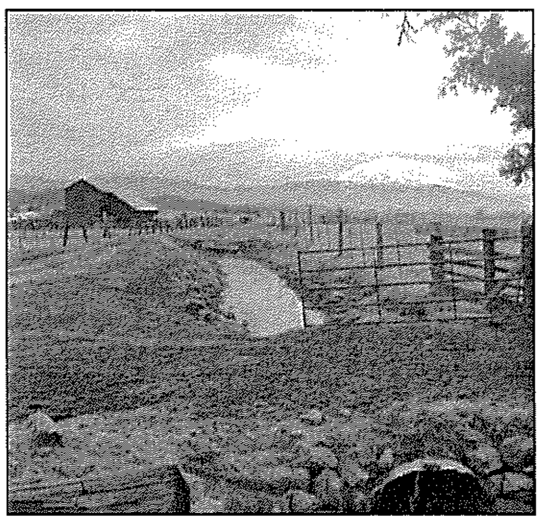
SHASTA RIVER WATER ASSOCIATION

Irrigation Water Measurement and Billing Accounting System

Funding Opportunity Announcement No. R15AS00002

WaterSMART: Water and Energy Efficiency Grants for FY 2015

Shasta River Water Association
PO Box 467
Grenada, CA 96038



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Date: January 22, 2015

Applicant Name: Shasta River Water Association
City: Grenada
County: Siskiyou County
State: California

1. Executive Summary

This proposal is being submitted by the Shasta River Water Association (SRWA), a small irrigation association; located in central Siskiyou County, California. The SRWA delivers pumped irrigation flows from the Shasta River (42 cubic feet per second or cfs) to a mosaic of small ranches and farms near Grenada and Montague, California, a major tributary to the Klamath River. This project will address inaccurate flow measuring equipment which contributes to inefficiencies in delivery and the Association's associated historic billing practices. The project will consist of completion of 12 new flumes, measuring boxes and up-to-date electronic equipment. These improvements will achieve the goals of this Funding Opportunity Announcement and will contribute to significant water savings in the Shasta River; by allowing deliveries of accurate irrigation flows to landowners who can depend on and then pay for what they use. The annual water savings are projected to be 1560 acre feet or 10%. These additional flows will benefit the anadromous fishery by improving flow and water quality in the Klamath River for 160 miles to the confluence with the Shasta River and 20 miles up the Shasta River to the SRWA pumps. The project will be completed within 2 years from the date of contract signing, and is not located at a federal facility.

2. Background Data

This proposal is being submitted by the Shasta River Water Association (SRWA), a small irrigation association, located in central Siskiyou County, California. The SRWA has been in operation since 1912, and serves approximately 110 agricultural irrigators and one lumber mill, covering 3400 acres. The major crops are livestock and alfalfa and grass hay. The SRWA delivers irrigation flows (42 cubic feet per second) to a mosaic of small ranches and farms between Grenada and Montague, California. Flows are pumped from a state of the art pump station on the Shasta River, a major tributary to the Klamath River, to a network of open ditches. Periodic drought puts pressure on the SRWA to conserve flows by more effective irrigation. Current Environmental Species Act (ESA) concerns for Coho salmon also present opportunities to assist with instream flow contributions while avoiding water supply fluctuations and shortfalls. The projected irrigation water demand is not expected to increase in the future.

The combined factors of land use pressures, agricultural economics and increased environmental regulations have made improved water efficiencies imperative for the sustainability of this irrigation association. These factors contribute to a continued focus on sharing scarce water resources with natural resources (listed Coho salmon). The Shasta River Total Maximum Daily Load (TMDL) was set in 2006 by the California Water Resources Control Board. A target of increasing cold water contributions to the river by 45 cubic feet per second was written into this Basin Plan: http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/shasta_river/060707/finalshastatmdlactionplan.pdf. This project will assist with efforts to protect the cold water contributions in the upper river reaches by reducing warm tailwater inputs and moderating irrigation demand in the lower reaches.

This project will address outdated and inaccurate flow measurement equipment that contributes to inefficiencies in delivery and difficulties in billing methods. The project will consist of completion of new flumes, **measuring boxes** and up to date **electronic equipment** in Phase 1. Phase 2 will consist of developing a new conservation incentive based **billing system** functioning with the new equipment, and training and consensus building for modification of water delivery methods. The existing delivery system consists of a new pump station at the Shasta River, with two buried pipelines delivering flows upslope to contour lateral delivery ditches flowing north and south along the side hill to the west of the river. The system wraps around the hills and spreads out across the flats between the towns of Grenada, Yreka and Montague. Flood irrigation directly from the main ditches is common, and most fields are wild flood or border flood irrigated on a time/shares rotation. One main lateral is piped, (3 miles) with another planned for pipe (3.5 miles) in the future. Tailwater from the upper laterals is redistributed and feeds into the lower ditches, making lining them the most likely conservation option, (8 miles). A long term irrigation upgrade study (Forsgren Study) was done in 2003 and is attached. It includes discussion of the need for measuring upgrades and billing changes, which is the focus of this proposal. This study is integral to the project proposed here and should be read for benchmark conditions, measurement techniques and assumptions.

Power savings are another integral feature of this project. New pumps and variable frequency drives (VFD's) are installed and have shown cost savings to date. Increased efficiency of water delivery will add more savings for the SRWA. Measurement of flow is considered a key component to recover more water savings and thus power savings from the system as a whole.

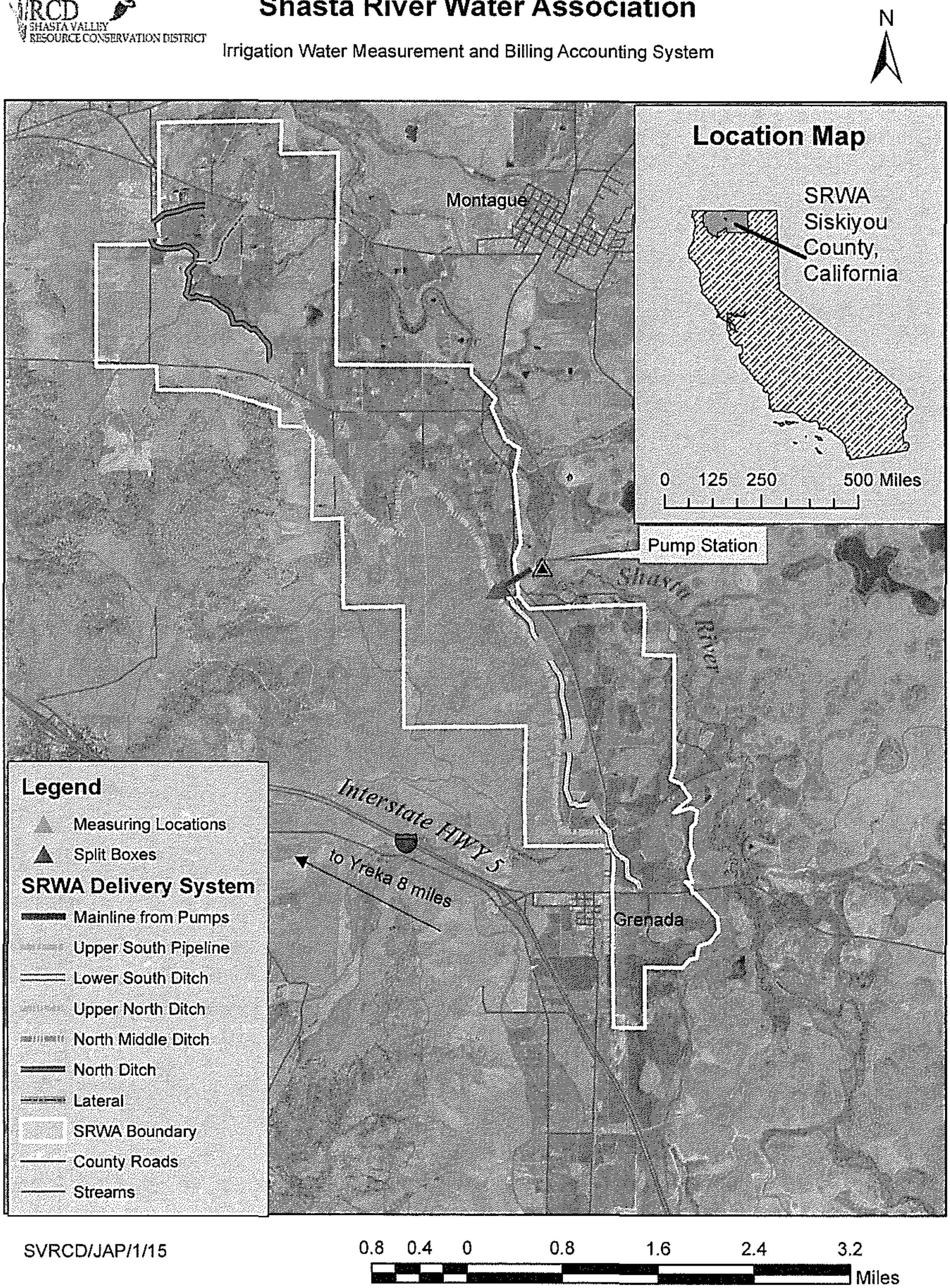
Funding has been obtained for 50% of this project from several sources. In-kind contributions listed in the budget were originally from grants to the SVRCD from the California State Water Resources Control Board (Prop 50) and (319h). The SRWA will contribute $75,000 to assist with the next two year's construction of one new box in 2015 and 2016 and management and training, plus management and maintenance of the new system.

Our fiscal agent is the Shasta Valley Resource Conservation District (SVRCD). They have a working relationship with the USDI Bureau of Reclamation (BOR), through the local office in Klamath Falls. They had a recent grant with the BOR that was completed in 2013. Other mutual technical efforts have been initiated over the years to work cooperatively.

Klamath River Restoration Program 07 FG200121
Planning, Coordination and Management of Restoration Projects in the Shasta Valley
This grant allowed the SVRCD to engage in Water Quality Ranch Planning, a voluntary effort with landowners focused on assessment, monitoring training and tailwater management discussions. Other coordination of watershed groups, agencies and strategic partnerships was also supported by this grant, closed in September 2013.

Shasta River Water Association

Irrigation Water Measurement and Billing Accounting System



SVRCD/JAP/1/15

3. Technical Project Description

This project will build on recent project work to complete a new set of 15 water measuring flumes, boxes and install modern electronics. This work is a phase of a larger project, initiated in the 1990's, to improve irrigation efficiency practices within the SRWA. The work was conceived and approached on several fronts; hardware, training, management and education. This proposal is part of the management theme, designed to allow the SRWA to create a billing system based on water used, rather than the current rotation of all flows in each lateral based on time. This historic system has been determined to be a significant source of water inefficiencies within the SRWA. Paying for shares (time per share based on acres) has been used in the past and does not lend itself to current standards for efficient water use. A new system is critical to water conservation efforts and will be based on volumetric measuring plan, (pay for what you use).

A work plan was written in 2012 and includes the following tasks.

- Evaluate alternatives for SRWA measuring equipment – completed
- Design new flumes, boxes, electronics – completed
- Construct 15 new flumes, split boxes and automate all measuring locations.
    - 3 are completed as of 1/15
- Website development to facilitate all irrigators having access to real time scheduled flows and needed information. – started in fall 2014
- Train irrigators to use the new technology and website, improved scheduling methods and flow measuring equipment.
- Develop and implement a new billing structure, based on the recently attained ability of the SRWA to control flows with variable frequency drive pumps, deliver more accurate flows and reward conservation efforts within the district.

Additionally please refer to the attached study by Forsgren Engineering:
Water Conservation Study for Shasta Water Association, Shasta River- 2003, 33 pages; submitted as a separate attachment. While this study is 12 years old, much of the data is still applicable to our work. The management and infrastructure for the SRWA is the same as it was 12 years ago. Improvements have been made to the pump station, fish screen and one lateral (Upper South Ditch) is now piped. A follow up study was completed in 2004 to assess future billing options and alternatives. This study is not attached but is available for review. It is titled:
"Preliminary Review of SWA Rate Structure Options" by Forsgren Engineering.

Please refer to the SVRCD website for a more detailed narrative of the pump station, fish screen, and new pipeline projects that have been completed.
http://svrcd.org/wordpress/projects/shasta-water-association/

4. Evaluation Criteria

Evaluation Criterion A: Water Conservation (28 points)

Subcriterion No. A.1: Quantifiable Water Savings

The maximum diverted flow rate for the SRWA is 42 cfs, which is their 1912 water right. Shasta River Adjudication 1932, Diversion # 419. http://www.californiaresourcecenter.org/viewpage.php?page_id=94. Irrigation delivery methods have historically been measured by staff gages; with many irrigators taking all the flow or head for a prescribed number of hours, or split between two ditches with old concrete split boxes. These methods have encouraged irrigators to take their full allowable amount for the full hours without regard to the possibly impacts to their pastures, ditches, downstream neighbors or the overall system. Often over-irrigation is the result, as well as creating a long rotation that is up to18-25 days. There is no perceived benefit to becoming more efficient. The water bill is the same, and the rotation is still too long for optimum management and pasture health.

Data from the 2003 Forsgren Study shows a seasonal use of 15,742 Acre Feet for 2002. Using available data for crop water use (evapotranspiration or ET), the water use efficiency was calculated on a monthly basis, (pg. 5). Efficiencies from 25% to 66% were found, for an average seasonal efficiency of 50%. This number agrees well with other historic or wild-flood irrigation efficiencies in Shasta Valley. Without changing on-farm delivery, open ditch flood irrigation is often less efficient than 50%. The Forsgren Study further states that 7600 AF is "being lost through conveyance and inefficiencies", (pg. 6).

The Study further states that overall irrigation efficiency is 62%. This is in large part due to the reuse of tailwater within the district distribution system. "This represents a loss of approximately 4850 acre feet per year due to inefficiencies", (pg. 7). Some tailwater is not captured and runs back to the Shasta River. This tailwater component is estimated in the Study to be 17 to 25% of the total pumped flow.

With the new measuring equipment, it is suggested that tailwater will be reduced by voluntary efforts of landowners paying for irrigation by volume used, not time. Conserved water will stay in the Shasta River, as part of the basin-wide conservation effort. Estimated water savings will be calculated based on flow measurements at the pump before and after the project is constructed. Quantifiable water savings for flow measuring and billing changes will be much easier to measure and will be monitored and reported. Additionally, landowners will be able to access remote devices and know how much water they are using.

