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SHELL VALLEY

Watershed Plan
Level I Study

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EXECUTIVE SUMMARY March 2010

SHELL VALLEY WATERSHED PLAN LEVEL I STUDY

EXECUTIVE SUMMARY

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1.0 INTRODUCTION

This study was requested by Shell Valley Watershed Improvement District (SVWID) and granted by Wyoming Water Development Commission (WWDC) to assess the existing irrigation structures and canals, survey irrigation canal locations and structure locations, identify upland water development projects for livestock and wildlife stock, review existing information available for this watershed at different agencies, gather field information on the watershed and its hydrology, provide geomorphology of stream runs, locate potential reservoir sites, and determine if power generation was possible. This study's goal is to compile existing data and new data into one document.

Created in 1981, the goal of SVWID would be to provide a governing entity to Shell Valley as a whole, while lending assistance to the individual private irrigation companies. The SVWID is under the governing authority of the South Big Horn County Conservation District. The SVWID encompasses approximately 26,200 acres within their boundary. Of the 26,200 acres, approximately 15,159 acres of water rights are on record at the State Engineer's Office (SE) under many different permit numbers. The SVWID does have governing authority to levy unequal per acre or acre-foot assessments for the irrigation companies within their boundary, if necessary. Otherwise stated, if certain areas will not benefit from a project they can be exempt from the additional assessments to fund the project. The members of the SVWID vote on all assessment increases.

Land ownership and administration within the watershed is a mixture of private lands, primarily located along Shell Creek and major tributaries, interspersed with public lands administered by the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS).

Various agencies have studied this area extensively throughout the last 50 years. One of the problems for the District is the amount of information published under various agencies and no clearinghouse to handle this information. A goal of this study was to research the known agencies that had information and compile it into this report. This will provide SVWID with a one-stop reference document for their District.

2.0 SHELL CREEK WATERSHED - BIOLOGICAL

Watershed analysis was completed through a review of existing data and supplemented with limited reconnaissance-level fieldwork. Shell Creek is the primary drainage within the watershed and runs from high-elevation sources in the Big Horn mountains to its confluence with the Bighorn River near Greybull, Wyoming. Elevations in the watershed range from about 3,900 feet in the western lowlands, to 11,000 feet in the eastern mountains.

2.1 VEGETATION

Vegetation is stratified between the high elevation mountains and the lower elevation foothills and floodplains. A variety of wildlife lives within the watershed. Land uses within the watershed are primarily agricultural with limited cultivation on stream terraces above Shell Creek and its major tributaries. Shell is the only town within the watershed. The largest economic sectors for individuals within this survey area are agriculture and education/social services. Dominant plant communities and biological assessments were the primary data collected to supplement the existing vegetation data.

2.1.1 RANGE CONDITION

Range condition is a rating system developed by the Natural Resource Conservation Service (NRCS) for determining grazing capacity and vegetation status. Range condition is often used as an indicator of ecological condition in addition to being a tool for assessing grazing management. Additional range data

was compiled by resource specialists at the USFS; Bureau of Land Management - Cody District (BLM – Cody); and Bureau of Land Management - Worland District (BLM – Worland).

The existing data did not include Ecological Site Descriptions (ESD's). ESD's were not available from the local NRCS office at the time of the report to provide as a valuable resource for range management.

2.1.2 FORESTRY RESOURCES

The limited forestry resources that occur within the watershed range from forested riparian zones in the valley bottoms to mid- and high-elevation coniferous forests. Timber management activities in the Shell watershed have been focused on an insect infestation and selective logging efforts. Due to the down slope proximity of Shell Creek, the logging plans have been developed to minimize the introduction of sediment and debris into the streams. Other timber activities in the watershed include the reestablishment of aspen through thinning and burning of encroaching conifers.

2.1.3 WETLAND AND RIPARIAN RESOURCES

The wetland resources in the watershed are widely varied from irrigation dependent slopes and depressions in the valley to sub-irrigated forested and wet meadow sites in the higher elevations. Numerous acres of herbaceous, shrub, and forested wetlands are also present along the streams and irrigation channels in the watershed. In addition, most of the natural ponds and constructed reservoirs in the watershed support a wetland fringe around the shore and larger wetlands at the inlet and outlet sites.

The riparian areas within the watershed range from narrow, densely forested communities in the higher elevations to broad, sparsely vegetated, and frequently flooded riparian zones in the lower elevations. The majority of streams in the Shell Creek watershed are buffered from uplands by some riparian vegetation, although the width and density of the riparian zone can vary greatly within proximal reaches.

Data regarding wetland and riparian community types and observed Proper Function Conditions (PFC) were collected from the USFS and BLM-Cody and BLM-Worland Districts. PFC data has not been reported for the riparian/wetland areas on Bighorn National Forest lands, although qualitative descriptions of community types and adverse conditions are present in the USFS database.

2.2 WILDLIFE

Diverse wildlife habitats exist in the Shell Creek watershed due to the juxtaposition of Great Basin vegetation communities in the valley bottoms and valleys and alpine environments at higher elevations. Sensitive habitats such as crucial winter habitat and calving habitat are present for elk, mule deer, and moose exist with the watershed. Other notable large game species present in the Shell watershed includes pronghorn antelope, white-tailed deer, and bighorn sheep. Sage grouse leks have been identified and surveyed in the watershed. No known federally-listed Threatened or Endangered plant species in the watershed. Three federally listed wildlife species have been documented within the watershed including the gray wolf (Canis lupus) [Threatened], black-footed ferret (*Mustela nigripes) [*Endangered], and the Canada lynx *(Lynx Canadensis)* [Threatened]. A variety of other rare or protected birds, mammals, herptiles and fish also occur within the watershed.

2.3 FISHERIES

The diversity of fish species within the Shell Creek watershed is dictated by elevation and stream gradients. Fish habitat within the Shell Creek watershed includes a total of 32 streams and 6 reservoirs/ponds identified as suitable fisheries in the Shell Basin Management Plan Fish species in the watershed include cutthroat, brook, rainbow and brown trout, flannel mouth sucker, flathead chub, and mountain sucker. Occasional reports of sager and channel catfish migrate upstream from the Big Horn River.

