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NOVEMBER 1, 2016

FINAL UPPER SNAKE RIVER LEVEL I WATERSHED STUDY

EXECUTIVE SUMMARY

PREPARED FOR:

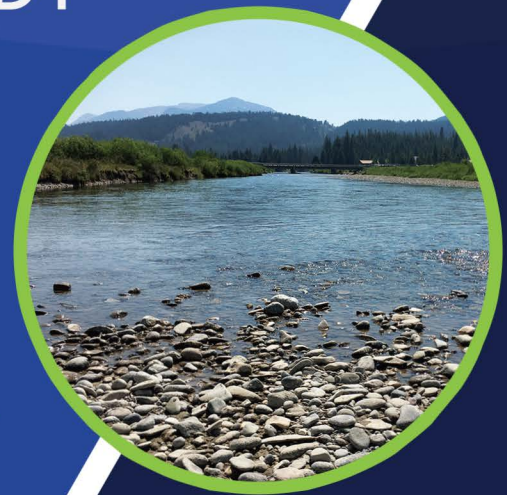
WYOMING WATER DEVELOPMENT COMMISSION
TETON CONSERVATION DISTRICT

PREPARED BY:

OLSSON ASSOCIATES

IN ASSOCIATION WITH:

STEADY STREAM HYDROLOGY
AND RON E. VORE, PHD



Executive Summary

for the

Upper Snake River Level I Watershed Study

WWDC Contract Number RN052616/F

November 1, 2016

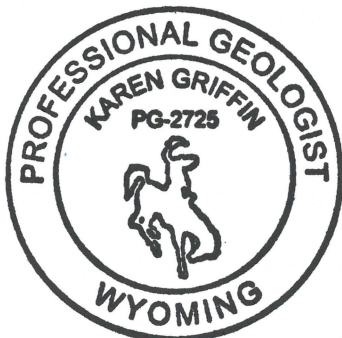
I hereby certify that this report was prepared by us or under our direct supervision and that we are duly licensed professional geologists and engineers under the laws of the state of Wyoming.

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Example of an irrigation system improvement needs in the Upper Snake River Watershed where a Jensen Creek diversion structure was crushed by a boulder during a debris flow. The replacement structure is proposed as Project Number #ISI-10.

1. INTRODUCTION

This Level I watershed study was prepared under contract to the Wyoming Water Development Commission (WWDC). The Teton Conservation District (TCD) in Jackson, Wyoming, is the project sponsor, and the plan was prepared on behalf of the landowners, land managers, stewards, and visitors of the remarkable Upper Snake River watershed. Olsson Associates completed the study in collaboration with Steady Stream Hydrology Inc. of Sheridan, Wyoming, and Ron E. Vore, Ph.D. of Sundance, Wyoming.

1.1. Purpose and Scope of the Study

A watershed study is holistic evaluation of an area that is interconnected by water. A Level I watershed study evaluates the current condition of an area and looks at opportunities for water improvement projects that will restore, maintain, and enhance healthy watershed function. Specifically, a Level I watershed study looks for projects, programs, or activities that support sustainable, beneficial water use for current and future watershed residents – be they human, animal, or plant. The study is comprehensive in that it evaluates many aspects of the

natural setting in order to ensure that any proposed projects that are beneficial to one, are indeed beneficial to the watershed as a whole. A holistic approach to watershed management is a keystone to the program developed by the WWDC when the watershed program was developed.

The purpose of this Level I watershed study and management plan is to describe the Upper Snake River watershed in its current condition, to suggest resolutions for any water-related issues, and to provide insight into opportunities for improvements.