Please address the following questions according to the type of project you propose for funding.

(3) Irrigation Flow Measurement:

Benchmark average annual water savings have been determined by field measurements and are presented in the Forsgren Study (attached). These measurements are taken as needed at the 15 measuring sites throughout the district (see map).

Existing old equipment including staff gages, Parshall flumes and sharp crested weirs are in poor repair and very inaccurate, possibly within 10% and often fluctuating over time. The low accuracy of the existing equipment has been documented by discussion with the ditch tender and Association Board. With billing based on shares, this was less of an issue. More accurate flow measuring equipment is known to improve flow control, delivery and efficient use. Based on equipment warranty information, accuracy can be expected to be within 1%-5%, per discussion with Davids Engineering for a fully calibrated site using SonTek equipment. Improved rate and duration accuracy is imperative for volumetric billing which is planned.

We expect improved water conservation results from the flow measuring and control equipment to be 10%. Total acre feet used before and after project implementation will be documented by electronic measuring equipment. This will be 1560 Acre Feet.

(4) SCADA and Automation:

SCADA (supervisory control and data acquisition) system, automatic gates, and some automated or remote access equipment is part of this project. A combination of technologies is needed to allow for a smooth transition for the SRWA from manual read, to fully automated systems. Training for irrigators, Board and ditch tenders is critical for this phase, as current knowledge of electronics is very limited in this population as a whole. Maintenance of new equipment is necessary and will require new skills and training.

Annual average water savings benchmarks have been determined by means of field measurements take for the Forsgren Study. This will be documented by measurements from the ultrasonic equipment at the pump station for comparison. While spills are a small part of the inefficiencies in this system, they have not been quantified. Many 'spills' result in over irrigation and are recaptured in the lower ditches for redelivery to other irrigators. In general, with better measurements, spills will be less as they will be charged to a landowner. "Canal seepage" or ditch losses are quantified in the Forsgren Study at 8.33 cfs or 18% of total inefficiencies, (pg. 11).

On-farm delivery volumes may be reduced by a combination of structural improvements, such as this project, and voluntary or incentive based improvements such as the new billing structure, (pg. 17). More efficient and timely deliveries are possible when the new rate structure and new measuring equipment (this project) are in place. Farm delivery volumes will be modified by landowners once this is a possibility. We expect improved water conservation results from the flow measuring and control equipment to be 10%. Total acre feet used before and after project implementation will be documented by electronic measuring equipment. This will be 1560 Acre Feet.

Subcriterion No. A.2: Percentage of Total Supply

Estimated Amount of Water Conserved = 1560 AF = 10% of Total Supply

Average Annual Water Supply 15,602 AF

The Forsgren Study, states that 15% percent of delivered irrigation flow could be preserved or conserved by the total of all recommended measures prescribed (in the study, (page 22). That would be 77% efficiency overall; 62%+15% = 77%. This project is a part of the overall package of improvements and at this point the savings are challenging to isolate. Some savings cannot be realized without on-farm changes, billing incentive changes and more ditch loss recovery. However we can anticipate savings of 10% of the annual pumped acre feet from Improved Measuring Equipment and its associated voluntary management changes by individuals. These are conservative and attainable numbers.

Evaluation Criterion B: Energy-Water Nexus (16 points)

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

Pumping costs were shown to be $127,000 in 2004, before the pumps were replaced. At that time, possible energy savings were estimated to be 15 to 20% efficiency, or $88 per day (pg. 20). The new pump station has been in operation for 5 years now, and is proving up on promised energy savings. While those savings cannot be counted in this calculation, additional savings are expected from the reduced pumping demand during the spring and fall, when this project is implemented. However this is partially offset by ever-climbing power rates. Management of the overall system will be improved with these electronics, and will result in increased water and energy efficiencies. For 2013, average power usage was 10,810 kilowatt hours. This may be a more accurate unit for comparison.

Water savings will translate to energy savings from the Variable Frequency Drives (VFD's) on the pumps, and from reduced total pumping demand. These savings will be at the point of diversion. Installation of the VFD's have allowed supply and demand to be modified and will be used more effectively once rates are changed. There is no energy required to treat the water.

Solar panels (12 more) will be installed at each measuring location to allow for remote monitoring and measuring of water. Electric service is difficult to obtain and solar is a simple and obvious an energy efficient solution. These solar systems are not replacing anything, so there is no 'energy savings' from them. However they will be very important to keep increasing electric energy costs in check in the future.

Substantial energy savings are possible from reduced vehicle miles driven by the ditch tender and Board. Rick Lemos, Board member stated that average mileage for one month under the old system was 24 miles per day for 720 miles per month to one site (Site#9). He estimated gas used at 20 gallons per week for the whole system. Labor, carbon emissions and fuel savings are already evident due to use of the cell phone capability of the 3 new boxes installed in 2014. For September 2014, he estimated 90% less mileage, hours and trips to Site#9 due to the new equipment. Mileage for maintenance of measurement equipment may increase, but mileage for reading staff gages and other onsite equipment, adjusting gates manually over and over will be realized. The mileage will be documented for this period, and can be compared to previous reimbursements for mileage (set at $350 per month historically).

Evaluation Criterion C: Benefits to Endangered Species (12 points)

The federally listed species in the Shasta River are determined to be impacted by water quality impairments, including high temperature and low dissolved oxygen. The Coho salmon, *Oncorhynchus kisutch,* is declining in numbers in the Southern Oregon/Northern California Coast Evolutionary Significant Unit (SONCC ESU). This has led to the listing of Coho salmon as threatened under the Endangered Species Act (ESA) and the California Endangered Species Act (CESA).

(1) How is the species adversely affected by a Reclamation project? A. There is no BOR owned or managed land within the Shasta River drainage. Upstream impacts can be partially attributed to land use decisions in the Klamath Basin, where BOR does have property and projects.

(2) Is the species subject to a recovery plan or conservation plan under the Endangered Species Act? A. Yes, the listed species are the focus of a California Salmon and Steelhead Recovery Plan and the Southern Oregon Northern California Coho (SONCC) Recovery Plan (Federal). http://www.nmfs.noaa.gov/pr/recovery/plans/cohosalmon_soncc.pdf. The newly released Federal plan identifies several actions that will tie into the project. On page 37-27 SONCC-ShasR.10.1.20.2 Water Quality "Reduce warm water inputs". The SVRCD has implemented a tailwater reduction program, which the SRWA is a party to. On page 37-29 SONCC-ShaR.3.1.6.2 "Improve irrigation practices". The project will 'Implement improved irrigation techniques and monitor associated flow and water quality enhancements".

(3) What is the extent to which the proposed project would reduce the likelihood of listing or would otherwise improve the status of the species? A. This project is one of many that will determine the health of the riparian over summering habitat in the Shasta River for Coho salmon. Additional flows, particularly cold water, are critical to the recovery of the habitat and the species within the Klamath Basin.

Evaluation Criterion D: Water Marketing (12 points)

The value of these improvements can be monetized by the value of this water to the local water trust, the Shasta River Water Trust. This organization is in its infancy, and does not have adequate transactions under way to set these market values at this time. However, water left in the river in the late summer and fall is increasingly needed for Coho salmon habitat. Receiving compensation for this conserved water is certainly something that the SRWA can investigate when this project is done. The amount of water available could be the water saved or 10% (1560 AF).

Evaluation Criterion E: Other Contributions to Water Supply Sustainability (14 points)

Subcriterion E.1: Addressing Adaptation Strategies in a WaterSMART Basin Study

The WaterSMART Klamath River Basin Study is not completed and cannot be used to gauge now these strategies may meet goals. However, any projects that allow additional flexibility for water supply and demand forecasting within the Klamath Basin should meet goals of this Study. The Basin Study was funded in 2011 according to the BOR website but is ongoing but not complete. http://www.usbr.gov/WaterSMART/bsp/docs/fy2011/Final_Factsheet_Klamath.pdf
Collaboration among Basin Study partners is ongoing through the Klamath Basin Management Plan or KBMP. http://www.kbmp.net/
The SVRCD works with groups and agencies to identify planning and study needs for our work. Recently a comprehensive Study Plan called the (*Study Plan to Assess Shasta River Salmon and Steelhead Recovery Needs*), was published for the Shasta River. It covers some of the content that will be needed in the Klamath Basin Study Plan. It can be reviewed here:
http://www.fws.gov/arcata/fisheries/reports/dataSeries/SVRCD%20Shasta%20River%20Final%20Study%20Plan.pdf

Subcriterion E.2: Expediting Future On-Farm Irrigation Improvements

Improved on-farm efficiencies are needed by landowners within the SRWA to take full advantage of the improvements proposed for completion with this project. Several irrigation pipelines, land smoothing and tailwater projects within the SRWA have shown how effective this will be. When irrigation out of the main ditch system is shown to be wasteful and costly, landowners will be ready for distribution improvements on their fields. Rate structure changes will make it very obvious to landowners that water conservation will save not only water but dollars.
NRCS is a willing partner in these projects and will be available to assist. We have no commitment from landowners or NRCS at this time. Based on previous programs, land ownership patterns and local knowledge; 50% of landowners would be interested in this idea. However they may account for more than 50% of the total acres within the SRWA. This is due to the fact that an economic unit (~400 acres) would drive decisions in this direction. Smaller landowners cannot always afford projects, and may not have the economic incentives necessary. Please refer to the Forsgren Study for documentation.

- Acres needing treatment: 3400 acres
- Acres that could be considered for water conservation savings: 3400 acres
- Possible savings from tailwater reduction: 5 cfs or ~1500 AF
- Possible savings from switching 2000 acres to sprinkler irrigation: 4.7 cfs (suggested but not likely)
- Possible savings from flood irrigation borders, laterals, shorter runs, land smoothing for 50% of the acreage: 20% or 1.3AF per acre – estimate 1600 acres x 1.3 AF =2080AF. (Based on 28 Ac. In/Ac. annual irrigation pasture requirement)
- Additional savings from SRWA ditch to pipeline and ditch lining replacement: 5 cfs or 1500 AF.

Subcriterion E.3: Building Drought Resiliency

Yes, this project could help alleviate water supply issues resulting from drought. Existing drought conditions in this area of Northern California have been in the D2 or more severe for 12 months. In January 2015, it is D2-D4. http://droughtmonitor.unl.edu/Home/RegionalDroughtMonitor.aspx?west
Snowpack and precipitation have been below normal for three years. The Montague, California normal 30 year average annual precipitation is 18 inches. Water use from the Shasta River is limited by our desert climate, instream requirements for salmon, over-adjudication and upstream riparian users. Surface water from underflow (springs feeding the Shasta River) supplies most of the irrigation districts and direct diverters.

Lake Shastina holds irrigation flows for the largest irrigation district, the Montague Water Conservation District (MWCD). This upstream district was completely shut down due to drought in 2014. This was a disaster for many irrigators in the valley who needed to buy hay, move livestock or sell their herds. In the SRWA, water was available for full season irrigation due to the 1912 water right they hold. In the summer of 2014, even with strict water master service, there were many days without minimum flows in the Shasta River (20cfs) due to record drought. In short, the SRWA is in a position to assist with supply security for the entire basin, if this project is completed. By being able to reduce the demand within the SRWA during peak season of use, the SRWA can respond to basin wide flow needs.

Subcriterion E.4: Other Water Supply Sustainability Benefits

The Shasta River Adjudication is applied by the Scott –Shasta Water Master Service to manage the limited water in the Shasta River. Water supply is often in critical shortage in late summer and fall, mainly due to our geographic location in the rain shadow of Mt. Shasta and on the edge of the Great Basin. These weather patterns may be exacerbated by climate change in the future. Low rainfall combined with variable snowpack can impact flow conditions that are detrimental to irrigated agriculture and fish populations. This project is part of a larger drive to improve irrigation efficiency and extend water supplies to enhance natural resource values within our watershed and throughout the Klamath River watershed.

The SRWA is in the forefront of groups and irrigation districts responding to Shasta Valley irrigation needs for water quality improvements targeting salmon species. Because of the SRWA's location in the valley and its very good water right, work done by this association has benefit to the whole river. Their water leadership and management within the Shasta River basin through flow coordination and project work has large area wide benefits. Projects that benefit salmon habitat and water quality improvements benefit all downstream users, including three tribes.

In the summer of 2014, the MWCD was allowed to deliver municipal water supply to the City of Montague from a new point of diversion, downstream from the SRWA pump station. This put the SRWA in the position of being able to assist with a critical water need for this rural low income community. This project and its predecessors are critical to the continued success of SRWA's steady progressive strategy, toward water and energy security for its users and the larger Shasta River valley. While, there have been some recent water resource litigation in Shasta Valley, the SRWA has been able to steer clear of these issues.

Evaluation Criterion F: Implementation and Results (10 points)

Subcriterion No. F.1: Project Planning

The original planning document used to start work within the SRWA and other Shasta River related projects is the *Shasta Watershed Restoration Plan* written in 1997 by the Shasta River Coordinated Resources Management Committee or CRMP. It is available on the SVRCD website at http://svrcd.org/wordpress/library/historical-crmp-documents/. Concurrent and complimentary studies, construction and education work by all local, state and federal agencies have contributed to the long term success of cooperation in the Shasta Valley. For example, out of 8 impoundments or diversion dams that were identified for modification or removal, only 2 remain on the list. This demonstrates the long term commitment of groups, irrigators, and agencies to improving water quality and habitat for salmon, as well as millions of dollars of funding.

The SVRCD and the SRWA have been working to perfect this specific project for several years in general and specifically this flow measuring and billing upgrade planning effort for 24 months. The results have been productive as we have worked through early project concerns and have progressed through the design and into the construction phase as of October 2013.

The project will move through the following tasks to completion:

- Hire a consultant to manage the project.
- Finalize project work plan with SRWA Board for funding support
- Review environmental coordination with BOR requirements
- Preparation of bid documents
- Award of bid or bids
- Construction of box or boxes per work plan schedule
- Construction of electronics, remote equipment, connect to network
- Training of irrigators, Board and ditch tender to manage network
- Hiring of billing design consultant or BOR
- Review billing format as per suggestions/recommendations
- Implement new billing scheme

The two milestones that will be crucial for this project's ultimate success are the completion of the 15 measuring boxes, and the implementation of a new billing structure for the SRWA.

