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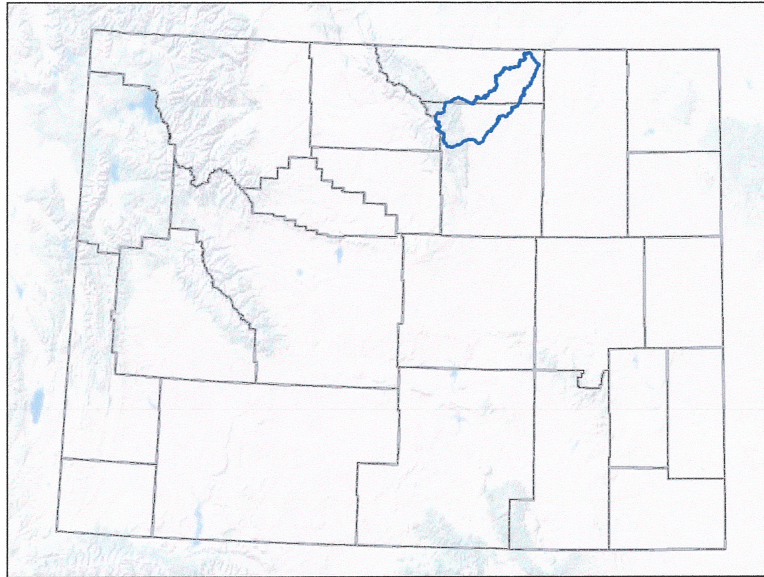
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Funding for WRDS and the creation of this electronic document was provided by the Wyoming Water Development Commission
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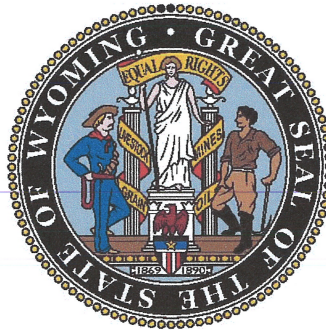
Executive Summary

Clear Creek Watershed, Level I Study



Prepared for:

**Wyoming Water Development Commission
Cheyenne, Wyoming**



Prepared by:

States West Water Resources Corporation – Cheyenne, Wyoming

In Association with:

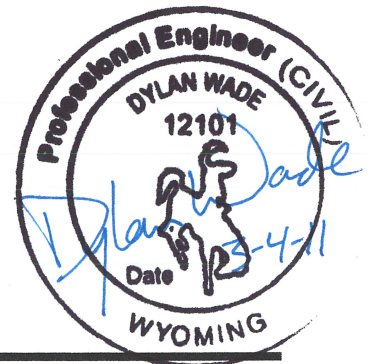
DOWL HKM – Sheridan, Wyoming

Anderson Consulting Engineers, Inc. – Fort Collins, Colorado

RJH Consultants, Inc. – Englewood, Colorado

Western EcoSystems Technology, Inc. – Cheyenne, Wyoming

Watts and Associates, Inc. – Laramie, Wyoming



March 2011

1. INTRODUCTION

In June 2008 States West Water Resources Corporation (States West) entered into a contract with the Wyoming Water Development Commission (WWDC) to provide professional services for the Clear Creek Watershed – Level I Study. The purpose of the contracted services was to render technical and professional services to assess, describe, and inventory the watershed and then develop management and rehabilitation plans for the watershed. This watershed study provides practical and economical solutions to issues identified during the inventory and assessment of Clear Creek watershed components.

Additionally, this study analyzes the potential for developing surface water within the Clear Creek watershed. States West has taken an in-depth look at the watershed for potential multiuse water storage facilities to supply water and benefit to various users including the irrigators in the watershed and the City of Buffalo. During the analyses, States West has taken a big picture approach in order to identify multipurpose projects that could potentially draw funding from multiple sources.

The study was conducted in association with DOWL HKM (DOWL), Anderson Consulting Engineers, Inc. (ACE), RJH Consultants, Inc. (RJH), Western EcoSystems Technology, Inc. (WEST), and Watts and Associates, Inc. (WATTS).

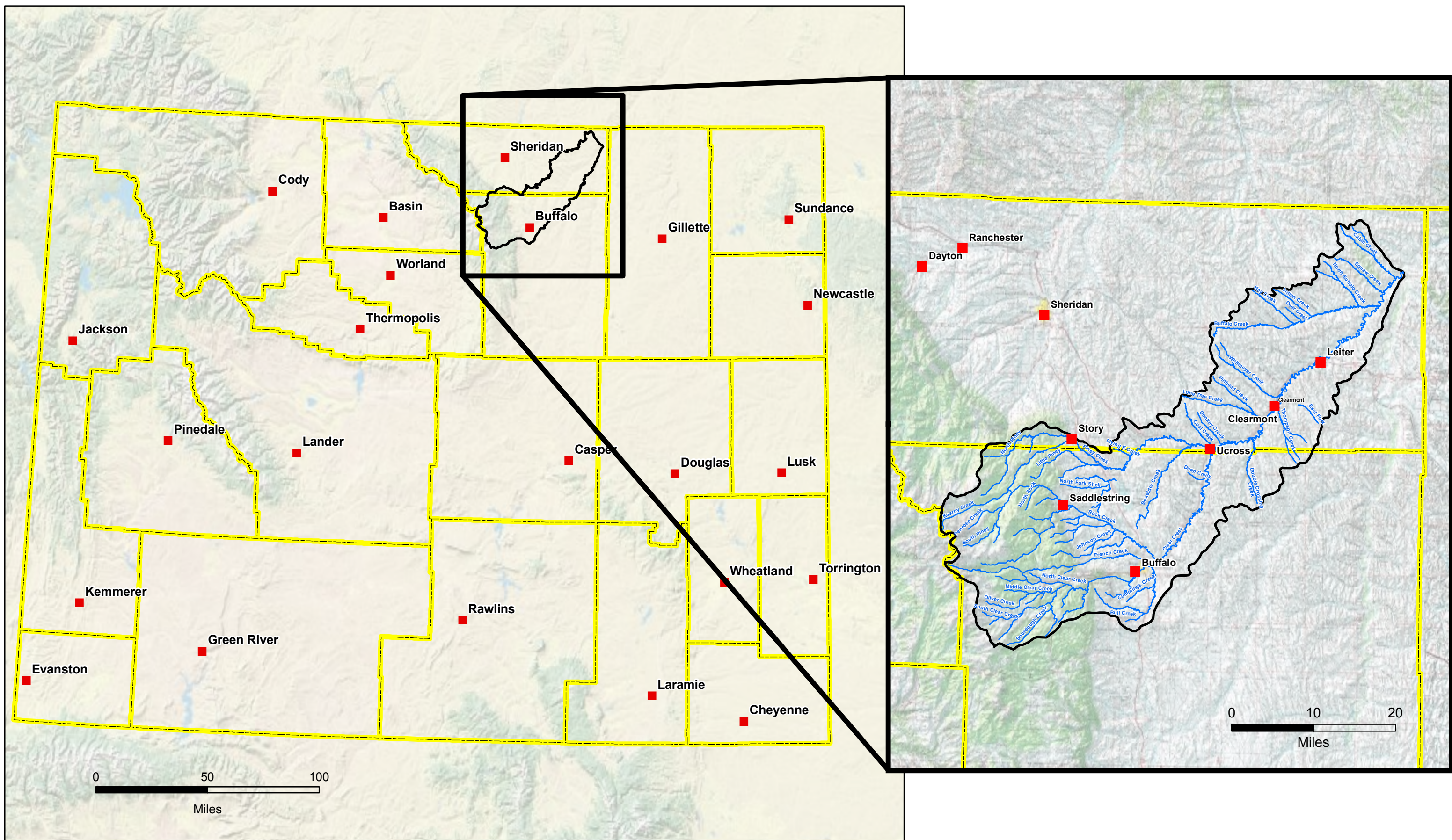
2. BACKGROUND

The Clear Creek watershed, located in northwest Johnson County and extending into southeast Sheridan County, is approximately 738,312 acres with land ownership divided among federal, private, and state. The watershed is defined as all the land area that contributes water or otherwise drains to the point where Clear Creek meets the Powder River. The watershed includes one primary river system, the main stem of Clear Creek, and tributaries including French Creek, Rock Creek, Shell Creek, Piney Creek and Buffalo Creek. Figure 1 generally depicts the Clear Creek Watershed. The watershed encompasses the Towns and surrounding areas of Buffalo, Clearmont, Leiter, Story, Saddlestring, and Ucross.