The Upper Snake River watershed, located primarily in Teton County, covers over 1.7 million acres. The watershed is defined by the interconnected stream drainage area of the Snake River and its numerous tributaries including the Gros Ventre River, Flat Creek, Fish Creek, Buffalo Fork, Pacific Creek, Spread Creek, and Fall Creek. As illustrated in Figure ES-1, from the north, the watershed study area includes the

The geographic scope of the study is illustrated in Figure ES-1. The watershed study area is not defined by political subdivisions or boundaries such as counties or roads but by the water system that sustains it. The project sponsor, the Teton Conservation District, developed this definition of the Upper Snake River watershed because it encompasses an area that has specific and often common issues that need to be identified and addressed.

headwaters of the Snake River in Yellowstone National Park south to the confluence of the Snake and the Hoback rivers at Hoback Junction. The Upper Snake River watershed covers the area from the east at the Continental divide at Togwotee Pass on Highway 26 west to the top of the Grand Teton mountain range. The watershed is connected by the surface water drainages since any raindrop or snowflake that falls within this geographic area, will flow out of the study area at the southern tip of the watershed near Hoback Junction.

The Upper Snake River watershed stretches across two national parks (Yellowstone and Grand Teton) and the Bridger-Teton National Forest, and it encompasses the entire National Elk Refuge. The watershed is in the center of the Greater Yellowstone Ecosystem – the largest intact ecosystem in the lower 48 states.