This project does implement tasks called out in the *Shasta River Study Plan* (2013). Improvements to temperature conditions, water quality standards, and fish health in the Shasta and Klamath rivers are discussed in the Plan. Instream flow recommendations for salmon are intrinsically linked to all these parameters. This document is available on the SVRCD website.
http://svrcd.org/wordpress/projects/

Subcriterion No. F.2: Readiness to Proceed

This project is ready to proceed. We have been working on permits and planning for 3 years. We engaged an engineering firm in 2013 to complete all design work. Construction began in early 2014 with other funding and could continue with this funding and with the understanding that the BOR would be involved in any notice to proceed.

Subcriterion No. F.3: Performance Measures

We are providing six (6) performance measures which we feel will allow the funders to gain a respectable knowledge of the project's objectives and benefits. They include acre feet of water conserved, acre feet potentially available for purchase by the local water trust, sample water savings by individual ranches, power savings from reduced pumping, reduced labor costs due to remote access to needed measuring equipment, and reduction in tailwater. They are described in more detail in the following section (Section 5. Performance Measures).

Subcriterion No. F.4: Reasonableness of Costs

For a total project cost of $506,000, and a water savings of 1560 AF X 20 years, or 31,200 acre feet, the cost per acre foot is $16.21. For comparison, from the Forsgren rate study, the cost per acre foot to irrigators, is estimated to $14/ac foot as currently billed.

A twenty year life span for all flumes and boxes is expected, based on data from the SRWA, and normal maintenance standards. Previous improvements have been well maintained and have lasted much longer than 20 years. All measuring equipment to be replaced is more than 40 years old. NRCS life spans for practices show a Structure for Water Control, 587, to be 20 years. The life span of the electronics is 10 years with good maintenance.

Evaluation Criterion G: Additional Non-Federal Funding (4 points)

This criterion will be met by our state of California funding through Prop 50. This funding was awarded to the SVRCD for design work, and 3 measuring boxes already installed. These and additional funds from the SRWA will contribute 50% non-federal dollars to the project. Some of this funding is now considered 'in kind' funding. No additional non-federal funding is available at this time.

Evaluation Criterion H: Connection to Reclamation Project Activities (4 points)

This criterion is met by our key location within the Klamath River Watershed. The Shasta River is an important tributary to the Klamath River and is required and expected to assist with all TMDL temperature or dissolved oxygen impairments that are "listed" for the Klamath River. The Bureau of Reclamation, Klamath Basin office is intimately involved in much of the project work, and monitoring that have been directly connected to overall environmental conditions in the Klamath River. All improvements to water quality impairments in the Shasta River will have a beneficial impact on the Klamath River and associated regulations throughout the Klamath Basin.

Our partner, the Shasta Valley Resource Conservation District is a partner in the Klamath Basin Monitoring Program or KBMP. This group is currently serving to provide big picture focus and collaboration with quarterly meetings for all interested stakeholders in the Klamath Basin, both Oregon and California. Tribal interests; Karuk, Hoopa, Klamath and Yurok are well represented in this venue, and their needs and values are addressed by improved water flow flexibility, quality and quantity benefits.
The Klamath Tracking and Accounting Program (KTAP) http://www.klamathpartnership.org/KTAP.html is working to guarantee and quantify measurable benefits from projects within the KBMP service area. The SVRCD is working to assist in creating tools to calibrate and demonstrate that these ecosystem services are valuable and valid.

5. Performance Measures

Here are the proposed Performance Measures to quantify the actual benefits of our project. This is generally defined as water actually conserved, and/or more efficiently managed, and some associated measures. We feel that these five parameters will accurately portray the results of our work with this grant. Other suggested performance measures may be more difficult to quantify due to challenges in data design, and diffuse resource benefits.

Projects with Quantifiable Water Savings

Measure #1 We propose pre and post project water use to show water saved. Acre feet per total irrigated acres before and after will show Acre Feet used / per Acre for each season. This will display the improved efficiency of the delivery system due to the measuring equipment and associated management shifts by landowners. Pre project baseline flows will be available using data from the pump station and the Water Master Service. Post project flows will be available using the new equipment and will be compared to pre project and historic data.

Measure #2 Calculations of water saved that could be leased for instream benefits would be an associated performance measure of great interest to the participants. Specifically, Acre Feet that could be available to the Shasta River Water Trust.

Projects with Water Measuring Devices: Irrigation Metering

Measures #3 Installed measuring devices include flow meters, weirs, flumes, meter gates. We propose tracking and recording total irrigation diversion flow quantity measurements pre and post project at the pump station. This will show results of improved management and can account for yearly fluctuations in weather patterns and irrigation demand. We hope to include samples of before and after usage by individual landowners to demonstrate response to the new system. The Study shows adequate information on irrigation data for every irrigator in the SRWA in Appendix A, at the end of the Study, which we will use for the benchmark condition.

Measure #4 We propose tracking the total labor or hours needed to manage the irrigation system pre and post new system. This will show the improved labor savings due to improved flumes, electronics and gauges. Estimates for labor hours under the older system will have to be found from interviews and records. In the past, the ditch tender salary was not based on mileage or hours worked.

Increasing Energy Efficiency in Water Management

Measure #5 Energy savings will be available via power bills pre and post project. Some savings have already been realized from the first phases of the project (pump replacement and 3 new measuring boxes), but these will not be counted. Savings will be calculated using 2015 as a baseline. While power costs continue to climb, savings are still anticipated to be significant. This will be measured in kilowatt hours (kWh). For an average day in 2009, kilowatt hours were 37,500. For an average day in 2013, kWh were 10,810kWh. These numbers, while cumbersome to compare, can be used to determine energy savings. Power bills are available for more complex metrics if desired.

Measure #6 Tailwater volumes returning to the Shasta River from specific locations have been monitored by the SVRCD for several years. We will select one location where tailwater returns to the Shasta River from a 'tailwater neighborhood' within the SRWA, for a before and after project monitoring based on best fit for the performance measure. The volumes are measured in two ways, total volume and instantaneous rates.

IV.D.1 Environmental and Cultural Resources Compliance

The answers below to the specific questions should address significantly any and all environmental and cultural concerns. (Answers within denoted with an "A".)

General: This project is 100% within the footprint of the existing SRWA irrigation delivery system ditches, diversion boxes and access roads. Any landowner easements and/or legal issues that may arise will be addressed by the SRWA Board in a timely manner. Existing funding has allowed planning, design and permits as well as CEQA to be completed. A NEPA exemption is considered to be needed. Typically all that may be required for another exemption is a letter stating what the action is, which exemption category it falls under and a statement that it does not encompass any extraordinary circumstances.

1) Will the 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.

A. All construction planned is within the footprint of the existing irrigation delivery system and outside of the stream channel and riparian zones. Excavation of existing concrete flumes, division boxes and ditch banks during replacement is planned. All earth disturbing activities will be carefully planned to minimize erosion, including staging, stockpiling and spreading of soil outside of any stream channel or wetland areas. A pre-construction bid tour is required of all contractors to acquaint them with the details of the implementation requirements.

2) 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? A. All construction planned is within the footprint of the existing irrigation delivery system and outside of the stream channel and riparian zones. Excavation of existing concrete flumes, division boxes and ditch banks during replacement is planned. All earth disturbing activities will be carefully planned to minimize erosion, including staging, stockpiling and spreading of soil outside of any stream channel or wetland areas. A pre-construction bid tour is required of all contractors to acquaint them with the details of the implementation requirements.

3) 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 project may have. A. No wetland or other surface waters will be found in the project area. A benefit will be long term irrigation efficiency over time to areas in pasture fields.

4) When was the water delivery system constructed? A. The SRWA system was constructed in the early 1900s, after the association was formed in 1912. The original pumps and pump house were recently replaced per grant and agency requirements. The system functions are basically intact and managed as it was in 1912.

5) Will the project result in any modification of or effects to, individual features of an irrigation system (e.g., head gates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously. A. All projects will replace existing measuring equipment constructed and maintained over the last 100 years. Historical records of all maintenance activities are not available, but no major improvements have been made in the past several decades with the exception of the mainline replacement project in 1985 and the new pump station, completed in 2010. Minor modification and construction upgrades to infrastructure have been ongoing during the 100 years of the SRWA, as needed.

6) 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. A. No

7) Are there any known archeological sites in the proposed project area? A. No. Several other projects were evaluated in the area, and have not been found to have any historic or prehistoric sites in the footprint of the ditch system. No work is proposed near the Shasta River as part of this project, where archeological sites are located.

8) Will the project have a disproportionately high and adverse effect on low income or minority populations? A. No

9) Will the project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands? A. No

10) Will the project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area? A. No

IV.D.2 Required Permits or Approvals

Applicants must state in the application whether any permits or approvals are required and explain the plan for obtaining such permits or approvals. A. All required permits and approvals will be obtained or are already obtained. A California Environmental Quality Act (CEQA) Notice of Exemption was submitted in 2013 for the first 3 boxes. This is a simple process and will be initiated before construction starts again. The project footprint is within the existing irrigation delivery system, and outside of any stream channels; therefore we expect that additional permits needed will be minimal. Further California Environmental Quality Act or CEQA review, California Water Board 401 Certification, California Department of Fish and Wildlife 1602 permit and Army Corps of Engineers 404 permit are not expected to be required. If any additional National Environmental Policy Act or NEPA, CEQA or permitting requirements are necessary, the Shasta Valley RCD will provide technical assistance to attain full compliance, with the support of assigned BOR staff.

IV.D.3 Official Resolution

The Chair of the SRWA Board of Directors has signed a resolution for this application, per requirements on page 28, in Section IV D3 of the application and submission information and it is attached.

IV.D.4 Project Budget

The project budget includes: (1) Funding Plan and Letters of Commitment, (2) Budget Proposal, (3) Budget Narrative and (4) Budget Form.

1. Funding Plan and Letters of Commitment

(Answers within, denoted with an "A".)

1) How you will make your contribution to the cost share requirement, such as monetary and/or in-kind contributions and source funds contributed by the applicant (e.g., reserve account, tax revenue, and/or assessments). A. SRWA will provide the full amount of the cost share requirements from their reserve account. This is projected to be $106,000.00. The remainder of the cost share is from in-kind contributions, (see below).

2) Describe any in-kind costs incurred before the anticipated project start date that you seek to include as project costs. A. In-kind contributions from the SRWA include:

- Design for the project, completed in 2013. The project can't be constructed without an engineered set of plans. The cost of the design was $24,000.
- Construction of the first 3 measuring boxes, completed in 2014. The project benefits from this first phase of construction because some of the initial questions and concerns regarding the functionality and the adaptability of this new technology are now laid to rest. The cost of this construction was $90,000.
- Instream modification needed to keep bypass flows adequate. Without a functional fish screen and intake gallery, the pumps cannot operate at an optimum level. This work cost $5,000 and was done in the summer of 2014.
- Communication to cell phone system for new measuring equipment at the first 3 measuring sites. This work was needed to actuate the new boxes and

allow the ditch tender to read the new measurements remotely. This work was done in the fall of 2014 and cost $3,000.

5) Describe any funding requested or received from other Federal partners. Note: other sources of Federal funding may not be counted towards your 50 percent cost share unless otherwise allowed by statute. A. All funding will be provided by the Shasta River Water Association. Therefore no letters of commitment are included with this proposal. No funding is expected to be received from other Federal sources.

Table 1. Summary of non-Federal and Federal funding sources.

Funding Sources	Funding Amount
Non-Federal Entities	
1. Shasta River Water Association	24,000
2. Shasta River Water Association	90,000
3. Shasta River Water Association	8,000
4. Shasta River Water Association	106,000
5. Other Funding	0
Non-Federal Subtotal:	253,000
Other Federal Entities	
1.	0
Other Federal Subtotal:	0
Requested Reclamation Funding:	253,000
Total Project Funding:	506,000

2. Budget Proposal

Table 3. Funding Sources

Funding Sources	Percent of Total Project Cost	Total Cost by Source
Recipient Funding	50%	253,000
Reclamation Funding	50%	253,000
Other Federal Funding	0	0
Totals	100%	506,000

Table 4. Budget Proposal

Budget Item Description	Computation		Quantity Type (hours/days)	Total Cost
	$/Unit	Quantity		
Salaries and Wages				**6000**
Project Manager	25	200	hours	5000

Financial Manager	20	50	hours	1000
Fringe Benefits				**0**
Travel				**0**
Equipment				**314000**
Flumes	10,000	3	each	30000
Control Boxes w/o flumes	5,000	8	each	40000
Gates	6,000	2	each	12000
Split Boxes	10,000	1	each	10000
Valves, other hardware	5000	12	each	60000
Electronic Equipment	11,000	12	each	132000
Website/online services 3 years	15,000	2	each	30000
Supplies/Materials				**0**
Contractual/Construction				**177528**
Engineering Services- Davids Eng.	7,000	9	each	63000
Construction Services - Phase 2	1	25,000	each	25000
Construction Services - Phase 3	1	25,000		25000
Construction Services - Phase 4	1	21,000		21000
Shasta Valley RCD	23,528	1	each	23,528
Environmental Compliance	10,000	1	each	10000
Technical Assistance - BOR	10,000	1	each	10000
Other				**1000**
Reporting				0
Misc.				**2000**
Total Direct Costs				**500528**
Indirect Costs - 0.05% (or less)				**5472**
Total Project Costs				**506000**

Table 4-1. Budget Proposal - Contract with SVRCD

Budget Item Description	Computation		Quantity Type (hours/days)	Total Cost
	$/Unit	Quantity		
Salaries and Wages				**12960**
District Administrator	30$/hr.	40	hours	1200
Project Manager	22$/hr.	400	hours	8800
Monitoring Specialist	24$/hr.	40	hours	960
Financial Manager	22$/hr.	100	hours	2000
Fringe Benefits (workmen's' comp., tax withholding. etc.)				**3888**
Full-Time Employees	30%		%	0
Part-Time Employees	30%		%	3888
Travel	0.56	3000	mile	**1680**
Equipment				**0**

Supplies/Materials	**2000**
Contractual/Construction	**0**
Other	**0**
Reporting	**3000**
Misc.	0
Total Direct Costs	**23528**

3. Budget Narrative

Salaries and Wages - The SRWA will contribute funds that already earmarked for upgrades to their delivery system. During construction, equipment and other maintenance and management services will be available. Our locally led irrigation association is frugal and all board members are irrigators and ranchers in the community. They receive a minimal stipend from the SRWA for their meeting attendance. Some additional book keeping is expected.

Travel - Mileage at the standard rate to and from the project site is requested.