Elevations within the watershed range from less than 3,500 feet at the confluence of Clear Creek with the Powder River, to over 13,000 feet at peaks within the Bighorn Mountains, resulting in overall relief of more than 9,500 feet. The southwestern portion of the watershed consists of the east slope of the Big Horn Mountains while the northeastern portion lies primarily in rolling hills.

Annual precipitation amounts vary with respect to elevation from 12 to 37 inches per year in the southwestern portion of the basin compared to 13 to 15 inches per year in the northeastern portion of the basin.

The majority of land within the basin is privately owned. The privately owned parcels account for about 60% of all land within the watershed. Public lands account for 39% of the



- Legend**
- Cities
 - Streams
 - Clear Creek Watershed
 - County Boundary

**Figure 1.2-1
Wyoming Overview**

landownership within the basin (US Forest Service – 25.67%, State of Wyoming – 10.47%, Bureau of Land Management – 3.04%).

In general, some of the issues related to water within the basin and utilization of resources are as follows:

Runoff Quantity and Timing Issues

- The Clear Creek drainage generates a significant amount of runoff. Generally, peak streamflow occurs early in the year when irrigation demands on the system are low. Shortages occur during the late season low flow periods. Several reservoirs in the watershed reduce late season irrigation shortages, however, demands upstream of these storage facilities exist.
- The City of Buffalo occasionally has flood events occur during spring runoff periods. Since 1962, Clear Creek has risen above flood stage at Buffalo four times.
- Late season irrigation shortages could potentially be mitigated by capturing spring runoff and releasing during low flow periods.
- Late season flows through the City of Buffalo are reduced due to upstream irrigation diversions.
- Multiple-use storage reservoirs located above the areas of need could provide numerous economic benefits to the surrounding area including: flow through town, agricultural enhancements, recreational opportunities, environmental benefits, wildlife and fishery enhancement, habitat enhancement, potential flood mitigation, etc.

Grazing Issues

- Grazing of livestock is one of the primary land uses within the study area; the livestock industry has played an important role in the economy and character of the area.
- The Bureau of Land Management – Buffalo Field office and U.S. Forest Service administer grazing allotments for federal land within Clear Creek watershed. There are approximately 57 BLM individual grazing allotments and 14 USFS individual grazing allotments within the watershed.
- Various NRCS programs have been utilized over the years to develop upland water opportunities throughout the watershed.
- There are further opportunities to develop additional upland water supplies for livestock/wildlife watering.
- The Clear Creek watershed range conditions appear to be generally in “high fair” to “good” ecological condition.
- Riparian areas appear to be heavily relied upon for their wildlife and livestock water, feed values, and cover.

Channel Stability Issues

- During the evaluation of existing channel conditions, several impaired reaches were identified.
- Within the mountainous areas, the channels are steep and bounded by very coarse, resistant materials. As a result, the channels are typically laterally and vertically stable.
- As the major stream channels descend into the Clear Creek basin, the channel slope lessens and the boundary materials become less coarse. Within this region, the streams tend to display meandering channel dynamics.
- Within the lower reaches of the watershed, Clear Creek maintains its nature of being a meandering stream.

- Riparian vegetation degradation has occurred in the lower reaches of Clear Creek. Little or no riparian buffer has been maintained in these areas.
- Generally, the Clear Creek system appears to have stable bank and channel characteristics. Some localized instances of stream bank erosion are evident.
- Actively eroding portions of stream-bank within the watershed were inspected per the request of local landowners.

Irrigation Issues

- The Clear Creek watershed contains approximately 40,000 acres of irrigated lands served by surface water sources. An additional 6,000 acres are served by trans-basin diversions. The ditches typically range in size from those conveying 1.5 cfs to ditches designed to convey 300 cfs.
- Numerous improvements to existing irrigation facilities could be made to improve the efficiencies of water delivery, thus increasing conservation.
- Several opportunities exist which would allow multiple ditches to be combined in a more efficient manner. This could improve water delivery efficiencies, promote water conservation, and improve economies of scale.
- Structural evaluations conducted throughout the watershed revealed that some of the existing structures are beyond the point of repair and could require replacement while other deficiencies could be easily remediated.
- Operational deficiencies result in both the over-utilization and under-utilization of irrigation appropriations.
- Projects have been prioritized according to facility deficiencies and the anticipated repair/replacement cost of facilities.
- Late season irrigation is frequently curtailed in the upper basin with the shortage of water in streams.
- Reservoir storage, coupled with irrigation improvements may conserve water and create opportunities that would benefit irrigators and other water users within the watershed.
- Opportunity exists by the way of using and modifying existing Lake DeSmet infrastructure to provide irrigators below the City of Buffalo with additional storage water and potentially increase water availability upstream via exchanges.

3. PURPOSE AND SCOPE

The primary purposes of the Clear Creek Watershed – Level I Study are to:

- Review Existing Background Information for the Clear Creek drainage,
- Describe and Inventory the Clear Creek Watershed to provide a holistic view of the natural resources,
- Implement Temporary Stream Gauging on Clear Creek tributaries,
- Develop a Watershed Management and Rehabilitation Plan for the Clear Creek drainage,
- Analyze permitting requirements for Clear Creek Watershed improvement projects, highlight potential “fatal flaws” associated with storage projects, and provide a solid foundation for the NEPA process,
- Develop cost estimates for Clear Creek Watershed improvement projects,
- Provide economic analyses for Clear Creek Watershed reservoir projects,

- Analyze financing opportunities for Clear Creek Watershed improvement projects,
- Prepare a report summarizing the findings of the Level I Study, and
- Compile and collate all of the relevant natural resources spatial data available into a comprehensive Geographic Information System (GIS) to facilitate the completion of this project and also to be available as a resource for future work.

4. WATERSHED DESCRIPTION AND INVENTORY

A considerable amount of information exists pertaining to the Clear Creek watershed and its resources. The data spans a wide variety of disciplines and includes basin hydrology, water quality, land use and ownership, infrastructure, geology and soils, vegetation, climate, wildlife, and agricultural practices as typical examples. One of the primary goals of this watershed planning study was to collect this information and provide it in a single cohesive document. The intent of the project is to provide this information not only for the current project but for other future planning and permitting efforts.

A project Geographic Information System (GIS) was developed and contains existing information available from a wide variety of sources and also contains project developed data and information. In addition, information describing watershed land use and activities, natural environment, stream geomorphology, water quality, and watershed hydrology is presented in the report.

5. WATERSHED MANAGEMENT PLAN

A watershed management plan was developed to provide technically sound, practical and economically feasible solutions to issues found in the watershed. The watershed management plan provides preliminary designs and cost estimates for identified projects and addresses the following areas:

- Livestock / Wildlife Upland Watering Opportunities
- Stream Channel Condition and Stability Components
- Grazing Management Opportunities
- Other Upland Management Opportunities
- Irrigation System Rehabilitation Components
- Irrigation System Efficiency and Conservation Improvement Concept Level Planning
- Water Supply and Storage Opportunities

6. CONCLUSIONS

Based on the work performed for this study, the following conclusions have been formulated. The conclusions address the watershed issues identified in the study.

6.1 Livestock/Wildlife Upland Watering Opportunities

1. A large percentage of the grazing lands in the watershed appear to be within one mile of a water source, however, further opportunities exist in the watershed to improve upland water supplies for livestock/wildlife.
2. A total of five potential wildlife/livestock water supply projects were identified. These projects primarily involved pipelines and tanks to provide additional watering. Cost estimates and components for these projects are included in Table 1.

