FINAL REPORT

TO

WYOMING WATER DEVELOPMENT COMMISSION

FOR THE
HIGHLINE CANAL, LEVEL II

NOVEMBER, 2002

SUBMITTED BY

Sage

1501 STAMPEDE AVE., SUITE 3210
PHONE (307) 527-0915 FAX (307) 527-0916
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INTRODUCTION

The Highline Canal (Highline Ditch) is located in Big Horn County, near Shell, Wyoming. It carries water from the diversion on Trapper Creek northwesterly to irrigated lands in and near the town of Shell (See Map Page 2). Currently, slightly more than 345 acres of land have adjudicated water rights from the Highline Ditch. The vast majority of these acres are used for agriculture; however, the town of Shell (Population 50) also receives its raw water from the ditch. The main crop is alfalfa hay and the appropriation for the ditch is 9.86 cfs.

The existing ditch is approximately 13,500 ft. long. Should the ditch be placed in pipe, inverted siphons can be installed in two locations along the ditch to reduce the overall length to 10,500 ft.

The lower portion of the ditch was placed in pipe in the spring of 2001. This eliminated seepage losses and greatly reduced maintenance needs for this section. It is now desired to study the upper 2+ miles of the ditch – mainly due to concerns about conveyance losses, but also increasing maintenance needs – to determine the costs and feasibility of improvements. An added benefit, should the upper portion of the ditch be placed in pipe, or lined with concrete, will be experienced by the lower portion. The sediment load carried through the pipe will be reduced further decreasing the maintenance needs for the lower section, as well as extending the life of the entire system.

A previous study was completed by the Natural Resources Conservation Service in January of 2001. This study was unpublished and resulted only in a cost estimate. The recommendation of this study was to install 10,500 ft of 27 inch diameter pipe.

Water users estimated the conveyance loss in the study area to be 60%. This loss and the high maintenance costs the Highline Ditch Company has incurred over the last several years prompted this study. Much of the side-hill portion of the ditch experiences soil piping and a large amount of work has been recently completed to fix these problem
areas. However, these repairs are temporary and new problem areas are likely to appear. In the spring of 2002, Sage Civil Engineering was selected to complete a Level II Study of the ditch to determine the feasibility of placing the ditch into pipe. Work began immediately and this report is the final product of that effort.
PROJECT MEETINGS

A project scoping/kick-off meeting was held at the The Hideout in Shell on June 26, 2002. The purpose of the meeting was for Sage Civil Engineering to present to the Shell Creek Watershed Improvement District (the “Sponsor”), representatives of the Highline Ditch Company (the “Company”), and the WWDC their plan for completing the Level II Study. Present were Chris Abernathy of the WWDC, Dave Nelson of the Town of Shell, Dave Flitner – property owner/water user, and representative of the Company, Jack Clucas, representing the Sponsor, and Jim Evans and Dave Shultz of SCE.

Throughout the presentation, numerous subjects were discussed, with the following highlights:

- Prior to the meeting, Jim Evans and Dave Shultz had walked the Highline Ditch along the project length to begin the Structural Inventory and Assessment portion of the project. At this time, several unauthorized diversions were noted, which included small head gates and pumps. It was noted during the meeting that K.L. Reed has the first official water right on the ditch. Two headgates and three pumps were observed in the ditch upstream of the Reed property.

- Methods of financing improvements to the ditch were discussed. If the WWDC approves of the project, it would be based on a “50/50” grant/loan scenario. Loans from the WWDC are typically based on a 20 to 30 year term; however a 50 year loan re-payment period is possible, with a 7¼ % interest rate. (It was later verified that the loan A.P.R. is 6% for agricultural purposes). One of the tasks to be completed for the project is Economic Analysis and Project Financing, which is presented later in this report. It was requested by the WWDC that as many options as possible for funding the construction be presented.

- The two most likely options for improving the ditch are pipe and concrete lining; However, it was mentioned that concrete lining is likely not a preferred option of the Sponsor or landowners.

- The due date for “Continuing Projects” was discussed. The Sponsor must have its application in to the WWDC for consideration by November 1. A vote will be necessary by Sponsor members to determine if applying for a grant and loan for 
improvement of the ditch is supported, so the importance that the draft report be complete and submitted by October 1 was emphasized.

- Landowners along the ditch have expressed concern to the District that seepage from the ditch is causing problems on their property. These particular landowners do not own a water right on the ditch.
- The District expressed a strong interest to save money by performing the construction work themselves.
- For the estimation of construction engineering costs and project contingencies, values of 10% and 15% respectively of the construction estimate should be used. Inflation also should be considered in the final estimate.

On Tuesday, September 10, 2002, a progress meeting was held, again at The Hideout, with Chris Abernathy, Dave Nelson, Mike Nelson, Dave Flitner, Jim Evans, and Dave Shultz in attendance. The progress of the project was presented by SCE, along with data of interest that had been collected, a rough preliminary design, and cost estimates. Also discussed were preferred improvements, financing scenarios, and scheduling for the report, public meetings, and construction. The same deadlines established during the kick-off meeting were reiterated.
STRUCTURAL INVENTORY AND ASSESSMENT

During the site review performed on June 26, all structures and appurtenances located on the ditch were examined and evaluated for usefulness (need), efficiency/ease of operation, capacity, and whether the components could be re-used in conjunction with proposed improvements. The following summary provides a general description of each individual structure. Detailed notes and photos are included in Appendix A.

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Diversion Structure from Trapper Creek w/headgate and 36 in culvert</td>
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<tr>
<td>2</td>
<td>30 in. Parshall flume</td>
</tr>
<tr>
<td>3</td>
<td>42 in. culvert for road crossing</td>
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<tr>
<td>4</td>
<td>Foot bridge w/12 in. flume attached</td>
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<tr>
<td>5</td>
<td>Light duty irrigation pump</td>
</tr>
<tr>
<td>6</td>
<td>12 in. cast iron wastewater pipe</td>
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<td>7</td>
<td>Bridge for residence access</td>
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<td>8</td>
<td>12 in. spiral wound wastewater pipe</td>
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<tr>
<td>9</td>
<td>12 in. steel wastewater pipe</td>
</tr>
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<td>10</td>
<td>12 in. salvage gated pipe for wastewater</td>
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<td>11</td>
<td>Field turnout – 8 in. slide gate</td>
</tr>
<tr>
<td>12</td>
<td>Light duty irrigation pump</td>
</tr>
<tr>
<td>13</td>
<td>36 in. culvert for road crossing</td>
</tr>
<tr>
<td>14</td>
<td>Field turnout – 8 in. slide gate</td>
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<td>15</td>
<td>42 in. steel culvert for road crossing</td>
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<tr>
<td>16</td>
<td>Light duty irrigation pump</td>
</tr>
<tr>
<td>17</td>
<td>24 in. CMP drainage culvert under County road</td>
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<td>18</td>
<td>Road crossing – concrete blocks and deck slab</td>
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<tr>
<td>19</td>
<td>36 in. CMP placed in Highline Ditch for seepage/washout mitigation</td>
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<tr>
<td>20</td>
<td>42 in. steel culvert for road crossing</td>
</tr>
<tr>
<td>21</td>
<td>Field turnout – 12 in. headgate connected to gated pipe</td>
</tr>
<tr>
<td>22</td>
<td>Field turnout – 12 in. headgate w/ delivery box. Connected to gated pipe</td>
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<tr>
<td>23</td>
<td>Road crossing – 36 in. culvert beneath cattle guard</td>
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<td>24</td>
<td>Field turnout – 12 in. headgate w/Parshall flume and bubbler</td>
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<tr>
<td>25</td>
<td>Treated water tank overflow pipe</td>
</tr>
<tr>
<td>26</td>
<td>Field turnout – 12 in. headgate w/Parshall flume and bubbler</td>
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</table>
SEEPAGE LOSS ANALYSIS