Equipment - Purchase of flumes, electronic equipment and other measuring devices is central to this grant. We will be working closely with our engineers to acquire exactly what is needed to allow for a long term upgrade to the SRWA delivery system. A tracking and billing system for the SRWA is expected to be required for this project, which may include a website, cell phones, computer and other hardware. We expect part or all of this new electronic data to be available on a private network. .

Materials and Supplies - Charges for materials and supplies will be tracked for this grant. Generally our grant manager, the SVRCD will need printer supplies, and other business work flow materials.

Contractual - We have a management agreement with the SVRCD to manage our project. The budget for this is included as a separate budget as per instructions on page 33.

Salaries and Wages for SVRCD - The Executive Director is Adriane Garayalde who is responsible to the SVRCD Board of Directors for all work performed by the Shasta Valley RCD. She has worked successfully with the Bureau of Reclamation on several occasions and has good relations with our previous grant manager in the BOR Klamath Falls office. Her involvement in this grant will be supervisory, with the day to day project management being handled by the project manager and other staff from both organizations.

The SVRCD has engineering and consulting services available, including Davids Engineering to perform various operations and training work for this project. We will complete the construction with a very detailed bidding process, already in place through the SVRCD.

Environmental and Regulatory Compliance Costs Reporting - Costs for NEPA are uncertain. We have inserted $10,000 into the budget for agency/consultant costs as a contingency.

Other Expenses - The SVRCD and the SRWA will work together to keep contingencies to a minimum.

Indirect Costs The SRWA and the SVRCD has ongoing administrative overhead costs. These include the cost of printing, internet services, meeting attendance, coordination time and routine filing, audits and bookkeeping. We expect to charge this grant 1% administrative overhead to help defray these ongoing costs of doing business. An agreement will be completed within the time frame required.

Total Costs - This request is part of a larger effort and this makes the cost of project planning less than for a standalone project. Our ongoing work to address irrigation efficiency has made cooperative efforts more streamlined and trust between all parties is well established. This is one outcome over the many years of outreach, education and partnership building within our community: the total cost of this project is spread over many projects and many years.

4. Budget Form

SF-424C, Budget Information—Construction Programs is included.

Resolution #15-1

December 9th, 2014

A Resolution Authorizing Entering into an Agreement with the Bureau of Reclamation and designating a representative to sign the agreement and any amendments thereto, for the "Shasta River Water Association, Irrigation Water measurement and Billing Accounting System".

Whereas, the Board authorizes the Shasta River Water Association to enter into an Agreement with the Bureau of Reclamation; and

Whereas, the Board authorizes the Board Chair, or designee to sign the Agreement, and any amendments thereto, for Funding Opportunity Announcement No. R14AS00001; WaterSMART: Water and Energy Efficiency Grants for FY 2015.

Now, therefore, be it resolved, that the Shasta River Water Association, Board of Directors hereby adopts Resolution #15-1 on December 9, 2014.

☐ The identity of the official with legal authority to enter into agreement is Marsha Pitkin, Board Chair.

☐ The board of directors, governing body, or appropriate official who has reviewed and supports the application submitted

☐ The capability of the applicant to provide the amount of funding and/or in-kind contributions specified in the funding plan

☐ That the applicant will work with Reclamation to meet established deadlines for entering into a cooperative agreement

Certification: I hereby certify that the foregoing Resolution #15-1 was duly and regularly adopted by eh board of Directors of the Shasta River Water Association at the meeting thereof held on the 9th day of December, 2014, motion by Rick Lewis motion passed by the following roll call vote: 2nd by Justin Sandahl

Ayes: 4
Noes: 0
Abstained: 0
Absent: 1
This resolution is approved: December 9 2014 Date

Signed by: Marsha A. Pitkin
Marsha Pitkin, Board Chair

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1.0 INTRODUCTION

1.1 Scope

The Shasta Water Users Association is a major diversion along the Shasta River. In recent years, the need to improve water resource management in the Shasta River valley has been recognized due to a variety of environmental and economic concerns. Improving water resources management and conservation along the Shasta River can improve environmental conditions as well as economic conditions if proper planning and coordination is utilized.

This water conservation plan has been prepared for the Shasta Water Users Association to evaluate and recommend improvements to current water management practices. The scope of this plan includes an evaluation of district irrigation and conveyance efficiencies and an evaluation of pump station efficiencies with respect to energy consumption. The potential to implement water conservation through price incentives has also been reviewed. Water conservation measures have also been evaluated in relation to replacement of SWA's existing dam and diversion structure with a new water control structure providing adequate fish passage and screening. A recommended water conservation strategy has been developed along with estimated costs.

1.2 Authorization

Forsgren Associates was authorized by Great Northern Corporation to prepare this study through an agreement dated April 28th, 2003. Funding for this study has been provided by the California Department of Fish and Game (CDFG). The Shasta Water Users Association has provided invaluable cooperation and assistance to Forsgren Associates, Great Northern Corporation, and the CDFG in completing this project.

1.3 Background

The Shasta Water Association (SWA) diverts approximately 42 cubic feet per second (cfs) from the Shasta River during the irrigation season. The irrigation diversion currently consists of a flashboard dam and an inlet structure providing fish screening. Water is diverted to a pump station where it is lifted to a series of ditches conveying water throughout the district. The SWA boundaries and water conveyance ditches are shown in Figure 1.

The Shasta River Coordinated Resource Management and Planning Committee (CRMP) have identified implementation of water conservation efforts to improve in-stream flows for fish migration and habitat as a priority. The recent listing of Coho Salmon as an endangered species provides additional incentive to improve water usage efficiency in the Shasta River Valley.

In 2001 the SWA flashboard dam and diversion was investigated with regard to fish passage and screening in the Shasta River Preliminary Engineering Report for Fish Screening/Passage Improvements. Options to improve fish passage and screening were documented in this effort as well as a recommendation to evaluate water conservation potential to reduce water withdrawal from the Shasta River. It was recognized that water conservation measures would impact fish passage and screening improvement design criteria for the diversion.

It was also unclear what impact upgrading the dam and diversion would have on operation of the existing pumps. A new diversion will lower water intake levels by approximately 2.0 to 4.0 feet. This would pose no problem if the existing pumps were replaced but it was unclear what affect lowering intake water levels would have on the existing pumps if they continued to be used. As part of the pump station testing, the effect of lowering water intake levels was investigated. (See Section 3.4)

This water conservation study will be used in conjunction with the 2001 fish passage and screening study to provide a design basis for overall improvements to the SWA diversion and irrigation district. These improvements will provide an economic benefit to the land-owners within the SWA and environmental benefit to fisheries within the Shasta River. The results of this study provide clear recommendations that will directly aid in the Statewide Coho Salmon recovery strategy.

2.0 DESCRIPTION OF THE SHASTA WATER USERS ASSOCIATION

2.1 General

The SWA was formed in 1912 and serves approximately 6,700 acres, approximately 3,400 acres are currently irrigated. The SWA dam and diversion is located at approximately river mile 17.4. The SWA has a water right established in November 1912 to 42 cfs during the period from April 1 to October 1 each year.

The SWA has an elected board of directors who manage the affairs of the Association. A secretary/treasurer accounts for Association finances and administers dues to collect revenues. The Association employs a part-time ditch tender who maintains the ditches and pump station and controls water distribution.

2.2 Crops and Soils

Pasture grass is the primary crop grown in the SWA district. Other crops include alfalfa and grass hay.

Soils throughout the district are generally gravelly and clay loams with some areas of silt loams. Soils are generally well suited to pasture grass and alfalfa crops. The soils can be limited by soil depth and available water holding capacity.

2.3 Water Distribution

2.3.1 River Diversion and Pump Station

The Shasta Water Association dam consists of two concrete piers and two abutments on either side of the stream. The abutments and piers support a metal catwalk. The piers and abutments are used to support slat boards that check up water. Water is checked up approximately 3.5 feet from natural river flow levels. The dam is located approximately 650 feet down stream of the pump station and diversion.

At the pump station, water is diverted through two grates providing course screening for large debris. A vertical fixed plate fish-screen has been installed in a concrete bay adjacent to the pump house. After water passes through the fishscreen it enters a wet well located directly underneath the pump station.

Pumping is provided by two Worthington split case centrifugal pumps. One pump is a 250 hp pump and the other is a 325 hp pump. The pumps operate independent of each other. The 250 hp pump lifts approximately 14 cfs (6,280 gpm) approximately 100 feet. The 325 hp pump lifts approximately 28 cfs (12,570 gpm) approximately 71 feet.

The pump station was constructed in 1914 and has not been significantly upgraded since that time. The SWA has diligently maintained the pump impellors and motors over the years and have had no serious problems.

Water was originally pumped to the canals through banded wooden pipes. The wooden pipes were replaced with a PVC piping system in 1985. Currently water is pumped to the upper ditch through a 24-inch PVC pipe. Water is pumped to the lower ditch through two 24-inch PVC pipes.

Until the summer of 2003 no flow measurement was provided at the pump station. During the summer of 2003 the Department of Water Resources installed ultrasonic flow measurement equipment on the transmission piping. This equipment provides an instantaneous flow readout as well as totalized flow.

The pump station is in good condition and remarkably efficient considering its age. However, replacement parts are no longer available for the pumps. A new pump would be required if one of the existing pumps was damaged. A detailed discussion on pump station efficiencies is provided in Section 3.4.

2.3.2 Water Conveyance

Water distribution for the district is accomplished by pumping into a series of five ditches. The ditch system is shown in Figure 1.

Water for the upper south ditch and upper middle ditch is supplied from the 250 hp pump at the pump station. Water for the lower south ditch and lower middle ditch is supplied from the 325 hp pump. The north ditch is fed with bypass water from the lower middle ditch and tail water reuse from the upper middle ditch.

2.3.3 Existing Flow Measurement

Flow measurement throughout the ditch system is provided by a series of sharp crested weirs and Parshall flumes. A sharp crested weir is provided at the head of the upper and lower south ditches and the upper and lower middle ditches. A Parshall flume is provided at the head of the north ditch. Other Parshall flumes are provided at various locations on the north ditch, lower middle, upper south, and lower south ditches (See Figure 1).

2.3.4 On Farm Irrigation

Flood irrigation is the primary method of water application. Some fields have been graded and checked to improve distribution. Approximately 170 acres are irrigated with wheel line sprinklers.

2.4 Current Financial Summary

The Shasta Water Association currently charges an annual fee from each of its members based on the number of shares each member holds. A share is equivalent to one irrigated acre. The annual fee is based on actual expenditures for the Association and has typically been on the order of $50 per share.

Total expenditures for the association from December 2001 through November 2002 were $180,184.07. Total assessments or revenues for the same period were $183,401.81. The net income for the Association for the same period was $3,217.74. The fee charged to members was $53.60 per share for this period.

The primary expense for the Association is power. During the 2001/2002 season, power costs were $127,886.08. Other major expenses included repairs and maintenance (including chemicals for ditch maintenance) at $15,209.28, labor expenses of $16,400.00, and insurance at $8,308.44.

3.0 CURRENT WATER MANAGEMENT AND ENERGY CONSUMPTION

3.1 Distribution and Irrigation Efficiencies

Defining irrigation and water usage efficiencies for an irrigation district help provide a basis for evaluating potential water conservation strategies. Improving water usage efficiency will also improve energy usage efficiency.

During this study, irrigation water conveyance and application throughout the district was reviewed and analyzed to gain an understanding of water usage efficiency. Water conveyance and irrigation efficiencies were estimated as well as an overall water usage efficiency for the Association.

Delivered / Diverted

*Conveyance efficiency is the ratio of water delivered to the farm to the total water diverted from the river. Conveyance efficiency accounts for seepage losses, evaporation, operational spills, and other potential water losses. For this study, irrigation efficiency has been defined as the ratio of the crop water requirement to the water delivered to the field. Irrigation efficiency accounts for water losses due to run-off, over application, and other application method water losses.

Field flow measurements throughout the district have been made to gain an understanding of water delivery efficiencies to farms and water conveyance losses. Flow measurements were taken at existing weirs and flumes. In addition, flow measurements were made at various locations using the area velocity method. Flow measurement locations are shown in Figure 1.

Based on this information an overall district water usage efficiency as well as water usage efficiencies for various sections of the district have been estimated. Water usage efficiencies were estimated using the flow measurements described above, irrigation rotation schedules for each ditch, and crop evapotranspiration data specific to the Shasta River Valley.

3.1.1 Overall District Water Usage Efficiency

An overall district water usage efficiency has been estimated based on estimated evapotranspiration requirements for pasture grass and alfalfa from long-term historical averages and water usage estimates based on energy consumption information from 2002. A monthly summary of crop water requirements for the district, water diverted, and estimated water usage efficiency is provided in Table 1. The information in Table 1 is shown graphically in Figure 2.

Table 1. Overall Association Water Usage Efficiency

Month	Crop Water Requirement[1] (Acre-ft)	Water Diverted (Acre-ft)	Estimated Efficiency
April	784	2,351	33%
May	1,466	2,686	55%
June	1,488	2,641	56%
July	1,683	2,691	63%
August	1,777	2,683	66%
September	679	2,673	25%
Total	7,876.4	15,724	50%

Notes:
[1]Estimated based on long term weather data.

Table 1 shows that monthly water usage efficiency ranges from 25 to 66 percent with an overall annual efficiency of 50 percent. This is a reasonable efficiency for an irrigation district similar to the SWA. Table 1 indicates that the greatest inefficiency exists during the spring and the fall when crop water requirements are lower and it is more difficult to match water application to crop needs.

Water usage efficiency for the Association has been broken down by ditch in Table 2. Table 2 indicates that efficiencies for the upper ditches are approximately 35 percent while efficiencies

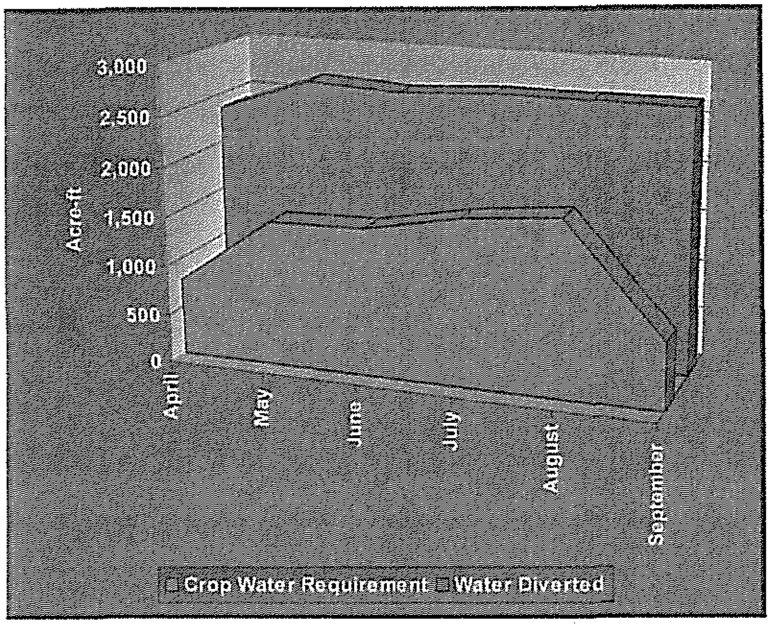


Figure 2 Monthly Water Usage

for the lower ditches are approximately 53 percent. The efficiencies shown in Table 2 are based on crop water requirement and water delivery estimates. A summary of water delivery estimates is provided in Appendix A. Observation indicates that much of the water delivered to the upper ditch acreages is being reused as tail-water in the lower ditch acreages. This, in part, provides some explanation as to why upper ditch efficiencies are so much lower than lower ditch efficiencies.

