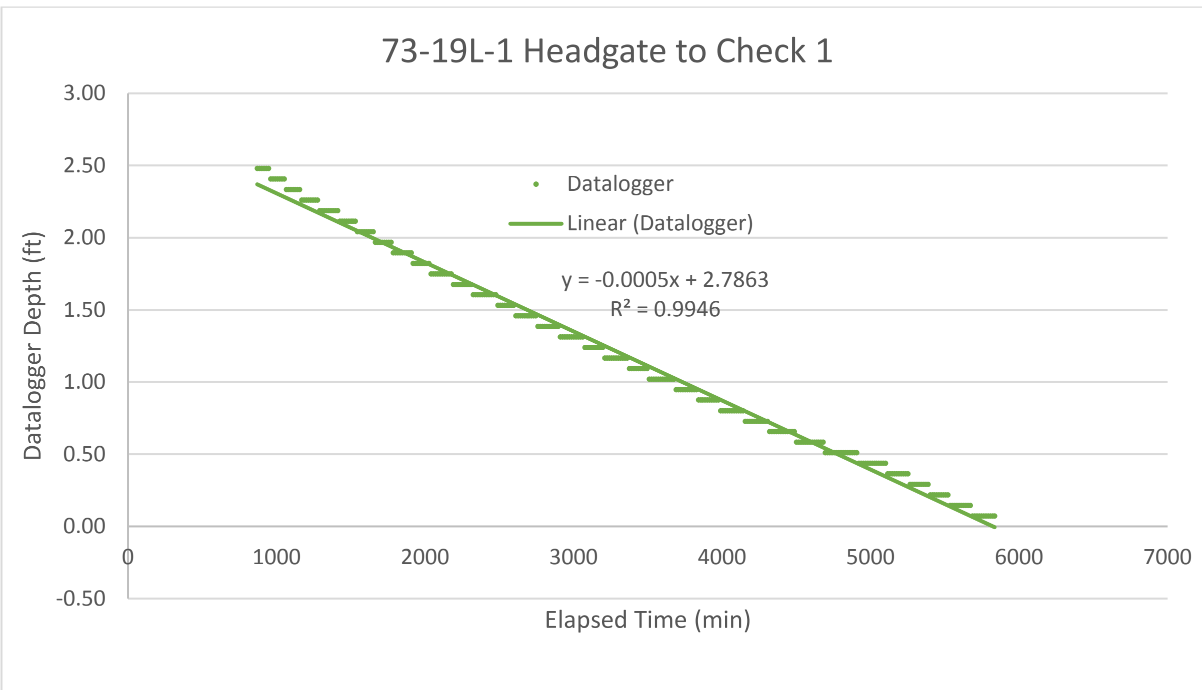

Figure 5. Raw data of seepage test via ponding method at Lateral 73-19L-1 between its Headgate and Check 1.

1.5.1.6 What are the expected post-project seepage/leakage losses and how were these estimates determined?

The geosynthetic membrane that would be used is considered watertight. No seepage will occur if the membrane is installed correctly as previously discussed. A properly installed geosynthetic membrane with a 1.5-inch shotcrete cover will last long-term and will only experience evaporation losses, which were calculated as 5.61 AFY in Section 1.5.1.

1.5.1.7 What are the anticipated annual transit loss reductions in terms of acre-feet per mile for the overall project?

The anticipated seepage loss will be $\frac{267\ AF}{0.77\ mi}$ (0.77 mi = 3,985 ft); therefore, the anticipated acre-feet saved per mile equates to 347 $\frac{AF}{mi}$.

1.5.1.8 How will actual canal loss seepage reductions be verified?

To verify annual seepage losses, seepage tests by means of the ponding method will be used during the annual dry-up periods. One will occur during the main dryup in January, and the other during CRIP's large lateral 73 dry-up in February. Verification by this method at twice per year would keep seepage analyses methods consistent.

1.5.1.9 Include a detailed description of the materials being used.

The two materials that will be utilized in this project are the geosynthetic membrane and shotcrete.

The geosynthetic membrane is a heavyweight fabric incorporating a special weave pattern to enhance thickness, flatness, and tear properties. This product is a combination of polyethylene reinforcement and co-extrusion which enhances UV Resistance and improves physical properties.

Shotcrete is compiled of cement, soil aggregates, and water mainly, similar to gunite. But, shotcrete has many advantages to conventional gunite. Shotcrete is more economically-friendly, and reduces the amount of man-power needed, as less formwork is required and the concrete can be applied by a nozzle from a safe distance in less time. The shotcrete that will be procured will be of 4,000 psi compressive strength after proper aggregates (maximum 0.75-inch) are implemented, which will be more than enough to protect the geosynthetic membrane from sharp rocks, erosion, and maintenance operators utilizing heavy machinery.

1.5.2 Evaluation Criterion B—Water Supply Reliability

This project will create a more reliable water supply for CRIT's irrigated lands that are currently not meeting their water requirements.

1.5.2.1 Will the project address a specific water reliability concern? Please address the following:

Explain and provide detail of the specific issue(s) in the area that is impacting water reliability, such as shortages due to drought, increased demand, or reduced deliveries. Will the project directly address a heightened competition for finite water supplies and over-allocation (e.g., population growth)?

The main issue for water users throughout the entire Lower Colorado River Basin is that they are facing, and have been facing a drought for the past 19 years. For example, Lake Mead's water elevation has consistently dropped in elevation since 2000, totaling 124 feet from 2000 to 2019 (USBR). This drought has come in the form of less overall precipitation into the basin and higher average temperatures. Due to hotter, dryer conditions, the average crop demand has been increasing to keep up with the more extreme weather conditions, especially those seen in the Parker Valley. Figure (6) displays the Parker Valley's reference evapotranspiration from the previous decade (Parker #1 and Parker #2 average 2010-2019). An average increase of 0.25 inches/year was found. Other irrigation districts are not too far from the Parker Valley, meaning they may be facing similar rises in crop consumptive use. It is crucial for CRIT to increase their irrigation efficiencies to keep up with their crops' demands.

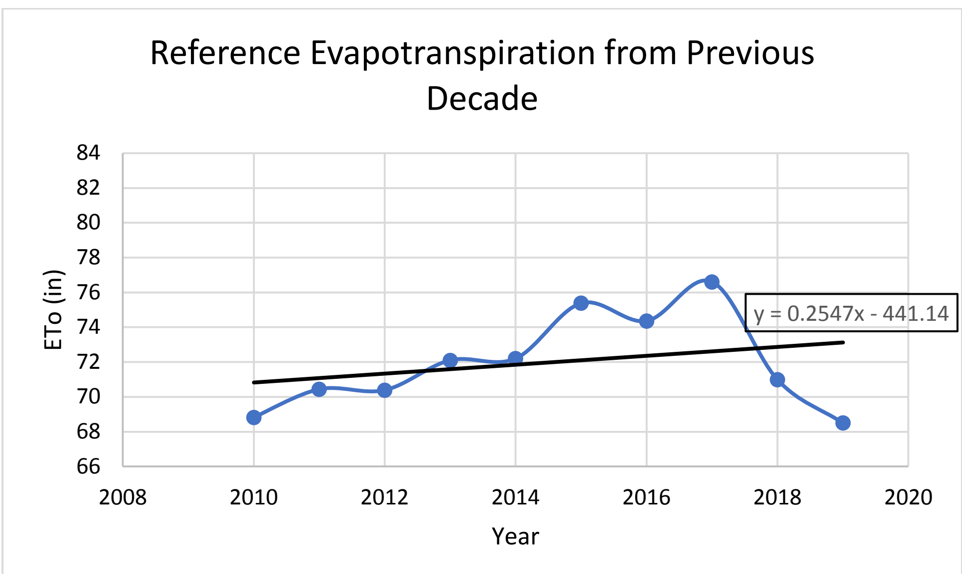

Figure 6. Reference Evapotranspiration from 2010-2019 on the CRIP.