3.0 WATERSHED CHARACTERISTICS

3.1 CLIMATE

Climate in the Shell Creek watershed area is subject to extreme weather conditions due to the varied topographic setting of mountains, hills, canyons, valleys, and rolling flatlands. Average annual precipitation in the mountains at Burgess Junction is 21.0 inches, with only 9.9 inches/year at Shell, and 6.9 inches/year at Greybull. Highest monthly precipitation in the mountains occurs in April; whereas, highest precipitation at the lower stations is in June. Highest monthly precipitation at all three stations generally occurs during April-May-June.

Snowfall in the watershed varies significantly from the mountainous eastern side to the lowlands in the west. Average annual snowfall at Burgess Junction is 242 inches, while snowfall at Shell and Greybull averages only about 20 inches/year. This snow-pack in the mountains provides a significant amount of surface water runoff in streams during the spring and early summer periods.

Temperature varies widely between the seasons, with the hottest months being July and August, and coldest months are December-January-February. Potential evaporation is >25 inches/year in most of the Shell Creek watershed, with lower rates of 17 to 21 inches/year in the mountains.

3.2 GEOLOGY

The Shell Creek watershed is located in a diverse geologic setting. The physical forces of folding, faulting, glaciers, wind/water erosion, and sedimentation have shaped the landscape over many years. Big Horn County is located primarily in the Bighorn structural basin containing bedrock from Precambrian through Tertiary age. The mountainous areas consist primarily of sedimentary and igneous rocks that form the core of the mountains.

The Shell Creek watershed is located in Uniform Building Code (UBC) Seismic Zone 1, and has no known or suspected active faults are delineated in Big Horn County. A review of landslide information shows that landslides occur in the study area, primarily along foothills of the mountains, including valley and canyon walls, but are not present in the western flatlands. Some of the common types of landslides in the area include: block slide, debris flow, rock slide, slump, and slump/flow complex.

3.2.1 SOIL RESOURCES

Soils in Big Horn County are diverse and vary according to parent geologic material and the forces that have eroded and deposited these materials. A comprehensive soil survey has not been published for Big Horn County. Additionally, soil information for portions of the Shell Creek watershed area, mostly along drainages and irrigated areas, is available from the NRCS office in Greybull. Available soil data for these areas includes: dominant soil complex, soil map unit, erosion hazard, percent coarse fragments, organic matter, plasticity and expansion index, chemical soil properties, and engineering properties.

3.3 HYDROLOGY

The Shell Creek Valley incorporates surface water drainage from the west-central portion of the Big Horn Mountains, which lies along the eastern edge of the Big Horn Basin. The Shell Creek watershed covers an area of 370,000 acres or 580 square miles, and is located within the Big Horn/Wind hydrologic basin of Wyoming. Stream morphology was studied on portions of the watershed using “Level I” and “Level II” of the Rosgen’s classification system.

Several lakes and reservoirs occur throughout the Shell Creek watershed. In the eastern mountainous region, the primary water bodies include: Shell Reservoir, Adelaide Lake, and Moraine Lake. These lakes receive cold, clear, high-quality water from precipitation in the mountains. They are used for fishing, recreation, wildlife, and irrigation storage. In the western flatlands, there are several man-made reservoirs including Leavitt Reservoir and some smaller unnamed reservoirs for irrigation and/or stock watering.

3.3.1 GROUNDWATER

Groundwater in the Shell Creek watershed is present in all geologic materials, from unconsolidated deposits (clay, silt, sand, and gravel) to sedimentary and igneous rocks. Groundwater is encountered in wells, springs, or as inflow to streams. Numerous springs occur throughout the watershed. Water in geologic formations is under either confined or unconfined conditions.

Highest yields from wells typically occur from deep unconfined aquifers where the water usually has the best quality characteristics. Domestic and stock watering wells, however, generally are completed in relatively shallow bedrock units and alluvial deposits. Specific information about groundwater wells in Big Horn County and the watershed can be obtained from the Wyoming State Engineer's office.

3.3.2 SURFACE WATER FLOW

Flow has been measured in several streams throughout the Shell Creek watershed by the USGS, SBHCD, and WWDC. Major irrigation diversion canals are located on Beaver Creek and Shell Creek streams which affect flow during and for some time after the irrigation season.

3.3.3 SURFACE WATER QUALITY

In 1996, the Wyoming DEQ published the federally-mandated 303(d) List of Impaired Water Bodies, naming rivers, streams, lakes, and reservoirs that were impaired for one or more reasons. In 2002, Shell Creek and Granite Creek, both Class 2AB streams, were listed as impaired due to fecal coliform which adversely affects contact recreation. Beaver Creek is listed as "threatened" because of fecal coliform measurements. According to the Wyoming DEQ Water Quality Rules and Regulations, Chapter 1, Section 27. E. coli Bacteria, Shell Creek and Granite Creek are identified as Primary Contact Recreation due to their listing in Table A of the Wyoming Surface Water Classification List. The SBHCD and Wyoming DEQ have measured water quality of the streams within the watershed.

4.0 IRRIGATION SYSTEMS

There are many irrigation canals and ditches, and many water rights permitted within the boundary of SVWID. SVWID comprises 26,200 acres and the permitted water rights, according to the State Engineer's Office, comprise approximately 15,159 acres. There are 105 different water rights permits covering the irrigated lands within SVWID's boundary; the majority of which are territorial or late 1800's water rights.

Engineering Associates completed a thorough location survey and review of the irrigation systems including all structures, head gates, measuring devices, and ditch location of all irrigation ditches that could be located by our personnel.

