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EXECUTIVE SUMMARY
FOR
CASPER ALCOVA IRRIGATION DISTRICT
COMPUTERIZED IRRIGATION SCHEDULING

Prepared For:
Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, WY 82002

Prepared By:
Anderson Consulting Engineers, Inc.
772 Whalers Way, Suite 200
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V-Notch Weir near Alcova Reservoir
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(ACE Project No. WYWDC16.1)

May 12, 2003
EXECUTIVE SUMMARY

1.0 General

On March 16, 2000, Anderson Consulting Engineers, Inc. (ACE) entered into a contract with the Wyoming Water Development Commission (WWDC) to provide professional services related to the Casper-Alcova Irrigation District (CAID) Rehabilitation Needs Analysis. ACE was retained to conduct a rehabilitation needs analysis of CAID’s irrigation system, to identify areas of the canal system where excessive losses are occurring, and to identify opportunities to conserve water.

During the completion of the work, the WWDC issued an amendment to the original contract to investigate the potential integration of a computerized irrigation scheduling system into the existing operation and management of the CAID. A final report summarizing the results of all tasks associated with the computerized irrigation scheduling system was submitted to the WWDC on May 12, 2003.

2.0 History of the Project

The CAID is located along the north side of the North Platte River between Alcova Dam and the City of Casper, Wyoming. The District was formed with the development of the Kendrick Project (formerly Casper-Alcova) by the United States Bureau of Reclamation, Department of Interior (Reclamation). This project conserves waters of the North Platte River for irrigation and electric power generation. As indicated on Figure 1, the major features of the Kendrick Project are Seminoe Dam and Powerplant, Alcova Dam and Powerplant, the Casper Canal and laterals, and appurtenant drainage and power systems facilities.

The original canal was designed to convey irrigation water necessary to irrigate two units totaling 66,000 acres. The first unit was constructed to deliver water to 35,000 acres, however, drainage related problems have resulted in only partial development of the first unit. Funding to advance the development of the second unit has not been realized (Reclamation, 1955). The total irrigated land in production during recent years is reported to be approximately 24,250 acres.

During its first year of operation in 1946, the Casper-Alcova Project irrigated only 600 acres on 14 farms. By 1976, there were 172 farms and 23,549 acres of irrigated land. Presently, 515 users divert water associated with the 24,250 acres of irrigated lands. The principal crops are alfalfa, irrigated pasture grass, and small grains. Presently, most of the water users within the CAID rely on flood irrigation systems to deliver water to their crops. In the last few years,
Figure 1. Kendrick Project Location Map
however, eight to nine center pivot sprinkler systems and six to seven side-roll irrigation systems have been installed.

3.0 Profile of Computer Capabilities within the CAID

Questionnaires were mailed to 224 irrigators of the CAID to determine the computer capabilities and computer knowledge of the individual water users. In addition, the interest of the water users in an Internet-based water ordering system was also queried. A review of the responses received from the water users is summarized below:

- Of the 100 water users that responded to the questionnaire, 70 owned a personal computer, one (1) stated interest in purchasing a computer in the near future and 29 expressed no interest in acquisition of a computer.

- Given the potential for placement of Internet-based water orders through a cable TV or satellite TV system, 95 water users (out of the 100 responses) owned a TV and of those that owned TVs, only 64 had either cable or satellite TV systems.

- The computer capability of those water users that responded to the questionnaire was determined to be above average based on a scale of 1 to 5 with the highest ability receiving a rating of 5.

- Of those water users that owned a computer, 61 had access to the Internet with an additional four (4) planning on accessing the Internet in the near future.

- The number of water users willing to use an Internet-based system to place water orders was determined to be 42 of the 100 water users that responded to the questionnaire.

The majority of the respondents questioned the economic benefit of switching to an Internet-based system of placing water orders. In addition, some of the water users expressed concern that no benefits to water conservation would be realized through an Internet-based system.