Describe how the project will address the water reliability concern? In your response, please address where the conserved water 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.

CRIT will use the water saved from this canal lining project to meet irrigation water requirements on currently irrigated lands under the CRIP that do not receive their full requirement and/or to make more water available for annual leaching of salts from the crop root zone.

Provide a description of the mechanism that will be used, if necessary, to put the conserved water to the intended use.

The amount of water that is guaranteed by the BIA Colorado River Agency to each water user throughout the CRIP will be increased to reflect the increase in water savings.

Indicate the quantity of conserved water that will be used for the intended purpose.

CRIT intends to put all 100% of the annually conserved 267 AF toward the benefit of lands on the reservation that do not currently reach their irrigation and/or leaching requirements.

1.5.2.2 Will the project make water available to achieve multiple benefits or to benefit multiple water users? Consider the following:

Will the project benefit multiple sectors and/or users (e.g., agriculture, municipal and industrial, environmental, recreation, or others)?

The main water-use sector affected by this potential project will be the agricultural sector on the CRIP.

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.

The project with neither harm nor benefit federally threatened or endangered species, a federally recognized candidate species, a state listed species, or a species of particular recreational or economic importance. Instream flows downstream of Head Rock Gate Dam will not be impacted.

Will the project benefit a larger initiative to address water reliability?

The Tribes intend for this project to be a first step towards conserving water through seepage reduction. With 140 miles of unlined canals on the CRIP and only 0.77 miles of lining for this proposed project, there is a larger goal to continue implementing lining projects to conserve much more water in the future for the benefit of the Tribes.

Will the project benefit Indian tribes?

This project will benefit the Colorado River Indian Tribes. With very high conveyance losses, this project will conserve water through increased conveyance efficiency. The project will modernize the near-century old system of deteriorating canals that are periodically blown out by the lateral pressure of water flowing through their system. These blowouts severely damage crop growth in the affected areas This proposed project will help prevent future canal blowouts throughout this reach as well as meet crop irrigation requirements that are currently unmet.

Will the project benefit rural or economically disadvantaged communities?

The water savings from this proposed project will benefit the Colorado River Indian Tribes. CRIT is economically disadvantaged given the fact that their median household income is 65% below the United States average (University of Arizona, August 2020).

Describe how the project will help to achieve these multiple benefits. In your response, please address where the conserved water will go and where 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.

Water conserved with this project is intended to support the higher irrigation efficiency goals set by CRIT. CRIT will use the water saved from this canal lining project to meet irrigation water requirements on currently irrigated lands under the Project that do not receive their full requirement and/or to make more water available for annual leaching of salts from the crop root zone.

Does the project promote and encourage collaboration among parties in a way that helps increase the reliability of the water supply?

The reliability of the water supply will increase, encouraging future collaboration among CRIT's water users and the BIA Colorado River Agency for future projects.

Is there widespread support for the project?

CRIT Tribal Council and their water users support the steps that must be taken to increase water use efficiency on the CRIP.

What is the significance of the collaboration/support?

Collaboration between CRIT, BIA, and other stakeholders is very significant as all parties would be affected upon completion of the project. It is important to sustain positive relationships to complete the project based on BIA's water delivery schedule.

Is the possibility of future water conservation improvements by other water users enhanced by completion of this project?

Yes. The level of encouragement of the CRIP's water users regarding the future implementation of on-farm improvements will increase as they see the efficiency increases of the Project's conveyance system.

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

Yes. Increasing the CRIP's water-use efficiency will prevent a water-related crisis among its water users. High tension was involved throughout the year 2019 due to low operating efficiencies. This project will reduce inefficiencies that result in high tension throughout the Project.

Describe the roles of any partners in the process. Please attach any relevant supporting documents.

CRIT's main partners of Reclamation and BIA would play major roles in this project. Specifically, funding from Reclamation would play the largest role in this project as this project may not be possible without their support. Also, BIA will play the other major role by collaborating with CRIT in determining the most efficient timing for completion of the project.

A letter of support from BIA Colorado River Agency is attached in Appendix C

Will the project address water supply reliability in other ways not described above?

This project addresses the CRIP's water supply reliability in a new, progressive canal-lining approach that will be very beneficial to the tribes future water conservation goals.

1.5.3 Evaluation Criterion C—Implementing Hydropower

No hydropower will directly be implemented from the completion of this project.

1.5.4 Evaluation Criterion D—Complementing On-Farm Irrigation Improvements

1.5.4.1 Describe any planned or ongoing projects by farmers/ranchers that receive water from the applicant to improve on-farm efficiencies.

CRIT, NRCS, and USBR have recently been having discussions pertaining to the need for on-farm improvements throughout the Reservation. The end goal of these discussions is to implement a salinity control program on the CRIP. It has been found that lands on the CRIP are highly saline, mainly due to improper on-field drainage.

1.5.4.2 Provide a detailed description of the on-farm efficiency improvements

The method that will be proposed to improve on-farm drainage is the implementation of tile drainage and de-watering wells throughout the CRIP. Tile drainage allows for proper on-farm drainage that would otherwise cause waterlogging and salinization of fields. The salinization of fields results in an inefficient use of water for the purpose of leaching salts out of the root zone. Currently, only 2% of the irrigated lands on the CRIP have tile drainage. The drastic increase of tile drainage implementation will help drain waterlogged fields and *leach* salts off the saline fields consistently, resulting in less waterloggomg and salt stress physically observed throughout the Reservation. De-watering wells would assist tile drainage in exporting groundwater from the system and lowering water tables. Lower water tables would result in decreased soil salinization in the root zone and a decreased water requirement for the purpose of leaching salts out of the root zone.

1.5.4.3 Have the farmers requested technical or financial assistance from the NRCS for the on-farm efficiency projects, or do they plan to in the future?

CRIT plans to request financial assistance when funds are available from NRCS for a program of this magnitude within the next 2 years.

1.5.4.4 If available, provide documentation that the on-farm projects are eligible for NRCS assistance, that such assistance has or will be requested, and the number or percentage of farms that plan to participate in available NRCS programs.

1.5.4.5 Describe how the proposed WaterSMART project would complement any ongoing or planned on-farm improvement

By reducing seepage, the proposed project would decrease the CRIP's groundwater inflow by 267 AFY thereby lowering water tables and lessening the need for on-farm drainage in the surrounding areas of lateral 73-19L-1.