6.2 Stream Channel Condition and Stability

1. There were limited channel reaches in the study that were identified as systemically impaired. Generally the Clear Creek system appears to have stable bank and channel characteristics. Some localized instances of stream bank erosion are evident.
2. Riparian vegetation degradation has occurred in the lower reaches of Clear Creek as little or no riparian buffer has been maintained in these areas.
3. Five potential channel stability projects were identified. These projects involved bank protection and channel management to reduce erosion.

6.3 Grazing Management Opportunities

1. Strategies, recommended in the state and transition models associated with NRCS descriptions of the ecological sites found within the watershed, should be adopted and employed to optimize range conditions through prescribed grazing management and best management practices.
2. Prescribed fire and other mechanical range treatments should be utilized as a tool to assist in the restoration of range health in areas benefitting by these treatments according to the state and transition models.

6.4 Invasive Species Treatment

1. Management efforts targeting Russian Olive and Leafy Spurge have been largely successful and continuation of these efforts is encouraged.
2. Noxious weed management programs currently being conducted by the respective weed and pest control districts of Johnson and Sheridan Counties should continue. Education opportunities for land owners and managers should continue to be made available.

Table 1 Upland water projects cost estimates

Project Name		Apache Ranch Phase I	Apache Ranch Phase II	Nelson	Wilwauka Ranch	Vignaroli
Project Component	Allotment Directly Benefitted	Sahara Draw	Sahara Draw	T.W.	Private Lands	State Lands
Well Construction Spring Development	Mobilization	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000
	Well / Spring	Existing Well	Well	Well	Spring	Rehabilitation of Existing System
	Units (each)	0	0	0	1	0
	Depth Each	NA	NA	NA	NA	NA
	Unit Cost (\$/LF wells or \$/EA springs	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000
	Well Screen (LF each well)					
	Well Screen (\$/LF)					
Component Subtotal	\$3,000	\$3,000	\$3,000	\$8,000	\$3,000	
Pump	Units (EA)	1	0	NA	0	0
	Type	Solar	Solar		Solar	Solar
	Unit Cost (EA)	\$8,640	\$48,800		\$8,640	\$8,640
	Component Subtotal	\$8,640	\$0		\$0	\$0
Pipeline	Units (LF)	36,375	33,000	4,500	800	32,125
	Unit Cost (EA)	\$2.00	\$2.00	\$1.34	\$1.34	\$2.00
	Component Subtotal	\$72,750	\$66,000	\$6,030	\$1,072	\$64,250
Additional Storage Tanks Fencing / Etc	Units (EA)	NA	NA	NA	0	0
	Size (gal)				15,000	15,000
	Unit Cost (\$/gal)				\$1	\$1
	Component Subtotal				\$0	\$0
Water Tanks	Units (EA)	7	5	1	1	7
	Size (gal)	1,200	1,200	1,200	1,200	1,200
	Unit Cost	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000
	Component	\$21,000	\$15,000	\$3,000	\$3,000	\$21,000
Miscellaneous	Item	Frost free hydrants	Frost free hydrants	NA	Fencing	Fencing
	Units (Each)	4	4			
	Unit Cost (\$/ea)	\$250	\$250			
	Component Subtotal	\$1,000	\$1,000			
Construction Subtotal		\$106,390	\$85,000	\$12,030	\$12,072	\$88,250
Engineering (10%)		\$10,639	\$8,500	\$1,203	\$1,207	\$8,825
Construction and Engineering Subtotal		\$117,029	\$93,500	\$13,233	\$13,279	\$97,075
Contingency (15%)		\$17,554	\$14,025	\$1,985	\$1,992	\$14,561
Total Construction Cost		\$134,583	\$107,525	\$15,218	\$15,271	\$111,636
Final Plans and Specs		\$2,000	\$2,000	\$2,000	\$1,000	\$2,000
Additional		\$0	\$0	\$0	\$0	\$0
Permitting / Legal Fees / Access and Rights of Way		\$1,000	\$1,000	\$1,000	\$1,000	\$1,000
Total Project Cost		\$137,583	\$110,525	\$18,218	\$17,271	\$114,636

6.5 Irrigation System Conservation and Rehabilitation Opportunities

1. A total of 30 ditch systems were inventoried. The inventories concentrated on the primary issues identified with the systems.
2. The structures and canals in need of rehabilitation were preliminarily designed and cost estimates were developed.
3. A rehabilitation plan prioritizing needed improvements was developed. Tables 2 and 3 contain a listing of structure and canal remediation projects and cost estimates.
4. The potential for combining several ditch diversions and canals into single systems was evaluated. In addition, developing piped conveyance systems and incorporation of irrigation improvements with storage concepts were evaluated. Conceptual designs and cost estimates were developed for six conceptual projects and are contained in Section 5 of the report.

6.6 Water Supply and Storage Opportunities

Potential reservoir sites were derived from previous studies, input from irrigators and sponsors, and new sites identified by the consultants to meet needs. These sites were preliminarily screened to eliminate sites that would not be feasible. A total of eleven sites were advanced to preliminary design and analysis. Those eleven sites were investigated by the project team for hydrologic adequacy, geotechnical conditions, environmental effects, and suitability for the purpose and need. Table 4 contains reservoir site information.

The estimated costs for the representative sizes of reservoirs were developed. These costs are summarized in Table 5. The estimated costs are total project costs including all foreseeable items. The total project costs include supply and delivery systems for off-channel storage sites. Also included are engineering costs, land acquisition costs, environmental mitigation costs, and legal costs. The costs were developed to reflect 2011 prices.