Preliminary Findings
Measurements for seepage loss estimates were made on July 15, 2002 and again on August 21, 2002.

July 15, 2002
Flows into and out of the ditch had been steady for a sufficient amount of time which allowed us to assume the ditch had reached a steady state condition. The turnouts along the ditch between the Trapper Creek diversion and the first official diversion were checked and verified to be closed. Measurements were made above the Parshall flume before the ditch leaves the fields and enters the side-hill reach, and immediately above the first 12 inch turnout. All inlets and outlets were accounted for and verified to be idle. The seepage loss in the first reach was 16+% and the loss in the second reach was 3+%, resulting in a total loss of nearly 20%.

August 21, 2002
A steady state condition for the ditch again was assumed. A total loss of 14% was computed. Again, the majority of the loss was in the first reach where the ditch flows over the alluvial deposits.

As documented, the seepage losses are significant, with the averages through the reach reaching nearly 17%. As mentioned in the introduction, the water users estimated seepage losses of nearly 60%. The discrepancy between our findings and the estimated losses is likely due to two reasons: unauthorized diversions and the success of maintenance work performed. For our flow measurements, we verified that all diversions were closed. If one of the large turnouts was in use, it could easily increase the apparent loss to 60%. Two 8 inch turnouts and multiple pumps for lawn watering exist along the ditch which will increase the apparent losses.
Maintenance work performed in various locations may also have been successful in reducing losses. For instance, to repair a washout on the side-hill reach, and to help minimize future washouts in this location, a portion of the ditch was placed in 30 inch corrugated metal pipe (CMP). In one location in this area the CMP bridged a large hole in the bottom of the ditch caused by soil piping. In another location, an impermeable lining was installed in the ditch to prevent leaks. Statements made by those who completed the repairs indicate significant “soil piping” occurred, necessitating the repairs. Despite the additional diversions and the success of the repairs, the losses are significant. Unfortunately, the major maintenance problems occur in areas where the least amount of loss occurs. This makes it impractical to complete work on only a portion of the ditch.

**Evaluation of Alternatives**

There are several items to be considered when evaluating alternatives to eliminate seepage losses and rehabilitation of a ditch. Those that we feel are important to the Highline Canal are: Reduction of Seepage Losses, Routine Maintenance Costs, Channel and Slope Stability, Maintenance Concerns Due to Beavers, Maintenance Concerns Due to Livestock/Wildlife and Unauthorized Diversions.

Reduction of Seepage Losses: The various alternatives are successful to different degrees in reducing losses from the ditch.

Routine Maintenance Costs: This category consists of the ditch cleaning, vegetation removal, and other routine maintenance that may be necessary.

Channel Slope and Stability: The current location of the ditch along the side-hill reach has made the ditch susceptible to slumping, piping and washouts. Much of the problem is likely due to the saturated soil beneath the ditch and slope of the side hill. Whichever alternative is chosen, it must address this problem.
Maintenance Concerns Due to Beavers: This is a common problem with irrigation systems. Beavers commonly plug irrigation ditches, causing them to overtop and wash out. In the case of the Highline Ditch, beaver dams have caused and will continue to cause extensive damage.

Maintenance Concerns Due to Livestock/Wildlife: Damage due to livestock and wildlife crossing or accessing the ditch for water has occurred. During our structural inventory and assessment, as well as during the proposal phase of this project, we identified several locations where grazing adjacent to the ditch and the associated crossing points had caused damage to the channel banks. Over time this could affect the integrity of the lining methods for eliminating seepage losses. Some linings such as concrete are more resistant.

Unauthorized Diversions: Diversions not included in the water rights for the ditch exist in the upper reaches of the ditch. Several of these are pumps for lawn watering, while two are larger and appear to be for crop irrigation. These diversions can significantly impact the flows.

Several alternatives exist for elimination of the seepage losses. These include:

1. Do Nothing
2. Concrete Lining
3. Fabric Lining
4. Pipeline Installation

The table below contains our ratings of each alternative and our opinion of their expected relative success at eliminating the concerns mentioned above. The scale is from 1 to 5, with 5 being the most desirable.
Below are discussions of each alternative’s ratings.

**Do Nothing:**
This alternative was rated the lowest of the alternatives because it preserves the status quo and does nothing to eliminate any of the problems the district is currently having.

**Fabric Lining**
Reduction of Seepage Losses: If intact, the membrane liner will nearly eliminate seepage through the bottom of the ditch, making it better than the concrete lining in this category. However, losses to evapotranspiration will still occur.

Routine Maintenance: The fabric or membrane liners will require more maintenance when compared to concrete but less when compared to the existing ditch. The fabric lining requires gravel to be placed over the top of the fabric. This gravel will trap sediment which will grow vegetation and require more frequent cleanings. Care will have to be exercised during cleaning to ensure that the lining is not damaged.
Channel and Slope Stability: As mentioned, a properly installed membrane liner will reduce the amount of seepage more than the concrete liner. Barring damage from natural causes and if maintenance is performed with proper care, membrane liner will resist forming leaks of any kind, virtually eliminating the problems with a saturated subgrade. The membrane liner is also flexible, so it will be minimally affected by frost heaving.

Maintenance Concerns Due to Beavers: The membrane liner is susceptible to damage by beavers. It can be susceptible to washout, can be punctured, and is more expensive to repair than an unimproved ditch because the membrane has to be replaced where it has been damaged.

Maintenance Concerns Due to Livestock/Wildlife: The membrane liner will be damaged by livestock and wildlife. Bank erosion and breakdown will not be prevented and livestock walking in the ditch will cause damage. Fencing should be considered if this alternative is chosen.

Unauthorized Diversions: This option will not likely prevent unauthorized diversions as the membrane and bank can be easily cut allowing installation of the diversions.