Table 2 Association Water Usage Efficiency Summary

Ditch	Total Acres	Flow (cfs)	Delivery Volume (acre-ft)	Crop Water Rqrmt (acre-ft)	Overall Efficiency
Upper South	351	6.5	2,321	818	35%
Lower South	793	9.9	3,535	1,850	52%
Upper Middle	415	7.6	2,713	967	36%
Lower Middle	978	12.1	4,320	2,281	53%
North	859	10.6	3,784	2,004	53%
Total	3,395	43.7	15,602	7,921	51%

The results of Tables 1 and 2 suggest that of the approximately 15,600 acre-feet of water being delivered to the irrigation district approximately 7,600 acre-feet is being lost through conveyance and irrigation inefficiencies.

3.1.2 Irrigation Efficiencies

As indicated above, the primary irrigation method used in the SWA is flood irrigation. Approximately 5 percent (170 acres) of the district is sprinkle irrigated with wheel lines. Factors affecting irrigation efficiency include water losses during application, uniformity of application, and irrigation management. The primary sources of water loss for flood and sprinkle irrigation systems is summarized in Table 3.

Table 3 Irrigation Inefficiency Sources

Method	Source of Inefficiency
Flood	1. Inefficient water management (over applying water where it is not needed or in excessive amounts) 2. Runoff and deep percolation 3. Leakage from on farm ditches and conveyance structures
Sprinkle	1. Inefficient water management (over applying water where it is not needed or in excessive amounts) 2. Evaporation droplets, wetted canopy, and the soil surface 3. Runoff and deep percolation 4. Leakage from irrigation equipment

For the SWA, individual land-owner water management practices and poor uniformity of application are the major sources of irrigation inefficiency. Much of the acreage being flood irrigated has surface irregularities that promote ponding, runoff, and uneven application. In low areas excessive deep percolation is most likely happening, while higher areas are not receiving sufficient moisture.

Field measurements and observations suggest that irrigation efficiencies for areas being flood irrigated within the district varied significantly. In areas where tail water from upper fields is being reused, water use efficiencies were very high. It was also observed that certain landowners are much more particular about water management and achieve relatively high irrigation efficiencies.

Typical flood irrigation efficiencies range from 50 to 70 percent depending on soil types, application frequency, and land slopes. It is estimated that flood irrigation efficiencies for SWA are generally from 50 to 60 percent. Typical sprinkler irrigation efficiencies range from 70 to 80 percent. A well-maintained and operated sprinkler system can achieve irrigation efficiencies as high as 85 percent.

Based on field observations and data available for the SWA, it is estimated that irrigation efficiency for the district is approximately 62 percent. This represents a loss of approximately 4,850 acre-feet per year due to irrigation inefficiencies. There will always be some level of inefficiency for any irrigation practice and it would not be feasible to recover all water lost due to irrigation inefficiencies. However, there is a significant opportunity to improve irrigation efficiencies within the SWA.

3.1.3 Water Conveyance Efficiency

Water conveyance losses can be a significant problem for irrigation districts. Conveyance losses result primarily from the following :

1. Seepage losses from ditches, canals, and pipelines;
2. Leakage through and around headgates, turnouts, and other structures;
3. Operational spills; and
4. Consumptive use from vegetation on ditch banks.

Field measurements and observation indicate that ditch seepage losses and leakage through turnouts and other structures are major sources of conveyance losses for the SWA. Water consumption from bank vegetation is also likely a significant sources of water loss along certain reaches of the ditch system.

Conveyance losses for the district were estimated from flow measurements taken at various locations along the ditch system during June of 2003. A summary of flow measurements taken during this period is provided in Table 4.

Table 4 Ditch Flow Measurement Summary

Ditch	Location	Flow (cfs)
Upper Middle	Just below head weir	7.25
Upper Middle	End of upper middle	6.50
Lower Middle	Just below head weir	19.49
Lower Middle	Just above last turnout	14.50
Upper South	Just below head weir	8.00
Upper South	At Sandal property line	5.41
Lower South	Just below head weir	9.95

.75
5
3

The flow measurements summarized in Table 4 were used to estimate ditch losses. These estimated ditch losses are summarized in Table 5.

Table 5 Estimated Ditch Loss Summary

Ditch	Estimated Loss (cfs)
Upper Middle	0.75
Lower Middle	4.99
Upper South	2.59
Total	8.33

Table 5 indicates an estimated ditch loss for the SWA of approximately 8 cfs. This translates to approximately 2,850 acres-feet per year. It should be understood that this value represents only a "snap shot" in time of ditch flows. Average losses in the ditches on an annual basis may be lower or higher depending on weather conditions, ditch maintenance, spill control, and others variables. No attempt was made to account for non steady-state flow conditions. However these measurements do indicate that significant ditch losses are occurring.

The results of Table 5 suggest that the reduction of ditch losses, particularly in the Lower Middle and Upper South Ditches represents a significant opportunity to improve overall district water usage efficiency. While the field measurements made during this study indicate less losses in the Upper Middle ditch, past association experience and observation indicate that significant losses in this ditch do occur.

No ditch losses were estimated for the Lower South Ditch. Past district experience suggests that losses through this ditch are minimal. A flow measurement was made at the head of this ditch to verify flows going to the Lower Middle Ditch. No other measurements were made on the Lower South ditch to estimate losses. It has also been the experience of the association that losses are minimal from the North Ditch. Visual inspection of the Lower South Ditch just downstream of the head weir indicates that lining approximately 1,500 feet will eliminate some ditch losses for the Lower South Ditch.

A typical ditch turnout is shown in Figure 3. This turnout is leaking at approximately 0.25 cfs. It is estimated that there are hundreds of similar turnouts throughout the association. If only a fraction of these turnouts are leaking at a similar rate, it is clear that this represents a significant conveyance loss component. Upgrading many of these turnouts will provide significant improvement.

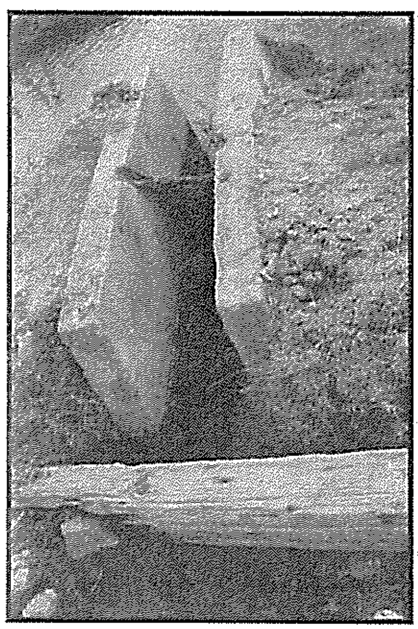


Figure 3 Typical Ditch Turnout

3.2 Tail Water Patterns

A significant amount of water returns to the Shasta River as tail water from the SWA. In addition, a significant amount of tail water feeds into other irrigation districts down stream. This study focused on assessment of tail water returning to the Shasta River or leaving SWA boundaries. It should be noted that a large amount of tail water leaves individual fields throughout the association boundaries. Much of this tail water is reused on lower fields within the association which improves overall water usage efficiency. Figure 4 shows major tail water patterns for the southern portion of the SWA. Figure 5 shows patterns for the middle portion.

Approximately 2 to 3 cfs of tail water returns to the river from the southern portion of the association. This represents approximately 18 percent of the water delivered to this portion of the association. Approximately 3 to 4 cfs returns to the river from the middle portion representing approximately 25 percent of the water delivered. Approximately 2 to 3 cfs of tail water leaves the northern portion of the association. However, the Antonio Ditch running north of the SWA boundary captures the majority of this tail water.

It is estimated that approximately 7 to 10 cfs of tail water leaves the SWA boundaries. This represents approximately 17 to 24 percent of the water diverted from the Shasta River. This tail water is the result of irrigation inefficiencies and conveyance losses.

Reductions in irrigation inefficiencies and conveyance losses will also result in a reduction of tail water to the Shasta River. It is unclear at this time what the net increase in stream flows downstream of the SWA will be from the improvement of water usage efficiency. However a major concern associated with tail water returning to the Shasta River is the impact it has on water quality. While tail water returning to the river has the benefit of increasing in-stream flows, it is detrimental to water quality parameters such as temperature, nutrient loading, and sediment loading. Improving water usage efficiency for the SWA will result in a significant improvement in water quality and will most likely increase in-stream flows downstream of the association.

3.3 Water Balance Summary

A water balance summary is shown in Figure 6. Figure 6 summarizes what ultimately happens to water diverted from the Shasta River by SWA. The information presented in Figure 6 is based on the water usage and loss estimates developed above. In Figure 6, it was assumed that tail water for the SWA is included in the irrigation losses component.

3.4 Pump Station Efficiency

A pump station efficiency test was performed as part of this study. A major operating cost for the Association is power (Section 2.4). Power costs for the 2002 operating year represent approximately 67 percent of total expenditures. The SWA realizes that improving pump station efficiency could provide significant economic benefit to the Association.

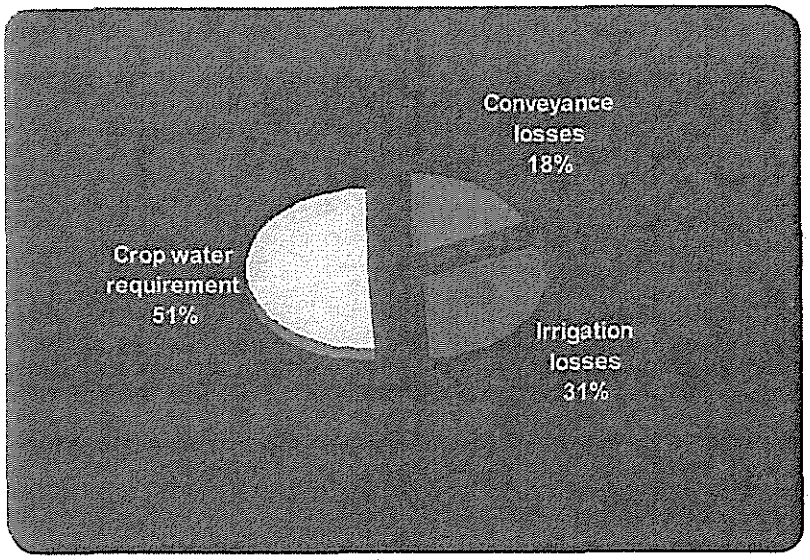


Figure 6 Water Balance Summary

The efficiency of the pump station was estimated by measuring pressure and amperage under different flow rates. Flow was restricted by partially closing the isolation valves just downstream of the pump discharge. The power draw for each pump was estimated by measuring the amperage in each motor lead and taking an average. A summary of the efficiency testing performed on the 250 horsepower pump is provided in Table 6. Table 7 provides this information for the 325 horsepower pump.

Table 6 Operating Data for the 250 Horsepower Pump

Flow (gpm)	Flow (cfs)	Pressure (feet)	Average amps	Work Horsepower	Brake Horsepower	Overall Pumping Efficiency
6450	14.4	103.9	268.3	169.3	273.8	62%
6568	14.6	103.9	268.3	172.4	273.8	63%
6500	14.5	103.9	268.7	170.6	274.1	62%
6440	14.3	103.9	268.3	169.0	273.8	62%
6300	14.0	103.9	265.7	165.3	271.1	61%
6060	13.5	103.9	258.7	159.0	263.9	60%
5300	11.8	99.3	244.7	132.9	249.7	53%
4400	9.8	97.0	223.7	107.8	228.2	47%
3210	7.2	94.7	202.0	76.8	206.1	37%
780	1.7	92.4	165.0	19.6	168.4	12%

Table 7 Operating Data for the 325 Horsepower Pump

Flow (gpm)	Flow (cfs)	Pressure (feet)	Average amps	Work Horsepower	Brake Horsepower	Overall Pumping Efficiency
13,290	29.6	73.9	414.7	248.0	423.1	59%
12,750	28.4	73.9	412.3	237.9	420.7	57%
9,085	20.2	73.9	385.0	169.5	392.8	43%
2,880	6.4	73.9	265.7	53.7	271.1	20%

The efficiencies estimated in Tables 6 and 7 are overall pump station efficiency values and include motor and pump efficiency. No attempt was made to determine individual motor or pump efficiencies.

Table 6 indicates that under normal operating conditions, the 250 horsepower pump is approximately 62 percent efficient. Table 7 indicates that the 325 hp pump is approximately 59 percent efficient. Considering the age of the pumps, this is an excellent efficiency.

No performance curves were available for the pumps to compare operating conditions. However, original test curves for the pumps were obtained from the suppliers' archives. The measured operating parameters for the pumps agree well with the test curves. A copy of the pump test curves have been provided in Appendix B.

As indicated in Section 1.3, a goal of this study was to determine what impact lowering the pump intake water level 2.0 to 4.0 feet would have on operation of the existing pumps. This test was performed during the pump station testing effort. It was determined that the effect of lowering the intake water level on the existing pumps' performance was negligible. The measurements indicated a drop in water delivery of approximately 2.5%. This translates to less than 0.5 cfs.

4.0 CONSERVATION ALTERNATIVES

A variety of conservation alternatives are available to the Shasta Water Association. The four primary alternatives include the following:

1. Improve water conveyance efficiency;
2. Improve water application efficiency;
3. Develop an incentive pricing structure; and
4. Improve pump station efficiency.