4.0 Existing Water Accounting Procedures

The existing operation of the CAID canal and laterals involves simple operational rules and manual operation of the delivery system. Administratively, daily water orders are placed by the water users via the telephone to the CAID staff for delivery the following day. The office staff compiles the water orders for each lateral to determine the lateral headgate diversion. Lateral diversions are compiled to estimate the main headgate delivery. The operational staff uses rule-of-thumb estimates to increase the individual water orders on laterals to account for net
losses (attributable to seepage, evaporation and operational waste) and the CAID manager determines a daily request for diversion from Alcova Reservoir to the Casper Canal. Ditch riders within the CAID manually operate the gates and check structures on the main canal and laterals to ensure adequate delivery of the individual water orders.

The existing computer program used by the CAID to track water orders and issue bills is a proprietary software program, which maintains individual information on water orders and provides the assessment data for billing at the end of each year. Data is manually entered by CAID office staff from the daily telephone orders. The computer-based program tracks the cumulative orders for each water user to assist the water users in planning their total allotments and to forewarn office staff and water users of the status of their individual allocations for each year.

5.0 Discharge Measurement and Recording Procedures

The CAID ditch riders typically divert additional quantities of water to ensure the irrigation demands are delivered following losses to evaporation and seepage. This occurs at the individual farmer's turnouts as well as the headgates to the laterals. Currently, the water that is actually diverted at the lateral headgate or individual turnout structure is not recorded; however records of irrigation demand (water orders) are maintained by the CAID. Procedures should be instituted to record the total diversion at the headgates associated with each lateral, sublateral, and individual turnout on a daily basis. Operationally, this data will significantly improve the tracking and equitable delivery of water to all users and will promote the quantification of losses within the irrigation delivery system.

6.0 Canal and Lateral Management

The CAID manager and ditch riders rely on experience and judgment to manage the water supply following diversion into the Casper Canal. The staff maintains accounting sheets of the water orders on a daily basis to assist in the day-to-day operations. The farmer's turnout structures are typically equipped with a measuring structure (cipolletti weir, parshall flume, or pipe flow meter), although several structures are in need of rehabilitation to ensure accurate discharge measurements. Given the information on the individual demand at each turnout structure, the ditch riders typically ensure that the delivery meets or exceeds the demand by not less than 10%. As stated previously, no records of actual deliveries are maintained by the ditch riders.

Rainfall that falls on the CAID affects the operation of the canal system by introducing direct precipitation into the canal/lateral system as well as capturing stormwater runoff. Direct
precipitation also reduces the required crop irrigation requirement, directly diminishing the demands at the farmer’s turnouts. This situation is handled by the ditch riders through: (a) delivery of the irrigation requirements into the individual farmer’s turnout structures and ultimately wasting the water into the field/drain system; or (b) utilizing the wasteway/spillway structures at the end of each lateral system to spill the operational waste into the existing drains.

7.0 Automated Water Accounting and Billing

With respect to integration of a computerized irrigation scheduling system, the first phase of improvements involves replacement of the existing water ordering system with an Internet-based ordering program. An existing program, developed by Dr. J. Mohan Reddy of the University of Wyoming was investigated for its application to the CAID. Based on a review of Dr. Reddy’s program, several improvements were identified. These improvements, intended to increase the functional benefits associated with implementation of Dr. Reddy’s computer program for the CAID, are listed below.

- The program should be tailored to specifically reflect the Casper Canal, all laterals, and all CAID water users by lateral to promote consolidation of water orders.
- A minimum and maximum diversion threshold should be established for each water user.
- Develop a screen interface that illustrates the connectivity of the laterals and the Casper Canal.
- Integrate estimates of seepage loss, operational waste, and evaporation into the program to obtain the consolidated diversion estimate at each lateral headgate as well as the diversion from Alcova Reservoir.
- Develop an interface between the existing proprietary software for placement of water orders/accounting and the program provided by Dr. Reddy. Avoid duplication of effort with respect to data entry.
- Pending future automation of headgates and real-time data collection with respect to water measurement at the v-notch weir from Alcova Reservoir as well as laterals and operational spills, integrate the capability to incorporate this data to promote management of the water supplies.
- Pending placement of automated weather stations within the CAID, incorporate the capability to access this data to obtain estimates of precipitation, crop evapotranspiration and promote irrigation scheduling.
8.0 Improvements to Automate Operation and Management

Simply automating the water ordering system does not enhance the operational management of the canal and laterals. The ability to monitor and remotely control the irrigation flows in the Casper Canal and major laterals will require the design and construction of water level monitoring stations, flow measurement/gaging stations and an integrated telemetry system. Consequently, to fully realize the benefits of a computerized management program, rehabilitation or installation of selected measurement and control structures will be required along with computer hardware and software to support their operation and provide a mechanism for remote data collection.