Concrete Lining:
Reduction of Seepage Losses: Expansion joints and the inevitable cracks which will form in the concrete reduce the effectiveness of concrete lining for reduction of seepage. Seepage losses will obviously be reduced with this alternative, but to a lesser degree than membrane lining

Routine Maintenance: Concrete lining is fairly effective for reducing routine maintenance costs because it eliminates much of the cleaning necessary with the other open channel alternatives.
Channel and Slope Stability: Due to the cracks discussed above, soils beneath the lining are still susceptible to saturation. This can result in weakened channel slopes, and if the soil is saturated when frost penetrates the lining, it can be damaged.

Maintenance Concerns Due to Beavers: Concrete-lined ditches are slightly better than the other open channel options when it comes to beaver damage. However, concrete-lined ditches do not eliminate beaver activity, and when such a ditch washes out, it is more expensive to repair than the other open channel options. All of the open channel options were poorly rated when it came to this concern.

Maintenance Concerns Due to Livestock/Wildlife: Concrete lining was rated high in this category because of the structural integrity of the lining. Foot traffic from livestock and wildlife will not damage the lining but the banks beside the concrete are somewhat susceptible to damage.

Unauthorized Diversions: Some of these diversions would likely be eliminated, if desired, with the installation of concrete lining. Currently, it is not difficult to install a headgate in the ditch. Cutting concrete lining to install a gate is difficult and obvious, making it less likely to happen. The ease of placing pumps in the ditch for lawn watering will not likely be affected, thus such unauthorized use would probably continue.

**Pipeline Installation:**
Reduction of Seepage Losses: The best of all of the alternatives, pipeline installation will eliminate all of the losses from the ditch, including evapotranspiration.

Routine Maintenance: With the pipeline option, routine maintenance will be minimal. The pipeline will require periodic flushing as well as draining at the end of the irrigation season. Commencement of the irrigation season is much simpler because removal of weeds and debris will not be necessary. Moss formation will also no longer be a problem.
Channel and Slope Stability: The pipeline option will eliminate any concerns with channel and slope stability problems. The only stability problems caused to the pipeline would be from outside sources, such as a source of moisture causing a slide or undermining the pipe’s foundation. This is not likely to occur along the limits of the Highline ditch.

Maintenance Concerns Due to Beavers: The pipeline is completely enclosed and underground. The impact by beavers will be eliminated.

Maintenance Concerns Due to Livestock/Wildlife: Livestock and wildlife will be able to move freely over the pipeline, eliminating this concern.

Unauthorized Diversions: No unauthorized diversions would be expected from a pipeline. Fittings, excavation, and considerable expertise would be necessary to make the connection to the pipeline. This would be likely under extremely rare instances by very determined individuals.

Recommendations

Based on the relative ratings, the pipeline alternative is unsurpassed. Concrete lining comes in a distant second followed by the fabric lining and the do nothing alternative. When the operation and maintenance methods of the ditch and the amount of manpower available are considered, the concrete lining and pipeline alternatives stand out. There is no full-time ditch rider and most of the ditch cannot be driven, making potential problems difficult to detect. This lack of ability to detect issues early causes most of them to be discovered only after they have become significant problems.

It must be kept in mind that construction costs were conspicuously absent from the evaluation parameters. We recommended to further study the concrete lining and pipeline installation alternatives (which consisted generally of preliminary designs of each in order to prepare cost estimates), as it is our opinion that these two options are the logical choices.
From Big Horn County records, the properties adjacent to the Highline ditch were researched. The results are depicted on the Ownership Map on the next page. County records were researched to identify water rights and existing written easements for the ditch. No written easements or right-of-way documentation were found.

Because no written easements or right-of-way agreements were found, part of this study was to estimate the costs and work involved to establish a written, recorded easement for the section of the ditch included in this study. A reasonable width will have to be determined and easements written and recorded before improvements can be made.

Estimates of the easement costs were compiled based on the length of ditch on each property and a 30 ft width. The easements were separated into two types. A “prescribed” easement exists for the ditch but is not recorded and has no specified width other than what is reasonably needed to maintain it. Areas where the proposed alignment is the same as the existing alignment were considered to fall under this category and labeled **Existing Easement**. Locations where the proposed alignment varies from the existing were considered as the second type because an existing easement does not exist and were labeled as **New Easement**.

Costs were not reduced for purchasing easements in areas where an existing unwritten easement exists. Costs for easements were estimated as if the entire length of the ditch would be constructed over virgin territory. This was done to ensure that the estimates are conservative. It seems reasonable that a lesser amount per acre could be negotiated for those areas where a prescribed easement currently exists.

Costs were calculated based on $1200/acre and are summarized in the tables on the map sheet on the next page. These values may ultimately be reduced during negotiations. Exact land quantities will vary depending on property surveys and final design.
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<tr>
<th>Summary</th>
<th>Acres</th>
<th>Price</th>
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REHABILITATION PLAN

Originally, a rehabilitation plan task was included as part of this project. After the initial scoping meeting and during the progress of the project it was concluded by the WWDC and SCE that the work originally intended to be completed under this task was not applicable.
CONCEPTUAL DESIGNS AND COST ESTIMATES

Conceptual Designs and Cost Estimates were completed based on the recommendations detailed in the Seepage Loss Analysis. The two alternatives chosen were concrete lining and pipeline installation. This task of Conceptual Designs and Cost Estimates consisted of 3 sub-tasks: surveying, preparation of preliminary designs, and cost estimates.

Surveying
Field surveys were performed using survey grade GPS for project control and total stations for topographic surveys. The data collected with these surveys was used to prepare the conceptual designs.

Preliminary Designs and Cost Estimates
Concrete Lining: Hydraulic calculations for the design of a concrete-lined ditch were completed using the existing length, grade, and alignment of the Highline Ditch. Based on these assumptions and the survey data collected, it is estimated a trapezoidal section 3 feet deep, with a 1 ft. wide bottom and 1:1 sides would be necessary. Cost estimates based on this preliminary design were completed and construction costs are estimated to be approximately $35 to $40 per foot. Along the present alignment (13,500 ft.), this results in an estimated construction cost of nearly $500,000 for the lining alone.

Irrigation districts throughout the region appear to be continually decreasing their use of concrete-lined ditches. There are two reasons for this trend – availability of inexpensive PVC pipe and the maintenance issues associated with concrete ditches. PVC pipe is now available in larger sizes than in the past and it is less expensive per foot to purchase and install than the traditional concrete pipe. This makes it a viable alternative for smaller ditches such as the Highline Ditch.