The mapping of the irrigation system was completed using RTK GPS equipment and a data dictionary that allowed us to systematically inventory the system. Over 6,000 shots were surveyed and took over six months to complete. Each survey shot included a point number, elevation, and descriptor. The point number and descriptor are used in the Structure Data Sheets and the Irrigation Inventory Maps to help

the reader locate the structure or reach of canal in question. A visual assessment of the physical condition and a photograph were taken of each structure and are included in the Structure Data Sheets.

The structures were ranked based on a 1 to 10 rating condition with 1 being the highest replacement priority. Engineering Associates prepared 2010 construction costs and conceptual designs for a head gate, ramp flume, check structure, weir, and spill. For estimation purposes, these estimates were prepared as contractor-bid estimates. Executive Summary: Table 1, shows the total construction cost for each private irrigation company in 2010 costs, broken down by the replacement groups.

The replacement schedule will be highly dependent upon the desire of the private ditch companies to initiate improvements. Thus, it is possible for an active ditch company to initiate improvements on structures rated a 4 before another group initiates improvements on structures rated a 1.

The majority of the canals and ditches has no lining material and do seep throughout the irrigation season. The installation locations of concrete lining need to be determined by each individual irrigation company. Engineering Associates suggests placing concrete lining in the ditch reaches that traverse through rock/gravel soils since these are naturally high seepage areas and are carrying a large amount of irrigation water. The next reaches would be those that have an abundant growth of green grasses and cattails. After these areas have been constructed, the irrigation companies should begin at the downstream end of the systems and work upstream. The completion of these improvements depends upon the ability of the private irrigation company's ability to repay their loans.

The following table summarizes the Probable Construction Costs to address seepage areas.

Seepage: 2010 Opinion of Probable Construction Costs	
Project Description	**Cost**
Concrete Lining 5200 for Lineal Feet of Ditch	$ 3,505,769.01
48" diameter RCP for 5200 Lineal Feet of Ditch	$ 1,702,753.44
30" PVC Pipe for 5200 Lineal Feet of Ditch	$ 1,535,347.46
18" PVC Pipe for 5200 Lineal Feet of Ditch	$ 627,543.34

4.1 SHELL CANAL TUNNEL

Shell Canal Tunnel was visited to assess the condition of the tunnel structurally and to determine the seepage losses caused by the tunnel. The Shell Canal Tunnel was built in the early 1900's and is constructed of concrete but without the use of steel reinforcement. This structure has far outlived its useful design life and the concrete has been deteriorating over time. The four options proposed below will prevent water loss through the tunnel as well as preventing water from getting behind the tunnel.

Of the options we reviewed, the 54" Snap Tite HDPE appears to be the preferred alternative which would carry the historic flow. This option will also minimize operation and maintenance costs over the 30-year design life.

Shell Canal Tunnel: 2010 Construction Cost Summary	
Alternative	**Cost**
63" Diameter "Snap-Tite" HDPE Pipe	$ 838,015.58
54" DIAMETER "SNAP-TITE" PIPE	$ 720,986.99
Concrete Lining	$ 1,198,245.27
6'x6' Box Culvert with Trench Excavation without backfill	$ 3,729,888.76
6'x6' Box Culvert with Trench Excavation with backfill	$ 4,562,102.92

4.2 FUNDING OPTIONS FOR PRIVATE IRRIGATION DISTRICT IMPROVEMENTS

Private irrigation districts in Wyoming do not have an available source of funding for large scale construction projects. For the larger projects such as ditch lining or enclosing a reach of canal in pipe, the irrigation companies need larger grants and loans to complete the recommended projects. To be eligible for some funding sources, the private irrigation districts would need to become part of an eligible public entity or an approved assessment district formed in accordance with Wyoming law. Currently the SVWID is considered an eligible public entity with the ability to allocate assessment.

For the smaller irrigation improvements, the landowners may be able to obtain financial assistance from the Wyoming Water Development Commission's Small Water Project Program and the Natural Resources Conservation Service (NRCS). In addition to the NRCS, individual land owners can receive funding opportunities from the Wyoming Office of State Land and Investments Small Water Development Project Loans or Regular Farm Loans. In addition, the Bureau of Reclamation has funding opportunities through the Water 2025 Challenge Grant Program to assist with water conservation efforts. Possible funding sources are listed in the Executive Summary: Table 2.

4.3 WATER RIGHTS RESEARCH & IRRIGATION EASEMENTS RESEARCH

A general search for water rights was conducted on the following Townships and Ranges: T.52N., R.91W.; T.52N., R.92W.; T.52N., R.93W.; T.53N., R.91W.; T.53N., R.92W.; and T.53N., R.93W. The proof number for each water right found was further refined in an advanced search on adjudicated water rights to find the permits. Once the permits were collected, they were sorted by the facility name and the amount of appropriation and acres were totaled.

The majority of older irrigation ditches in the Big Horn Basin have prescriptive easements stating the easement to be a certain distance from the centerline of the ditch. Some prescriptive easement documents may be recorded in the county courthouse. Some prescriptive easement documents may be filed in the ditch company files. EA could not find any prescriptive or descriptive easement documents in the courthouse.

5.0 RESERVOIR SITE EVALUATION

Twelve potential reservoir or reservoir expansion sites were evaluated relative to a variety of criteria such as storage capacity, service area, water source, geotechnical hazards, elevation (as it related to the ability to manage water in winter), and environmental permitting constraints. Several sites on the initial list were eliminated prior to reconnaissance level survey work due to a variety of limiting factors such as lack of water, limited service area, or difficult permitting issues. The potential for hydroelectric power was considered at each potential reservoir site. Upon field analysis, the reservoirs did not provide favorable conditions for hydroelectric potential.

To compare among the potential reservoir sites, a comprehensive matrix was developed relative to key criteria (e.g. storage capacity, available water, service area, construction costs and permitting complexity). High scores within the matrix indicate a more favorable score for the reservoir.