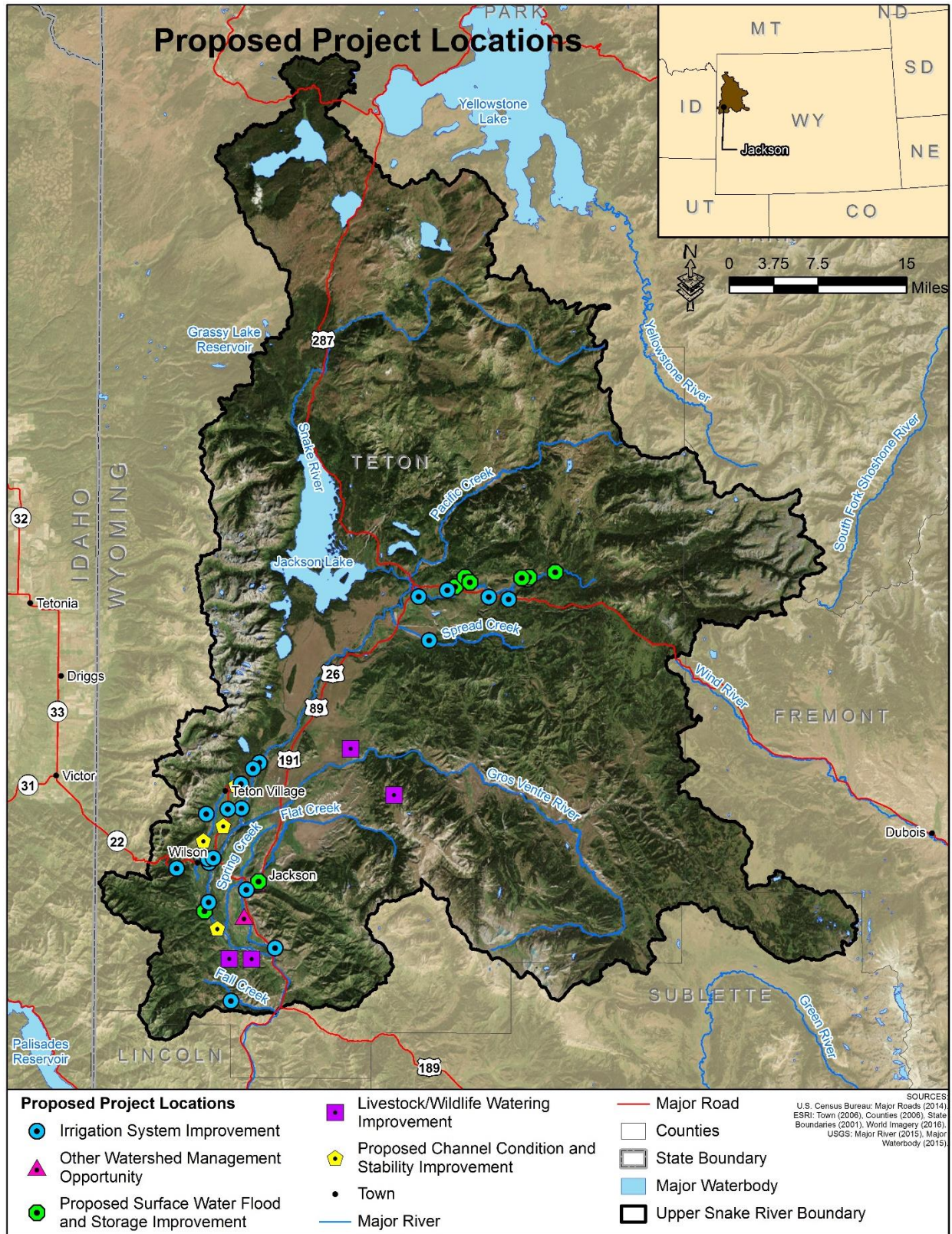


Figure ES-1 Upper Snake River Watershed Study Location and Proposed Project Types

Additionally, with a 9.4 percent growth rate in the past five years, Jackson is one of the fastest growing rural areas in the United States. Along with this growing population, there has also been a significant increase in tourism. In 2015, over four million people visited Yellowstone National Park and the Upper Snake River watershed. In 2015, tourism is estimated to have generated \$911 million in economic revenue for the area (U.S. Census Bureau 2016; National Geographic 2016). The residents of the area have long recognized that the quality of this ecosystem has attracted numerous visitors throughout the years and is the primary reason many residents live in the Jackson area. The quality of life depends on many factors, but the primary factor contributing to the quality of life is the continued health and viability of the natural environment (Teton County 2012).

1.2. Key Issues in the Watershed

The TCD requested this Level I watershed be conducted to address specific issues that are affecting the area. Initially, the TCD board of directors was asked to identify its top concerns. Discussions along these lines were held at the TCD monthly board meetings, and a list was generated to use in the application for the watershed study. Additionally, since approximately 97 percent of the land in the Upper Snake River watershed is comprised of public land managed by agencies including the Grand Teton National Park, Yellowstone National Park, Bridger-Teton National Forest, and the National Elk Refuge, the managing agencies were asked to identify both the concerns and opportunities for the area. Twice a year, the water planning coordinator in the Interstate Streams Division of the Wyoming State Engineer’s Office (WSEO) coordinates an interagency meeting to discuss topics related to the Snake River including operations of the major reservoirs, research activities, water rights, and invasive species to name a few. At these meetings, the agencies were asked to provide input on the issues and opportunities they are currently working to address on the lands they manage. Finally, throughout development of this watershed study, public meetings were held at the Teton County Library in Jackson and Fire Station #4 in Moran, Wyoming, where landowners, ranchers, and interested citizens were invited to identify potential water development projects that would benefit their properties, their operations, and/or the area. Table ES-1 summarizes the recurring themes and issues identified in the agency and public meetings.

Table ES-1 Upper Snake River Watershed Issues, Opportunities, and Resolutions

Identified by	Issue or Opportunity	Resolution
Agency	A comprehensive GIS dataset needs to be developed and accessible by all groups working in the area.	Completed
Agency	A geomorphic classification of the streams in the Upper Snake River watershed is important to complete as a foundation to watershed improvement projects.	Completed
Agency	Some of the engineered wetlands designed as mitigation for projects in the watershed need to be addressed.	Swan Lake wetland issues were resolved by agency and landowner cooperation. Future opportunities exist elsewhere.
Agency	There is a need to evaluate fish entrainment and fish passage along irrigation ditches to protect and enhance the habitat of native species.	Project improvements identified in this study will be evaluated by Trout Unlimited, TCD, and Wyoming Game and Fish.

