

GRAND VALLEY WATER MANAGEMENT PROJECT

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ABSTRACT

The Grand Valley Water Management Project (Project) consists of irrigation system improvements which provide the ability to reduce irrigation diversions from the Colorado River. The concept behind the Project was originally developed through a study conducted under the Bureau of Reclamation's General Investigations Program in cooperation with the Grand Valley Water Users Association and California Polytechnic State University. The Project was subsequently adopted by the Upper Colorado River Recovery Implementation Program as a key component in the overall strategy to provide flow augmentation to critical habitat reaches of the Colorado River. The Project concept was previously reported in a paper presented at the October 1998 USCID Conference.³ Project performance and cost effectiveness is exceeding expectations. When totally completed, the Project will conserve water at a unit cost of approximately \$ 9 per acre-foot per year. This paper provides a brief background on the technical aspects of the Project but primarily focuses on actual performance and institutional agreements required to implement the Project. Potential future applications of this highly cost effective concept to address environmental and/or human water uses are also briefly discussed.

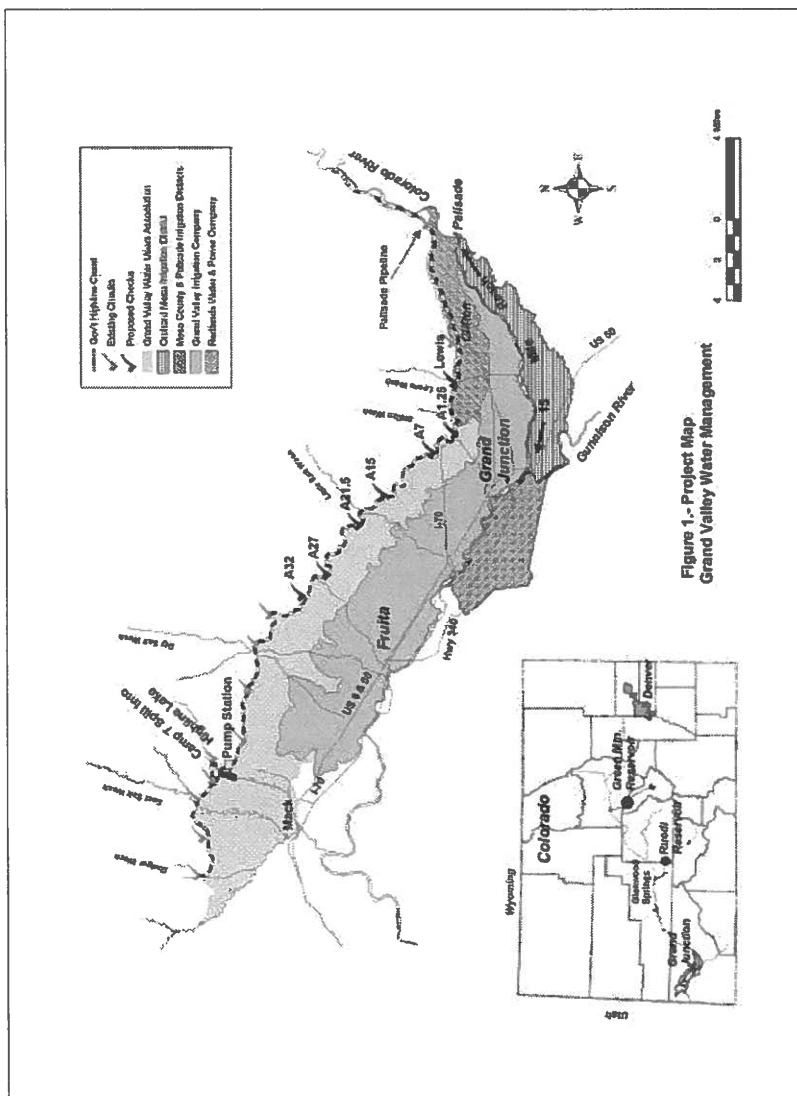
BACKGROUND AND SETTING

The 15-Mile Reach of the Colorado River extends from the Grand Valley Irrigation Company diversion dam downstream to the confluence with the Gunnison River (see Figure 1). Five entities divert water from the Colorado River to irrigate approximately 69,000 acres of land in the Grand Valley. The Grand Valley Project, a Federal Bureau of Reclamation (Reclamation) project, provides water to about 60 percent of this irrigated acreage. Annual irrigation and hydropower diversions average 698,000 acre-feet. These diversions contribute to the severely depleted flow regime in the 15-Mile Reach.