TABLE 5.1

Potential Reservoir Comparison Matrix Shell Creek Watershed

Potential Reservoir Site[1]	Storage Capacity (acre-feet)	Score	Assumed Mean Annual Flow Volume (af/yr) [2]	Score	Fill \ Capacity Score [3]	Service Area (irrigable acres)	Score[4]	Construction Cost Per acre-foot of Storage	Score[5]	Permitting Complexity	Score[6]	Ranking Score Sum[6]
Bratsky Draw	5,839	**5.8**	174,700	**17.5**	**69.9**	8,807	**17.6**	5,592	**17.8**	Moderate	**2**	**107.3**
Collingwood Draw - Upper	2,692	**2.7**	1,800	**0.2**	**8.7**	4,719	**9.4**	2,031	**49.2**	Moderate	**2**	**69.3**
Collingwood Draw - Middle	11	**0.0**	1,800	**0.2**	**0.6**	4,719	**9.4**	181,722	**0.5**	Moderate	**2**	**12.5**
Collingwood Draw - Lower	71	**0.0**	162,200	**16.2**	**48.6**	6,499	**12.9**	16,658	**6.0**	Complex	**1**	**68.5**
Coyote Basin	3,112	**3.1**	28,620	**2.8**	**17.7**	9,840	**19.7**	9,268	**10.8**	Moderate	**2**	**50.2**
High Line Reservoir Expansion	20	**0.0**	35,300	**3.5**	**10.5**	5,326	**10.6**	53,703	**1.9**	Complex	**1**	**24.0**
Leavitt Reservoir Expansion	45	**0.0**	28,000	**2.8**	**8.4**	9,937	**19.8**	21,111	**4.7**	Moderate	**2**	**34.9**
Red Canyon	546	**0.5**	8,500	**0.9**	**4.2**	9,765	**19.5**	14,815	**6.7**	Moderate	**2**	**32.4**
Trapper Creek	2,507	**2.5**	35,300	**3.5**	**18.0**	14,962	**29.9**	24,046	**4.2**	Simple	**3**	**55.1**
Trapper Creek East	734	**0.7**	35,300	**3.5**	**12.6**	14,962	**29.9**	21,697	**4.6**	Simple	**3**	**50.1**

NOTE:
1) See Appendix O – Water Storage Site Maps for site locations.
2) Includes drainage area currently supplying water to existing reservoirs (High Line and Leavitt), water that is piped either through a site (Trapper Creek East) or to a site (Trapper Creek), or water that could relatively easily be diverted to fill a site (Shell Canal to Collingwood Draw Lower).
3) Fill/Capacity Score equals sum of scores from Storage Capacity and Immediate Mean Annual Flow Volume, weighted by a factor of "3".
4) Service area divided by 1,000, and weighted by a factor of "2".
5) One divided by the Construction Cost per Acre-Foot of Storage per acre-feet of storage, weighted by a factor of "100,000".
6) Permitting Complexity based on professional experience with similar projects. Sites that would affect public land, substantial wetlands, streams, or other sensitive resources were considered more complex to permit. This variable was weighted by a factor of "1.0".
7) Ranking Score Sum is the sum of the Fill / Capacity Score, Service Area Score, Construction Cost per Acre Foot of Storage, and Permitting Complexity Score.

Field survey work included, site characterization and description, fatal flaw assessment (e.g. geotechnical hazards), wetland delineation; and permitting constraints. Executive Summary: Table 3, summarizes the characteristics of the potential reservoir sites.

6.0 UPLAND WATERSHED REHABILITATION PLAN

Small water development projects within the watershed were identified based on questionnaires with participating local residents and NRCS staff. The goals of many of the projects are to provide water to wildlife, enhance the distribution of livestock and wildlife, distribute livestock and wildlife into vegetated areas that previously did not have a reliable water source for the animals to use, provide longer rest rotations for vegetation, and minimize livestock impacts to natural seepage areas. In addition, some

projects are desired to provide year round water to wildlife and livestock to enhance the distribution of the animals. The systems will provide water to the animals in the winter, when currently water is not available in the winter.

A total of 45 water shed improvement projects were identified by landowners, the NRCS, and the BLM that range in construction costs of approximately seven thousand dollars to close to one hundred thousand dollars. A list of projects is provided in Executive Summary Table 4. Possible funding sources are listed in the Executive Summary: Table 4.

7.0 RECOMMENDATIONS

This Level I Study was a preliminary analyses and comparison of development alternatives and is meant to provide SVWID with reconnaissance information on their watershed and the many private irrigation companies that have facilities within the watershed boundary. This study will provide SVWID with information so they can determine if they would like to proceed to a Level II Study for hydropower and reservoir sites, or Level III Construction for rehabilitation of the irrigation systems. Following are recommendations for SVWID to proceed further to a Level II Study (with various items of this study):

- Hydropower was found to be minimally feasible. However, if SVWID is interested in pursuing hydropower, they should apply for a Level II, Phase I and II Study. The Phase I would address the project feasibility by providing amount of water that can be legally and physically developed, the water needs, technical and safety feasibility, geotechnical evaluation, preliminary operation plan, construction cost estimates, fee estimates for consultant services, operation and maintenance needs and funds required, identification of direct and indirect benefits of the project, identify economic, legal, environmental, and administrative issues, and a financing plan. A Phase II would take the feasible site identified in the Phase I and address issues such as operating plan for water management, conceptual designs, identification of state and federal permits, an environmental assessment, and preparation of itemized project budget, to be used for Level III Construction. These additional studies may provide SVWID with a level of comfort knowing they have exhausted all efforts in finding a viable hydropower site.

- SVWID should pursue a Level II, Phase I, Phase II, and Phase III Studies for their preferred reservoir sites. This study found reservoir sites that either had the storage capacity but not enough flow to fill the reservoir, or the flow to fill the reservoir but the inlet ditch would need to be extremely large to handle the maximum runoff to fill the reservoir. A Level II Study would provide SVWID with a level of comfort knowing that they have received a thorough analysis of this studies reservoir sites and any sites they prefer to have thoroughly evaluated.