As mentioned earlier, fine graded and clayey soils make it difficult to provide foundations for concrete-lined ditches. Concrete linings are not completely impermeable due to cracks and expansion joints. The water, which infiltrates and saturates the soil
underneath the concrete, causes heaving and cracking either due to expansive soils or frost heaving. Because it is cost prohibitive to construct concrete ditches that will resist this cracking, most become deformed, sometimes to the point of failure, in a relatively short time. We estimate that the life of a concrete lining is less than ½ that of a pipeline. Concrete-lined ditches are best suited for larger canals where inexpensive pipe is not available in large enough sizes or for relatively short sections. No further study was completed on the concrete lining option due to the high initial cost and the shorter life.

**Placing the Ditch in Pipe:** The complete system required to place the Highline Ditch into pipe was separated into three components: 1) the pipeline; 2) the Trapper Creek diversion structure; and 3) field deliveries. The preliminary design was performed as a complete system, however cost estimates were prepared for each component individually, as the Company would not necessarily have to build the complete system all at one time if sufficient funding is not available. Of course the pipe installation is the single most important component, but the pipe could be tied into the existing diversion structure as well as the existing deliveries if necessary.

The pipeline consists of pipe, a Parshall flume at the beginning of the ditch, fittings, valves and appurtenances such as blowoffs/drains and Air/Vacuum (airvacs) valves necessary for operation. Blowoffs and flushing valves would be required at certain locations to provide for draining, flushing and other maintenance operations. The preliminary design drawings are located in Appendix B. Following is the cost estimate for the pipe installation. An inflation rate of 3% was assumed for calculating 2003 costs.

For the preliminary design, it was assumed that field turnouts or deliveries would be placed at their current locations. The costs of a 12 inch valve and tee have been included in the pipeline estimate. These items will be necessary whether or not new deliveries are installed. The existing delivery piping will be tied to the new system downstream of the valve.
During the project meetings, it was requested that the pipeline installation costs be separated so that the Company can evaluate the possibility of providing the installation as part of the loan portion of the project thereby reducing the amount financed. This estimated cost is the Trench Excavation and Backfill item. Installation of the fittings, valves, blowoffs and airvacs is considered to be subsidiary to the installation of the pipeline.

### Preparation of Final Designs - Pipeline

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### Pipeline Construction Estimate

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<tr>
<td>7</td>
<td>27in PIP PVC 11.25Deg bend</td>
<td>4 ea</td>
<td></td>
<td>$385.00</td>
<td>$1,540.00</td>
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<tr>
<td>8</td>
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<td>$385.00</td>
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<tr>
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<tr>
<td>13</td>
<td>27in X 12in TEE</td>
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<td></td>
<td>$805.00</td>
<td>$805.00</td>
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<tr>
<td>14</td>
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<td></td>
<td>$667.80</td>
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<tr>
<td>15</td>
<td>24inX27in Expansion</td>
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<td>16</td>
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<tr>
<td>17</td>
<td>8in Blowoff</td>
<td>3 ea</td>
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<tr>
<td>18</td>
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<tr>
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<tr>
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<td>ft</td>
<td>$3.60</td>
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</tr>
<tr>
<td>22</td>
<td>2in Air Vac</td>
<td>4 ea</td>
<td></td>
<td>$400.00</td>
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<tr>
<td>23</td>
<td>30 in. Parshall Flume</td>
<td>1 ea</td>
<td></td>
<td>$1,000.00</td>
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<table>
<thead>
<tr>
<th>Description</th>
<th>2002 Costs</th>
<th>2003 Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Costs</td>
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<td>$34,680.00</td>
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<tr>
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<td>$381,480.00</td>
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<tr>
<td>Pipeline Project Cost Total</td>
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<td>$487,600.00</td>
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</table>

As can be seen from the values shown above, the major portion of the project is the cost of the pipe and fittings. However, these costs are also the most volatile. For example, during our research suppliers reported that the price for 80 psi 27 inch PIP has ranged...
from $11/ft. to nearly $20/ft over the past year. Considering this, the estimates provided are conservative, and were prepared with prices toward the higher end of the spectrum given by the suppliers and seen historically.

The next component is the Trapper Creek diversion structure. The existing structure does not appear to provide reliable control for diverting water. The existing structure also lacks a trash rack or any protection against debris entering the ditch. This lack of protection for the gate makes it susceptible to damage by debris during high flows in Trapper Creek. It is likely that this is the reason for the bent stem in the gate. However, the existing structure could operate acceptably for several years if necessary, but with less reliability and higher maintenance needs.

Permitting could become an issue with the diversion structure. Replacement of the structure as proposed requires construction work to take place within Trapper Creek, therefore it may fall under the regulation of the Army Corps of Engineers (COE). However, based on discussions with the COE, cooperation with the Wyoming Game and Fish Department will likely provide the ability to maintain an exempt status for this structure, precluding the requirement of having to go through the permitting process. Some additional work will be caused by this coordination. An estimated cost for this additional work has been included under the Permitting and Mitigation item.

A new diversion structure, as proposed by the preliminary design, would consist of a concrete cut-off wall and crest across Trapper Creek. The crest would be constructed to accommodate stop logs, thereby providing additional head and improving the ability to divert water during low flows. Gabions would be placed up and downstream of the structure to prevent movement and erosion of the stream channel. As mentioned in the Structural Inventory and Assessment section, the existing gate is in overall good condition with the exception of the bent stem. The existing gate could be re-used; however, the cost estimate includes the cost of a new gate. The preliminary design drawings are located in Appendix B.
Preparation of Final Designs - Diversion

<table>
<thead>
<tr>
<th>Item Description</th>
<th>2002 Costs</th>
<th>2003 Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of Final Designs and Specifications</td>
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<tr>
<td>Permitting and Mitigation</td>
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<td>$2,100.00</td>
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<tr>
<td>Legal Fees</td>
<td>$-</td>
<td>$-</td>
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<tr>
<td>Acquisition of Access and Rights of Way</td>
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Diversion Structure Construction Cost Estimate

<table>
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<tr>
<th>Item Description</th>
<th>Quantity</th>
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<th>Price/Unit</th>
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<td>$4,600.00</td>
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<td>lf</td>
<td>$70.00</td>
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<td>$30.00</td>
<td>$300.00</td>
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<td>28 Rip Rap</td>
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<td>cy</td>
<td>$100.00</td>
<td>$7,500.00</td>
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<td>29 36&quot; Gate</td>
<td>1</td>
<td>ea</td>
<td>$2,600.00</td>
<td>$2,600.00</td>
<td>$2,700.00</td>
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$16,800.00 $17,100.00

<table>
<thead>
<tr>
<th>Item Description</th>
<th>2002 Costs</th>
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<tbody>
<tr>
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<tr>
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<tr>
<td>Contingency</td>
<td>$2,739.00</td>
<td>$2,822.00</td>
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</table>

Pipeline Construction Cost Total $21,000.00 $21,600.00

Diversion Project Cost Total $28,500.00 $29,400.00

The final component of the pipe project is the installation of new delivery structures. No apparent problems were noted with the existing deliveries. The first two deliveries (nos. 21&22) do not have provisions for measurement. The second two deliveries (nos. 24&26) do have measurement and have had a substantial amount of improvements (See Appendix A structures 24 and 26). We recommend leaving these two structures in place and tying to them with the new pipeline. These two structures would likely function satisfactorily for many years. However, in order to have the project price reflect new components for the entire system, costs to replace these deliveries have been included in the estimates.