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³ Brent Uilenberg and Karen Fogelquist, Win-Win Water Supply Solution for Endangered Species Recovery in the 15-Mile Reach of the Colorado River (Proceedings U.S. Committee on Irrigation and Drainage 1998 Conference on Shared Rivers)



PROBLEMS AND OPPORTUNITIES

The diversion and consumptive use of water, along with other environmental factors, has resulted in the population decline of native fishes. Four of these species are currently listed as endangered under the Endangered Species Act. The 15-Mile Reach is considered important habitat for the recovery of two of the listed fish species, the razorback sucker and the Colorado pikeminnow. In the mid-1980's it was recognized that water development was heading for a confrontation with the Endangered Species Act. As a result state and Federal entities developed the Upper Colorado River Recovery Implementation Program (Recovery Program). The Recovery Program has the dual objectives of recovering the four listed species while the Upper Basin States continue to develop their Colorado River Compact entitlements.

As part of the Recovery Program, Reclamation conducted an appraisal-level evaluation of water supply alternatives for the 15-Mile Reach.⁴ A wide range of alternatives were identified and evaluated. From technical, socio-economic and political perspectives water conservation appeared to be the most attractive alternative. Because of their location immediately above the 15-Mile Reach and because they are the last major diversion from the Colorado River within the State of Colorado, the Grand Valley irrigation systems and associated relatively senior water rights presented unique water conservation opportunities.

The primary feature of the Grand Valley Project is the Government Highline Canal. The canal has an initial capacity of 1,620 cubic-feet-per-second (cfs) and extends approximately 55 miles from the diversion dam above the 15-Mile Reach to its end near the Colorado-Utah state line. This distance translates into an approximate 72 hour transit time from the point of diversion to the end of the canal. Due to the length of the canal and the lack of control and monitoring systems, it was physically impossible to closely match river diversions with fluctuating irrigation demands. Furthermore, because of an inadequate number of check structures, it was not possible to maintain the minimum water surface elevation required to serve the irrigation laterals at low flow rates. As a result of these deficiencies approximately 70,000 acre-feet of water was diverted above the 15-Mile Reach and spilled into waste ways.

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Based on the results of the appraisal-level evaluation, a detailed study was initiated. The study was conducted by the Grand Valley Water Users Association, California Polytechnic State University and Reclamation. The first phase of the study consisted of a detailed inventory of diversions, spills and water deliveries. A

⁴ Bureau of Reclamation, Study of Alternative Water Supplies for Endangered fishes in the 15-Mile Reach of the Colorado River, January 1992.

hydrologic/hydraulic model was then developed based on the inventory data and the physical parameters of the canal system. Various canal system improvements and operating strategies were modeled to estimate potential diversion reductions. Preliminary cost estimates were prepared for each system configuration. Based on these analyses, a preferred system configuration was identified that addressed water user needs and optimized costs and benefits. In September of 1998 a Final Environmental Assessment was issued for the Project, final designs were prepared in 1999 and construction was initiated in 2000.

The Project consists of seven new check structures and installation of a supervisory control and data acquisition (SCADA) system which integrates the operation of the new structures with eight existing check structures. The additional check structures and SCADA system provide the ability to maintain a minimum water surface elevation at a wider range of flows throughout the length of the canal and thereby more closely match river diversions with actual irrigation demands. The check structures and SCADA system also transform the canal into a series of storage reservoirs. When an increase in demand is detected in downstream reaches of the canal the SCADA system responds by making upstream gate adjustments to quickly respond to the increased demand.

A 100 cfs bypass pipeline, which discharges into the Colorado River above the 15-Mile Reach, was also installed and integrated into the SCADA system. This facility provides the ability to return water back to the river to benefit fish habitat if canal diversions exceed irrigation demands or conversely to increase canal flows by reducing pipeline flow to meet sudden increases in irrigation demand. The check structures, bypass pipeline and SCADA systems were completed prior to the 2002 irrigation season.