Identified by	Issue or Opportunity	Resolution
Agency	Winter flooding along Flat Creek continues to be a problem for the residents of Jackson.	This issue is currently being addressed by the Flat Creek Watershed Improvement District.
Agency	Additional water supply is needed for fire suppression and possibly for some subdistricts, the southern part of Jackson, and potentially the ski resort in Jackson (Snow King Mountain).	Proposed improvements were identified in Buffalo Valley with the assistance from Teton County Fire Department. No specific need was identified for Jackson or for Snow King at the time of this report.
Agency	Habitat enhancements are needed for specific species of interest and/or threatened and endangered species.	Proposed improvements were described for trumpeter swan and for fish habitat.
Agency	Irrigation system improvements are needed for leases and allotments on public lands.	Numerous proposed improvements were identified that will benefit allotments on federal and state lands.
Agency	Flood protection that is needed may be accomplished through levee improvements.	Proposed improvements were identified for Blackrock Creek levee.
Landowner	There are water quality issues in Fish Creek related to septic systems.	It was proposed that TCD continue its support for Friends of Fish Creek initiatives and recirculating wetlands for residents near Fish Creek.
Landowner	Historic control structures that feed irrigation ditches from the main stem of the Snake River are no longer functioning adequately because of changes in river dynamics over time.	Several improvements were proposed for large headgates along the Snake River. An additional Level II study was proposed at project meetings.
Landowner	Control structures along irrigation ditches need to be modified to allow for safer operations, enhancements to fish habitat, and better operations for irrigated fields.	Several improvements were proposed for medium-sized diversion structures.
Landowner	Certain areas of Jackson are experiencing high water-table issues.	Monitoring and potential mitigation measures were suggested for a subdivision south of Jackson.
Landowner	Control structure replacements were suggested for where damage has occurred.	Several improvements were proposed for medium-sized diversion structures on Jensen and Trail creeks.
Landowner	Irrigation management optimization is needed.	Several options were identified for irrigation system optimization on both privately and publicly owned lands.
Landowner	Stream stabilization may be needed in specific areas.	Several options were identified for stabilization measures for Lake Creek.

Identified by	Issue or Opportunity	Resolution
Landowner	There are concerns of the cumulative impacts of small ponds on hydrology of the area.	This issue was not resolved with this study. WSEO is conducting a mapping inventory.
Landowner	Irrigation improvements are needed to minimize sedimentation to streams and enhance water quality.	Structures were identified to help control flow across pastures.

2. WATERSHED MANAGEMENT PLAN AND MORE

The objective of this Level I watershed study is to provide plans for watershed management and rehabilitation to address the key issues identified by landowners and agencies. The plans must be practical, technically sound, feasible, and cost effective. For the Upper Snake River watershed study, conceptual plans for rehabilitation were presented in Section 4 of Volume I. The projects were grouped into five categories that incorporate a wide variety of project types including:

- Irrigation System Improvements
- Livestock/Wildlife Upland Watering Improvements
- Surface Water Flood and Storage Improvements
- Stream Channel Condition and Stability Improvements
- Other Watershed Management Opportunities

The conceptual plans for the improvements were developed in collaboration with the Olsson project team of scientists and engineers with input from the local agencies and partners. Collaboration was important to ensure that the proposed projects were practical and feasible in the unique ecological setting and regulatory environment of the Upper Snake River watershed.

It is important to note the significance of this watershed to the surrounding area. As a central part of the greater Yellowstone ecosystem, the Upper Snake River watershed is the home to the largest concentration of wildlife in the lower 48 states. The migration patterns across the watershed have been the subject of numerous studies that are summarized in “Great Migrations: Keeping Yellowstone’s Life-blood Flowing” (National Geographic 2016). More than 40 maps were developed as Volume II of this watershed study to illustrate the distribution of the unique natural resources and man-made features of the Upper Snake River watershed.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

This watershed study provides a holistic evaluation of the Upper Snake River watershed. This Level I watershed study evaluated the current condition of the Upper Snake River watershed and looked at opportunities for water improvement projects to restore, maintain, and enhance healthy watershed function. The current condition of the watershed was evaluated and summarized in the description and inventory of the watershed, Sections 2 and 3 in Volume I of this watershed study. The datasets and reports evaluated for the inventory and description were incorporated into a GIS dataset and digital library provided

electronically to the TCD and WWDC. The datasets and digital library will provide the TCD, WWDC, and cooperating agencies information for planning and implementation of the watershed improvements outlined in this report. Section 4 presents the details of the proposed project improvements, and Section 5 includes engineering and construction cost estimates. Certain improvements will require permitting and, therefore, Section 6 describes many of the permits that will be required to complete specific enhancements. Since the projects cannot be completed without adequate funding, Section 7 presents opportunities for project financing through local, state, and federal agencies.