  The Phase I would address the project feasibility by providing amount of water that can be legally and physically developed, the water needs, technical and safety feasibility, geotechnical evaluation, preliminary operation plan, construction cost estimates, fee estimates for consultant services, operation and maintenance needs and funds required, identification of direct and indirect benefits of the project, identify economic, legal, environmental, and administrative issues, and a financing plan.

  A Phase II would take the feasible site identified in the Phase I and address issues such as operating plan for water management, conceptual designs, identification of state and federal permits, an environmental assessment, and preparation of itemized project budget, to be used for Level III Construction.

  If the reservoir site is enlarging an existing reservoir by more than 1,000 acre-feet or a new reservoir with a capacity of 2,000 acre-feet or more, a Phase III study would provide final

engineering design drawings, reviews required by National Environmental Policy Act (NEPA), consultation required by the Endangered Species Act, and acquisition of state and federal permits.

- It is recommended SVWID determine the increment in which landowners would be willing to purchase water from a proposed reservoir site. EA currently recommends landowners purchase reservoir water on a 1.0 acre-foot basis. In addition, it is recommended SVWID determine the amount landowner's would be willing to pay to construct a reservoir.

- Each private irrigation company should review Table 6.3.2 Structure Replacement Schedule and Construction Costs within the Final Report to determine a plan of action for rehabilitating their systems and begin the application process to WWDC through their Small Water Projects Program. For the larger projects of lining the canals or placing the canals in pipe, the private irrigation companies should decide whether they will become a public entity and obtain WWDC Level III funding or provide descriptive easements to SVWID so SVWID can obtain WWDC Level III funding for the private irrigation company. Both the processes take a substantial amount of time to complete so additional time should be factored into the planning. WWDC SWPP applications are due by January 1 of each year. The funds become available after the March WWDC meeting, should the project receive funding. New WWDC Level III (Construction) applications are due by August 1 of each year. The application deadline for on-going projects is October 1. The money will then be available by June 1 of the following year.

- Each private irrigation district should begin a maintenance program during the off-season for their systems. The maintenance program should include burning dead grass and weeds along their ditches and around their structures, repairing any broken head gates or other damaged structures, patching any concrete structures, adding fill material to badly eroded areas in the canal, mechanical cleaning of areas that would be difficult to burn, fixing ruts and potholes on the canal access roads, repairing any cattle guards that are not in good working order (or if this is the landowners responsibility notify the landowner of the needed repair).

Executive Summary: Table 1

2010 Construction Cost Totals for Rating Category

Irrigation Company	Rating 1	Rating 2	Rating 3	Rating 4	Rating 5	Rating 6	Rating 7	Rating 8	Rating 9	Rating 10	Total*
Arthur Mason Ditch		$ 11,564.36									$ 11,600
Beaver Ditch	$ 12,044.34	$ 12,044.34					$ 11,564.36	$ 11,564.36			$ 47,300
Calvin Ditch								$ 11,564.36			$ 11,600
Crain Jenks Ditch								$ 11,564.36			$ 11,600
Crandall Williams Ditch					$ 11,564.36						$ 11,600
Davis Ditch				$ 11,564.36							$ 11,600
Ewen Reservoir	$ 11,564.36										$ 11,600
Friese Ditch	$ 46,257.44				$ 19,287.63			$ 46,257.44			$ 111,900
Hatten Ditch					$ 12,044.34			$ 23,608.70			$ 35,700
High Line Ditch					$ 23,128.72			$ 30,851.99			$ 54,000
Howe Ditch	$ 11,564.36										$ 11,600
Kenyon Ditch		$ 11,564.36									$ 11,600
Kerschner Ditch								$ 92,514.88			$ 92,600
Leavitt Ditch				$ 11,564.36							$ 11,600
London ditch				$ 11,564.36							$ 11,600
Loveland Ditch	$ 11,564.36			$ 7,713.59							$ 19,300
McDonald Ditch	$ 11,564.36		$ 11,564.36	$ 11,564.36	$ 76,032.84	$ 50,120.25	$ 57,821.80	$ 92,514.88		$ 73,077.42	$ 384,300
Nathan Ditch								$ 11,564.36			$ 11,600
Pense Ditch		$ 11,564.36									$ 11,600
Porter Canal	$ 11,564.36				$ 66,025.05	$ 15,427.17	$ 23,128.72	$ 23,128.72	$ 11,564.36	$ 11,564.36	$ 162,500
Sabin Brown Ditch	$ 70,826.10			$ 23,128.72							$ 94,000
Shell Canal	$ 135,555.73	$ 86,637.24	$ 75,072.88	$ 75,072.88	$ 274,066.90	$ 88,497.27	$ 69,195.24	$ 172,701.74		$ 17,251.08	$ 994,100
Shell Canal North Bench	$ 11,564.36	$ 11,564.36			$ 46,066.52			$ 23,128.72			$ 92,400
Thompson Lateral		$ 11,564.36			$ 35,173.06			$ 23,608.70			$ 70,400
Trout Ditch								$ 11,564.36			$ 11,600
Whaley Ditch	$ 11,564.36	$ 40,379.80	$ 35,173.06	$ 23,128.72	$ 12,044.34	$ 23,140.76		$ 94,360.51		$ 11,564.36	$ 251,400

* Totals were rounded up to the hundred dollars.