Table 2 Summary of Irrigation Structure Remediation Costs

Clear Creek Unit / Division Structure Remediation Priority Ranking Summary

<i>HKM ID</i>	<i>BIA ID</i>	<i>Canal</i>	<i>Structure Type</i>	<i>Action</i>	<i>Rehab. Cost</i>	<i>CRV</i>	<i>FCI</i>	<i>API</i>	<i>RPI</i>	<i>Deficiency Category / Rating</i>	<i>Remediation Cost</i>	<i>Pg #</i>
2PF-DD1		Pratt & Ferris #2	Diversion Dam (NT)	Replace	\$0.00	\$398,977.97	1.00	90	90	CHSci Critical	\$398,977.97	
3PF-DD1		Pratt & Ferris #3	Diversion Dam (NT)		\$411,747.44	\$484,704.13	0.85	100	85	CHSdm Critical	\$411,747.44	
FOX-HG1		Fox Ditch	Headgate (NT)		\$143,454.92	\$166,613.36	0.86	90	77	CMDM Serious	\$143,454.92	
RC-HG1		Rock Creek & South Piney	Headgate (NT)		\$99,966.75	\$120,835.13	0.83	90	75	CHSci Critical	\$99,966.75	
JH-SPN1		Johnson Holt	Siphon (NT)	Replace	\$0.00	\$53,196.99	1.00	70	70	CMDM Critical	\$53,196.99	
1PF-DD1		Pratt & Ferris #1	Diversion Dam (NT)		\$221,844.28	\$264,338.02	0.84	80	67	CHSci Serious	\$221,844.28	
LP-HG1		Little Piney Ditch	Headgate (NT)		\$69,441.91	\$86,716.13	0.8	80	64	CMDM Critical	\$69,441.91	
LD-HG1		Leiter Ditch	Headgate (NT)		\$96,335.31	\$157,081.99	0.61	100	61	CMDM Minor	\$96,335.31	
BB-CH1		Big Bonanza	Wasteway (NT)	Replace	\$0.00	\$72,209.58	1.00	60	60	CRPci Critical	\$72,209.58	
BF-HG1		Brown & Foster	Headgate (NT)	Replace	\$0.00	\$22,563.97	1.00	60	60	CMDM Serious	\$22,563.97	
BB-CH2		Big Bonanza	Check (NT)	Replace	\$0.00	\$8,477.26	1.00	60	60	CMDM Serious	\$8,477.26	
BB-CH3		Big Bonanza	Check (NT)	Replace	\$0.00	\$8,477.26	1.00	60	60	CMDM Serious	\$8,477.26	
BB-CH4		Big Bonanza	Check (NT)	Replace	\$0.00	\$8,477.26	1.00	60	60	CMDM Serious	\$8,477.26	
CD-CH2		Crown Ditch	Check (NT)	Replace	\$0.00	\$8,124.04	1.00	60	60	CMDM Serious	\$8,124.04	
CD-CH1		Crown Ditch	Check (NT)	Replace	\$0.00	\$8,124.04	1.00	60	60	CMDM Serious	\$8,124.04	
6M-HG1		Six Mile	Headgate (NT)		\$154,386.65	\$255,652.22	0.6	90	54	CHSci Serious	\$154,386.65	
LX-HG1		LX Ditch	Headgate (NT)		\$147,438.80	\$170,602.04	0.86	60	52	CMDM Serious	\$147,438.80	
MK-HG1		Fort McKinney Ditch	Headgate (NT)		\$44,027.29	\$51,122.37	0.86	60	52	CMDM Minor	\$44,027.29	
ST-HG1		Sturdovant Ditch	Headgate (NT)		\$140,293.27	\$176,415.35	0.8	60	48	CMDM Serious	\$140,293.27	
BR-DD1		Big Redman	Diversion Dam (NT)		\$157,790.69	\$273,848.95	0.58	80	46	CHSci Serious	\$157,790.69	
HO-SPN		Hillyer & Onslow	Siphon (NT)		\$86,508.93	\$99,412.03	0.87	50	44	CMDM Critical	\$86,508.93	
6M-SPN2		Six Mile	Siphon (NT)		\$72,592.09	\$131,412.81	0.55	80	44	CMDM Serious	\$72,592.09	
PD-HG1		Piney Divide	Headgate (NT)		\$41,597.95	\$98,545.07	0.42	100	42	CMDM Critical	\$41,597.95	
SNF-CH4		Senff Ditch	Check (NT)	Replace	\$0.00	\$13,691.63	1.00	40	40	CMDM Serious	\$13,691.63	
SNF-CH3		Senff Ditch	Check (NT)	Replace	\$0.00	\$13,691.63	1.00	40	40	CMDM Serious	\$13,691.63	
SNF-CH2		Senff Ditch	Check (NT)	Replace	\$0.00	\$13,691.63	1.00	40	40	CMDM Serious	\$13,691.63	
SNF-CH1		Senff Ditch	Check (NT)	Replace	\$0.00	\$13,691.63	1.00	40	40	CMDM Serious	\$13,691.63	
SNF-CH5		Senff Ditch	Check (NT)	Replace	\$0.00	\$8,395.64	1.00	40	40	CMDM Serious	\$8,395.64	
BB-TO1		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$6,189.93	1.00	40	40	CMDM Serious	\$6,189.93	
BB-TO12		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$6,189.93	1.00	40	40	CMDM Serious	\$6,189.93	
BB-TO11		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$6,189.93	1.00	40	40	CMDM Serious	\$6,189.93	

Table 2 Summary of Irrigation Structure Remediation Costs - Continued

Clear Creek Unit / Division Structure Remediation Priority Ranking Summary

<i>HKM ID</i>	<i>BIA ID</i>	<i>Canal</i>	<i>Structure Type</i>	<i>Action</i>	<i>Rehab. Cost</i>	<i>CRV</i>	<i>FCI</i>	<i>API</i>	<i>RPI</i>	<i>Deficiency Category / Rating</i>	<i>Remediation Cost</i>	<i>Pg #</i>
BB-TO2		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$6,189.93	1.00	40	40	CMDM Serious	\$6,189.93	
BB-TO3		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$6,189.93	1.00	40	40	CMDM Serious	\$6,189.93	
BB-TO9		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$6,189.93	1.00	40	40	CMDM Serious	\$6,189.93	
BB-TO10		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$6,189.93	1.00	40	40	CMDM Serious	\$6,189.93	
BB-TO7		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$6,189.93	1.00	40	40	CMDM Serious	\$6,189.93	
BB-TO8		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$6,189.93	1.00	40	40	CMDM Serious	\$6,189.93	
BB-TO4		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$5,651.68	1.00	40	40	CMDM Serious	\$5,651.68	
BB-TO6		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$5,651.68	1.00	40	40	CMDM Serious	\$5,651.68	
BB-TO5		Big Bonanza	Turnout (NT)	Replace	\$0.00	\$5,651.68	1.00	40	40	CMDM Serious	\$5,651.68	
JH-HG1		Johnson Holt	Headgate (NT)		\$133,546.49	\$297,959.59	0.45	80	36	CRPdm Serious	\$133,546.49	
SNF-HG1		Senff Ditch	Headgate (NT)		\$75,217.03	\$131,934.73	0.57	60	34	CMDM Serious	\$75,217.03	
WJD-HG		WJD Ditch	Headgate (NT)		\$69,419.13	\$122,307.21	0.57	60	34	C&ODM Minor	\$69,419.13	
LC-HG1		Last Chance	Headgate (NT)		\$61,852.03	\$126,773.67	0.49	70	34	CMDM Minor	\$61,852.03	
LP-WR1		Little Piney Ditch	Weir (NT)		\$5,491.73	\$11,227.29	0.49	60	29	C&ODM Serious	\$5,491.73	
LADD-H		Ladd Ditch	Headgate (NT)		\$53,813.14	\$129,341.85	0.42	60	25	CMDM Critical	\$53,813.14	
LADD-C		Ladd Ditch	Check (NT)		\$8,261.71	\$13,856.62	0.6	40	24	CMDM Serious	\$8,261.71	
DD-FL1		Dunlap Ditch	Flume (NT)		\$29,180.80	\$81,401.57	0.36	60	22	CMDM Serious	\$29,180.80	
BB-DD1		Big Bonanza	Diversion Dam (NT)		\$124,846.58	\$452,425.94	0.28	80	22	CHSci Critical	\$124,846.58	
HL-HG1		High Line Ditch	Headgate (NT)		\$52,206.98	\$177,739.50	0.29	60	17	CMDM Serious	\$52,206.98	
Total for Project						\$4,806,722.52					\$3,225,716.87	