3.2. Recommendations

A Level I watershed study looks for projects, programs, or activities that support sustainable, beneficial water use for current and future watershed residents. The following recommendations are made to help achieve this goal. At the end of this section, Table ES-2 lists the specific project recommendations developed for the Upper Snake River watershed. Locations of the proposed projects and cost estimates are provided for reference.

3.2.1. Irrigation System Improvements

Twenty specific irrigation improvements are proposed as requested by ranchers/landowners/agencies in the Upper Snake River watershed. The irrigation improvements focus on rehabilitation/replacement of existing structures, enhanced delivery of water, reduction in annual operation and maintenance costs, improvement in ditch management and efficiency, addressing fish passage issues, and economic practicality and physical feasibility. The specific recommendations include regrading ditches, replacing open ditches with piping and/or lining, replacing headgates, creating new diversion structures, and several options for upgrading irrigation systems. The cost estimates for the projects range from just over \$1,000 to install a low-cost discharge measuring device for a diversion structure near Wilson to an option presented for a new irrigation system at the Elk Ranch at Grand Teton National Park that, if selected, would cost over \$2 million.

As stated in Governor Mead's Wyoming Water Strategy, 2015, "Aging infrastructure for irrigation and diversion can negatively affect stream systems. Rebuilding old infrastructure provides opportunities to use new technologies and improve efficiencies in water and in time spent on management. Irrigation practices can be more efficient and precise than ever imagined in earlier generations."

More than half of the projects may apply to the WWDC Small Water Project Program (SWPP), National Resources Conservation Service programs, and/or Technical Assistance Cost-share (or TAC grants) through the TCD for funding. The projects that were estimated to cost over \$135,000 have other options including programs administered by the WWDC, Wyoming Wildlife and Natural Resources Trust, and others. Additional improvements could be made across the watershed using the plans and cost estimates provided in this report as a guide for conceptual design, cost, and financing opportunities.

3.2.2. Livestock/Wildlife Watering Opportunities

One of the best options to enhance rangeland and riparian habitat is to ensure adequate watering opportunities in the uplands and away from riparian zones. With dispersal of livestock watering sources to uplands, not only are riparian areas relieved of grazing and trampling pressure, but little used forage on

remote uplands may also be accessed by foraging animals. For these reasons, livestock/wildlife watering development projects in underserved areas are recommended.

The proposed livestock/wildlife projects include combinations of the following elements: development of existing springs; construction of a small stock pond on an existing seep; and installation of groundwater wells, solar powered pumps, stock tanks, piping, and fencing to maximize water distribution for livestock and wildlife. The projects were all estimated to cost less than \$135,000 and may be eligible for the WWDC SWPP. Additional livestock/wildlife water development improvements could be made, as needed, using the plans and cost estimates provided in this report as a guide for conceptual design, cost, and financing opportunities.

3.2.3. Surface Water Flood and Storage Improvements

The Upper Snake River watershed is unique for watershed studies because there have been no requests for large surface-storage improvements. In contrast, the issues that were repeatedly identified for communities in the watershed include surface water flood control along Flat Creek in Jackson because of winter ice dams and environmental enhancements related to the U.S. Army Corps of Engineers flood control levees. These two issues are currently being evaluated and addressed through the Flat Creek Watershed Improvement District and the U.S. Army Corps of Engineers. Continued involvement and support by the TCD is encouraged to ensure that the projects identified by these initiatives are implemented.