Executive Summary: Table 2
Summary of Funding Source Options

Funding Source	Funding Program	Project Type	Funding Available To	Grant	Required Match for Grant	Web Site	Application Due Date
Local							
South Big Horn Conservation Distric	NA	Services range from technical guidance, administrative, and partnering with local landowners.	Land owners, organizations	See website.		http://www.conservewy.com/sbhcd/index.html	NA
County Weed and Pest	NA	Noxious weed control and identification	Land owners	See website.		http://www.bighorncountywy.gov/dep-weed-pest.htm	NA
State							
Wyoming Department of Environmental Equality	Nonpoint source Implementation Grants (319 Program)	Water Quality Best Management Practices	Conservation District, Cities, Counties	Up to $40,000	25%	http:deq.state.wy.us	Sept. 15
Wyoming Game and Fish Department	Riparian Habitat Improvement Grant	Water development for livestock; projects to stabilize stream banks, projects to improve riparian habitat	Land owners, Conservation Districts, Government agencies, Industry, non-profit organizations.	UP to $10,000	50%	http://gf.state.wy.us	Jan. 1 and Aug. 1
	Water Development/Maintenance Habitat Project	Water Developments for livestock		UP to $7500	50%		Please see website.
	Industrial Water Habitat Project Fund			NA	NA		
	Upland Development Grant	Range Management Activities		Up to $10,000	50%		
	Fish Wyoming	Activities that improve public fishing		See website.	50%		
	Wyoming Sage Grouse Conservation Fund	Projects that protect sage grouse		Please see website.		http://gf.state.wy.us/wildlife/wildlife_ management/sage grouse/index.asp	
Wyoming Office of State Lands and Investments	Regular Farm Loans	Agricultural based projects	Please see website.			http://slf-web.state.wy.us/admin/forms.aspx	Please see website.
	Small Water Development Project Loans	Improve efficiency of water delivery systems and converting native land into farm production.					
Wyoming Water Development Commission	Wyoming Water Development Program	Planning, Design & Construction of water related projects. (reservoirs, irrigation systems)	Recognized Public Entity with assessment capabilities.	NA	33%	http://wwdc.state.wy.us	New Projects: Aug. 1 On-going Projects: Oct. 1
	Small Water Project Program	Small projects that improve a watershed. (water distribution systems, water conveyance systems, etc.)	Land owners, Conservation Districts	up to $25,000	75%	http://wwdc.state.wy.us/small_water_project.html	Jan. 1
Wyoming Wildlife and Natural Resource Trust	N/A	Numerous projects that encompass range management and watershed improvement activities.	Non-profit and Governmental Organizations	See website.	8 to 1	http://wwnrt.state.wy.us	Mar. 31 and Sept. 30
Federal							
Bureau of Land Management	Riparian Habitat Management Program	Projects to create or improve wetlands and riparian areas.	Please see website.			http://www.blm.gov/wy/st/en.html	See website.
	Cooperative Agreement for Range Improvements	Livestock watering projects (wells, spring developments, pipelines, reservoirs, etc.)					
Bureau of Reclamation	Water SMART	Improvements to water systems to improve efficiency and conservation.	Please see website.			http://www.usbr.gov/WaterSMART/	See website.
Environmental Protection Agency	Targeted Watershed Grants Program	See website.				http://www.epa.gov/owow/watershed/initiative/	
Farm Service Agency	See website for current listing of programs.	Program Specific.	See website: http://www.fsa.usda.gov/FSA/stateoffapp?mystate=wy&area=home&subject=prog&topic=landing				
Fish and Wildlife Service	See website for current listing of programs.	Program Specific.	See website: http://www.fws.gov/				
Natural Resources Conservation Service	See website for current listing of programs.	Program Specific.	See website: http://www.nrcs.usda.gov/				
Non-Profit and Other Organizations							
Ducks Unlimited	NA	Projects that create, promote or enhance water fowls habitat.	See website: http://www.ducks.org/				
National Fish and Wildlife Foundation	See website: http://www.nfwf.org/AM/Template.cfm?Section=Home						
Trout Unlimited	See website: http://www.tu.org/						