Consideration has been given to combining the first two deliveries and the second two deliveries (nos. 21 & 22; nos. 24 & 26) to reduce construction costs, maintenance costs, and to improve efficiency. During the preliminary design process, it was determined that (nos. 21&22) cannot be combined because they supply water to two different parcels. The second two could be combined, but new delivery equipment would be required making the cost savings minimal. The preliminary design drawings for the new deliveries are located in Appendix B.
As shown by the cost estimate, the relative cost of replacing all of the deliveries is relatively small when compared to the cost of the rest of the project. If the existing facilities for the last two deliveries are not replaced, the cost savings would be roughly half of the total Delivery Construction Estimate, or $4,450. This savings when considering the entire project is minimal. For this reason, an additional option detailing the costs for only replacing two of the deliveries was not included.
ECONOMIC ANALYSIS

We began this task by researching the United States Department of Agriculture Statistics for Wyoming and Big Horn County. This resource provided information that was used to calculate a general indication of income/acre for the lands irrigated under the Highline Ditch. The primary crop is alfalfa hay. Values for hay production were used and the results are summarized below.

| Average Value for Alfalfa Hay from 1991 through 2000 | $75.35/ton |
| Average Yield for the Northwest District for 2000   | 3.3 tons/acre |
| Average Yield for Wyoming between 1991 and 2000    | 3.07 tons/acre |
| Income/Acre using 3.07 tons/acre                   | $231.32/acre |

The work performed under this task included determining the characteristics of the project financing based on the parameters provided by the WWDC. The WWDC will support a 20 year, 30 year, or 50 year term and the current interest rate for agricultural projects is 6%. The project would be funded with a 50% grant and 50% loan, based on the total cost of the work undertaken. The payment/acre/year for the portion of the project covered by the Sponsor’s loan was calculated and is included in the table on the next page labeled “Economic Analysis – Full Loan Amount”. The estimated construction costs to place the ditch into pipe, construction of the Trapper Creek diversion, and reconstruction of all field deliveries were evaluated separately, but all figures can be combined as desired to illustrate expected costs for a complete project. This information can be used to make a decision about whether the project can be paid for, or which portions of the project to build.

During the project meetings, the Company indicated a strong desire to complete as much of the project as possible themselves. One of the water users on the Highline Ditch is a contractor, and the Company hopes to utilize this expertise and availability of equipment as an “in-kind” contribution towards the Sponsor’s half of the project costs, reducing the amount of the loan. The in-kind work would generally entail the pipe installation – the structural work would be performed by others.
### Economic Analysis - Full Loan Amount

#### Pipeline Construction

<table>
<thead>
<tr>
<th>Total Cost</th>
<th>Sponsor Loan Portion</th>
<th>Rate</th>
<th>Term</th>
<th>Yearly Payment</th>
<th>Price/Acre/Year</th>
</tr>
</thead>
<tbody>
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<td>$61.59</td>
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<tr>
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<td>6.00%</td>
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</table>

#### Diversion Construction

<table>
<thead>
<tr>
<th>Total Cost</th>
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<th>Term</th>
<th>Yearly Payment</th>
<th>Price/Acre/Year</th>
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#### Delivery Construction

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<th>Rate</th>
<th>Term</th>
<th>Yearly Payment</th>
<th>Price/Acre/Year</th>
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<tr>
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<td>6.00%</td>
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#### Total Cost - Pipeline, Diversion and Delivery Construction

<table>
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<th>Sponsor Loan Portion</th>
<th>Rate</th>
<th>Term</th>
<th>Yearly Payment</th>
<th>Price/Acre/Year</th>
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<td>$16,841.29</td>
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</table>

To illustrate the potential benefits to the water users should the Company provide in-kind service, the Trench Excavation and Backfill item in the pipeline estimate was used as the monetary value of the in-kind contribution. The resulting cost to the Sponsor is shown in the table on the next page.
### Economic Analysis - District Completes Pipeline Installation as an In-Kind Contribution

#### Pipeline

<table>
<thead>
<tr>
<th>Total Cost</th>
<th>Sponsor Loan Portion</th>
<th>Installation</th>
<th>Loan amount</th>
<th>Rate</th>
<th>Term</th>
<th>Yearly Payment</th>
<th>Price/Acre/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>$487,600.00</td>
<td>$243,800.00</td>
<td>$88,992.00</td>
<td>$154,808.00</td>
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<td>30 years</td>
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#### Total Cost - Pipeline, Diversion and Delivery Construction

<table>
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<th>Sponsor Loan Portion</th>
<th>Installation</th>
<th>Loan amount</th>
<th>Rate</th>
<th>Term</th>
<th>Yearly Payment</th>
<th>Price/Acre/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>$530,900.00</td>
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<td>$88,992.00</td>
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<td>6.00%</td>
<td>50 years</td>
<td>$11,195.25</td>
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</tbody>
</table>

Comparing the figures in the above table to those in the “Pipeline Construction” portion of the “Full Loan Amount” table shows the significance of the Company’s contribution of in-kind services.
CONCLUSION

The information in this study is intended to provide the Sponsor, Company and WWDC with the information necessary to make a decision regarding the feasibility of this project. The water rights and the crop production supplied by the ditch are an important part of the Town of Shell and the surrounding area’s economy. The future of the lands and ranches irrigated by the ditch depends upon the Highline Ditch Company’s ability to economically maintain and operate the ditch. Rising maintenance costs and temporary solutions are quickly becoming burdensome and this project will alleviate that burden.
Structure Number: 1

Description: Diversion Structure from Trapper Creek

Components: Waterman 36” gate, approximately 20 ft of 36” CMP culvert

Need: This structure is required.

Capacity: Required minimum capacity for this structure is the entire appropriation. The operators must have the ability to divert the full appropriation during the lowest flows in Trapper Creek.

Ease of Operation: For most of the year this structure operates satisfactorily. However, debris buildup caused by high flows increases maintenance and during low flow periods there is not enough control of the flow of Trapper Creek to easily divert water to the ditch. In the past, fabric dams have been used at this location in an attempt to divert more water, however this is time consuming and inefficient.

Salvage and Reuse: The gate could be reused. It is in fair condition with the exception of the stem, which is bent, possibly by debris carried by high flows.