The final Project component to be constructed and integrated into the SCADA system is a 75 cfs pumping plant. The pumping plant will be located at an existing reservoir (Highline Lake) that obtains the majority of its water supply from canal spills. The reservoir has a total storage volume of approximately 3,400 acre-feet and is operated by the Colorado Division of Parks and Outdoor Recreation. Highline Lake pumping plant will provide the ability to quickly respond to peak irrigation demands in the lower reaches of the canal service area and thus reduce river diversions. This facility is scheduled for completion in June of 2004.

The detailed study projected an average reduction in canal spills and associated river diversions of 19,400 acre-feet during the critical August through October time period when flow recommendations for the endangered fish were historically not being met. Additionally the modeling projected average bypass pipeline flows of 9,000 acre-feet during this same period for a total potential 15-Mile Reach flow benefit of 28,400 acre-feet per year assuming all water could be legally protected.

Total estimated costs associated with preconstruction planning, permitting, design, construction and capitalized annual operation and maintenance expenses were \$8.4 million or approximately \$300 per acre-foot on a unit capital cost basis. Projected annual unit costs were \$16 per acre-foot using Reclamation's 2004 fiscal year plan formulation interest rate of 4.8934 percent and assuming a 50 year replacement life cycle.

The Project presented a technically feasible, cost effective solution to meet the late irrigation season flow needs of the 15-Mile Reach; however, legal protection of the conserved water raised significant issues that needed to be addressed in order to implement the Project. Project conserved water is defined as reduced diversions resulting from operation of Project facilities. As part of its charter, the Recovery Program operates within the constraints of all applicable state and Federal regulations and therefore any legal protection mechanism or strategy had to comply with Colorado State water law. To address these issues the Recovery Program formed a team of legal and technical staff representing Federal, state and local stakeholders.

Project conserved water represents two categories of water from a legal protection perspective: 1) deliveries of stored water from upstream reservoirs that are no longer needed due to the reduced irrigation diversions, and 2) natural flow water available to the direct flow water rights that are no longer diverted for irrigation use.

The Grand Valley Project receives deliveries of stored water from Green Mountain Reservoir (see Figure 1) when natural flows are insufficient to satisfy irrigation demands. Green Mountain Reservoir is a component of Reclamation's Colorado-Big Thompson Project with a total capacity of approximately 152,000 acre-feet. This capacity is allocated to various East and West slope uses. The Grand Valley Project's status as a beneficiary of this storage facility is defined in the authorizing legislation and operating policies. By virtue of being a beneficiary, the Grand Valley Project along with other West slope water users is entitled to releases from the 66,000 acre-foot Green Mountain Reservoir Historic Users Pool (HUP). The Grand Valley Project also relies on very senior direct flow water rights decreed for irrigation, domestic and hydropower purposes.

In order to legally protect deliveries of stored water from diversion by other appropriators, the intended new use of the water (i.e. instream piscatorial) must be compatible with the beneficial uses claimed in the water storage right decree. Likewise, in order to redirect and legally protect the conserved natural flow water and apply it to a new use, the new use must be compatible with the beneficial uses and points of diversion claimed in the direct flow water right decree. In the case of Federal facilities such as Green Mountain Reservoir and the Grand Valley Project, the intended new use must also be compatible with the authorizing Federal legislation. Absent these water right attributes the owner of the water

right seeking to redirect conserved natural flow water or stored water to a new beneficial use must prove non-injury to all other appropriators before the water court will award the additional decreed beneficial use. Additionally, if the proposed new use of the Federal facility is inconsistent with the authorizing legislation new authority must be obtained from Congress.

LEGAL AND INSTITUTIONAL SOLUTIONS

Obtaining a decreed change of use and expanded Congressional authority were immediately recognized as very difficult actions to achieve and therefore alternative mechanisms for legally protecting Project conserved water were developed using unconventional strategies. One of these strategies involved a water right application that was filed by the United States in Colorado water court in 1991.