Executive Summary: Table 3
Reservoir Site Summary

Site Number	1	2	2a	2b	3	4	5	6	7	7a
Site Name	Bratsky Draw Reservoir	Collingwood Draw Complex Upper	Collingwood Draw Complex Middle	Collingwood Draw Complex Lower	Coyote Basin	High Line Reservoir Expansion	Leavitt Reservoir Extension	Red Canyon Reservoir	Trapper Creek	Trapper Creek East Complex
Location Information										
USGS 7.5-minute Topographic Quadrangle	Shell	Shell	Shell	Shell	Leavitt Reservoir	Shell	Leavitt Reservoir & Bear Creek Ranch	Shell	White Sulfur Spring	White Sulfur Spring
Water Source	Seasonal Runoff, Beaver or Shell Creek	Seasonal Runoff	Seasonal Runoff	Seasonal Runoff	Seasonal runoff, Beaver Creek	Siphon from High Line Ditch	Beaver Creek	Red Canyon Creek / Seasonal Runoff	Trapper Creek	Bush Creek/ Seasonal Runoff
Primary Conveyance	Shell or Beaver Creek	Shell Canal	Shell Canal	Whaley Ditch	Beaver Creek	Shell Canal	Beaver Creek	Beaver Creek	High Line Ditch / Shell Canal	High Line Ditch / Shell Canal
Onstream / Offstream	Offstream	Offstream	Offstream	Offstream	Offstream	Offstream	Offstream	Offstream	Offstream	Offstream
Basin Characteristics and Hydrology										
Immediate Watershed										
Drainage Area (square miles)	3.1	2.8	2.8	2.8	1.1	61	41.8	3	60.2	12.5
Estimated Mean Annual Flow Characteristics										
Estimated Runoff Volume (thousand acre-feet)	1.9	1.8	1.8	1.8	0.62	35.3	28	1.6	35.3	No Data [1]
Supplemental Watershed										
Drainage Area (square miles)	285.6	None	None	257.2	64.9	61	41.8	67.8	60.2	60.2
Estimated Mean Annual Flow Characteristics										
Estimated Peak Discharge of 2 year storm (thousand cfs)	2.08	None	None	1.94	0.66	0.63	0.51	0.66	0.32	0.32
Estimated Runoff Volume (thousand acre-feet)	174.7	None	None	162.2	36.5	35.33	28	36.5	35.3	35.3
Annual Peak Flow Characteristics										
Region	Ephemeral Valley	Ephemeral Valley	Ephemeral Valley	Ephemeral Valley	Ephemeral Valley	Existing Reservoir	Broad Valley	Ephemeral Drainage	U-Shaped Basin	Ephemeral Drainage
Average Annual Precipitation (in)	11	9.7	9.2	8.9	11.7	10	12.7	11	12.8	13.2
Reservoir Characteristics and Operation										
Normal High Water										
Capacity (acre-feet)	5,839	2,692	11	71	3,112	20	45	546	2,507	734
Surface Area (acres)	160	157	4	13	86	4	4	20	62	24
Water Surface Elevation	4295	4295	4195	4155	4605	4230	4804	4535	4575	4655
Average Water Depth (feet)	36	17	3	6	36	5	12	27	40	31
Site Geology										
Geology										
Potential Soil Constraints										
Landslide Deposits										
Soil Limitations for Embankment Material										
Borrow										
Relative apparent availability										
Relative apparent quality										
Site Environmental Conditions										
Environmental Issues										
NWI Wetlands (acres)	0.96	0	0	7.8	1.71	4	1	0.01	0	0
Sage Grouse Leks	none	none	none	none	none	none	none	none	none	none
Big Game Habitat - Crucial	Mule Deer	none	none	none	Elk / Mule Deer	Mule Deer	Mule Deer	Mule Deer	Mule Deer	Mule Deer
Big Game Parturition (Birthing Areas)										
Infrastructure and Ownership										
Infrastructure / Utilities Conflicts										
Residences / Facilities	0	0	0	0	0	X	0	X	0	0
Highways	0	0	0	0	0	1	0	0	0	0
Railroads	0	0	0	0	0	0	0	0	0	0
Pipelines	0	0	0	0	0	X	0	0	0	0
Irrigated Lands (acres)	0	0	0	0	0	0	0	0	0	0
Energy Resources										
Oil Field										
Gas Field										
Land Ownership										
Private	X			X		X		X	X	X
State										
Federal	X	X	X	X	X		X	X	X	X
Dam Characteristics and Hydraulic Structures										
Dam										
Freeboard/ Head on Spillway (ft)	5	5	5	5	5	5	5	5	5	5
Crest Elevation (feet)	4300	4300	4200	4160	4610	4235	4809	4540	4580	4660
Total Crest Length (feet)	1004	1240	700	310	900	270	530	500	1900	1000
Crest Width (ft)	20	20	20	20	20	20	20	20	20	20
Maximum Dam Height (feet)	98	65	16	16	98	21	12	65	98	65
Riprap (cy)	23050	1880	2620	1160	20660	1330	1490	7610	43610	15220
Foundation Excavation Volume (thousand cy)	157	133	24	11	141	11	15	54	297	107
Total Earthwork Fill Volume (thousand cy)	1419	820	45	20	1272	26	23	331	2685	661
Storage Efficiency (ac-ft/1000cy)	4.11	3.28	0.24	3.53	2.45	0.76	1.94	1.65	0.93	1.11
Height Efficiency (feet/ac-ft)	0.74	1.60	381.82	58.59	1.48	211.75	106.87	8.32	1.83	6.35
Outlet Works										
Proposed Type	Pipe & Valve	Pipe &Valve	Pipe &Valve	Pipe &Valve	Pipe &Valve	Pipe &Valve	Pipe &Valve	Pipe &Valve	Pipe &Valve	Pipe &Valve
Service Spillway										
Design Capacity (cfs)	5400	5000	5000	5000	1700	1600	1300	1700	800	800
Approximate Width (feet)	17.5	16.5	7	7	7	7	6	7	4	4
Emergency Spillway										
Design Capacity (cfs)	6032	5626	5626	5626	1914	1827	1479	1914	928	928
Approximate Width (feet)	317	270	270	270	90	86	70	90	41	41
Approximate Length (feet)	100	250	200	150	200	200	250	150	200	200
Cut Volume (cy/1000)	12.48	12.96	10.37	7.78	3.7	7.85	3.7	2.78	1.89	12
Supply and Delivery Facilities										
Supply Canal										
Characteristics of Supply Ditch to carry Peak Flows										
Terrain										
Other										
Access										
Cultural Resources										
Irrigated Acres Below Point of Diversion	8,807	4,719	4,719	6,499	9,840	5,326	9,937	9,765	14,962	14,962
Costing										
Total Project Cost	$ 32,651,770	$5,468,515	$1,998,937	$ 1,182,744	$ 28,841,232	$1,074,050	$ 949,990	$ 8,088,877	$ 60,283,741	$15,925,368
Total Project Cost per Irrigated Acre	$ 3,707	$ 1,159	$ 424	$ 182	$ 2,931	$ 202	$ 96	$ 828	$ 4,029	$ 1,064
Total Project Cost per AC-FT of Storage	$ 5,592	$ 2,031	$ 181,722	$ 16,658	$ 9,268	$ 53,703	$ 21,111	$ 14,815	$ 24,046	$ 21,697

Excellent or more than adequate
Favorable or adequate
Potentially marginal or unfavorable value
Probable Fatal flaw or very unfavorable value

Note 1. Site added late in the study. Previous analysis of Trapper Creek indicated surplus water was not available in the area so data not computed.