Each of these alternatives will have different impacts on district users and will require different approaches for implementation. This section will discuss these alternatives in detail and provide an estimate of implementation costs.

4.1 Conveyance Efficiency Improvement

Typical methods used to improve water conveyance efficiency include canal lining, conversion of canals to pipelines, and diversion point relocation. Relocation of the point of diversion would be impractical for the SWA and was not considered in this study. Canal lining methods and conversion of canals to piping was investigated in this study. It is estimated that improvements to water conveyance infrastructure could reduce conveyance losses by 90 percent. Assuming current conveyance losses of approximately 2,850 acre-feet per year (Section 3.1.3), this suggests a water savings of approximately 2,560 acre-feet per year.

4.1.1 Ditch Lining

Traditional canal lining materials have typically included concrete and compacted clay. More recently buried geomembranes have been used for canal lining. These lining materials often have significant limitations that make them impractical for application. Limitations can include lack of local availability (such as compacted clay), too costly, large right-of-way requirements for construction, extensive over excavation and sub-grade preparation. Observation over time has also indicated that these materials lose their effectiveness due to cracking, difficult maintenance, and lack of protection.

In recent years a variety of canal lining materials and techniques have been developed. Many of these materials are simpler to construct and maintain than concrete or traditional buried geomembranes and have been demonstrated to be more durable when maintained properly.

For this study, several lining materials and techniques were evaluated. The materials were evaluated based on the following criteria:

1. Life Cycle;
2. Effectiveness;
3. Construction and maintenance requirements; and
4. Construction and maintenance costs.

Various lining techniques include fluid applied membranes, concrete or shotcrete, geomembranes and geotextiles, or a combination of these materials. A summary of these materials and associated data is provided in Appendix C. After reviewing these materials and discussing options with the SWA personnel, two lining options were evaluated in detail. These included:

1. An exposed SBS (styrene-butadiene-styrene) geomembrane-asphalt material; and
2. A concrete liner with a geomembrane underliner.

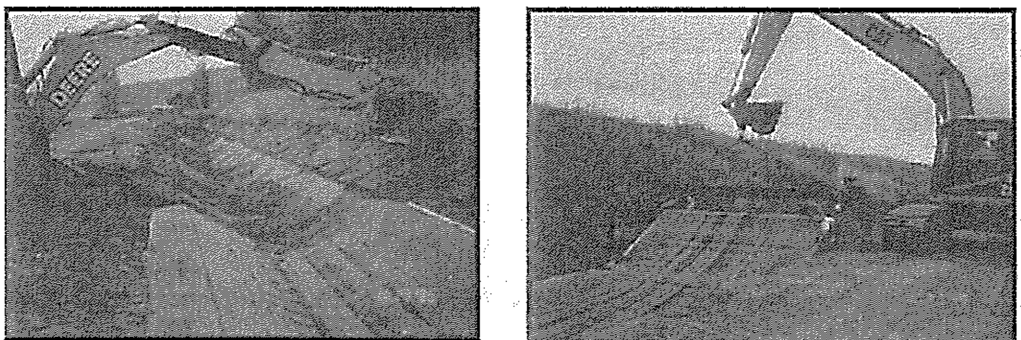
The exposed SBS-asphalt material would be installed in the existing ditch sections. It is estimated that the SBS-asphalt liner would be effective in eliminating seepage losses by approximately 90 percent. The life of the liner system is estimated at approximately 20 years. Fencing would need to be provided for this liner system to keep animal traffic off of the material. Cattle and other animals would puncture the material if they were allowed to walk across it.

Installation costs for the SBS-asphalt material are estimated to be $1.50/square foot. Assuming a width requirement of 12-feet, this would translate to an estimate of $95,000.00 per mile. Providing fencing to protect against animal traffic is estimated at approximately $13,200 per mile. A total installation cost for the SBS-asphalt option would be approximately $108,200 per mile. Annual maintenance costs for this liner system is estimated at approximately $6,300 per year.

A concrete liner with a geomembrane underliner is another option for SWA. This type of lining system is estimated to be 95 percent effective in eliminating seepage losses. The lift cycle for a concrete liner with geomembrane underliner is estimated at 40 to 60 years. This option would required no fencing since animal traffic would not damage the concrete lining.

Installation costs for the concrete/underliner system is estimated at $2.75/square foot. Again, assuming a 12-foot wide section, this translates to approximately $174,250 per mile. This would be the total installation cost. Annual maintenance costs for the concrete liner system is estimated at $3,200 per year.

Figure 7 shows installation of an SBS-asphalt liner system. This installation process is also representative of installation of the underliner for the concrete/underliner system.



a. subgrade preparation b. laying liner

Figure 7 Typical Liner System Installation

4.1.2 Ditch Conversion to Piping

Conversion of the existing canals to pipe was also considered. For this option, it was assumed that the pipeline would follow the same alignment as the existing ditches and would operate as a gravity flow system. Different pipe sizes would be required for the different ditch sections. A summery of ditch sections and pipe size requirements are shown in Table 8. Table 8 also shows estimated installation costs for the different pipe sizes.

The information provided in Table 8 suggests that the cost to convert the existing ditches to pipe would be approximately $148,000 per mile for 24 inch pipe and approximately $169,000 per mile for 30 inch pipe. A properly designed and constructed pipeline can be expected to have a life cycle of 40-60 years or longer. Annual maintenance costs for a pipeline is estimated at approximately $8,500 per year. Very little if any seepage would be expected from a properly installed and maintained pipeline. Elimination of seepage by as much as 95 percent or more would be expected.

Table 8 Pipe Size and Cost Summary for Ditch Sections

Ditch	Flow (cfs)[1]	Pipe Size[2] (inches)	Cost $/LF
Upper South	5.52	24	$ 28.00
Lower South	12.49	30	$ 32.00
Upper Middle	6.53	24	$ 28.00
Lower Middle	15.40	30	$ 32.00
North	13.53	30	$ 32.00

Notes:
[1]Based on peak demand for irrigated acreage.
[2]Based on class 125 PVC (PIP) pipe.

4.1.3 Comparison of Lining Options

An evaluation of the two lining options and the piping options was performed based on the criteria listed in Section 4.1.1. The analysis was done assuming one mile of ditch with a 12-foot wide section. A summary of this evaluation is provided in Table 9.

Table 9 Comparison of Lining Options

Option	Installation Cost	Life Cycle O&M[1]	Replacement[2] Cost	Life Cycle Cost	Life Cycle	Effectiveness
SBS-Asphalt	$108,200	$94,800	$347,000	$550,000	20-25 yrs	90%
Concrete/Underliner	$174,250	$48,200	$0.00	$222,450	40-60 yrs	95%
Piping	$169,000	$128,000	$0.00	$297,000	>40-60yrs	>95%

Notes:
[1]Based on 40 years at an inflation rate of 6.0%.
[2]Assumes replacement of SBS-asphalt liner system in 20 years at an inflation rate of 6.0%.

Table 9 indicates that while the SBS-asphalt liner system has the lowest installation cost it has the greatest life cycle cost. This is due primarily to a shorter life cycle of 20 years. The life cycle cost of the piping system is approximately $75,000 greater than the concrete/underliner system life cycle cost when compare on a 40 year basis. However, the piping option is anticipated to have a higher level of effectiveness and will most likely have a longer life cycle and ultimately a lower life cycle cost.

The piping option is not feasible for the lower ditches since the lower ditches need to allow tail water from upper fields to flow into them. Piping the upper ditches however, is feasible.

4.2 Irrigation Efficiency Improvement

Irrigation efficiency can be improved through various approaches. These approaches typically include improved irrigation scheduling and water management or on-farm improvements to more efficient irrigation equipment and methods. Improving irrigation scheduling and water management often requires equipment or infrastructure upgrades that allow adequate water control and measurement.

Defining on-farm infrastructure improvements will required coordination with land-owners since each farm will have different needs and restrictions. This effort should be pursued on an individual basis in cooperation with local agencies such as the NRCS. Improving water management and irrigation scheduling will also need to be approached on an individual farm basis. One location that has been identified in this study is the area served by the Lower Middle ditch just south of Oberlin Road. Potential improvements here could include installation of a piping network with individual land-owner taps to replace the existing surface water ditches. This concept is illustrated in Figure 8.

Providing incentive for land-owners to pursue water management improvements will be critical if on-farm water management and irrigation scheduling improvements are to be realized. This incentive can be provided through an incentive pricing fee structure (see Section 4.3).

4.2.1 Irrigation Scheduling

Irrigation scheduling is determining when to irrigate and how much water to apply. Irrigation scheduling requires information about the crop, soil, climate, irrigation system, and water delivery capabilities. The objective is to match water application with soil moisture conditions to just meet crop water requirements. Accurate irrigation scheduling will improve irrigation efficiency by reducing over irrigation. Accurate irrigation scheduling will also improve crop yields by maintaining adequate soil moisture. To accomplish this, soil moisture monitoring information and crop water requirement estimates must be obtained.

A variety of soil moisture monitoring methods exist. These methods range from simple feel and appearance methods to sophisticated computer models. A variety of soil moisture monitoring equipment is available on the market. The local NRCS will soon have soil moisture monitoring services available.

Crop water requirements are typically estimated based on historical and current climate and weather data. This data is available from a variety of sources including the DWR, NRCS, and the Bureau of Reclamation (BOR).

4.2.2 Conversion to Sprinkle Irrigation

As indicated in Section 3.1.2, current average irrigation efficiencies estimated for the district are approximately 62 percent. Section 3.1.2 also indicates that a well-maintained and operated sprinkler irrigation system can achieve efficiencies on the order of 70 to 80 percent.

Table 10 shows an estimate of water savings due to conversion of flood irrigated acreage to sprinkle irrigation for the SWA. Water savings have been estimated for an efficiency improvement to 70, 75, and 80 percent. It was assumed that approximately 2,000 acres are converted.

As indicated in Table 10 as much as 2 to 5 cfs could be saved if 2,000 acres of the association was converted to sprinkle irrigation. Installation of a wheel line sprinkle irrigation system will typically cost in the rage of $1,000 to $1,500 per acres. The actual water savings would depend on the success achieved from individual landowner improvement projects.

Table 10 Estimated Water Savings From Conversion of 2,000 Acres to Sprinkle Irrigation

Efficiency[1]	Annual Water Delivery Requirement[2] (Acre - ft)	Annual Water Saving (Acre - ft)	Water Saving (cfs)
62%	7,516	0.00	0.00
70%	6,657	859	2.41
75%	6,213	1,303	3.65
80%	5,825	1,691	4.74

Notes
[1]Assumed efficiencies except 62% witch is the current estimate.
[2]Estimated based on annual crop water requirement of 28-inches. ←

4.2.3 Tail Water Recovery

Tail water recovery is a water conservation measure used often in irrigation districts. Some individual landowners within the Association are already making use of tail water recovery systems consisting of a catchment pond and return pumping system. These ponds are serving primarily as storage reservoirs from which water can be taken during periods when water is not being delivered to the farm.

The use of tail water recovery systems on a district wide basis would be of limited benefit since water would need to be pumped twice. A significant amount of infrastructure would be required and energy costs would most likely increase. Since tail water is a direct result of irrigation inefficiencies and conveyance losses, focusing on improvements in these areas will reduce tail-water generation and be more beneficial from an energy conservation perspective.

While the reduction in tail water will translate to a reduction in in-stream flows in the Shasta River, this will be offset by a reduction in water being taken out of the river at the SWA diversion. It is anticipated that there will be a net increase in river flows but the primary benefit of eliminating tail water return flows to the Shasta River will be a significant improvement in water quality.

4.3 Incentive Pricing Rate Schedule

As indicated in Section 2.4 the SWA currently assesses an annual fee to its members based directly on actual association expenditures. No attempt is made to assess fees based on water consumption or usage. This approach has worked well for the association in the past and has been relatively simple to administer. However, under the current fee structure there is no incentive to conserve water or use it efficiently. In fact, this system has served as a disincentive for some association members to use water efficiently.

Establishment of an incentive pricing rate schedule would create a direct relationship between farm water deliveries and water bills. Under this scenario, the incentive to take unnecessary deliveries is reduced and water will be used more efficiently.

Incentive pricing involves setting water rates that are based on fixed costs plus a price per acre-foot of water delivered to an individual farm. This will shift the incentive to conserve water to each individual land-owner.

In order to receive full benefit from an incentive pricing rate structure, improvements to the Association's current water measurement infrastructure will need to be made. These improvements will include installation of water measurement devices at various farm turnouts and locations throughout the district. The district will also need to modify its accounting procedures and methods. In addition, the Association should be prepared to conduct a member participation and education effort to present the new rate schedule to association members and give them the opportunity to understand and comment on the new schedule.

Under this type of rate schedule, the SWA will most likely see an improvement in water usage efficiency while maintaining or enhancing revenues. A key benefit to this conservation measure is that land-owners will have a direct incentive to improve water management practices and will be encouraged to seek out programs that will assist them in making on-farm upgrades that will improve irrigation efficiency.

Implementation of an incentive pricing rate schedule will be a significant effort that may take several years before it is completely implemented. The following steps will need to be taken:

1. Gather needed information;
2. Define goals;
3. Select candidate rate schedule;
4. Set initial rate parameters;
5. Evaluate potential effects; and
6. Implement and monitor.

Developing a rate schedule and implementation plan for the SWA is beyond the scope of this study. It is unclear at this time how water measurement data would be collected and what the pricing system would be based on. This effort should be pursued however, as improvements are made to SWA infrastructure. It is possible that additional personnel may be needed to administer an incentive pricing rate schedule.

5.0 RECOMMENDED WATER CONSERVATION MEASURES

A water conservation strategy for the SWA has been developed based on the alternatives outlined in Section 4.0 This strategy includes infrastructure improvements as well as modifications to the existing fee structure in order to provide an incentive for users to conserve water. Under this strategy, the SWA can make improvements to infrastructure it has direct control over (ditch system and pump station) and provide an economic incentive for land owners to make improvements on individual farms. The strategy includes the following major elements:

1. Reduce conveyance losses (piping, ditch lining, and turnout replacement);
2. Upgrade pump station with variable frequency drive capability;
3. Develop and implement an incentive pricing fee structure; and
4. Provide support to local landowners to make on-farm conservation improvements.

The first two items listed above include reduction in conveyance losses and upgrades to the pump station. While it is estimated that approximately 2,560 acre-feet of water could be conserved per year through piping and ditch lining (Section 4.1), without upgrades to the pump station it will be difficult to realize the benefit of this conserved water in the form of increased in-stream flows, improve water quality, and energy savings. Upgrades to the pump station will allow water deliveries to be matched more closely with water requirements and improve water usage efficiency.