Table 3 Summary of Irrigation Canal Remediation Costs

Clear Creek Unit / Division Canal Remediation Priority Ranking Summary

<i>HKM ID</i>	<i>Canal</i>	<i>Section Type</i>	<i>Length</i>	<i>Rehabilitation Cost Total</i>	<i>\$/FT</i>	<i>FCI</i>	<i>API</i>	<i>RPI</i>	<i>Deficiency Category / Rating</i>	<i>Remediation Cost</i>	<i>Pg #</i>
LD-4	Leiter Ditch	Canal Constriction	1,400 ft	\$750,768.09	\$536.26	1	100	100	CMDM Serious	\$750,768.09	
LD-2	Leiter Ditch	Seepage Area Lining	3,250 ft	\$526,683.30	\$162.06	1	100	100	CMDM Serious	\$526,683.30	
3PF-2	Pratt & Ferris #3	Seepage Area Lining	3,300 ft	\$440,728.82	\$133.55	1	100	100	CMDM Minor	\$440,728.82	
3PF-3	Pratt & Ferris #3	Seepage Area Lining	2,250 ft	\$303,003.94	\$134.67	1	100	100	CMDM Serious	\$303,003.94	
LDS-2	Lake Desmet Ditch	Seepage Area Lining	6,500 ft	\$258,618.32	\$39.79	1	100	100	CMDM Minor	\$258,618.32	
LD-3	Leiter Ditch	Seepage Area Lining	1,100 ft	\$178,262.04	\$162.06	1	100	100	CMDM Serious	\$178,262.04	
LDS-1	Lake Desmet Ditch	Cleaning/Reshaping	69,300 ft	\$116,281.00	\$1.68	1	100	100	C&ODM Minor	\$116,281.00	
3PF-1	Pratt & Ferris #3	Cleaning/Reshaping	49,400 ft	\$66,017.60	\$1.34	1	100	100	C&ODM Minor	\$66,017.60	
PD-2	Piney Divide	Seepage Area Lining	600 ft	\$54,491.01	\$90.82	1	100	100	CMDM Serious	\$54,491.01	
LD-1	Leiter Ditch	Cleaning/Reshaping	7,000 ft	\$11,703.12	\$1.67	1	100	100	C&ODM Minor	\$11,703.12	
PD-1	Piney Divide	Cleaning/Reshaping	8,250 ft	\$9,002.40	\$1.09	1	100	100	C&ODM Minor	\$9,002.40	
RC-5	Rock Creek & South Piney	Seepage Area Lining	2,900 ft	\$405,256.50	\$139.74	1	80	80	CMDM Critical	\$405,256.50	
2PF-2	Pratt & Ferris #2	Seepage Area Lining	2,950 ft	\$270,486.84	\$91.69	1	80	80	CRPci Serious	\$270,486.84	
HAL-3	Hallie Ditch	Seepage Area Lining	3,200 ft	\$216,336.21	\$67.61	1	80	80	CMDM Serious	\$216,336.21	
HAL-2	Hallie Ditch	Seepage Area Lining	2,100 ft	\$142,850.49	\$68.02	1	80	80	CMDM Serious	\$142,850.49	
RC-4	Rock Creek & South Piney	Seepage Area Lining	900 ft	\$128,104.02	\$142.34	1	80	80	CMDM Critical	\$128,104.02	
2PF-1	Pratt & Ferris #2	Cleaning/Reshaping	66,750 ft	\$78,020.80	\$1.17	1	80	80	C&ODM Minor	\$78,020.80	
6M-1	Six Mile	Cleaning/Reshaping	55,200 ft	\$64,517.20	\$1.17	1	80	80	C&ODM Minor	\$64,517.20	
RC-2	Rock Creek & South Piney	Seepage Area Lining	330 ft	\$46,749.78	\$141.67	1	80	80	CMDM Critical	\$46,749.78	
RC-3	Rock Creek & South Piney	Seepage Area Lining	325 ft	\$46,749.78	\$143.85	1	80	80	CMDM Critical	\$46,749.78	
HAL-1	Hallie Ditch	Cleaning/Reshaping	32,340 ft	\$32,408.64	\$1.00	1	80	80	C&ODM Minor	\$32,408.64	
RC-1	Rock Creek & South Piney	Seepage Area Lining	175 ft	\$24,163.92	\$138.08	1	80	80	CMDM Critical	\$24,163.92	
FOX-1	Fox Ditch	Cleaning/Reshaping	13,680 ft	\$12,565.85	\$0.92	1	80	80	C&ODM Minor	\$12,565.85	
BB-2	Big Bonanza	Canal Liner Rehabilitation	5,700 ft	\$243,967.68	\$42.80	1	60	60	CMDM Serious	\$243,967.68	
LP-2	Little Piney Ditch	Seepage Area Lining	3,200 ft	\$217,903.54	\$68.09	1	60	60	CMDM Serious	\$217,903.54	
BR-3	Big Redman	Seepage Area Lining	3,700 ft	\$188,072.24	\$50.83	1	60	60	CMDM Serious	\$188,072.24	
JH-2	Johnson Holt	Sediment Deposition	1,250 ft	\$69,985.57	\$55.99	1	60	60	CMDM Serious	\$69,985.57	
JH-1	Johnson Holt	Cleaning/Reshaping	43,630 ft	\$43,661.64	\$1.00	1	60	60	C&ODM Minor	\$43,661.64	
1PF-1	Pratt & Ferris #1	Cleaning/Reshaping	36,760 ft	\$42,911.44	\$1.17	1	60	60	C&ODM Minor	\$42,911.44	
BB-1	Big Bonanza	Cleaning/Reshaping	28,190 ft	\$28,507.60	\$1.01	1	60	60	C&ODM Minor	\$28,507.60	
BR-1	Big Redman	Cleaning/Reshaping	24,500 ft	\$20,480.46	\$0.84	1	60	60	C&ODM Minor	\$20,480.46	
LP-1	Little Piney Ditch	Cleaning/Reshaping	15,700 ft	\$17,029.54	\$1.08	1	60	60	C&ODM Minor	\$17,029.54	
BR-4	Big Redman	Wasteway Headcutting	1,300 ft	\$16,374.60	\$12.60	1	60	60	CMDM Serious	\$16,374.60	
BR-2	Big Redman	Bank Instability	300 ft	\$9,551.52	\$31.84	1	60	60	CMDM Serious	\$9,551.52	
FH-2	Frank Hopkins	Seepage Area Lining	4,400 ft	\$225,545.68	\$51.26	1	40	40	CMDM Serious	\$225,545.68	
PA-3	Prince Albert	Seepage Area Lining	1,600 ft	\$82,653.08	\$51.66	1	40	40	CMDM Serious	\$82,653.08	
PA-2	Prince Albert	Seepage Area Lining	1,320 ft	\$68,597.19	\$51.97	1	40	40	CMDM Serious	\$68,597.19	
DD-2	Dunlap Ditch	Seepage Area Lining	550 ft	\$29,943.50	\$54.44	1	40	40	CMDM Critical	\$29,943.50	
PA-1	Prince Albert	Cleaning/Reshaping	22,500 ft	\$22,506.00	\$1.00	1	40	40	C&ODM Minor	\$22,506.00	