1.5.4.6 Will the proposed WaterSmart project directly facilitate the on-farm improvement? If so, how? For example, installation of a pressurized pipe through WaterSMART can help support efficient on-farm irrigation practices, such as drip-irrigation.

The proposed WaterSmart project at CRIP's 73-19L-1 will reduce the need for on-farm drainage throughout the surrounding irrigated fields. Currently, 267 AFY are lost to seepage throughout the proposed reach for lining under this FOA. This potential water savings will reduce the water load on the proposed on-farm improvements of tile drainage and de-watering well(s) implementation. Lower water tables would result in reduced soil salinization in the root zone which would decrease the water requirement for leaching salts out of the root zone.

1.5.4.7 *Describe the on-farm water conservation or water use efficiency benefits that are expected to result from any on-farm work*

A reduction of required leach water would result from improved on-farm drainage, resulting in a higher on-farm water use efficiency.

1.5.4.8 *Estimate the potential on-farm water savings that could result in acre-feet per year. Include support or backup documentation for any calculations or assumptions.*

With the current improper drainage observed throughout the CRIP via high water table elevation and soil salinization, a large amount of leach water is required to leach salts out of the root zone. The reduction of leach water will result in a higher water-use efficiency throughout the Reservation. It is still unknown how much leach water will be conserved, as CRIT is currently working on a method to quantify this water savings. Figure (7) displays the past leach water used on the CRIP from 2012-2019, where an average of 11,105 AFY was used (BIA Colorado River Agency). Improving leach efficiency is a major goal for the Tribes as even a small percentage increase of leach water efficiency will result in a large overall quantity of water savings.

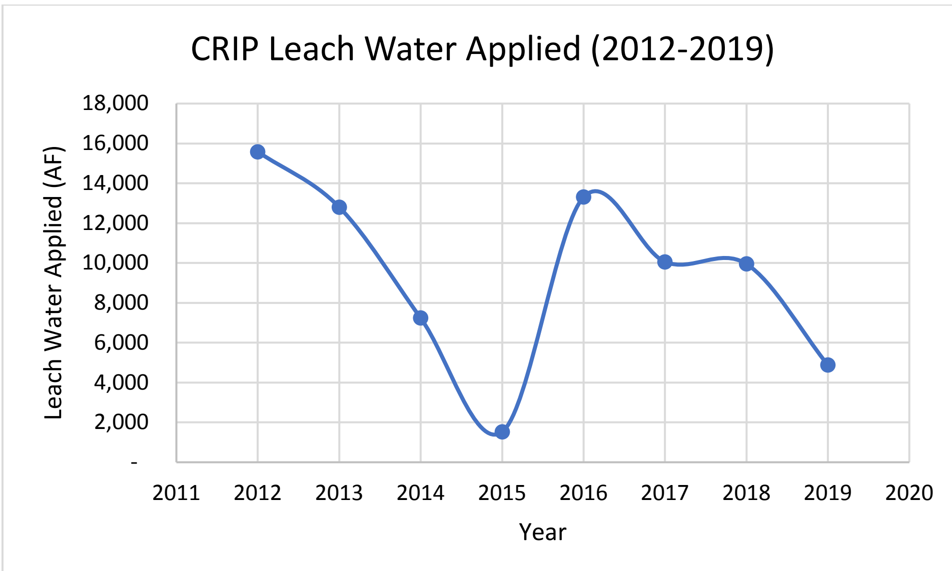

Figure 7. Applied leach water throughout the CRIP from 2012-2019

1.5.5 Evaluation Criterion E—Department of the Interior Priorities

1.5.5.1 Creating a conservation stewardship legacy second only to Teddy Roosevelt

a. Utilize science to identify best practices to manage land and water resources and adapt to changes in the environment

Shotcrete covered geosynthetic membranes have been identified as the best method for reducing seepage in open channel flow by many irrigation districts. CRIT understands that water resources management is being much more increasingly valuable throughout the dry Lower Colorado River Basin, and they plan to utilize the best practices identified to assist in their water management.

d. Review Department water storage, transportation, and distribution systems to identify opportunities to resolve conflicts and expand capacity

The water distribution system throughout the CRIP has its inefficiencies. Reviewing and acting on the points of most importance will optimize the reduction of system losses and lessen the liklihood of future conflicts between water users on the CRIP.

1.5.5.2 Restoring trust with local communities

a. Be a better neighbor with those closest to our resources by improving dialogue and relationships with persons and entities bordering our lands

This continued attempt from CRIT to increase their water conservation effort will result in an even stronger trust between CRIT's water users during water shortages and increasing demands.

b. Expand the lines of communication with Governors, state natural resource offices, Fish and Wildlife offices, water authorities, county commissioners, Tribes, and local communities.

CRIT has large potential for future water savings. The lines of communications will increase to benefit as many stakeholders as possible throughout the CRIP.

1.5.5.3 Moderizing our infrastructure

a. *Support the White House Public/Private Partnership Initiative to modernize U.S. infrastructure*

If awarded, CRIT will contract private businesses for the procurement of materials and services for installation for both the geosynthetic membrane and shotcrete. Private companies previously contracted by CRIT to repair concrete canals throughout the CRIP have showed pride in their work and installed a lasting product. The CRIP has aging infrastructure with substantial need for modernization. This project will modernize Canal 73-19L-1.

b. *Remove Impediments to infrastructure development and facilitate private sector efforts to construct infrastructure projects serving American Needs*

CRIT will work closely with the BIA to ensure all permits are gained to allow for private sector completion in a timely manner.

c. Prioritize Department infrastructure needs to highlight:

1. *Construction of infrastructure*
2. *Cyclical Maintenance*
3. *Deferred Maintenance*

Earthen canals are outdated and not considered a sustainable method of conveyance. The modern, near impenetrable infrastructure of geosynthetic membranes and shotcrete will provide for a much more sustainable future for the Colorado River Irrigation Project

1.5.6 Evaluation Criterion F—Implementation and Results

1.5.6.1 Does the applicant have a Water Conservation Plan and/or System Optimization Review (SOR) in place? Please self-certify or provide copies of these plans where appropriate to verify that such a plan is in place.

CRIT's Water Conservation Plan is collectively, the reports prepared by NRCE. These reports are mentioned above in the Background section. The reports include the modernization of infrastructure throughout the project that will benefit CRIT and optimize their water right to benefit their water users.

1.5.6.2 Provide the following information regarding project planning:

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.

NRCE has prepared Agricultural Resource Management Plan (ARMP) Phase I and Phase II studies and reports and a water measurement inventory for CRIT Tribal Council (NRCE 2016, 2017a, 2017b). These are discusssed in detail in the Background Section. The goals of these studies were to fully describe the CRIP, identify system inefficiencies, and ultimately interventions to result in improved efficiency and to conserve water. Section 5.3 of the ARMP (NRCE 2017b) describes several options for water conservation on the Reservation. Canal-Lining projects and their potential water savings are discussed for several areas within the CRIP system. This proposal develops the canal-lining project that has the best potential to cost-effectively conserve water for the CRIP.