In contrast, the issue of source water for fire protection was a significant concern for the watershed. In late August 2016, when this report was being completed, the Berry fire at the north end of Jackson Lake in the Grand Teton National Park, the Lava Mountain fire near Dubois, and the Cliff Creek fire near Bondurant were all actively burning and causing evacuations, road closures, and property destruction. The proposed source water for fire protection projects includes suction drafting from static water sources such as creeks or ponds, portable or permanent tanks, and underground storage tanks.

*At the June 2016 Western Governors' annual meeting in Jackson, one of the seven resolutions passed by the governors was about wildfires. **The governors' resolution identified the need "to take advantage of current authorities to expedite projects that would improve western ecosystems and reduce extreme wildfire danger."** The modest projects proposed in this watershed study are examples of the types of projects that could be implemented to address this important issue.*

The projects were all estimated to cost less than \$135,000 and may be eligible for the WWDC SWPP. These projects can be described as source water development projects since the primary purpose of each is to provide additional sources of water for watershed fire protection. As source water development projects in the SWPP, they rank in the highest of priorities (WWDC 2015).

The surface water flood and storage improvement projects could be made in other parts of the watershed, as needed, using the plans and cost estimates provided in this report as a guide for conceptual design, cost, and financing opportunities.

3.2.4. Stream Channel Condition and Stability

Stream channels within the watershed were characterized using the Rosgen classification system. Impaired channels were identified through the classification and through input from residents and landowners. The improvement projects focus on stream restoration to minimize channel erosion and reduce sedimentation and best management practices that contribute to fish habitat enhancements in the creeks and tributaries of the Snake River.

The project cost estimates varied greatly depending on the length and extent of the proposed stream channel enhancement. The projects that were estimated to cost less than \$135,000 may be eligible for the WWDC SWPP as environmental stream stability improvements. Additional funding from the U.S. Army Corps of Engineers Environmental Restoration program may be available for projects like the one proposed for Morel Creek. For the Fish Creek projects that will be identified by the Friends of Fish Creek, funding may be available through local nonprofits in the Jackson area along with the WWDC and through the TCD technical assistance cost-share grants. The stream channel condition and stability improvement projects could be made in other parts of the watershed, as needed, using the plans and cost estimates provided in this report as a guide for conceptual design, cost, and financing opportunities.

3.2.5. Other Management Opportunities

Numerous other management practices and improvements are in various stages of implementation across the watershed. The specific improvements and/or best management practices recommended in this report include additional engineered wetland improvements, habitat enhancements for specific threatened or endangered species, monitoring and mitigation for high water-table conditions, and noxious weed control.

Because the cost estimates for most of the other management practice improvements are very site-specific and the locations for the improvements have not yet been identified, cost estimates for the improvements at specific sites were not provided. As described above, the other management practice projects that cost less than \$135,000 may be eligible for the WWDC SWPP as environmental improvements.



The Grand Tetons at Grand Teton National Park

Table ES-2 Brief Descriptions of the Proposed Projects, Location, and Cost Estimates