Table 3 Summary of Irrigation Canal Remediation Costs - Continued

Clear Creek Unit / Division Canal Remediation Priority Ranking Summary

<i>HKM ID</i>	<i>Canal</i>	<i>Section Type</i>	<i>Length</i>	<i>Rehabilitation Cost Total</i>	<i>\$/FT</i>	<i>FCI</i>	<i>API</i>	<i>RPI</i>	<i>Deficiency Category / Rating</i>	<i>Remediation Cost</i>	<i>Pg #</i>
FH-1	Frank Hopkins	Cleaning/Reshaping	21,000 ft	\$17,629.70	\$0.84	1	40	40	C&ODM Minor	\$17,629.70	
LC-1	Last Chance	Cleaning/Reshaping	22,000 ft	\$16,504.40	\$0.75	1	40	40	C&ODM Minor	\$16,504.40	
LC-2	Last Chance	Bank Instability	215 ft	\$15,780.73	\$73.40	1	40	40	CMDM Serious	\$15,780.73	
DD-1	Dunlap Ditch	Cleaning/Reshaping	11,740 ft	\$9,827.62	\$0.84	1	40	40	C&ODM Minor	\$9,827.62	
WJD-2	WJD Ditch	Seepage Area Lining	5,200 ft	\$441,417.24	\$84.89	1	20	20	CMDM Critical	\$441,417.24	
BF-2	Brown & Foster	Pipeline Rehabilitation	6,900 ft	\$289,761.69	\$41.99	1	20	20	CMDM Minor	\$289,761.69	
BF-3	Brown & Foster	Bank Instability	7,580 ft	\$177,280.75	\$23.39	1	20	20	CRPci Serious	\$177,280.75	
HL-2	High Line Ditch	Seepage Area Lining	7,800 ft	\$172,026.29	\$22.05	1	20	20	CRPci Critical	\$172,026.29	
JC-1	Johnson Creek	Pipeline Rehabilitation	3,480 ft	\$102,845.52	\$29.55	1	20	20	CMDM Minor	\$102,845.52	
ST-2	Sturdivant Ditch	Seepage Area Lining	1,400 ft	\$96,086.85	\$68.63	1	20	20	CMDM Serious	\$96,086.85	
SNF-2	Senff Ditch	Seepage Area Lining	2,500 ft	\$74,431.70	\$29.77	1	20	20	CMDM Serious	\$74,431.70	
ONO-3	Ono Ditch	Seepage Area Lining	2,400 ft	\$71,807.96	\$29.92	1	20	20	CMDM Serious	\$71,807.96	
LX-2	LX Ditch	Canal Constriction	1,950 ft	\$61,115.26	\$31.34	1	20	20	CMDM Serious	\$61,115.26	
ONO-2	Ono Ditch	Seepage Area Lining	1,300 ft	\$39,965.60	\$30.74	1	20	20	CMDM Serious	\$39,965.60	
LX-3	LX Ditch	Seepage Area Lining	1,000 ft	\$33,615.04	\$33.62	1	20	20	CMDM Serious	\$33,615.04	
MK-1	Fort McKinney Ditch	Pipeline Rehabilitation	600 ft	\$17,368.56	\$28.95	1	20	20	CMDM Serious	\$17,368.56	
ST-1	Sturdivant Ditch	Cleaning/Reshaping	20,100 ft	\$16,804.48	\$0.84	1	20	20	C&ODM Minor	\$16,804.48	
WJD-1	WJD Ditch	Cleaning/Reshaping	16,100 ft	\$13,503.60	\$0.84	1	20	20	C&ODM Minor	\$13,503.60	
LX-1	LX Ditch	Cleaning/Reshaping	13,000 ft	\$8,702.32	\$0.67	1	20	20	C&ODM Minor	\$8,702.32	
LADD-1	Ladd Ditch	Cleaning/Reshaping	9,200 ft	\$7,689.55	\$0.84	1	20	20	C&ODM Minor	\$7,689.55	
ONO-1	Ono Ditch	Cleaning/Reshaping	8,000 ft	\$6,676.78	\$0.83	1	20	20	C&ODM Minor	\$6,676.78	
BF-1	Brown & Foster	Cleaning/Reshaping	5,600 ft	\$6,001.60	\$1.07	1	20	20	C&ODM Minor	\$6,001.60	
HO-1	Hillyer & Onslow	Cleaning/Reshaping	8,700 ft	\$5,776.54	\$0.66	1	20	20	C&ODM Minor	\$5,776.54	
JC-2	Johnson Creek	Cleaning/Reshaping	6,900 ft	\$3,450.92	\$0.50	1	20	20	C&ODM Minor	\$3,450.92	
SNF-1	Senff Ditch	Cleaning/Reshaping	4,280 ft	\$2,888.27	\$0.67	1	20	20	C&ODM Minor	\$2,888.27	
HL-1	High Line Ditch	Cleaning/Reshaping	3,500 ft	\$2,625.70	\$0.75	1	20	20	C&ODM Minor	\$2,625.70	
1PF-2	Pratt & Ferris #1	Bank Instability	500 ft	\$0.00	\$0.00				None	\$0.00	
Total for Unit / Division					\$7,223,045.65					\$7,223,045.65	

Table 4 - Potential Reservoir Storage Sites Matrix

Site Name	Site PT019 - Tie Hack Reservoir Enlargement	Site PT024 - Camp Comfort Reservoir	Site PT030 - Lake DeSmet Reservoir Utilization Concept	Site 2 - Willow Park Reservoir Enlargement	Site 7 - French Creek Reservoir Site 3	Site 8 - French Creek Reservoir Site 8
Lat/Long	44.2856, -106.9214	44.3165, -106.8883	44.4503, -106.7194	44.4656, -107.0346	44.3502, -106.8645	44.3484, -106.9015
GIS Identifier	PT019	PT024	PT030	2	7	8
Location	On Channel South Clear Creek	On Channel Clear Creek	Off Channel	On Channel South Piney Creek	On Channel French Creek	On Channel Cottonwood Creek
Indirect Supply Source	NA	NA	Piney Creek, Clear Creek, Rock Creek, Shell Creek	NA	North Clear Ck	North Clear Ck
Supply Mechanism	NA	NA	Existing canal, tunnel, and pump station	NA	Enlarge Four Lakes Diversion	Enlarge Four Lakes Diversion
Storage Capacity (AF)	1,400 AF enlargement	10,400 and 6,000	80,000	4,000 AF enlargement	5500, 3000	5500, 2500
Surface Area (acres)		90		275	84, 55	87, 64
Water Surface Elevation	7467	6880	Between 4615.5 and 4590	8631.5	6230, 6190	7100, 7070
Water Availability (AF/yr)	1,400			12,000	Water year 2010: ~2,000 AF	Water year 2010: ~2,000 AF
Irrigated Acres Supplied		All acreage under Clear Creek	Upper Clear Creek basin via exchange	All acreage under Rock and Piney Creek and non trib via exchange	French Ck, Johnson Ck	French Ck, Johnson Ck
Average Annual Shortages (AF)	Irri: 4000, Fish: 1500	Irri: 4000, Fish: 1500	4,000		2,500 to 3,000	2,500 to 3,000
Average Annual Yield (AF)	1,400				3350, 1950	3310, 1630
Uses	Municipal	Ag Irri., Municipal, Environmental, Recreation	Ag Irri., Environmental	Ag Irrigation	Ag Irri., Municipal, Environmental, Recreation	Ag Irri., Municipal, Environmental, Recreation
Other Benefits		Fishery flow above and through Buffalo, flat water recreation, flood control			limited water available may preclude water delivery to Clear Ck	limited water available may preclude water delivery to Clear Ck
Dam Type	RCC	RCC	Earth embankment	Zoned embankment	Earth embankment or RCC	Earth embankment or RCC
Borrow Material Availability	Process onsite bedrock materials for RCC	Process onsite bedrock materials for RCC	NA	available on site	Rock avail, fine grain unknown	Rock avail, fine grain unknown
Dam Height (ft)	20' upstream raise	220		15 raise	230, 190	230, 200
Crest Elevation (ft)	7472	6890		8640.5	6240, 6200	7110, 7080
Crest Length (ft)		1050		6000	1000, 880	800, 700
Crest Width (ft)	37	20		20	56, 48	56, 50
Embankment Volume (1000 CY)	50	320, 240 (RCC)			3500, 2200	2400, 900
Storage Efficiency (CY/AF)	36 (RCC)	31, 40 (RCC)			636, 733	436, 360
Design Flood	PMF	PMF		PMF	PMF	PMF
Relative Peak Flood Size	Moderate	Large		Moderate	14150 cfs	9500 cfs
Avg Precip (in)		27			20	20
Drainage Area (sq-mi)		98		34.0	11.9	6.2
Potential for Flood Control	Minimal	Moderate		Minimal	Moderate	Moderate
Reservoir Supply	South Clear Creek	Clear Creek	Piney Creek, Clear Creek, Rock Creek, Shell Creek	South Piney Creek	Enlarge Four Lakes diversion and pipe existing canal	Enlarge Four Lakes diversion and pipe existing canal
Outlet Works	new multi-level intake, extend conduit	400 cfs multi level intake, conduit and control valve	Existing 66" pipeline and new 36" pipeline to Clear Creek and 18" pipeline to Redman ditch		Multilevel Intake	Multilevel Intake
Spillways	new ogee crest, extend existing chute	integral to RCC dam			Excavate around left abutment	Excavate around left abutment
Geology	enlargement would be constricted by right abutment	granitic gneiss, white river formation above left abutment, wide joints identified in exposed rock, depth of suitable foundation unknown, fault in valley bottom may impact seepage control and foundation strength				Precambrian granite
Land Ownership	Forest Service	Forest Service	private	Forest Service	Forest Service	Forest Service
Irrigated Acreage Inundated (acre)	0	0	0	0	0	0
Inundated Infrastructure	-	cabins immediately up and downstream	-	none	none	French Creek cow camp (structure)
Cultural/Archaeological impacts	unknown	unknown		unknown	Mining site, historic road	French Creek cow camp (structure)
NWI Wetlands impacts (ac)	at upstream end	~4 ac wetland or possible fen		~26 ac wetlands, possible fen in areas	<0.5	<1.0
Riparian impacts	minor woody riparian, large amount of upland forest	minor woody riparian, large amount of upland forest		very little woody riparian, large amount of upland forest	some willow riparian, large amount of upland forest	some willow riparian, large amount of upland forest
Core Sage Grouse Habitat	No	No	No	No	No	No
Species of concern	may occur in area	may occur in area	may occur in area	may occur in area	occur in area	occur in area
Big Game impacts - crucial	none	elk	none	none	elk	elk
WDEQ Stream Class	Class 2AB	Class 2AB	-	Class 2AB	Class 2AB	Class 2AB
WGFD Stream Class	Yellow ribbon	Yellow ribbon (2.5 mi inundated)	-	Green ribbon	Green ribbon (0.7 mi inundated)	Green ribbon (1.0 mi inundated)
Access	Hwy 16	Hwy 16		4WD, Limited public access	improve existing private road or improve existing Forest Service road	improve existing Forest Service road
Project Cost (\$)	\$12M	\$57M, \$45M	\$2.9M to \$4.1M		\$59.5M, \$44.2M	\$39.9M, \$21.9M
Cost/AF (\$/AF)	\$8.6k	\$5.5k, \$7.5k	\$0.036k to \$0.051k		\$10.8k, \$14.7k	\$7.3k, \$8.8k
Cost/AF Yield (\$/AF Yield)	\$8.6k	\$5.5k, \$7.5k	\$0.7k to \$1.0k		\$17.8k, \$22.7k	\$12.0k, \$13.4k
Cost/CY fill (\$/CY)		\$178, \$188	-		\$17, \$20	\$17, \$24