Each year, CRIT Water Resources Department, in conjunction with NRCE, develops and produces a Five-Year Irrigation Development Plan update for the CRIP to fulfill requirements under the P.L. 93-638 (25 USC 450 et.seq.) Irrigation Engineering and Support Services Contract (No. A15AV00449).

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(s).

CRIT's ARMP (NRCE 2017b) identified water conservation measures to develop the Tribes' water resources for improved efficiency. Section 5.3 of the ARMP Phase II Report describes several options for water conservation on the Reservation, including both structural and non-structural conservation measures. Canal-Lining projects and their potential water savings are considered throughout the irrigation system. This proposal highlights the canal reach on the CRIP that has the best potential to cost-effectively conserve water for the Lower Colorado River by canal lining, based on the ratio of water conserved in acre-feet to square feet of lining required (NRCE, 2020).

1.5.6.3 Subcriterion F.2—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).

CRIT, BIA, and NRCE were collectively able to quantify current seepage losses through this selected canal reach by conducting a seepage test via ponding method. CRIT would continue to conduct and evaluate seepage tests via ponding method to verify seepage losses have been reduced in the amount of 267 AF.

1.5.6.4 Subcriterion F.3—Readiness to Proceed

Describe the implementation plan of the proposed project. Please include an estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates.

Lining 73-19L-1 from its heading to check 1 lies under Funding Group I, which would require the project to be completed within 2 years of award. This project's steps include 1) Preparation of earthen channel and geomembrane anchors, 2) Application of geosynthetic membrane, 3) Backfilling of geosynthetic membrane anchors, and 4) Application of a 1.5-inch-thick shotcrete cover over the geosynthetic membrane.

For step 1), preparation of the earthen channel and anchor trenches for the geosynthetic membrane can take place during the periodic no-flow periods throughout the year. The awarded contractor for this step would need to collaborate with BIA to determine these times of no-flow so that irrigation demands remain the top priority.

For step 2), an estimated work duration of 1-2 days for the installation of the geosynthetic membrane was obtained from *Western Environmental Liner, Inc.*. Given that the membranes are pre-fit according to given channel dimensions, the awarded contractor for this step would not have to do any additional field-fitting once at the work site. 73-19L-1's channel will also only require one geosynthetic membrane *sheet* along its cross section, meaning sheets will only be needed to be bonded throughout the reach's length, rather than both the length and width like what would happen if the channel was much wider. With only a 1-2 day installation time for the geosynthetic membrane, it may not have to take place during the annual dryups. With proper collaboration with the BIA, installation may occur during the irrigation season when there are not any scheduled water deliveries for the canal as also discussed in Step 1.

For step 3), backfilling the geosynthetic membrane would take place preferrably as soon as possible upon the geosynthetic membrane installation. This step can be completed anytime after Step 2, since water flow would not prevent this part of the project.The geosynthetic membrane's anchors may be backfilled using the previously excavated soil from step 1.

For step 4), it is expected that the shotcrete application will occur during the annual dryup periods. Dryups occur in this project area during two different periods—usually 2-3 weeks in January, and 1 week in February. If shotcrete application timing is dedicated throughout both periods, the job may be completed successfully. If not, an additional dryup year would be more than enough to successfully complete this part of the project..

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

Permits from the BIA are be required for any work on their assets. Requested permits would be approved by BIA Irrigation Supervisor, Gary Colvin.

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

The design work included gathering cross-sectional measurements at five sites throughout the proposed project's canal reach. These measurements were used to create the average canal cross section located in figure (3). The seepage analysis used to justify this proposed project is based on a report by NRCE (NRCE, 2020), which included the methods used to determine the amount of water conservation resulting from this project.

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

This does not apply to this project.

1.5.6.8 Describe how the environmental compliance estimate was developed. Has the compliance cost been discussed with the local Reclamation office?

Minimal environmental compliance costs are expected for this project. Therefore, it was estimated that this budget task would cost an estimated 1% of the total project cost.

1.5.7 Evaluation Criterion G—Nexus to Reclamation Project Activities

1.5.7.1 Is the proposed project connected to Reclamation project activites?

The USBR Lower Colorado Region office in Boulder City, NV manages operations in the Lower Colorado River Basin at the Boulder Canyon Operations Office. Daily water orders compiled by the CRIP BIA Irrigation office are transmitted to the Boulder Canyon Operations Office for release and delivery scheduling. The CRIP diverts water from the Colorado River at Headgate Rock Dam near Parker, AZ.

CRIT coordinates regularly with the USBR Yuma Area Office on matters related to maintenance activites in the reach of the Colorado River that passes through the Reservation. These include planning and implementation of projects to improve backwaters and side channels along the reach, removal of alluvial wash sediment outflow fans, etc.

The 43 Code of Federal Regulations, Part 417 obligates the Secretary of the Interior to see that releases of Colorado River water to Colorado River tribal entities will not exceed those reasonably required for beneficial use. CRIT prepares and submits an estimate of the Tribes' twelve-month Colorado River diversion rate and anticipated monthly diversion schedules to the BIA for the following calendar year. The BIA is directed by Part 417 to consult with Colorado River tribal entities each year regarding water conservation measures, operating practices, and the beneficial use of Colorado River water. CRIT and BIA engage in the Part 417 Consultation with the USBR each year.

CRIT has worked closely with Reclamation as part of the Ten Tribes Partnership to complete the Colorado River Basin Ten Tribes Partnership Tribal Water Study in October 2018.

CRIT was recently awarded funding for fiscal year 2019 through the USBR WaterSMART Water and Energy Efficiency grant program for the modernization of the existing SCADA system on the CRIP (FOA BOR-DO-19-F004) and the WaterSMART Small Scale Water Efficiency grant program for the installation of flow measurement devices on CRIP laterals and spill sites (FOA BOR-DO-19-F005). The most recently awarded funding for fical year 2019 was for the design of a re-regulation reservoir through FOA BOR-LC-19-F002.

CRIT has has participated in the Colorado River Basin Pilot System Conservation Program established by Reclamation and four municipal entities in July 2014 to fund the creation of Colorado River system water through voluntary water conservation. CRIT is currently participating in a System Conservation Agreement with the State of Arizona, Central Arizona Water Conservation District and Reclamation for the period 2020-2022 as part of the Lower Colorado River Basin Drought Contingency Plan. See Table (5) below.

Table 5. Programs implemented by CRIT in their continued attempt of voluntary water conservation for the Lower Colorado River Basin.

Project	Description
System Conservation Implementation Agreement (SCIA) No. 16-XX-30-W0606	Water Conservation through a reduction of consumptive use on the CRIP by fallowing 1,591 acres of irrigated cropland for the period October 1, 2016 - September 30, 2018
SCIA No. 18-XX-30-W0634	Water Conservation through a reduction of consumptive use on the CRIP by fallowing 1,884 acres of irrigated cropland for the period October 1, 2018 - September 30, 2019
SCIA No. 19-XX-30-W0647	Water Conservation through a reduction of consumptive use on the CRIP by fallowing 3,705 acres of irrigated cropland for the period January 1, 2019 - December 31, 2019
System Conservation Agreement under Lower Colorado River Basin Drought Contingency Plan	Water Conservation through a reduction of consumptive use on the CRIP by fallowing approximately 10,000 acres of irrigated cropland to create 50,000 AF of water savings per year for the period January 1, 2020 - December 31, 2022

1.5.7.2 Will the project benefit any tribe(s)?

Yes. The Colorado River Indian Tribes will improve their irrigation project's conveyance efficiency with this project.