Upgrades to the pump station will also be required to realize the benefits for the third and fourth items listed above. As individual land-owners begin to respond to an incentive pricing fee structure and as they begin to make improvements to on-farm water management, SWA personnel will need to be able to adjust pumping rates to deliver water more efficiently. An initial improvement project will need to be completed to implement the strategy. This initial project is described below.

5.1 Recommended Infrastructure Improvements

The initial water conservation project recommended for the SWA includes the following major elements:

1. Piping the Upper South Ditch (approximately 3.0 miles) and approximately 1.5 miles of the Upper Middle Ditch;
2. Lining approximately 1.2 miles of the Lower Middle Ditch and sections of the Lower South Ditch (approximately 1,500 feet) with a concrete/geomembrane system as described in Section 4.1.1;
3. Replace select turnouts along ditch sections; and
4. Upgrades to the pump station.

The ditch sections to be piped and lined are shown on Figure 9. Figure 10 shows a typical turnout schematic to be used at major diversion points. Upgrades to the pump station include the following major elements:

1. Four new vertical turbine pumps installed in the existing wet wells;
2. Variable frequency drive controllers;
3. Pump house structural modifications; and
4. Discharge piping modifications

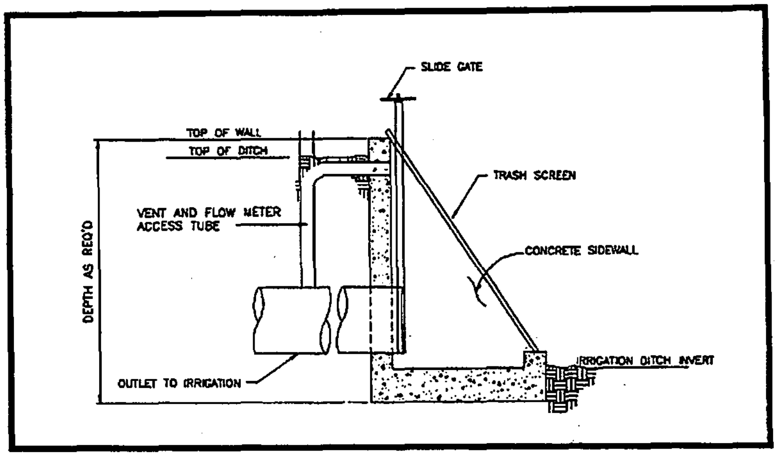


Figure 10 Typical Turnout Schematic

Adding new pumps will require modifications to the discharge piping and will most likely required minor improvements to the building structure and ventilation.

Addition of variable frequency drives (VFDs) will be critical to improving water management. Installation of VFDs will allow SWA personnel to match pumping rates with water distribution requirements efficiently.

As part of the overall improvements to the SWA it is recommended that the existing dam and diversion be replaced with a water control structure as recommended in the 2001 Preliminary Engineering Report on Fish Screening and Passage. A schematic of the water control structure is provided in Appendix D.

5.2 Project Economics

Table 11 summarizes estimated costs for the project. Table 11 indicates a total estimated project cost of $2,701,100. As indicated in Section 4.0, it is estimated that the proposed project would result in a water diversion reduction of approximately 7 to 10 cfs (2,500 to 3,500 acre-ft) per year. This translates to an energy savings of as much as $126 per day or $22,680 annually.

As indicated in Section 4.0 it is estimated that upgrades to the pump station will result in a 15 to 20 percent increase in energy usage efficiency. This translates to an additional savings of approximately $88 per day or $15,840 annually. The total energy savings from the project are estimated to be approximately $38,520 annually. These savings could be used to implement an incentive pricing rate schedule or assist with individual on-farm improvements.

As indicated in Section 2.4 annual O&M expenditures for SWA are approximately $15,200. Approximately $13,500 of this amount is for chemicals used to control weeds throughout the ditches. Annual maintenance costs for the piping and liner system is estimated at approximately

$11,700. Installation of the liner system will significantly reduce the need for chemical treatment of weeds along the sections of the ditches where ling has taken place. In addition, ditch sections that have been piped will no longer need chemical treatment. Chemical treatment will still be required for weed control on ditch sections where no improvements are made. For this planning effort it was assumed that savings in weed control chemical costs would offset liner maintenance costs and there would be no net change in ditch maintenance costs. It was also assumed that O&M costs for the upgraded pump station would be similar to current pump station O&M costs.

For the purposes of this study it was assumed that a major portion of the capital costs associated with the proposed project would be funded by grants from various agencies or programs and that a minor portion would need to be provided by the SWA. Funding could come from agencies such as the California Department of Water Resources, California Department of Fish and Game, U.S. Fish & Wildlife, or other Salmon recovery and water conservation organizations. The details of a final funding package will be developed after project design.

Table 11 Preliminary Opinion of Probable Project Cost

Item	Description	Quantity	Unit of Measure	Unit Costs	Total Amount Quantity x Unit Price
1.0	Mobilization and Demobilization 7%	JOB	LS	118,000	$118,000
2.0	Piping				
	24-inch PVC	24000	LF	$ 32	$768,000
	Flow Measurement	1	LS	$ 25,000	$25,000
	Highway Crossing	1	LS	$ 30,000	$30,000
3.0	Canal Lining				
	Inlet Structures	4	EA	$ 7,000	$28,000
	Liner Installation	94,000	SF	$ 2.75	$258,500
	Turn outs	75	EA	$ 1,500	$112,500
4.0	Pump Station Upgrades				
	Upper Ditch Pumps	2	EA	$ 30,400	$60,800
	Lower Ditch Pumps	2	EA	$ 13,400	$26,800
	Variable Frequency Drives	1	LS	$ 57,000	$57,000
	Mechanical	1	LS	$ 20,000	$20,000
	HVAC	1	LS	$ 10,000	$10,000
	Building Modifications	1	LS	$ 10,000	$15,000
5.0	Diversion Dam Improvements				
	Existing Dam Demolition	1	LS	$ 7,000	$7,000
	Structural Concrete	75	CY	$ 850	$63,750
	Excavation/Earthfill	2,300	CY	$ 20	$46,000
	Rock Riprap	250	CY	$ 55	$13,750
	Stream Water Control	1	LS	$ 30,000	$30,000
	Sheet Piling	1,100	SF	$ 20	$22,000
	Metal Fabrication	1	LS	$ 7,000	$7,000
	Piping for Kuck Diversion	1,000	LF	$ 15	$15,000
	Pumping for Kuck Diversion	1	LS	$ 7,000	$7,000
	Screening Relocation	1	LS	$ 35,000	$35,000
	Site Work	1	LS	$ 25,000	$25,000
	Total Construction Costs				**$1,801,100**
	Contingency				**$360,000**
	Legal, Administrative, Engineering				**$540,000**
	Total Installation Cost				**$2,701,100**

6.0 CONCLUSIONS AND RECOMMENDATIONS

A significant opportunity exists for the Shasta Water User's Association to improve water usage efficiency and water quality in the Shasta River. Current overall water usage efficiency for the Association is approximately 50 percent. Implementing the water conservation strategy outlined in this study should allow the Association to improve its water usage efficiency to approximately 65 percent. This represents a reduction of water diverted from the Shasta River of approximately 10 cfs. The reduction in water diverted will have a direct affect on tail water return to the Shasta River. Figure 11 shows anticipated water diversion rates after project implementation on a monthly basis for the irrigation season. Current rates are shown in Figure 11 as well. Figure 11 indicates that reduced water diversion rates are anticipated to be greater for the early and late months of the season.

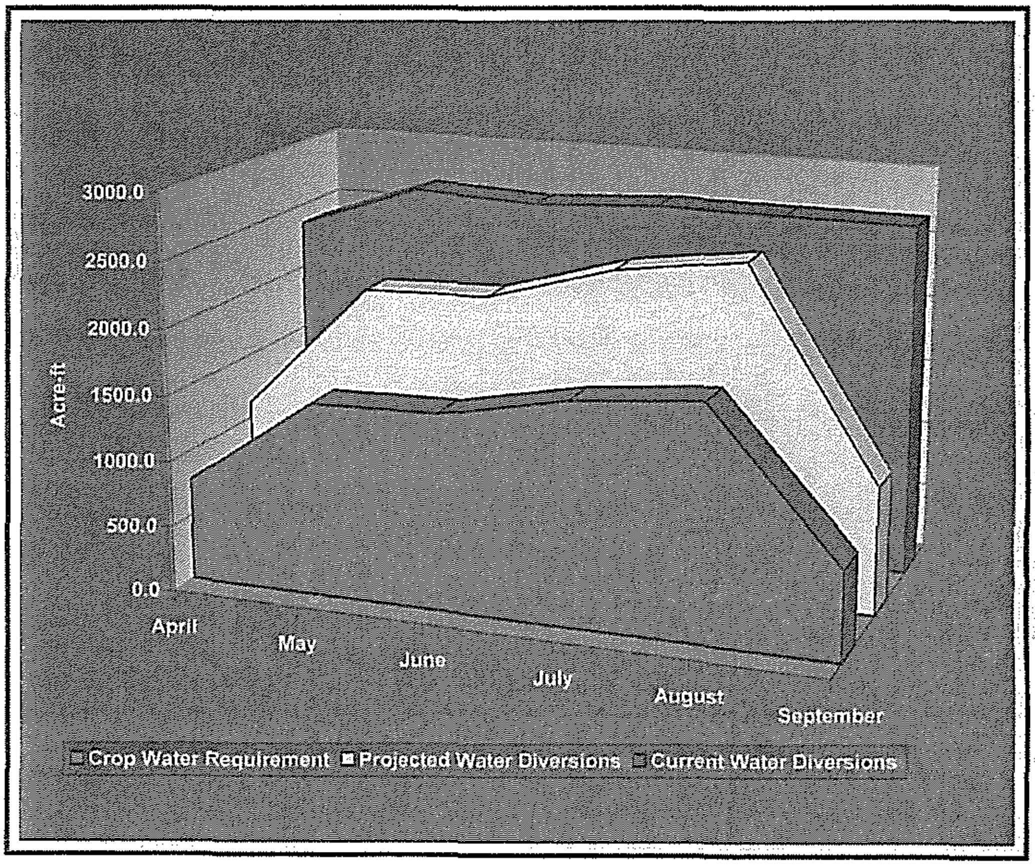


Figure 11 Projected Water Diversion Rates

The actual net increase in flows in the Shasta River will become clear as the recommended project is implemented. However, The improvement in water usage efficiency for the SWA and subsequent reduction in trail water return flows should significantly improve water quality from a temperature and nutrient loading perspective. In addition, replacement of the existing flash-board dam and diversion will eliminate a fish passage barrier and significantly improve fish screening at this location on the Shasta River. Improving water usage efficiency will also improve energy usage efficiency and result in an economic benefit to the association.

As discussed in Section 5.0, basic infrastructure improvements including piping, ditch lining, and pump station upgrades will result in an immediate increase in water usage efficiency and provide the association with the capability to respond to incentive pricing conservation measures implemented by the association.

APPENDICES

Appendix A
Water Delivery Estimates

UPPER SOUTH DITCH
TOTAL HOURS: 526, 22 DAY ROTATION
Total Shares: 350.5

Ditch Flow	6.5
Applications per year	8

Shareholder	Shares	Time	Volume (cf)	Volume Acre-ft	Inches per application	Inces per year	Estimated Efficiency
Barnes, Glenn	3.5	5.25	122,850	2.8	9.7	77.4	36%
Duhart, Dominique	13	19.50	456,300	10.5	9.7	77.4	36%
Sandahl & Sons	24	36	842,400	19.3	9.7	77.4	36%
Suter, Peter	12	18	421,200	9.7	9.7	77.4	36%
Sandahl & Sons	14	21	491,400	11.3	9.7	77.4	36%
Franklin, Jesse	5	7.50	175,500	4.0	9.7	77.4	36%
Sandahl & Sons	86	129	3,018,600	69.3	9.7	77.4	36%
Cross over Julian Creek							
Sandahl & Sons	11	16.50	386,100	8.9	9.7	77.4	36%
Bridwell, Martin	42	63	1,474,200	33.8	9.7	77.4	36%
Bridwell, Martin	60	90	2,106,000	48.3	9.7	77.4	36%
Sanders, Richard	80	120	2,808,000	64.5	9.7	77.4	36%

UPPER MIDDLE DITCH
TOTAL HOURS: 518.10 - 21 1/2 DAY ROTATION
Total Shares: 414.5

Ditch Flow	7.6
Applications per year	8

Shareholder	Shares	Time	Volume (cf)	Volume Acre-ft	Inches per application	Inces per year	Estimated Efficiency
Barnes, Glenn	12	15	410,400	9.4	9.4	75.4	37%
Sunflower Subdivision:	35	43.76	1,197,274	27.5	9.4	75.4	37%
Crowell, George	7.5	9.38	256,637	5.9	9.4	75.4	37%
Eiler, Jim	22.5	28.13	769,637	17.7	9.4	75.4	37%
Silva, John	5	6.25	171,000	3.9	9.4	75.4	37%
Silva, John	8.5	10.6	290,016	6.7	9.4	75.2	37%
Scala, James	77	96.25	2,633,400	60.5	9.4	75.4	37%
Brooks, Marion	45	56.25	1,539,000	35.3	9.4	75.4	37%
Delphic Elementary	2	2.5	68,400	1.6	9.4	75.4	37%
Leoni, Thora	38	47.50	1,299,600	29.8	9.4	75.4	37%
Mayernick, John	2	2.50	68,400	1.6	9.4	75.4	37%
Alley, Marilou	20	25	684,000	15.7	9.4	75.4	37%
Brooks, Marion	118.5	148.11	4,052,290	93.0	9.4	75.4	37%
Pitts, Nancy	1.5	1.88	51,437	1.2	9.4	75.6	37%
Ballestin, John	25	31.25	855,000	19.6	9.4	75.4	37%
Wilson, James	15	18.75	513,000	11.8	9.4	75.4	37%
Sutter, Thomas	15	18.75	513,000	11.8	9.4	75.4	37%