The water operation and management improvements should be developed in modular form to integrate specifically into the module developed for the web-based water ordering and accounting program. Depending on the needs or desires of the CAID, three levels of implementation were developed for consideration.

**Level I Implementation:** Development of software to support the estimation of diversion requirements at each lateral headgate as well as Alcova Reservoir. Estimates of seepage loss, operation waste and evaporation for each lateral should be determined from measured diversion data and utilized along with the daily water orders to develop an estimate of the diversion requirements at each lateral headgate. Similarly, these losses should be determined on a reach-by-reach basis for the Casper Canal and utilized with the lateral diversion requirements to develop an estimate of the diversion requirement at Alcova Reservoir.

**Level II Implementation:** Integration of real-time measurement data at each lateral headgate and the v-notch weir near Alcova Reservoir. This data will be utilized to determine system losses and estimate diversion requirements at each lateral and Alcova Reservoir. In addition to the system automation identified with improvements under the original contract, implementation at this level will require acquisition of real-time measurement data at sixteen (16) additional lateral headgates.

**Level III Implementation:** Integration of real-time measurement data at each lateral headgate and automation of slidegates to remotely control the diversions at those locations. Implementation at this level will: (a) provide instantaneous data of the diversions at each location as well as any daily fluctuation in the diversion; (b) ensure the delivery continuously meets the demand requirements through remote adjustment of the slidegate; and (c) provide for control of the slidegates to ensure the integrity of the existing facilities.
9.0  Cost Estimates and Economic Feasibility

Detailed cost estimates were prepared for the phased implementation of two major components: (a) Internet-based water ordering program; and (b) water operation and management program. With respect to the implementation of the water operation and management program, costs are provided assuming the three levels of implementation. An economic analysis was also completed to determine the impact of implementing the project components on the current annual assessment of the water users.

Total costs associated with the installation of the water ordering program were determined to be $20,150. In addition to these costs, the water users will be required to purchase computer hardware to place the water orders. Based on the survey questionnaire, 30% of the water users did not own a computer. Purchase of a computer to place the water orders is estimated to cost $1,000. Placement of the water orders will also require access to the Internet through an ISP. The monthly charge for Internet access is estimated to be $20/month for each water user.

For the water operation and management program, Level I implementation involves the development of software to support the integration of losses within the system along with water orders to obtain estimates of diversions at each lateral headgate as well as the headgate at Alcova Reservoir. No additional hardware or equipment requirements are necessary. The cost associated with Level I improvements are related to engineering and software development and are estimated to be $20,000.

Level II implementation requires the placement of accurate measurement structures at all lateral headgates and installation of a radio-telemetry system to transmit the data. Sixteen (16) sites were identified specifically for real-time data collection. Each site will monitor the water level in the Casper Canal and lateral, remotely record the measurement data, and transmit the measurement data to a base station at the CAID office. Typical costs associated with the instrumentation and equipment requirements at each headgate are estimated to be $15,600. Assuming radio-telemetry systems are installed at sixteen (16) headgates as part of this project, the total construction cost becomes $249,600.

Level III implementation requires the automation of one slide gate at each headgate structure to remotely control the diversions from the Casper Canal. This level of implementation assumes the integration of the real-time measurement data at each headgate as indicated for the implementation of Level II improvements. Similar to Level II, sixteen (16) sites were identified specifically for automation and control of the diversions from the Casper Canal. Each site will monitor the water level in the Casper Canal and lateral, remotely record the measurement data, transmit the measurement data to a base station at the CAID office, and provide for remote operation of the slide gate. Typical costs associated with the instrumentation and equipment requirements at each headgate are estimated to be $35,100. Assuming Level III improvements
are placed at sixteen (16) headgates as part of this project, the total construction cost becomes $561,600.