Executive Summary Table 4: Watershed Improvement Projects

PROJECT NAME	LOCATION	WATER SOURCE		PIPELINE LENGTH (LF)	STORAGE TANKS		WATER STOCK TANKS (NUMBER)	RESERVOIR OR DIKE		2010 PROBABLE PROJECT COST*
		SPRINGS (NUMBER)	WELLS (NUMBER)		NUMBER	SIZE (GAL)		NUMBER	AVERAGE SIZE (CY)	
Battle Creek Spring Development	T 52 R88 Section 14	1		1,000			2			$ 14,200
Black Mountain Pipeline - Phase 1	Drainage - Trapper Canyon to Shell Creek Area - From top of Black Mountain to the West to Table Mountain and Trone Gulch			12,500	1	4,000	2	1-Reservoir	2,000	$ 92,090
Black Mountain Pipeline - Phase 2				20,000			3			$ 88,560
Collingwood Draw Pipeline-Phase 1	Drainage - North Sheldon to Shell Creek Area - from Hwy 14 southeast then east to South of Fox Mtn.	1 Solar Pump Shell Canal		10,000			2	1-Reservoir	3,500	$ 84,610
Collingwood Draw Pipeline-Phase 2				10,560			2	2-Reservoirs	3,500	$ 96,200
Collingwood Reservoir	Drainage - North Sheldon to Shell Creek Area - between Douglas Draw and North Sheldon along Hwy 14. Rebuild Dam and clean reservoir							1-Reservoir	9,000	$ 65,500
Dutch Springs Well - Phase 1	Drainage - North Sheldon to Shell Creek Drainage Area - North of N. Sheldon Gulch		1 Solar Well Pump	50			1			$ 99,750
Dutch Springs Well - Phase 2				10,560	1	5,000	2			$ 97,730
Fox Mountain Allotment - Phase 1	Drainage - Douglas Draw & North Sheldon to Shell Creek Area -North, South and East of Fox Mountain							7-Dikes	2,300	$ 93,550
Fox Mountain Allotment - Phase 2								2-Reservoirs	6,000	$ 72,590
Fox Mountain Allotment - Phase 3								2-Reservoirs	6,000	$ 72,590
Home Pasture	Shell Creek Drainage	4		4,800			6			$ 53,220
Little Horse Creek Pipeline	Horse Creek Drainage	1		7,500			2			$ 42,970
Mesa Well	Red Gulch Drainage		1-Solar Well Pump	25			1			$ 95,670
Mesa Pipeline - Phase 1				12,000			1	1-Reservoir	2,025	$ 68,930
Mesa Pipeline - Phase 2				9,000			1	1-Reservoir	3,500	$ 64,570
North Slope Pipeline - Phase 1	Drainage - Red Gulch to Shell Creek Area - project spans multiple State Lease areas	1		19,500			3			$ 99,650
North Slope Pipeline - Phase 2				15,000			1	1-Reservoir		$ 82,060
North Slope Pipeline - Phase 3				19,000			1			$ 87,670
North Slope Pipeline - Phase 4				7,500			1			$ 36,760
Potato Ridge Allotment - Phase 1	Drainage - Douglas Draw and North Sheldon to Shell Creek Area - North South and East of Fox Mountain							4-Reservoirs	3,500	$ 84,690
Potato Ridge Allotment - Phase 2								3-Reservoirs	3,500	$ 63,510
Ralston Gulch Pasture	Ralston Gulch Drainage	1		20,000			2			$ 98,320
Rattle Snake Hill Pipeline - Phase 1	Drainage - White creek to Shell Creek Area - South of White Creek running to the west			8,000	1	6,000	2			$ 97,830
Rattle Snake Hill Pipeline - Phase 2				10,000			3			$ 54,930
Red Canyon Creek Reservoir	Red Canyon Creek Drainage - 20 foot tall dam. 4 ac-ft storage.							1-Reservoir	32,265	$ 212,140**

* Costs include 10% Engineering Fees and 5% Permitting Fees.

** Costs for this Project included 10% Engineering and 15% Permitting

Executive Summary Table 4: Watershed Improvement Projects (continued)

PROJECT NAME	LOCATION	WATER SOURCE		PIPELINE LENGTH (LF)	STORAGE TANKS		WATER STOCK TANKS (NUMBER)	Reservoir or Dike		2010 PROBABLE PROJECT COST*
		SPRINGS (NUMBER)	WELLS (NUMBER)		NUMBER	SIZE (GAL)		NUMBER	AVERAGE SIZE (CY)	
Red Mountain Well	Drainage - North Sheldon to Shell Creek Drainage Area between Red Gulch and North Sheldon Gulch		1 Solar Well Pump	25			1			$ 99,940
Red Mountain Pipeline - Phase 1				18,000			1			$ 83,250
Red Mountain Pipeline - Phase 2				6,000	1	7,500	1			$ 95,920
Red Mountain Pipeline - Phase 3				20,000			1			$ 92,100
Red Mountain West				6,000	1	7,500	1			$ 95,230
Red Mountain North				13,200			1			$ 69,100
Shell Creek Probst	Site Identified by NRCS Office	1		15,000			7			$ 93,940
Shell Creek Pike - Phase 1	Site Identified by NRCS Office	1	1 Solar Well Pump	100			2			$ 61,060
Shell Creek Pike - Phase 2				15,000			4			$ 80,620
Split Ear Spring	T 52 R90 Section 9		1 Solar Well Pump	100			1			$ 34,120
Sunlight Gulch Pipeline	Sunlight Gulch Drainage	1		8,000			2			$ 45,190
Trapper Creek Phase 1	Site Identified by NRCS Office	1	1 Solar Well Pump	5,000			1			$ 58,470
Trapper Creek Phase 2				15,000			5			$ 84,170
West Slope Pipeline - Phase 1	Site Identified by NRCS Office	1	1 Solar Well Pump	200	1	10,000	2			$ 98,400
West Slope Pipeline - Phase 2				20,980			2			$ 100,000
West Slope Pipeline - Phase 3				20,980			2			$ 100,000
West Slope Pipeline - Phase 4				20,980			2			$ 100,000
Whaley Spring	White Creek Drainage	1		150			1			$ 6,880
White Sulphur Spring	Sheldon Gulch Drainage	1		150			1			$ 6,880

Shell Valley Overview Map

Map Legend

Evaluated Reservoir Sites

Shell Watershed Boundary

Land Ownership

- Bureau of Land Management
- Forest Service
- Private
- State

N W E S

0 5 10 Miles

Leavitt Reservoir - addition

Coyote Basin Reservoir

Red Canyon Reservoir

Bratsky Reservoir

High Line Reservoir - addition

Collingwood Middle Reservoir

Collingwood Middle Reservoir

Collingwood Upper Reservoir

Trapper Creek Reservoir

Trapper Creek East Reservoir

WESTECH ENVIRONMENTAL SERVICES, INC.
Helena, Montana

Figure 11.0.1