1.5.8 Evaluation Criterion H—Additional Non-Federal Funding

The non-federal funding portion of the total project cost is 51%, assuming the remaining portion will be funded by Reclamation. More information regarding the source of these numbers is in the next section.

$$\frac{NonFederal\ Funding}{Total\ Project\ Cost} = \frac{\$226{,}047}{\$443{,}229} = 51\%$$

2. PROJECT BUDGET

The estimated total cost of the project is estimated as $443,229.

2.1 Summary of Funding Sources

The Colorado River Indian Tribes request Federal funding equal to $209,182 from Reclamation. CRIT is committed to contributing an amount of $226,047 as a monetary contribution from the Tribes' Funds. The remaining balance of $8,000 are in-kind costs contributed by CRIT and derive from other Federal funding as in-kind cost share under a BIA Colorado River Agency PL93-638 contract with CRIT Water Resources Department for Irrigation Engineering Services. CRIT Water Resources work under the PL93-638 contract and is currently on-going. No in-kind contributions or costs will be incurred before the start of the project. There is no other funding received from other Federal partners, and there are no other pending funding requests for this project. Table 6 is a summary of Federal and non-Federal funding sources of the proposed project.

Table 6. Summary of Federal and non-Federal funding sources

Funding Sources	Funding Amount
Non-Federal Entities	
1. Colorado River Indian Tribes	
Non-Federal Subtotal	**$ 226,047**
Other Federal Entities	
1. Other Federal Subtotal (PL93-638 Contract) (In-kind cost share contribution)	$ 8,000
Other Federal Subtotal	$ 8,000
Requested Relamation Funding	$ 209,182
Total Project Funding	$ 443,229

2.2 Budget Proposal

Table 7 provides details of the estimated project costs in the format provided in the Funding Opportunity Announcement.

Table 7. Details of Budget Proposal

Budget Item Description	Computation $/Unit	Computation Quantity	Quantity Type	Funding Request ($)	In-kind Contributions ($)
Salaries and Wages (Labor and Overhead)					
Devin Heaps, WR Dept Director	$ 200	40	Hours		$ 8,000
Contracts					
Earthen Channel Preparation [1]	$ 4.93	1900	Cubic Yard	$ 9,367	
Geoliner Anchor Preparation/Backfill [1]	$ 4.93	295	Cubic Yard	$ 1,454	
Earthen Channel/Geoliner Prep & Geoliner Backfill Mobilization [2]	$ 2,000	2	Each	$ 4,000	
Geoliner (Material)	$ 0.33	144,288	Square Feet	$ 47,615	
Geoliner (Installation)	$ 15,127	1	Each	$ 15,127	
Geoliner (Freight)	$ 1,700	1	Each	$ 1,700	
Shotcrete (Mobilization)	$ 15,000	1	Each	$ 15,000	
Shotcrete (Material and Installation)	$ 570	477	Cubic Yard	$ 271,890	
NRCE	$ 8,490	1	Each	$ 8,490	
Total Contingencies (15%)	$ 56,197	1	Each	$ 56,197	
Environmental and Regulatory Compliance					
Estimation of 1% Total Project Cost	$ 4,388	1	Each	$ 4,388	
Total Direct Costs				**$ 435,229**	**$ 8,000**
Indirect Costs				0.00	
Total Estimated Projects Costs				**$ 443,229**	

[1] Estimated from NRCS EQIP schedules for Arizona
[2] Estimation

2.3 Budget Narrative

2.3.1 Salaries and Wages

Devin Heaps, Director of CRIT Water Resources Department, will be the project manager. Labor expenses were included to cover the time necessary to efficiently coordinate the project, maintain project schedules, and for meetings and other communication with sub-contractors. The amount listed in Table 7 includes overhead costs.

2.3.2 Fringe Benefits

Project funds will not be used to support any fringe benefits. Overhead costs such as fringe benefits are included in the salaries and wages amount.

2.3.3 Travel

None for CRIT Staff. Travel expenses including mileage for round trip field visits to project site for CRIT Staff as required for Project field support and implementation is considered within the scope of normal duties.

Travel costs for the earthen channel and geomembrane anchor preparation, and geomembrane anchor backfill contractor will require two mobilization costs. The first for the earthen channel and geomembrane anchor preparation. The second for the geomembrane anchor backfill. Two mobilization costs are required because the geomembrane installation needs to take place in between the preparation and backfill of the anchors. Therefore, with two mobilization costs, it was estimated that each mobilization would cost roughly $2,000, resulting in a total travel cost of $4,000 for this part of the project.

Travel costs for the geosynthetic membrane contractor are not expected, according to a quote from Western Environmental Liner, Inc., which can be found in Table (A2) in Appendix A.

Travel costs associated for the shotcrete contractor is included in the “Shotcrete (Mobilization)” row in Table (7), which was given in a quote by Air Place Masters, Inc. that can be found in Table (A3) in Appendix A.

2.3.4 Equipment

Equipment costs required to prepare the earthen channel and provide trenches for the Geosynthetic Membrane anchors, install the Geosynthetic Membrane, backfill Geosynthetic

Membrane Anchors, and those required to install the Shotcrete cover are included in the Budget Proposal.

The first step will include the earthen channel preparation that will be conducted by a private contractor. Materials required will be one Gradall, or similar type excavator that will be utilized for the cleaning of the channel from rubble, roots, vegetation, debris, voids, and any other objects that can potentially puncture the geosynthetic membrane through time. Also required will be one dozer capable of transporting fill material to the site. Once each fill layer has been placed, a rolling compactor attachment for the excavator will be required to compact the soil layer. The excavator will then be responsible for providing dug-out anchors for the geosynthetic membrane. Standard earth preparation and anchor design can be seen in Figures B2 and Figure B3, respectively, in Appendix B.

The second step towards project completion will include the installation of the geosynthetic membrane. Equipment required will be one flatbed pickup to haul material to site and to transport throughout the project duration.

The third step's required equipment will be similar to the first step. One excavator will be utilized to backfill the anchors created for the installation of the geosynthetic membrane so that the membrane remains in place until shotcrete application is possible.

The fourth and final step's required equipment will be one concrete truck for the use of one shotcrete applicator hose.

The costs associated for all equipment is included in the budget proposal.

2.3.5 Materials and Supplies

Earthen Channel Preparation

An excavated depth of 6 inches throughout the entire channel to remove debris is expected, equating to roughly 1,900 cubic yards throughout the proposed canal reach. Similarly, 1,900 cubic yards of compacted fill material will be required to fill the removed material before geosynthetic membrane installation.

Geosynthetic Membrane Anchor Preparation and Backfill

According to Figure B3, the geosynthetic membrane anchors will need to be prepared in a 1-ft x 1-ft cross section throughout the 3,985-ft canal reach on both banks, resulting in an additional 295 cubic yards of excavation and backfill.