During the planning phase of the Project the United States was involved in litigation associated with a water right application for an appropriative right of exchange on the Colorado River. This litigation was commonly referred to as the Orchard Mesa Check Case. The application drew numerous statements of opposition from water right owners on both the East and West Slopes of Colorado. Through a long and contentious negotiation process the co-applicants to the water right application (United States, Grand Valley Water Users Association and Orchard Mesa Irrigation District) were successful in obtaining a water court sanctioned Settlement Agreement which provided the foundation for legally protecting Project conserved water.⁵

The Settlement Agreement provides criteria for defining when a surplus storage condition exists in Green Mountain Reservoir. A surplus storage condition in this context is defined as reservoir storage contents that are projected to exceed the demands of all Green Mountain Reservoir beneficiaries. These criteria were developed by analyzing historic storage conditions in the Green Mountain Reservoir HUP during major drought years throughout its period of operation. If actual storage conditions exceed the volume required to provide a full water supply to all eligible users, a surplus storage condition can be declared by Reclamation. The Settlement Agreement further defines Operating Criteria for Green Mountain Reservoir, which along with the authorizing Federal legislation, provides the authority to enter into contracts for the disposition of surplus water.

In below average snow pack years the direct flow rights for the Grand Valley Project yield a limited amount of water to meet late irrigation season demands during the months of August through October. Under these conditions Green Mountain Reservoir HUP releases augment the water supply derived from the

⁵ Stipulation and Agreement, District Court, Water Division 5, State of Colorado, Case No. 91CW247.

direct flow water rights. Therefore, reduced Grand Valley Project diversions increase the occurrences of a surplus storage condition in Green Mountain Reservoir under many hydrologic conditions. This recognition guided the negotiations in the Orchard Mesa Check Case.

In order to legally protect and deliver the Project conserved water, non-consumptive uses that are compatible with the Green Mountain Reservoir water storage rights were identified. These uses were further screened on their ability to indirectly benefit flow and habitat conditions in the 15-Mile Reach if they were supplied with surplus water from Green Mountain Reservoir.

Using this criteria, two uses were identified which would provide the mechanism to legally protect deliveries of surplus storage water and indirectly benefit fish habitat. The first was the Grand Valley Power Plant, a component of the Grand Valley Project. This plant, with an 800 cfs capacity discharges water immediately above the 15-Mile Reach. The water right for the power plant has a relatively junior priority water right and frequently has unused capacity during the late summer months. The second use was instream municipal recreation which is recognized as a valid beneficial use under Colorado water law.

The identification of these uses led to the negotiation of water service contacts for delivery of stored water from Green Mountain Reservoir. The first contact, between the United States, Grand Valley Water Users Association and the Orchard Mesa Irrigation District provides for the delivery of water to the Grand Valley Power Plant. It requires that all water declared to be surplus to the needs of the Green Mountain Reservoir HUP must first be delivered to the power plant to the extent unused capacity exists. The second contract, between the United States, Town of Palisade Colorado, City of Grand Junction Colorado and Town of Fruita Colorado, provides for the delivery of surplus water for instream municipal recreation uses in the Colorado River as it flows through these municipalities. Both contracts were executed in 2001. Water deliveries under both contracts indirectly result in improved flow and habitat conditions in the 15-Mile Reach.

The above discussed protection strategy involving surplus water contracts addresses the stored water component of Project conserved water but does not address the natural flow component or bypass pipeline flows. Natural flow water that is no longer needed or diverted is now available for use by other appropriators and therefore provides a more dependable water supply for water users on both the East and West slopes of Colorado. However, as was previously mentioned, the direct flow irrigation water right for the Grand Project yields only minor amounts of water during the late summer months of below average runoff years. In above average runoff years these rights do yield a substantial portion if not the entire supply of water for the Grand Valley Project. In these types of years there is little or no need for flow augmentation to benefit fish habitat but if a need does arise surplus water is available to address those needs because there is little

or no demand for flow augmentation by Green Mountain Reservoir beneficiaries. Bypass pipeline flows are available for diversion by downstream appropriators. However, due to the fluctuating nature of these flows they do not provide a dependable water supply and are not currently diverted by existing appropriators.