The culvert is in good condition and appears to be salvageable, however further evaluation is recommended. Should the ditch be improved, including the construction of a new diversion structure, the pipe would likely be removed and replaced, providing the opportunity to evaluate it.

The rock making up the head wall and diversion structure is large and would work well as a source of rip rap, if required, for a new diversion structure.

Comments: This existing structure is the diversion point which supplies the Highline Ditch, with a headwall constructed of large rock and native soil. It appears the soil filling
the voids between the rocks has been cleaned out by erosion and it is possible that water has been flowing through the embankment alongside the 36” CMP culvert. In the low water conditions encountered at the time of our inspection this flow was not evident.

The diversion dam itself is constructed of large rock arranged across the bottom of the channel. As seen in the photo, this dam creates a restriction which collects a large amount of debris potentially causing changes in the channel location, increasing the risk of wash out for the headwall and gate. Full control of the stream flow is not possible, and operators must resort to earthen or canvass dams during low flows.
Structure #1

1. Diversion Dam– View from downstream looking upstream.

2. Gate and Headwall

3. Diversion Dam; Gate and Headwall

4. Gate Erosion

5. Gate and Headwall

6. Gate and Headwall

7. Outlet to Canal Downstream
Structure Number: 2

Description: Parshall Flume

Components: 30 inch Parshall Flume

Need: A Parshall flume is required for measurement of the diverted flow rate.

Capacity Required: Minimum capacity for this structure is the entire appropriation.

Ease of Operation: If working properly and not washed out this structure will provide nearly maintenance free operation and provide accurate flow measurements.

Salvage and Reuse: Although generally in good condition, the flume appears to have been in service for some time and is likely corroded.

Comments: Materially, the flume is in fair condition. However, it is partially washed out, therefore it no longer measures correctly. The high water mark is at approximately 1.3 ft. on the staff gage. Observations early in the year indicated that water is probably flowing underneath the flume in addition to around the sides.
Structure #2

1. Parshall Flume– Washed Out

2. Parshall Flume– Washed Out

3. Parshall Flume– Staff gage & Flume condition

4. Parshall Flume– Washed Out
Structure Number: 3

Description: Culvert for Road Crossing

Components: Approximately 20 ft. of 42 in. CMP

Need: Ditch access must be maintained.

Capacity Required: Minimum capacity for this structure is the entire appropriation.

Ease of Operation: N/A.

Salvage and Reuse: Appears to be in fair condition, however, reuse is not likely. The culvert will be replaced completely should the ditch be placed in pipe.

Comments: This structure is required for field access and ditch maintenance. Headwalls have been constructed out of timber and steel fence posts to control erosion. The culvert is not aligned with the ditch which is causing some of the erosion problem.
Structure #3

1. Culvert and Timber Wing Wall

2. Culvert Inlet
Structure Number: 4

Description: Flume and Foot Bridge

Components: 12 inch Flume, Wooden Foot Bridge

Need: A structure of some sort will be required to serve this purpose, but can be different in nature from the existing

Capacity Required: Unless other evidence is discovered indicating a larger pipe is required, a pipe equal in capacity should suffice, if an open channel option is chosen. If the ditch is placed in pipe another type of collection and conveyance system is possible.

Ease of Operation: N/A – not part of this ditch system

Salvage and Reuse: Replacement recommended.

Comments: This is a structure which purpose is to provide water for lands below the ditch from an independent source.
Structure #4

1. Walking Bridge and Flume

2. Walking Bridge and Flume
Structure Number: 5

Description: Small pump for miscellaneous watering

Components: N/A

Need: Not required for the operation of the Highline Ditch (See Comments).

Capacity Required: N/A

Ease of Operation: N/A – not part of this ditch system

Salvage and Reuse: Pump and intake pipe would be reused. Sump would be new.

Comments: The future of this appurtenance is dependent upon the District’s policy on this type of situation. If allowed to remain, a sump would need to be built to provide water for the pump.
Structure #5

1. ± 1” HDPE and Anchor Post (Pump Removed for Winter)
Structure Number: 6

Description: Waste way from field above.

Components: 12 inch cast iron pipe

Need: Regardless of the improvements chosen, a culvert would have to remain for the purpose of conveying waste water under the road.

Capacity Required: Sufficient to handle wastewater from the field above.

Ease of Operation: N/A – not part of this ditch system.

Salvage and Reuse: Pipe is operational and would last indefinitely for its purpose. This pipe can likely be left intact and undisturbed by improvements to the ditch, unless changes in its outlet location are made (See Comments).

Comments: This pipe crosses under and protects an existing road. If an open channel system for improvements is chosen, it is recommended to modify this structure such that waste water is delivered to a point other than the ditch.
Structure #6

1. Wasteway Inlet

2. Wasteway Outlet
Structure Number: 7

Description: Bridge to residence

Components: 2 arch pipes placed on edge approximately 38 inch x 24 inch, decorative timber railing and gravel drive.

Need: Access must be maintained.

Capacity Required: If the Highline Ditch is placed in pipe, the design will dictate size. Existing culverts appear to satisfactorily handle flows, so the existing capacity should be maintained if an open channel option is chosen.

Ease of Operation: N/A.

Salvage and Reuse: Decorative rails should be salvaged and reused. If an open channel option is chosen, other than the “do nothing” option, a new crossing should be provided, resulting in the probable disposal of the existing culverts.

Comments: Landowner will have to be contacted during design to find out what he wants to do with the bridge. If the pipeline option is selected, the bridge will not be necessary, however the timber entryway may still be desired. If an open channel option is chosen, the fence will have to be disassembled and reassembled or replaced.
1. Bridge Access
Structure Number: 8

Description: Waste Ditch/Delivery Flume

Components: 12” Spiral wound pipe crossing the ditch.

Need: Required

Capacity Required: It apparently is sufficiently sized to serve its purpose.

Ease of Operation: N/A relative to the Highline Ditch.

Salvage and Reuse: Replacement recommended if necessary.

Comments: An open ditch could be placed across the Highline Ditch alignment if it is placed in pipe. The existing wastewater pipe will have to be replaced or reused if an open channel option is selected.
Structure #8

1. Bridge and Delivery Flume
Structure Number: 9

Description: Waste Ditch/Delivery Flume

Components: 12” steel pipe crossing the ditch.

Need: Required

Capacity Required: It apparently is sufficiently sized to serve its purpose.

Ease of Operation: N/A relative to the Highline Ditch.

Salvage and Reuse: Replacement recommended if necessary.

Comments: An open ditch could be placed across the Highline Ditch alignment if it is placed in pipe. The existing wastewater pipe will have to be replaced or reused if an open channel option is selected.
Structure #9

1. Waste Ditch/Delivery Flume
Structure Number: 10

Description: Waste Ditch/Delivery Flume

Components: 12” Aluminum Gated Pipe

Need: Required

Capacity Required: It apparently is sufficiently sized to serve its purpose.