Geosynthetic Membrane

144,288 ft^2 of geosynthetic membrane material is required to line the entire canal-reach and provide enough anchor length as required by Western Environmental Liner, Inc., which is provided in Table (7). The geosynthetic membrane material quoted by Western Environmental Liner, Inc. was the Aqua 30 Coextruded Polyethylene Liner (Aqua 30 Coex). The Aqua 30 Coex is a new liner formulation that allows for the tear strength and puncture resistance of the high quality Aqua reinforced polyethylene (RPE) series but also adds an extra coextruded layer of coating. This extra film layer enhances the base materials U.V. and weathering resistance along with giving the geomembrane an extra layer of leak protection. Aqua 30 Coex liner comes with a 20-year U.V. and Weathering warranty and can be used in several critical applications as well as tank liners that put a lot of pressure on standard geomembrane liner material. The material's specifications can be seen in Figure (B1) in Appendix B.

The quote obtained from Western Environmental Liner, Inc. included the size of the material to be used, which was 501 feet long by 36 feet wide. With 36 feet wide being just enough to cover the perimeter of the canal and the anchors, quick installation is expected.

Shotcrete

This work will consist of the construction and installation 477 cubic yards of non-reinforced shotcrete. Application of shotcrete requires the use of several materials and supplies. Cement, water, sand and aggregate will be the main materials used and should result in a minimum of 4,000 psi compressive strength. Cement used will be either Portland I or II Cement and will conform to the requirements of ASTM Specification C-150. The maximum size of the aggregates will be no larger than 0.75-inch and will conform to the durability and gradation requirements of ASTM Specification C-33. Forms will be required to ensure the shotcrete stays in place, and bull floats will be used to acquire a smooth finish. Materials required to implement perpendicular joints will also be utilized. All required shotcrete materials and supplies are included in the Budget Proposal in the "Shotcrete (Material & Installation)" row in Table (7).

2.3.6 Contractual

The total amount of contractual costs is estimated as $430,840, including 15% contingencies. This cost includes all mobilizations, materials, installation/labor, and freight costs. Contractual costs for each of the four steps required for project completion are in this section.

2.3.6.1 NRCE

NRCE will be the prime sub-contractor for the project. They will be responsible for developing three separate RFP's: 1) for the soil preparation and anchor backfilling for the geosynthetic membrane 2) for the geosynthetic membrane material and installation, and 3) for the shotcrete material and installation. NRCE has provided the details of their cost estimate (inclusive of labor and expenses) for the proposed scope of work in Table (A1) included in Appendix A, totaling a cost of $8,490.

2.3.6.2 Earthen Channel Preparation/Geosynthetic Membrane Anchor Backfill

NRCE will prepare and the Tribes will advertise an RFP for competitive bidding for the procurement of services for the preparation of the earthen channel and anchor trench prior to the application of the geosynthetic membrane, and for the services of backfilling the anchor trench after installation of the geosynthetic membrane. For excavation and fill in an open channel, unit costs were obtained from NRCS EQIP schedules for Arizona, where an average unit cost of $4.93 per cubic yard was estimated. The estimated amount of excavation/fill material required for this project is 2,195 cubic yards. With a total estimated mobilization cost of $4,000, the total estimated cost for this portion of the project is $14,821.

2.3.6.3 Geosynthetic Membrane

NRCE will prepare and the Tribes will advertise an RFP for competitive bidding for the procurement of needed material and services for installation of the Geosynthetic membrane. The Tribes will award the work to the best value bidder. This work is estimated to cost $64,442 based on a preliminary, non-binding cost estimate acquired by Western Environmental Liner, Inc. on 7/1/2020 and can be found in (Figure (A2) in Appendix A.

2.3.6.4 Shotcrete

NRCE will prepare and the Tribes will advertise an additional RFP for competitive bidding for the procurement of needed material and services for installation of shotcrete. The Tribes will award the work to the best value bidder. This work is estimated to cost $286,890 (plus 15% contingency) based on a preliminary, non-binding cost estimate acquired by Air Place Masters, Inc. on 7/15/2020 (quote was based on. This quote can be found in Figure (A3) in Appendix A.

2.3.7 Third-Party In-Kind Contributions

The in-kind costs contributed by CRIT derive from other Federal funding as an in-kind cost share under a BIA Colorado River Agency PL93-638 contract with CRIT Water Resources Department for Irrigation Engineering Services. CRIT Water Resources work under the PL93-638 contract and their work is currently on-going.

3. ENVIRONMENTAL AND CULTURAL RESOURCE COMPLIANCE

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

The surrounding environment will be minimally impacted. The only ground-disturbing work will be the shaping of the existing earthen canal section along the lined length, and preparing and backfilling of the geosynthetic membrane. Removed soil will be placed on BIA's Right-of-Way, and will be replaced upon anchoring of the geosynthetic membrane. Due to an arid climate, some dust will be expected, but will be kept to a minimum with intermittent sprinkling of water on the project area.

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?

According to the Fish and Wildlife Services IPAC tool, there are a total of seven threatened endangered species that are potentially affected by activities on the CRIP. These include three bird species (Southwestern Willow Flycatcher, Yellow-billed Cuckoo, and Yuma Clapper Rail), two reptile species (Desert Tortoise, and Northern Mexican Gartersnake), and two fish species (Bonytail Chub, and Razorback Sucker). The CRIP is outside of the final critical habitat published in the Federal Register for five of these species. The critical habitat for the Yuma Clapper Rail has not yet been designated. The CRIP is within the proposed critical habitat of the Yellow-billed Cuckoo published in the Federal Register on August 15, 2014. Yellow-billed cuckoos use wooded habitat with dense cover. In western states, nests are often placed in willows along streams and rivers with nearby cottonwoods serving as foraging sites (USFWS, 2019). The minor scope of geosynthetic membrane preparation does not involve the removal of riparian habitat and is not expected to affect critical habitat of the Yellow-billed cuckoo or any other species listed or proposed to be listed as Federal threatened or endangered species.

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, this does not apply.

When was the delivery system constructed?

The water delivery system construction was originally authorized in the late 1860's. Construction and expansion continued through the early 1900's. Major work was initiated in the 1940's. The most recent canals and laterals were completed in the 1960's and early 1970's.

Will the proposed project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, 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.

This proposed project will result in modification to features of the irrigation system as it will involve the implementation of a geosynthetic membrane covered with shotcrete on top of the existing earthen channel. This section of 73-19L-1 from its Heading to Check 1 was constructed in the 1940's.

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.

There are no structures listed or eligible for listing on the National Register of Historic Places within the project area that will be modified.

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

There are no known archeological sites within the proposed project area that will experience modification.

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

No.

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.

4. REQUIRED PERMITS OR APPROVALS

Any project implementation activities which will require ground disturbance / earth moving will require prior consultation and approval from CRIT's Tribal Historic Preservation Office (THPO). THPO personnel must be on site to monitor any earth moving activity. The only work in this project anticipated to involve earth / ground disturbance is the channel shaping and preparation of the geosynthetic membrane. This will require the removal of large, sharp rocks that would otherwise poke holes in the membrane.