LOWER MIDDLE DITCH
TOTAL HOURS: 556.25. 26 DAY ROTATION
Total Shares: 977.5

Ditch Flow 12.1
Applications per year 10

Shareholder	Head	Shares	Time	Time @24min/share	Volume (cf)	Volume Acre-ft	Inches per application	Inces per year	Estimated Efficiency
Barnes, Glenn	1	24.5	12.25	9.8	426,888	9.8	4.8	48.0	58%
Divide 1/2 6.0 ft.									
Wheeler/Rizzardo	0.5	50.0	50.0	40	871,200	20.0	4.8	48.0	58%
Lemos, David	0.5	40.0	40.0	32	696,960	16.0	4.8	48.0	58%
Regnani, Maria	0.5	45.0	45.0	36	784,080	18.0	4.8	48.0	58%
Split Ends:									
Sunflower									
Moreno, Bob	1	5	2.5	2.0	87,120	2.0	4.8	48.0	58%
Peters, Barry	1	5	2.5	2	87,120	2.0	4.8	48.0	58%
Page, Marian	1	4	2.0	1.6	69,696	1.6	4.8	48.0	58%
Brastow, Edgar	1	10	5.0	4	174,240	4.0	4.8	48.0	58%
Brazil, Philip	1	14	7.0	5.6	243,936	5.6	4.8	48.0	58%
Mohar, Lee	1	14	7.0	5.6	243,936	5.6	4.8	48.0	58%
Crawford, Larry	1	5	2.5	2	87,120	2.0	4.8	48.0	58%
Hahn, George	1	5	2.5	2	87,120	2.0	4.8	48.0	58%
Handley, Richard	1	20	10	8	348,480	8.0	4.8	48.0	58%
Moore, Duane B.	1	5	2.5	2	87,120	2.0	4.8	48.0	58%
Scott, Garry	1	14	7	5.6	243,936	5.6	4.8	48.0	58%
Moore, Robert	1	5	2.5	2	87,120	2.0	4.8	48.0	58%
Mackey/Pickard	1	5	2.5	2	87,120	2.0	4.8	48.0	58%
Rawlings, Ernest	1	18	8.75	7	304,920	7.0	4.8	48.0	58%
Atteberry	1	10	5	4	174,240	4.0	4.8	48.0	58%
Roe, W.H.	1	5	2.5	2	87,120	2.0	4.8	48.0	58%
Rose, Mel	1	61	30.5	24.4	1,062,864	24.4	4.8	48.0	58%
Search, Pat	1	9	4.5	3.6	156,816	3.6	4.8	48.0	58%
Summers, Joy	1	5	2.5	2	87,120	2.0	4.8	48.0	58%
Scala, Jim	1	60	30	24	1,045,440	24.0	4.8	48.0	58%
Lower Middle Ditch cont.									
Grigsby, Contract	1	25	12.5	10	435,600	10.0	4.8	48.0	58%
Lawrence, Gregson	1	61.5	30.75	24.6	1,071,576	24.6	4.8	48.0	58%
Sellstrom, Maurine	1	40	20	16	696,960	16.0	4.8	48.0	58%
Holcomb Subdivision									
Alldredge	1	5	3.4	2	87,120	2.0	4.8	48.0	58%
Breslin, P.J.	1	3	2.0	1.2	52,272	1.2	4.8	48.0	58%
Graves, Larry	1	16	11	6.4	278,784	6.4	4.8	48.0	58%
Herfindahl, Donald	1	27	50	10.8	470,448	10.8	4.8	48.0	58%
Amos/Jones	1	9	6.10	3.6	156,816	3.6	4.8	48.0	58%
McCollom, Eldon	1	6	4.10	2.4	104,544	2.4	4.8	48.0	58%
Roye, Ken	1	12	8.20	4.8	209,088	4.8	4.8	48.0	58%
Taylor, Lawrence	1	3	2	1.2	52,272	1.2	4.8	48.0	58%
Thomspon, Levita	1	13	8.80	5.2	226,512	5.2	4.8	48.0	58%
Brooks, Maria (McCollom)	1	6	4.10	2.4	104,544	2.4	4.8	48.0	58%
Reynold, Richard	1	58	29	23.2	1,010,592	23.2	4.8	48.0	58%
Frederick, Edward	1	10	5	4	174,240	4.0	4.8	48.0	58%
Frederick, Rick (B of A)	1	8	4	3.2	139,392	3.2	4.8	48.0	58%
Hendren, James	1	7	3.50	2.8	121,968	2.8	4.8	48.0	58%
Robustellini, Philip	1	11	5.50	4.4	191,664	4.4	4.8	48.0	58%
Sampson, Harry	1	10	5	4	174,240	4.0	4.8	48.0	58%
Frey, Harold	1	10	%	4	174,240	4.0	4.8	48.0	58%
Nylund, Roy	1	50	25	20	871,200	20.0	4.8	48.0	58%
Ballestin, John	1	64	32	25.6	1,115,136	25.6	4.8	48.0	58%
Wilson, James	1	15	7.50	6	261,360	6.0	4.8	48.0	58%
Sutter, Thomas	1	15	7.50	6	261,360	6.0	4.8	48.0	58%
Holdiay Develop Co.	1	55	27.50	22	958,320	22.0	4.8	48.0	58%
		977.5	600.95	445					

LOWER SOUTH DITCH
TOTAL HOURS: 660.25, 27 1/2 DAY ROTATION
Total Shares: 793

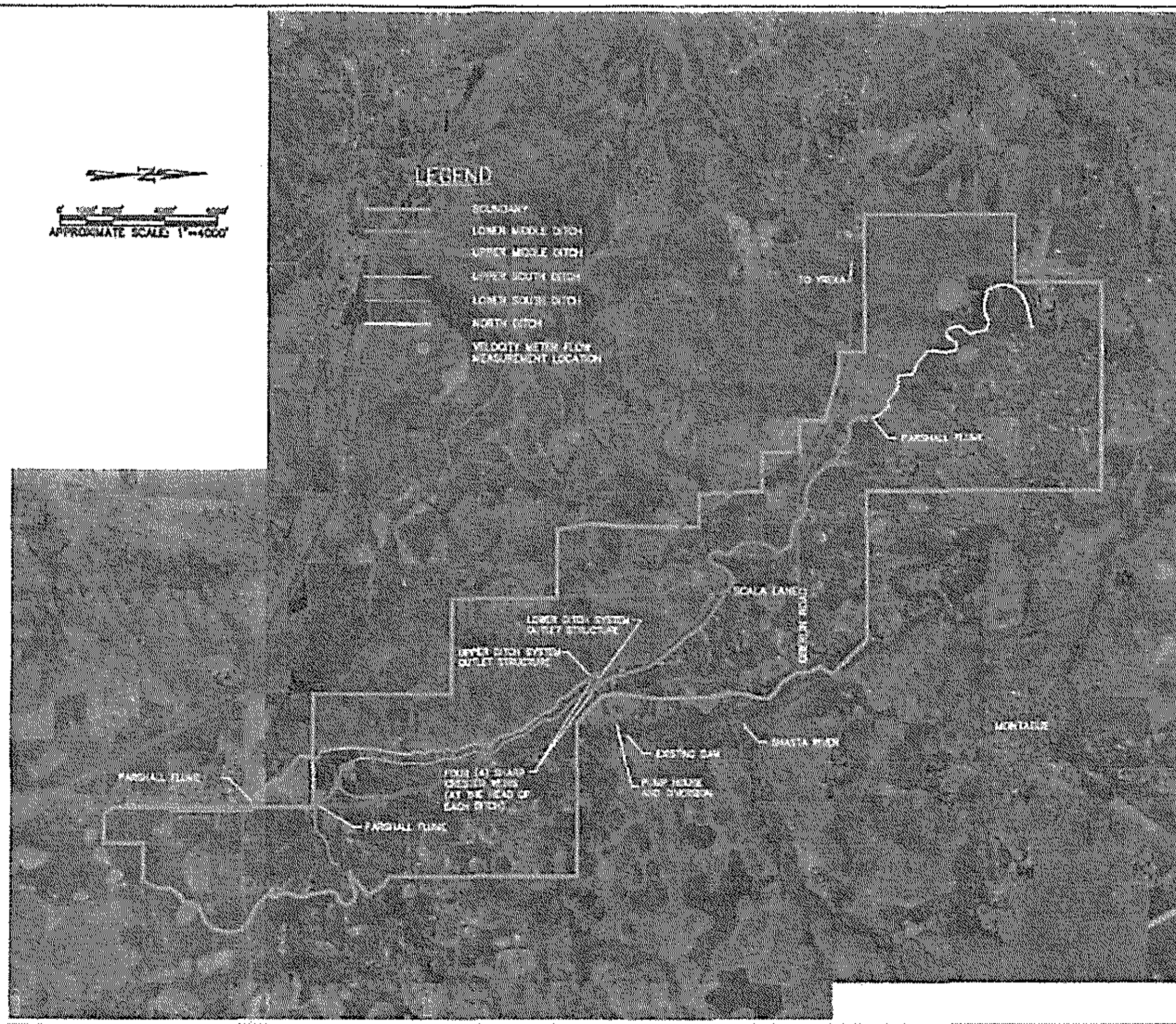
Ditch Flow 9.9
Applications per year 6.5

Shareholder	Shares	Time	Volume (cf)	Volume Acre-ft	Inches per application	Inces per year	Esimated Efficiency
Barnes, Glenn	10	6.25	222,750	5.1	6.1	39.9	70%
Duhart, Dominique	34	21.25	757,350	17.4	6.1	39.9	70%
Mario's Drop: 1/3 gets 37.5 minutes, (Shares X Time X 3)							
2/3 gets 45 minutes, (Shares X Time X 1.5)							
Rizzardo, Marino	3	5.625	66,825	1.5	6.1	39.9	70%
Simmons, Richard	4	7.5	89,100	2.0	6.1	39.9	70%
Rizzardo, Mario	29	54.37	645,916	14.8	6.1	39.9	70%
Sears, Raymond	21	38.50	457,380	10.5	6.0	39.0	72%
Roberson, Bob	47	52.50	1,247,400	28.6	7.3	47.5	59%
Sandahl & Sons	40	45.0	1,069,200	24.5	7.4	47.9	58%
Sears, Raymond	4	4.50	106,920	2.5	7.4	47.9	58%
Split Ends on McKillop							
McKillop, Harold	10	6.25	222,750	5.1	6.1	39.9	70%
Sandahl & Sons	54	33.75	1,202,850	27.6	6.1	39.9	70%
Suter, Peter	24	15.0	534,600	12.3	6.1	39.9	70%
Sandahl & Sons	36	22.50	801,900	18.4	6.1	39.9	70%
Helwig, Carl	4	2.50	89,100	2.0	6.1	39.9	70%
Franklin, Jesse	40	25.00	891,000	20.5	6.1	39.9	70%
Sandahl & Sons	40	25.00	891,000	20.5	6.1	39.9	70%
Cross Road to Added Time							
Cunningham, Palmer	5	3.75	133,650	3.1	7.4	47.9	58%
Pratt, Edward	3	2.25	80,190	1.8	7.4	47.9	58%
Horton, Albert	12	9	320,760	7.4	7.4	47.9	58%
Sandahl & Sons	63.3	47.50	1,692,900	38.9	7.4	47.9	58%
Stewart, Malcom	32	24.0	855,360	19.6	7.4	47.9	58%
Iten, Carl (Bridwell)	20	15.0	534,600	12.3	7.4	47.9	58%
Bridwell, Martin	62	46.50	1,657,260	38.0	7.4	47.9	58%
Peters, Eric	45.7	34.25	1,220,670	28.0	7.4	47.8	59%
Horton, Albert	15	11.25	400,950	9.2	7.4	47.9	58%
Sandahl & Sons	90	67.50	2,405,700	55.2	7.4	47.9	58%
Rohl, Steve	45	33.75	1,202,850	27.6	7.4	47.9	58%

NORTH DITCH
TOTAL HOURS: 485, 20 1/2 DAY ROTATION
Total Shares: 859

Ditch Flow (cfs) 10.6
Applications per year 9

Shareholders	Head	Shares	Time (hrs)	Volume (cf)	Volume Acre-ft	Inches per application	Inces per year	Estimated Efficiency
Yreka Western R/R	1	10	5	190,800	4.4	5.3	47.3	59%
C. Lorenzini	1	106	53	2,022,480	46.4	5.3	47.3	59%
Lemos, Edwin	1	197	98.50	3,758,760	86.3	5.3	47.3	59%
One hour ditch time West Side								
Bly, Rosemary	1	15	7.50	286,200	6.6	5.3	47.3	59%
Bly, Rosemary	1	10	5	190,800	4.4	5.3	47.3	59%
Shutteroff, David	0.5	2	2	38,160	0.9	5.3	47.3	59%
Capovilla, R.M.	0.5	2	2	38,160	0.9	5.3	47.3	59%
Capovilla, Ruby	1	76.5	38.25	1,459,620	33.5	5.3	47.3	59%
Novy, Lowell	1	39.5	19.75	753,660	17.3	5.3	47.3	59%
Daman, Don	1	18.5	9.25	352,980	8.1	5.3	47.3	59%
Bell, Helen	1	16.5	8.25	314,820	7.2	5.3	47.3	59%
One hour ditch time East Side								
Langford, David	0.5	50	50	954,000	21.9	5.3	47.3	59%
Selby, Stella	0.5	2	2	38,160	0.9	5.3	47.3	59%
Holiday Devel. Co.	0.5	51	51	973,080	22.3	5.3	47.3	59%
Newiswanger, Billy	0.5	5	5	95,400	2.2	5.3	47.3	59%
Shaffer, Iven	0.5	4	4	76,320	1.8	5.3	47.3	59%
Maplesden, Iven	0.5	4	4	76,320	1.8	5.3	47.3	59%
Horn, Richard	0.5	4	4	76,320	1.8	5.3	47.3	59%
Russell, Donald	0.5	6	6	114,480	2.6	5.3	47.3	59%
Codr, Emil	0.5	8	8	152,640	3.5	5.3	47.3	59%
Wigley, Nellie	0.5	12	12	228,960	5.3	5.3	47.3	59%
Favero, Frank	0.5	15	15	286,200	6.6	5.3	47.3	59%
Fiock, Mildred	1	200	100	3,816,000	87.6	5.3	47.3	59%
Fiock, Norman	1	4.5	2.25	85,860	2.0	5.3	47.3	59%
Hogan, C.W.	1	0.5	0.25	9,540	0.2	5.3	47.3	59%
Fuster Fiock								



FORSGREN ASSOCIATES, INC.

SHASTA WATER ASSOCIATION AERIAL VIEW

SHASTA WATER ASSOCIATION WATER CONSERVATION STUDY

FIGURE 1

PROJECT NO. 203032