Project Number	Brief Proposed Project Description	Longitude	Latitude	Section, Township, Range	Cost Estimate*
ISI-1	Install drainage pipe and diversion structure	-110.476	43.8306	S30, T45N R113W	\$54,900
ISI-2	Regrade irrigation ditch	-110.381	43.8252	S35, T45N R113W	\$95,840 to \$356,890
ISI-3	Reinforce levee	-110.352	43.8240	S31, T45N R 112W	\$68,075
ISI-4	Replace diversion structure/irrigation system	-110.502	43.8260	S35, T45N, R114W	\$997,500 to \$2,026,750
ISI-5	Install pipeline	-110.484	43.7726	S13, T44N, R114W	\$284,450
ISI-6	Install diversion structure and regrade ditch	-110.770	43.6213	S9, T42N, R116W	\$265,300
ISI-7	Construct new diversion channel	-110.799	43.5650	S32, T42N, R116W	\$105,450
ISI-8	Replace diversion structure	-110.780	43.6139	S9, T42N, R116W	\$229,650
ISI-9	Install diversions and ditches	-110.822	43.5641	S36, T42N, R117W	\$20,050
ISI-10	Construct headgate	-110.858	43.5578	S35, T42N, R117W	\$121,550
ISI-11	Install piping, sprinkler, and pump system	-110.800	43.5943	S20, T42N, R116W	\$31,550
ISI-12	Replace headgate	-110.907	43.4907	S29, T41N, R117W	\$82,165
ISI-13	Install staff gage and measurement flume	-110.853	43.4983	S23, T41N, R117W	\$1,150 to \$29,900
ISI-14	Install pipeline	-110.846	43.5037	S23, T41N, R117W	No cost estimate available
ISI-15	Realign ditch	-110.855	43.5027	S23, T41N, R117W	\$8,210
ISI-16	Replace headgate	-110.790	43.4653	S5, T40N, R116W	\$234,250
ISI-17	Replace headgate and regrade ditch	-110.853	43.4496	S10, T40N, R117W	\$234,250
ISI-18	Replace diversion structure	Exact location yet to be determined			\$253,225
ISI-19	Replace headgate and install gated pipe	-110.741	43.3941	S27, T40N, R116W	\$88,085
ISI-20	Replace diversion structure	Exact location yet to be determined			\$81,350
LWW-1	Develop spring and associated improvements	-110.542	43.5828	S21, T42N, R114W	\$12,636

Project Number	Brief Proposed Project Description	Longitude	Latitude	Section, Township, Range	Cost Estimate*
LWW-2	Construct small stock pond	-110.818	43.3804	S36, T40N, R117W	\$32,147
LWW-3	Install new wells	Exact location yet to be determined			\$35,276
LWW-4	Develop spring and associated improvements	-110.785	43.383	S32, T40N, R116W	\$55,639
SWF-1	Identify improvements to help prevent flooding	Various project locations along Flat Creek			No cost estimate available
SWF-2	Restore channel stability and restore habitats	Various project locations along Snake River			No cost estimate available
SWF-3	Install fire suppression water supply tank	-110.441	43.8383	S29, T45N, R113W	\$20,205
SWF-4	Install fire suppression water supply tank	-110.424	43.8503	S21, T45N, R113W	\$19,123
SWF-5	Install fire suppression water supply tank	-110.416	43.8440	S22, T45N, R113W	\$24,444
SWF-6	Install fire suppression water supply tank	-110.328	43.8494	S20, T45N, R112W	\$25,012
SWF-7	Install fire suppression water supply tank	-110.315	43.8504	S21, T45N, R112W	\$20,205
SWF-8	Install fire suppression water supply tank	-110.319	43.8479	S20, T45N, R112W	\$21,529
SWF-9	Repair existing drafting site equipment	-110.271	43.8566	S23, T45N, R112W	\$3,461
SCC-1	Improve erosion and irrigation efficiency	-110.808	43.5904	S19, T42N, R116W	No cost estimate available
SCC-2	Minimize bank erosion on Lake Creek	-110.830	43.5436	S1, T41N, R117W	No cost estimate available
SCC-3	Restore stream and improve habitat	-110.837	43.4166	S23, T40N, R117W	No cost estimate available
SCC-4	Minimize sediment loads on Fish Creek	Various project locations along Fish Creek			No cost estimate available
OMP-1	Mitigate high-water table	-110.793	43.4328	S17, T40N, R116W	No cost estimate available
OMP-2	Assess current conditions, develop O&M plan	-110.773	43.5231	S33, T41N, R116W	No cost estimate available

* See Volume I, Section 5.0 for details on cost estimates.

As stated in Governor Mead’s Wyoming Water Strategy (2015), “Vibrant Wyoming watersheds are essential to the health and sustainability of farms and ranches, kayak rental businesses and fly stores, municipal water systems, and family fishing vacations. In short, ensuring the health of Wyoming’s watersheds is essential to ensuring the health of our state.”