Construction and operation of the Project pumping plant also presented legal and institutional issues. Highline Lake is operated by the Colorado Division of Parks and Outdoor Recreation primarily for water based recreation. Water storage rights for this facility are decreed primarily for recreation and the irrigation of park lands surrounding the lake. Using Highline Lake as a storage vessel to provide irrigation water to meet peak demands in the Grand Valley Project would constitute an expansion of the water storage rights which would require a water court sanctioned change of use decree with the associated non-injury standard. Again, it was decided not to pursue a change of use decree but rather rely on an administrative policy of the Colorado State Engineer which recognizes temporary storage of water as a means to maximize the beneficial use of water. Under this policy water can be stored for up to 72 hours by another party without a storage decree with the permission of the reservoir owner. In order to capitalize on this policy a contract was negotiated with the Colorado Division of Parks and Outdoor Recreation that provided the ability to use the top two feet of Highline Lake (320 acre-feet) as a source of water for the pumping plant. In exchange for the use of this storage space the Recovery Program paid the Colorado Division of Parks and Outdoor Recreation for the appraised value of the space and agreed to pump rate limitations, water quality maintenance parameters and minimum water storage levels to safeguard recreational use of the reservoir.

RESULTS

The detailed study projected an annual irrigation diversion reduction of 19,400 acre-feet and 9,000 acre-feet of bypass pipeline return flows resulting in a total projected potential benefit to the 15-Mile Reach of 28,400 acre-feet. The 1998 water year was selected to represent pre-Project diversions as no Project facilities had been installed and comparable diversion data sets were available from the Division 5 Office of the State Engineer for water years 1998, 2002 and 2003. All Project facilities with the exception of the Highline Lake Pumping Plant were operational for the 2002 and 2003 irrigation seasons. Table 1 and 2 present actual post-project results.

Table 1. Irrigation Diversions (acre-feet)

1998	2002	2003
285,217	240,424	252,301

Table 2. Reduced Irrigation Diversions and Bypass Pipeline Flows (acre-feet)

Water Year	Reduced Irrigation Diversion	Bypass Pipeline Flow	Total Potential Benefit to 15-Mile Reach
2002	44,793	2,053	46,846
2003	32,916	10,161	43,077

The 2002 water year was a period of severe drought conditions and the Grand Valley Water Users Association had implemented a demand management program, therefore the reduced irrigation demands cannot be entirely attributed to Project facilities. However, a full water supply was available to the Grand Valley Project in 2003 and no demand management program was in place. Upon completion of the pumping plant, total potential benefits to the 15-Mile Reach are anticipated to be in the 50,000 acre-foot range.

Total actual Project costs, including the pumping plant, will be approximately \$8.2 million. Annual unit cost will be approximately \$9 per acre-foot per year using Reclamation's 2004 fiscal year plan formulation interest rate of 4.8934 percent and assuming a 50 year replacement life cycle.

The last column in Table 2 is labeled "Total Potential Benefit to the 15-Mile Reach" because of the nature of the legal protection mechanism employed to protect Project conserved water. Only the stored water component of the reduced diversions has the potential to be legally protected if they result in a surplus storage condition in Green Mountain Reservoir.

In 2002 the HUP never achieved a fill and actual storage conditions never exceeded the surplus storage criteria because of the severity of the drought. Therefore no surplus water was delivered to benefit endangered fish habitat. However, without the Project facilities and the ability they provide to manage irrigation diversions, the HUP would have been exhausted by mid August of 2002 with disastrous results for West slope irrigators and municipalities.

In 2003 Green Mountain Reservoir HUP storage levels resulted in the declaration of a surplus storage condition in late August. As a result 47,526 acre-feet of Green Mountain HUP water was released and legally protected to benefit endangered fish habitat. This magnitude of surplus water could not have been achieved without operation of Project facilities and the resulting 32,916 acre-feet of reduced diversions.

FUTURE APPLICATIONS

The Highline Canal serves approximately 50 percent of the lands in the Grand Valley that are irrigated by diversions from the Colorado River. Similar

opportunities to conserve water by increasing irrigation delivery efficiencies are possible from the other canal systems with potentially very attractive unit costs. Because of their geographic location and relative water right priority within the State appropriation system, conserved water could be redirected for environmental and/or human uses on both the West and East slopes without injury to other appropriators. This concept is equally applicable to any river system if the appropriate environmental protections and institutional agreements can be developed to capitalize on technical advances in water use efficiency.