Favorable characteristic
 Unfavorable characteristic
 Probable fatal flaw or very unfavorable characteristic

Table 4 - Potential Reservoir Storage Sites Matrix Continued

Site Name	Site 101 - North Rock Creek Reservoir	Site 108 - Lower Middle Clear Creek Reservoir	Site 109 - Upper Middle Clear Creek Reservoir	Site 114 - Sand Creek Reservoir	Site 116 - Bench Reservoir	Site 115 - Bull Creek Reservoir
Lat/Long	44.4660, -106.9057	44.2999, -106.9780	44.3021, -106.9848	44.3107, -106.7306	44.2855, -106.6900	44.2734, -106.7152
GIS Identifier	101	108	109	114	116	115
Location	On Channel North Rock Creek	On Channel Middle Clear Creek	On Channel Middle Clear Creek	Off Channel	Off Channel	Off Channel
Indirect Supply Source	South Piney Creek	NA	NA	Clear Creek	Clear Creek	Clear Creek
Supply Mechanism	Rock Creek and South Piney Ditch Diversion	NA	NA	Enlarge existing Johnson County Farm ditch (~2mi), construct new ditch (~1.25mi). 250 cfs capacity	Enlarge existing Johnson Holt ditch (7.6mi), construct new ditch (1mi). 175 cfs capacity	Construct new supply canal (9.1 mi). 250 cfs capacity
Storage Capacity (AF)	8800, 3650	3,800	5,000	8000, 4000	3,500	9170, 4000, 2000
Surface Area (acres)	130	75	90	220, 150	160	248
Water Surface Elevation	5720, 5680	7,870	7,990	5060, 5040	4,945	5200
Water Availability (AF/yr)	12,000 in South Piney Ck					
Irrigated Acres Supplied	All acreage under Rock Creek and non trib via exchange		All acreage under Clear Creek	Johnson Holt, Six Mile, Crown, and Clear Creek ditches by pipeline	Six Mile, Crown, and Clear Creek ditches by pipeline, Johnson Holt by exchange	Johnson Holt, Six Mile, Crown, and Clear Creek ditches by pipeline
Average Annual Shortages (AF)	2500 to 3500	Irri: 4000, Fish: 1500	Irri: 4000, Fish: 1500	Irri: 3500, Fish: 2000	Irri: 3500, Fish: 2000	Irri: 3500, Fish: 2000
Average Annual Yield (AF)		approx. reservoir capacity	approx. reservoir capacity	approx. reservoir capacity	approx. reservoir capacity	approx. reservoir capacity
Uses	Ag Irrigation, Environmental	Ag Irri., Municipal, Environmental, Recreation	Ag Irri., Municipal, Environmental, Recreation	Ag Irri. Municipal, Environmental, Recreation	Ag Irri., Environmental	Ag Irri., Environmental, Recreation
Other Benefits	Flat water recreation if alternate access obtained	Fishery flow above and through Buffalo and flat water recreation, however, these would reduce water available for irrigation	Fishery flow above and through Buffalo and flat water recreation, however, these would reduce water available for irrigation	Fishery flow above and through Buffalo, reduce irrigation seepage losses, flat water recreation	limited fishery flow above and through Buffalo, reduce irrigation seepage losses	Fishery flow above and through Buffalo, reduce irrigation seepage losses, flat water recreation
Dam Type	Homogeneous or zoned earth fill	RCC	RCC	Homogeneous earth fill	Homogeneous earth fill	Homogeneous or zoned earth fill
Borrow Material Availability	likely available onsite	Process onsite bedrock materials for RCC	Process onsite bedrock materials for RCC	Fine grain likely available. Filter, riprap unknown	Fine grain likely available. Filter, riprap unknown	Fine grain and riprap likely available. Filter unknown
Dam Height (ft)	150, 110	200	200	110, 90	50	120
Crest Elevation (ft)	5730, 5690	7880	8000	5070, 5050	4955	5210
Crest Length (ft)	1,550	1150	1300	3400	7000	3250
Crest Width (ft)	20	20	20	24	20	28
Embankment Volume (1000 CY)	4000, 1800	530 (RCC)	425 (RCC)	2500, 1550	2800	1900, 1350, 700
Storage Efficiency (CY/AF)	454, 493	139 (RCC)	85 (RCC)	313, 388	800	207, 338, 350
Design Flood	PMF	PMF	PMF	PMF	PMF	PMF
Relative Peak Flood Size	Moderate	Moderate	Moderate	Minor	Minor	Minor
Avg Precip (in)	22	26	26	15	15	16
Drainage Area (sq-mi)	16	16.5	7	4	0.75	15
Potential for Flood Control	Moderate	Moderate	Moderate	Moderate - Sand Creek	Minimal	Moderate - Bull Creek
Reservoir Supply	North Rock Creek and South Piney Creek	Middle Clear Creek	Middle Clear Creek	Clear Creek	Clear Creek	Clear Creek
Outlet Works	48" outlet pipe, 200c cfs	150 cfs multi level intake, conduit and control valve	200 cfs multi level intake, conduit and control valve	36" concrete encased steel, 100c cfs. 2.65mi of 36" to 18" delivery pipeline	30" concrete encased steel, 75 cfs. 3.9mi of 30" to 18" delivery pipeline	36" concrete encased steel, 100c cfs. 4.92mi of 36" to 18" delivery pipeline
Spillways	unlined emergency spillway	integral to RCC dam	integral to RCC dam	unlined emergency spillway	unlined emergency spillway	
Geology	Cody Shale, Mesaverde Formation, Bearpaw Shale, and Lance and Fox Hills Formations. Depth of suitable foundation unknown, landslide upstream of reservoir	granitic gneiss, wide joints identified in exposed rock, depth of suitable foundation unknown	granitic gneiss, white river formation above left abutment, wide joints identified in exposed rock, depth of suitable foundation unknown	Wasatch formation, shallow ds dip, possible gypsum	Wasatch formation, possible gypsum	Wasatch formation, shallow ds dip, possible gypsum, depth of suitable foundation unknown
Land Ownership	State	Forest Service	Forest Service	State, private	Private	State, private
Irrigated Acreage Inundated (acre)	0	0	0	0	0	0
Inundated Infrastructure	none	numerous cabins downstream, no structures	numerous cabins downstream, no structures	portion of Johnson Holt ditch, 8" petroleum line		8" petroleum line
Cultural/Archaeological impacts	unknown	unknown	unknown	unknown	unknown	unknown
NWI Wetlands impacts (ac)	wetland fringes along stream in places, 0.06 ac wetland above stream	none on NWI, minor amount likely occur along drainage	0.05ac area not on NWI, 1.44 ac (NWI) wetland or possible fen	0.18	Minimal	none
Riparian impacts	substantial cottonwood gallery forest with understory of willow/alder riparian	very little woody riparian, large amount of upland forest	some willow riparian, some upland forest	minor	none	minor
Core Sage Grouse Habitat	No	No	No	No	No	No
Species of concern	may occur in area	may occur in area	may occur in area	may occur in area	may occur in area	two raptor nests, sensitive species may occur in area
Big Game impacts - crucial	elk	none	none	none	none	none
WDEQ Stream Class	Class 2AB	Class 2AB	Class 2AB	NA	NA	Class 3B
WGFD Stream Class	Green ribbon	Yellow ribbon (1.5 mi inundated)	Yellow ribbon (1.1 mi inundated)	NA	NA	NA
Access	Existing private road	Existing primitive Forest Service road 2.5mi	Existing primitive Forest Service road 2.5mi	Existing county road	Existing county road 96	Existing county road (Klondike Rd)
Project Cost (\$)	\$60M, \$32M	\$80M	\$68M	\$39M, \$27M	\$33M	\$41M, \$32M, \$23M
Cost/AF (\$/AF)	\$6.8k, \$8.8k	\$21.1k	\$13.6k	\$4.9k, \$6.8k	\$9.4k	\$4.5k, \$8.0k, \$11.5k
Cost/AF Yield (\$/AF Yield)		\$21.1k	\$13.6k	\$4.9k, \$6.8k	\$9.4k	\$4.5k, \$8.0k, \$11.5k
Cost/CY fill (\$/CY)		\$151.00	\$160.00	\$15.60, 17.40	\$11.79	\$21.58, \$23.70, \$32.86