Ease of Operation: N/A relative to the Highline Ditch

Salvage and Reuse: Replacement recommended if necessary.

Comments: An open ditch could be placed across the Highline Ditch alignment if it is placed in pipe. The existing wastewater pipe will have to be replaced or reused if an open channel option is selected.
Structure #10

1. Waste Ditch/Delivery Flume
Structure Number: 11

Description: Field Turnout

Components: 8” slide gate through the side of the ditch.

Need: Not required for the operation of the Highline Ditch (See Comments).

Capacity Required: No capacity is required. If allowed to remain, size would be dependent upon the adjudicated acreage being irrigated.

Ease of Operation: Operates satisfactorily.

Salvage and Reuse: Replacement recommended if improvements are made. If allowed to remain, the cost of replacement appurtenances should be borne by the Landowner.

Comments: Unauthorized field turnout. The future of this appurtenance is dependent upon the Company’s policy on this type of situation. If allowed to remain, a similar slide gate could be used with an open channel – a valve and tee would be necessary if the Highline Ditch is placed in pipe. Also, the water right for the irrigated land should be added to the ditch.
Structure #11

1. 8” Slide Gate
Structure Number: 12

Description: Small pump for miscellaneous watering

Components: 1 ½ in. pipe inlet.

Need: Not required for the operation of the Highline Ditch (See Comments).

Capacity Required: No capacity is required. If allowed to remain, size should remain 1½ in.

Ease of Operation: N/A.

Salvage and Reuse: Salvageable.

Comments: Unauthorized diversion. The future of this appurtenance is dependent upon the Company’s policy on this type of situation. If allowed to remain, a similar installation, or possibly a stand-pipe, could be used with an open channel – a valve and tee would be necessary if the Highline Ditch is placed in pipe
1. ±1” HDPE Pump Inlet (Pump Removed for Winter)
Structure Number: 13

Description: Culvert for Road Crossing

Components: Approximately 20 ft. of 36 in. CMP Culvert

Need: Access must be maintained.

Capacity Required: N/A, if the Highline Ditch is placed in pipe - design will dictate size. Existing culvert appears to satisfactorily handle flows, so the existing capacity should be maintained if an open channel option is chosen.

Ease of Operation: N/A.

Salvage and Reuse: Replacement is recommended.

Comments: This is an existing structure required for residence access. Alignment modification may be desirable to improve flow and reduce erosion.
Structure #13

1. Culvert Inlet

1. Culvert Outlet
Structure Number: 14

Description: Field Turnout

Components: 8” slide gate through the side of the ditch.

Need: Not required for the operation of the Highline Ditch (See Comments).

Capacity Required: No capacity is required. If allowed to remain, size would be dependent upon the adjudicated acreage being irrigated.

Ease of Operation: Operates satisfactorily.

Salvage and Reuse: Replacement recommended if improvements are made. If allowed to remain, the cost of replacement appurtenances should be borne by the Landowner.

Comments: Unauthorized field turnout. The future of this appurtenance is dependent upon the Company’s policy on this type of situation. If allowed to remain, a similar slide gate could be used with an open channel – a valve and tee would be necessary if the Highline Ditch is placed in pipe. The water right for the irrigated lands should be added to the ditch.
Structure #14

1. Barely Visible Outlet

2. Inlet from Canal (Bent Stem is Apparent)
Structure Number: 15

Description: Culvert for Road Crossing

Components: Approximately 20 ft. of 42 in. steel culvert

Need: Access must be maintained.

Capacity Required: If the Highline Ditch is placed in pipe - design will dictate size. Existing culvert appears to satisfactorily handle flows, so the existing capacity should be maintained if an open channel option is chosen.

Ease of Operation: N/A.

Salvage and Reuse: Replacement recommended.

Comments: This is an existing structure providing field access.
Structure #15

1. Culvert Inlet
Structure Number: 16

Description: Small pump for miscellaneous watering

Components: 1 ½ in. pipe inlet.

Need: Not required for the operation of the Highline Ditch (See Comments).

Capacity Required: No capacity is required. If allowed to remain, size should remain 1½ in.

Ease of Operation: N/A – not part of this ditch system

Salvage and Reuse: Salvageable.

Comments: The future of this appurtenance is dependent upon the Company’s policy on this type of situation. If allowed to remain, a sump would need to be built to provide water for the pump.
1. Small Pump for Lawn Watering
Structure Number: 17

Description: Highway drainage culvert

Components: 24 in. CMP

Need: Required for the county road, but not for the operation of the ditch.

Capacity Required: N/A.

Ease of Operation: N/A.

Salvage and Reuse: N/A.

Comments: This culvert is installed under the adjacent county road, and delivers storm water from above the road directly into the Highline Ditch. It is not part of the ditch system, nor is it for irrigation purposes, but it cannot be modified. If an open channel option for improvements, or the “do nothing” option is chosen, it should be evaluated by the District to determine whether to allow this pipe to continue to discharge into the Highline Ditch.

If it is determined that the discharge of stormwater from this pipe into the ditch will no longer be allowed, OR, the ditch is placed in pipe, the new route and destination of stormwater flows from this pipe should be evaluated. Negative impacts to property downstream from this pipe outlet may be experienced should it be that the stormwater no longer is directed to the ditch, regardless of the reason. In our opinion, the evaluation and mitigation of stormwater effects (if necessary) should be performed in conjunction with Big Horn County, as the stormwater flows from culverts under this road are probably the responsibility of the County.
Structure #17

1. Culvert Outlet into Canal
Structure Number: 18

Description: Ditch crossing

Components: Crossing constructed of cinder blocks and a concrete deck slab.

Need: Access must be maintained.

Capacity Required: If the Highline Ditch is placed in pipe - design will dictate size. Existing culvert appears to satisfactorily handle flows, so the existing capacity should be maintained if an open channel option is chosen.

Ease of Operation: N/A.

Salvage and Reuse: Replacement recommended.

Comments: This structure is required for residential access, and is located on Road 42.
Structure #18

1. Bridge

2. Bridge
Structure Number: 19

**Description:** 36 in. CMP Lining

**Components:** 36 in. CMP.

**Need:** The need for elimination of seepage to avoid saturation of the hillside through this portion of the ditch is distinct. However, it will not likely be provided with this 36 in. CMP, unless the “do nothing” alternative is chosen.

**Capacity Required:** Design will dictate capacity required of either pipe or open channel.

**Ease of Operation:** N/A.

**Salvage and Reuse:** Pipe is salvageable, but will not likely be reused should improvements be constructed.

**Comments:** This pipe was apparently installed to bridge a section of the Highline Ditch that is prone to washouts. Numerous washouts along this reach were observed and large holes caused by piping in the bottom of the ditch, beneath the culvert, were also evident.
Structure #19

1. Pipeline Inlet

2. Large hole bridged when pipeline installed
Structure Number: 20

Description: Culvert for Road Crossing

Components: Approximately 20 ft. of 42 in. steel culvert

Need: Access must be maintained.