5. OFFICIAL RESOLUTION

The official resolution of the CRIT Tribal Council approving this grant application is currently under review. The endorsed resolution will be submitted within 30 days of the application deadline

6. UNIQUE IDENTIFIER

The Colorado River Indian Tribes is currently registered in the System for Award Management (SAM), and maintains an active registration in SAM. The registration number is 074481706 / 3UHH4.

The organizational DUNS number for the Tribes is 074481706.

7. LETTERS OF SUPPORT

Letters of support/partnership are attached in Appendix C.

8. REFERENCES

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9. APPENDIX A: PRICE QUOTES

Table A1. Contractual estimate from NRCE to produce three Request for Proposals.

Staff Title	Hourly Rate	Task 1		Task 2		Task 3		Totals	
		Production of Excavating Contractor RFP		Production of Geosynthetic Membrane RFP		Production of Shotcrete Covering RFP			
		Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost
Principal Engineer	$285.00		$0		$0		$0		
Supervising Senior	$260.00		$0		$0		$0		
Senior Engineer IV	$240.00	3	$720	3	$720	3	$720		
Senior Engineer III	$230.00		$0		$0		$0		
Senior Hydrogeologist II	$200.00		$0		$0		$0		
Senior Engineer II	$190.00		$0		$0		$0		
Senior Engineer I	$180.00		$0		$0		$0		
Associate Engineer IV	$160.00		$0		$0		$0		
Associate Engineer III	$150.00		$0		$0		$0		
Associate Engineer II	$140.00	4	$560	4	$560	4	$560		
Associate Engineer I	$135.00		$0		$0		$0		
Assistant Engineer IV	$130.00		$0		$0		$0		
Assistant Engineer III	$125.00		$0		$0		$0		
Assistant Engineer II	$120.00		$0		$0		$0		
Assistant Engineer I	$115.00	12	$1,380	12	$1,380	12	$1,380		
Hydrogeologist II	$115.00		$0		$0		$0		
Engineering Aide II	$85.00	2	$170	2	$170	2	$170		
Engineering Aide I	$75.00		$0		$0		$0		
Clerical/Administrative	$60.00		$0		$0		$0		
Total		**21**	**$2,830**	**21**	**$2,830**	**21**	**$2,830**		**$8,490**

Page 1 of 1

Western AG Enterprises, Inc.
Western Environmental Liner

Address: **8121 W. Harrison St., Tolleson, AZ 85353**
Ph: **(623) 414 - 4432**
Fax: **(623) 907- 4100**
Email: **info@westernliner.com**

Natural Resources Consulting Engineers
Fort Collins
CO
80524
7196919063
07/01/2020

Quotation

Ref: TJ Trujillo liner quote 7196919063 **Quote no. 03149**
Site: (Natural Resources Consulting Engineers)

Hello TJ,

It was a pleasure speaking with you regarding your project, and thank you again for giving us the opportunity to quote you. This quote is for our Aqua 30 Coext liner. This is a 30 mil Reinforced Polyethylene liner with extra UV resistance which makes it last 20 years for exposed pond lining applications. This is a reinforced product which makes it quite a bit stronger and more puncture resistant. The main advantage of this liner is the limited 20-year warranty you get for it being exposed. Please feel free to reach out with any additional questions.

Item	Description	Qty	Unit Price	Line Total
Aqua 30 Coext	Aqua 30 Coext Prefabricated Geomembrane (8) 501' x 36' cut size 501' x 35' weld size Size after field seaming: 4,000' x 35'	144,288.00	$0.33	$47,615.04
Installation Crew	Installation Crew to 80524 3 people	1.00	$15,127.20	$15,127.20
Freight	Freight Cost Flatbed- Partial truckload to 80524	1.00	$1,700.00	$1,700.00
			Total	**$64,442.24**
			Tax	**$0.00**
			Total (Inc Tax)	**$64,442.24**

8121 W. Harrison St. Tolleson AZ 85353
Telephone: (623) 414 - 4432 • Email: info@westernliner.com • www.westernliner.com

Figure A1. Contractual Estimate from Western Environmental Liner, Inc for procurement and installment of Geosynthetic Membrane

Air Place Masters, Inc
11331 Newland Ct
Victorville, CA 92392
310-864-4849
admin@airplacemasters.com

Estimate

ADDRESS
TJ Trujillo
NRCE

ESTIMATE # 1265
DATE 07/15/2020

ACTIVITY	DESCRIPTION	QTY	RATE	AMOUNT
Mobilization	Due prior /or on the day of first workday.	1	15,000.00	15,000.00
Shotcrete	Furnish place and finish concrete per plan.	482	570.00	274,740.00
Geo Liner	Furnish and install liner membrane	104,000	2.25	234,000.00

Estimate for Liner and concrete placement only.
No earthwork in the estimate.

TOTAL **$523,740.00**

Accepted By

Accepted Date

Figure A2. Contractual Estimate from Air Place Masters, Inc. for procurement and installation of shotcrete. Also included is the cost to furnish and install geoliner. They were not the primary source for the cost to furnish nor install geoliner.

10. APPENDIX B

Further details on Geosynthetic Membrane Specifications

Western Environmental Liner

Aqua 30 Coextruded

30mil Reinforced Polyethylene

DATA SHEET

Heavyweight fabric incorporating a special weave pattern to enhance thickness, flatness, and tear properties. This product is a combination of polyethylene reinforcement and co-extrusion which enhances UV Resistance and improves physical properties. For use in geomembrane applications such as soil remediation, pond lining, canal lining, landfill covers, tank lining, etc.

FABRIC SPECIFICATIONS

WEAVE	Woven black HDPE scrim
COATING	Top side - 11 mil LLDPE/LDPE w/ special blend Bottom side - 3 mil LDPE
COLOR	Black/Black
WEIGHT	17 oz/yd^2 (505 g/m^2) +/- 5%
THICKNESS	Nominal 30 mil (0.75 mm) +/- 10% ASTM D1777

GRAB TENSILE	Warp 385 lb 1712 N	Weft 385 lb 1712 N	ASTM D7-7004
TOUNGE TEAR	Warp 52 lb 245 N	Weft 52 lb 245 N	ASTM D5884-01
TRAPEZOIDAL TEAR	Warp 66 lb 293 N	Weft 66 lb 293 N	ASTM D4533-04
MULLEN BURST	800 psi 5515 kPa		ASTM D3786-01
HYDROSTATIC RESISTANCE	600 psi 4136 kPa		ASTM D751-00
PERMEABILITY	2.06×10^{-12} cm/sec		ASTM D4491-99a
PUNCTURE RESISTANCE INDEX	230 lb 1076 N		ASTM D4833-02

These values are typical data and are not intended as limiting specifications.

Western Environmental Liner, A Division of Western AG Enterprises
Over 30 years of quality containment, liner and cover manufacturing and installation.
www.westernliner.com I 8121 W Harrison St Tolleson, AZ 85353 I 1 800 347-8274 I info@westernliner.com

Figure B1. Aqua 30 Coextruded Specifications from Western Environmental Liner, Inc.