Favorable characteristic
 Unfavorable characteristic
 Probable fatal flaw or very unfavorable characteristic

Table 5 Storage Cost Summary

Site	Size (AF)	Cost in Millions	Unit Cost
Upper Middle Clear Creek Reservoir	5,000	\$68.0	\$13,600
Lower Middle Clear Creek Reservoir	3,800	\$80.0	\$21,052
Camp Comfort Reservoir	10,400	\$57.0	\$5,481
Tie Hack Reservoir Enlargement	1,400	\$12.0	\$8,570
Sand Creek Reservoir	4,000	\$27.0	\$6,750
Sand Creek Reservoir	8,000	\$39.0	\$4,875
Bench Reservoir	3,500	\$33.0	\$9,429
Bull Creek Reservoir	4,000	\$32.0	\$8,000
Bull Creek Reservoir	9,170	\$41.0	\$4,471
French Creek Reservoir #3	3,000	\$44.2	\$14,730
French Creek Reservoir #3	5,500	\$59.5	\$10,820
French Creek Reservoir #8	2,500	\$21.9	\$8,760
French Creek Reservoir #8	5,500	\$39.9	\$7,255
North Rock Creek Reservoir	8,800	\$60.0	\$6,818
North Rock Creek Reservoir	3,650	\$32.0	\$8,767
Lake DeSmet Transfer – Existing pipeline	4,000	\$2.9	\$725
Lake DeSmet Transfer – Canal	4,000	\$4.1	\$1,025

Storage Evaluation Matrix

To evaluate the non-monetary factors for reservoir suitability, a matrix was developed as shown in Table 6. This matrix values items such as ability to meet needs, land ownership, environmental issues, technical feasibility, multi-purpose potential, and ability to permit. Each of the items was assigned a weight based on the importance of the item for this project. Weights of 10 to 40 were assigned as shown in the table. Each potential reservoir site was assigned a value of 0 to 10 for each item with high values being most favorable. The scores were then totaled to develop overall reservoir site evaluation.

Table 6 Clear Creek Storage Evaluation Matrix

Rank	Site	Size (AF)	Ability to Meet Needs	Land Ownership	Envir. Issues	Geotechnical Feasibility	Flood Control	Multi-Purpose Potential	Ability to Permit	Relative Cost	Total Score	Comments
	Weight		40	20	30	20	20	40	40	20		
1	Bull Creek Reservoir	9,170	8	10	8	6	4	8	10	8	1,840	Note 1
2	Sand Creek Reservoir	8,000	8	6	8	6	4	8	10	8	1,760	Note 1
3	Camp Comfort Reservoir	10,400	10	4	4	6	8	10	4	8	1,600	Note 1
4	Bench Reservoir	3,500	4	10	10	6	0	2	10	6	1,380	Note 1
4	French Creek Reservoir #3	5,500	8	4	6	6	4	10	4	2	1,380	Note 1
6	French Creek Reservoir #8	5,500	8	2	6	6	4	10	2	6	1,340	Note 1
7	North Rock Creek Reservoir	6,600	6	4	6	4	4	6	4	2	1,100	
8	Upper Middle Clear Creek Reservoir	5,000	6	2	4	6	4	6	2	2	960	Note 1
9	Lower Middle Clear Creek Reservoir	3,800	4	2	4	6	4	4	2	2	800	Note 1
10	Tie Hack Reservoir Enlargement	1,400	2	2	4	8	2	2	4	5	780	Note 1
11	Willow Park Enlargement	4,000									0	Fatal Flaw-Fen Wetlands

Note 1 - The feasibility of new storage in the Clear Creek basin is dependent on the utilization of the M&M Ranch water rights from Clear Creek. If the water rights are fully utilized, insufficient water would be available for new storage projects.

7. RECOMMENDATIONS

Based on the information developed for this report, the following recommendations are made.

7.1 Upland Watershed Management Opportunities

Smaller projects involving upland watering, stream channel improvement, and grazing management could be eligible for the WWDC's Small Water Project Program (SWPP). Projects with a total cost of less than \$100,000 are eligible. Grants can be available up to 50% of the project costs or \$25,000, whichever is less. Funding through this program does not require formation of a district, but does require a legal entity sponsor.

7.2 Irrigation System Opportunities

1. Smaller irrigation system rehabilitation projects could be eligible for the WWDC's Small Water Project Program (SWPP). Projects with a total cost of less than \$100,000 are eligible. Grants can be available up to 50% of the project costs or \$25,000, whichever is less. Funding through this program does not require formation of a district, but does require a legal entity sponsor.
2. Larger projects would be eligible for funding under WWDC's larger project program. This program offers two thirds grant and one third loan for rehabilitation projects. Projects in this program would require formation of a district or entity that can incur debt and has the authority under State statute to levy assessments.
3. Potential projects under both programs have been prioritized.

7.3 Water Supply and Storage Opportunities

The opportunities for improvement of water supply and storage in the Clear Creek basin that are most favorable have been identified. The opportunities are summarized below.

7.3.1 Utilization of Lake DeSmet Water in Clear Creek

The issues that must be addressed to evaluate the feasibility of this alternative include the following:

- Availability and costs of coalition storage water
- Willingness of M&M to allow use of their pipeline to deliver water
- Identification of potential users of water discharged to Clear Creek to establish demand
- Preliminary design and cost estimates of the project
- Funding opportunities for the project

7.3.2 Bull Creek and Sand Creek Reservoir Projects

The feasibility of construction of either the Bull Creek or Sand Creek Reservoir projects would involve the following issues:

- The hydrological studies have indicated that the water availability depends upon the potential for M&M Ranch to fully utilize their Clear Creek water rights to Lake DeSmet. The feasibility of the storage projects could depend upon the extent of usage of these water rights.
- The project would require the cooperation of the irrigation ditches directly impacted by the dam and reservoir, supply system, and discharge pipeline.
- A more rigorous hydrological model is needed to establish water availability and irrigation shortages. The WWDC has been utilizing the StateMod model for this type of study.
- The geotechnical feasibility investigation of the dam sites should be conducted. The program should include core drilling and test pit investigations.
- The optimum size of reservoir should be established. Preliminary design and updated cost estimates should be developed.
- The economic analysis should be updated to incorporate the optimum size and fully evaluate project benefits to establish the benefit-cost ratio.
- The grant-loan ratio from the WWDC should be determined to determine project feasibility.