Capacity Required: If the Highline Ditch is placed in pipe - design will dictate size. Existing culvert appears to satisfactorily handle flows, so the existing capacity should be maintained if an open channel option is chosen.

Ease of Operation: N/A

Salvage and Reuse: Replacement recommended.

Comments: This is structure is required for ditch maintenance.
Structure #20

1. Culvert with Accumulated Debris
Structure Number: 21

Description: Field Delivery

Components: 12 in. head gate tied to gated pipe.

Need: Delivery to the adjacent field is required, however, it may be determined during design that this turnout can be combined with the next delivery downstream. If so, the location will likely change.

Capacity Required: Capacity for this structure is the entire appropriation.

Ease of Operation: This structure appears to operate satisfactorily. The lack of control of the water level in the ditch appears to have caused problems as shown by the straw bale being used as a check in the ditch.

Salvage and Reuse: Replacement recommended.

Comments: This is the first authorized diversion of water from the Highline Ditch. There is no measurement for this structure.
Structure #21

1. Straw Check & Headgate

2. Headgate and Bridge

3. Pipe Outlet
Structure Number: 22

Description: Field Delivery

Components: 12 in. head gate with delivery box. Tied to gated pipe.

Need: Delivery to the adjacent field is required, however, as mentioned for structure number 21, it may be possible to combine this structure number 21.

Capacity Required: Capacity for this structure is the entire appropriation.

Ease of Operation: This structure appears to operate satisfactorily, however there is no measurement ability and no apparent control over the flows in the ditch.

Salvage and Reuse: Replacement recommended.

Comments: This is the second authorized delivery.
Structure #22

1. Headgate

2. Diversion Box
Structure Number: 23

Description: Culvert, bridge and cattle guard for road crossing.

Components: 36 in. culvert with cattleguard for road crossing, timber fence, and swing gate.

Need: Required (See Comments)

Capacity Required: N/A (assuming structure is left intact. See Salvage and Reuse)

Ease of Operation: N/A.

Salvage and Reuse: The structure will likely be able to be left intact, regardless of the option chosen. An open channel should be connected to the structure, and a pipe should be able to be sliplined.

Comments: This road is the main access for the Hideout guest ranch. Regardless of the improvements chosen, the cattleguard, fence, and gate will be required.
Structure #2 3

1. Cattle Guard and Concrete Channel

2. Cattle Guard and Concrete Channel

3. Culvert Location
Structure Number: 24

Description: Field Delivery

Components: 12 in. head gate tied a to Parshall flume and bubbler.

Need: Delivery to the adjacent field is required, however, it may be considered during design to combine this turnout with the next delivery downstream.

Capacity Required: Capacity for this structure is the entire appropriation.

Ease of Operation: This structure appears to operate very well. No modifications are recommended, if left in place.

Salvage and Reuse: If a single delivery is constructed, combining this structure with number 26 to serve this entire field, most of the components, with the exception of the concrete, can be salvaged and possibly reused. If the deliveries are not combined, this structure should be left in place, and incorporated into the new system.

Comments: This is the third authorized delivery along this ditch.
Structure #24

1. Bubbler

2. Headgate

3. Parshall Flume and Bubbler

4. Parshall Flume and Bubbler
Structure Number: 25

**Description:** Water Tank overflow.

**Components:** Outlet pipe, size unknown.

**Need:** This pipe is obviously needed for the water tank, but is not necessary for the operation of the ditch.

**Capacity:** N/A.

**Ease of Operation:** N/A.

**Salvage and Reuse:** N/A.

**Comments:** These intermittent flows should be accommodated if an open channel option is chosen. The water received from this overflow will be clean and will not contribute to or cause additional maintenance needs. If the Highline Ditch is placed in pipe, another destination for this overflow water should be determined, and the necessary measures taken to accommodate the flow.
1. Tank Outlet
Structure Number: 26

Description:  Field Delivery

Components:  12 in. head gate tied to Parshall flume and bubbler.

Need:  Delivery to the adjacent field is required, however, it may be considered during design to combine this turnout with structure number 24.

Capacity Required:  Capacity for this structure is the entire appropriation.

Ease of Operation:  This structure appears to operate very well.  No modifications are recommended, if left in place.

Salvage and Reuse:  If a single delivery is constructed, combining this structure with number 24 to serve this entire field, most of the components, with the exception of the concrete, can be salvaged but probably not reused.  If the deliveries are not combined, this structure should be left in place, and incorporated into the new system.

Comments:  This is the fourth authorized delivery for this section, and constitutes the end of the project.  This structure is required for delivery of water to a different portion of the same field served by structure number 24.  As mentioned, it may be considered to combine structures 24 & 26.
Structure #26

1. Headgate and Culvert Inlet Across Trapper Creek Road

2. Riser Bowl, Parshall Flume, and Bubbler
HINGE FOR LOWERING DURING THE OFFSEASON

FIELD AND MAINTENANCE ROAD

SECTION A-A

CONCRETE BOWL

30 FT OPEN DITCH

30 IN PARSHALL

TRASH RACK

36 IN Gate

PLAN

CONCRETE BOWL

30 IN PARSHALL FLUME

TRASH RACK

SECTION B-B
8 IN STEEL

PROFILE

THRUST BLOCK

3/4 IN Curb Stop

8 IN GATE VALVE

STEEL Riser

PLAN

BLOWOFF ASSEMBLY DETAIL

NOT TO SCALE

TURNOUT DETAIL

NOT TO SCALE

CONCRETE Riser BOWL

2 FT 4 IN

1 FT PARshall Flume

CONCRETE DELIVERY BOWL

3 FT 4 IN

27 x 12 TEE

THRUST BLOCK

VARIES 12 IN P.I.P.

THRUST BLOCK

FIELD CONNECTION

FINISH GROUND

27 x 12 P.I.P.

FINISH GROUND

8 IN STEEL

ADAPTING FITTING

BLOWOFF ASSEMBLY DETAIL

NOT TO SCALE

PLANE

8 IN GATE VALVE

3/4 IN POLYETHYLENE PIPE

PLACE 3 CUBIC FEET CLEAN 1-1/2 IN GRAVEL BELOW CURB STOP FOR DRAIN

EXISTING CONCRETE HEADWALL

TURNOFF DETAIL

NOT TO SCALE

3/4 IN Curb Stop

8 IN GATE VALVE

12 IN GATE VALVE

FINISH GROUND

4 FT

CULVERT UNDER TRAPPER CREEK ROAD

TRAPPER CREEK ROAD

CULVERT UNDER TRAPPER CREEK ROAD

TRAPPER CREEK ROAD