Western Environmental Liner
A Division of Western Ag Enterprises, Inc

Western Environmental Liner
8121 W Harrison St
Tolleson, AZ 85353
info@westernliner.com
Phone: (623) 907-4034
Fax: (623) 907-4100

Pond Preparation Recommendations

Sub-grade:

- The area to be lined must be flat and smooth, dry, and free of rocks, rubble, roots, vegetation, debris, voids, protrusions, and any other objects that can potentially puncture the liner through time.

Bedding:

- If the sub-grade cannot meet the above specification, placing a layer of bedding at a minimum of 6" compacted above the highest lying obstruction is recommended. Bedding material can be clean dirt, sand, clay, etc. This recommendation can also be used as a design preference.

Backfill/Liner Protection:

- If potential liner puncture from wildlife, livestock or animal traffic is not a concern, a minimum of 4" of compacted backfill is recommended.
- If puncture due to wildlife traffic is a concern, at least 12" of compacted backfill is recommended.
- A geotextile fabric (8, 12, or 16oz) may be used for extra protection. This can be placed above the liner then backfilled, or used as an underlayment, or 2 layers so the liner is sandwiched with the geotextile fabric.

Liner Termination:

- If the liner is terminated around the perimeter via an earthed-anchor trench, there must be at least a 1' x 1' trench to anchor the liner.
- If the liner is terminated to concrete, the concrete structure must be solid and strong enough to withstand drilling for batten strip attachment.
- If there is a pipe/column or other protrusion that the liner needs to be sealed around, a custom-made boot must be utilized.

Western Environmental Liner will not be held responsible or liable for any subgrade, earthwork or engineering design as the items above are recommendations based off previous projects.

Figure B2. Standard earth bedding preparation for geosynthetic membrane from Western Environmental Liner, Inc.

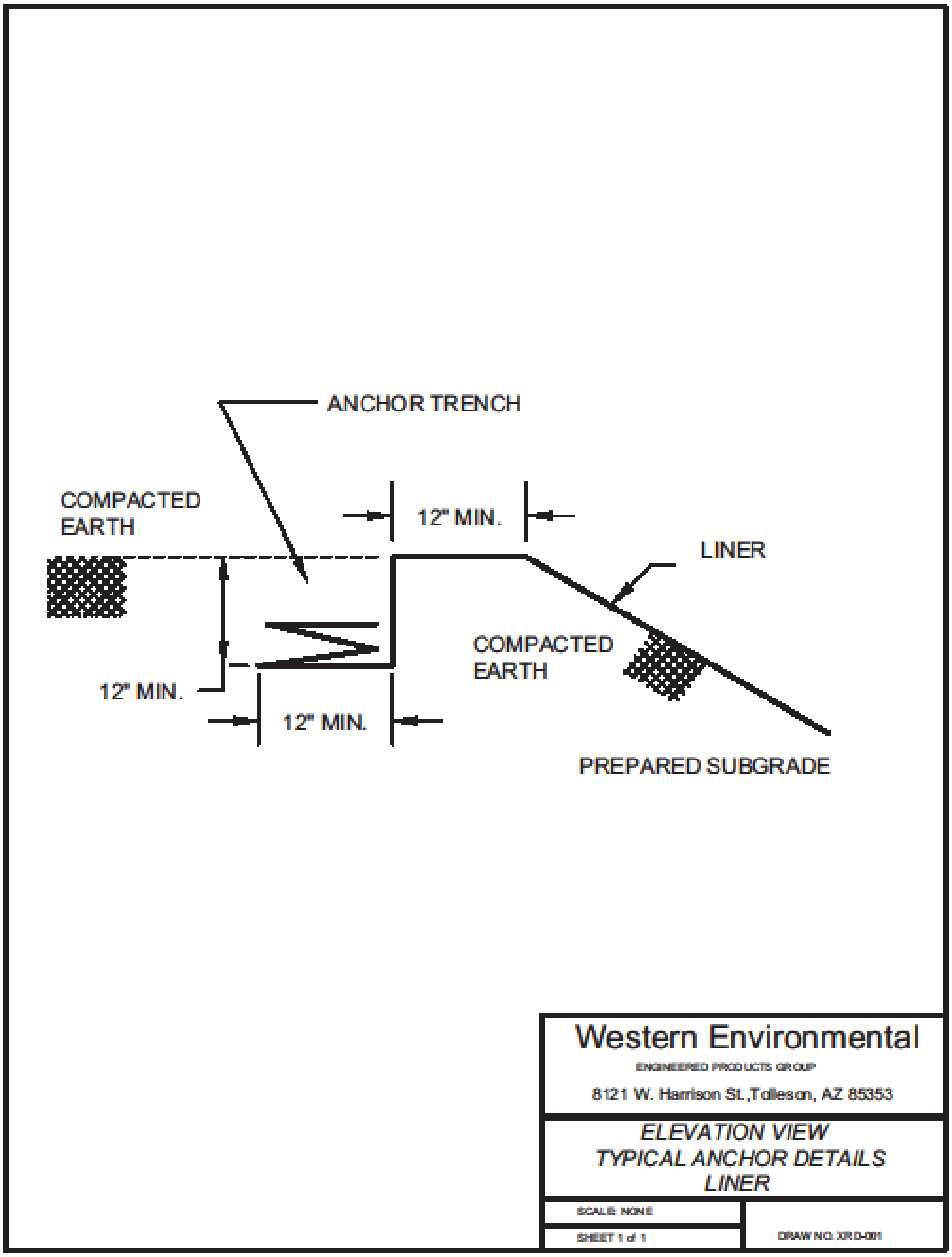

Figure B3. Standard Geosynthetic Membrane Anchor Standards from Western Environmental Lining, Inc.

11. APPENDIX C Letters of Support

12. APPENDIX D Federal Forms

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS
Colorado River Agency
12124 1st Ave
Parker, Arizona 85344

IN REPLY REFER TO:
Irrigation O&M

SEP 17 2020

TJ Trujillo, EIT
Assistant Engineer
Natural Resources Consulting Engineers, Inc.
131 Lincoln Avenue, Ste. 300
Fort Collins, CO 80524

Dear Mr. Trujillo,

This letter is provided to affirm the support of the Bureau of Indian Affairs, Colorado River Agency (BIA) for the approval of funding to the Colorado River Indian Tribes (CRIT) under the Bureau of Reclamation's WaterSMART Grants Program. The CRIT has identified a lateral that an investigation indicates a significant seepage loss. Lateral 73-19L-1 delivers water to 17 farm turnouts and the resulting seepage from this lateral could be reduced by lining with a geomembrane and shotcrete.

The Colorado River Irrigation Project operated by the BIA is in complete support of this effort. The BIA will cooperate with CRIT in this endeavor and will collaborate with CTRIT in determining the most efficient timing for completion of the project.

For these reasons, the BIA fully supports the CRIT's application to receive funding through the Bureau of Reclamation's WaterSMART Water and Energy Efficiency Grant Program. If you have any questions regarding this letter of support for the CRIT, please contact Mr. Gary Colvin at BIA at (928) 662-4392.

Sincerely,

Davetta Ameelyenah
Superintendent, Colorado River Agency

cc: File