The total project costs associated with installation of the water ordering program and the water operation and management program have been estimated and are presented in Table 1. This estimate includes costs associated with construction contingency, engineering, and preparation of final plans and specifications. Table 1 also presents the final repayment plan for each implementation alternative. As indicated, the repayment plan assumes a 50% loan/50% grant from the WWDC with a term of 20 years and an interest rate of 6.0% on the loan.

Table 1. Total Project Costs And Assessment Increase

<table>
<thead>
<tr>
<th>Item</th>
<th>Water Ordering Program</th>
<th>Water Operation &amp; Management Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Project Components / Installation</td>
<td>$20,150</td>
<td>$20,000 $249,600 $561,600</td>
</tr>
<tr>
<td>Engineering (included in Project Components)</td>
<td>$0</td>
<td>$0 $0 $0</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>$20,150</strong></td>
<td><strong>$20,000</strong> $249,600 <strong>$561,600</strong></td>
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<tr>
<td>Contingency (15%)</td>
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<td>$3,000 $37,400 $84,400</td>
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<td><strong>Total Installation Cost</strong></td>
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<tr>
<td>Final Plans / Specs</td>
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<tr>
<td>Permitting and Mitigation</td>
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<td>$0 $0 $0</td>
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<tr>
<td>Legal Fees</td>
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<td>$0 $0 $0</td>
</tr>
<tr>
<td>Access and Right-of-Way</td>
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<td>$0 $0 $0</td>
</tr>
<tr>
<td><strong>TOTAL PROJECT COST</strong></td>
<td><strong>$25,500</strong></td>
<td><strong>$23,000</strong> $312,000 <strong>$686,000</strong></td>
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<tr>
<td>50% Loan</td>
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<td>$11,500 $156,000 $343,000</td>
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<tr>
<td>Repayment Factor (20 years)</td>
<td>0.0872</td>
<td>0.0872 0.0872 0.0872</td>
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<tr>
<td><strong>Annual Payment</strong></td>
<td><strong>$1,112</strong></td>
<td>$1,003 $13,603 $29,910</td>
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<tr>
<td>Annual Assessment Increase</td>
<td>$0.04</td>
<td>$0.04 $0.56 $1.23</td>
</tr>
</tbody>
</table>

10. Conclusions and Recommendations

Based on our investigation of computerized irrigation scheduling within the CAID, the conclusions and recommendations described below are provided.

1. Presently, the administrative staff of the CAID utilizes a personal computer to track the orders from individual water users. A continuous record of water usage for each user is developed and provides the basis for individual assessments for water
delivery. Daily water orders are placed via telephone from the water users and compiled to estimate a daily diversion requirement from Alcova Reservoir and each lateral headgate. Records of actual diversions from Alcova Reservoir, lateral headgates or farm turnout structures are not maintained.

2. The existing computer program used by the CAID administrative staff to track water orders and issue bills is a proprietary software program that maintains individual information on water orders and provides the assessment data for billing at the end of each year.

3. The administrative staff along with the CAID manager use rule-of-thumb estimates to increase the individual water orders on laterals to account for net losses (attributable to seepage, evaporation and operational waste) and ultimately develops a daily request for diversion from Alcova Reservoir to the Casper Canal. Ditch riders within the CAID manually operate the gates and check structures on the main canal and laterals to ensure adequate delivery of the individual water orders.

4. The CAID does not presently record the diversions at the lateral headgates or farm turnout structures. Procedures should be instituted, and a diligent effort provided, to record the total diversion at the headgates associated with each lateral, sublateral, and individual farm turnout structure on a daily basis.

5. A review of the Internet-based water ordering program developed by Dr. Reddy resulted in the following recommendations:

   • The program should be tailored to specifically reflect the Casper Canal, all laterals, and all CAID water users by lateral to promote consolidation of water orders.
   • A minimum and maximum diversion threshold should be established for each water user.
   • A screen interface should be developed that illustrates the connectivity of the laterals and the Casper Canal.
   • Estimates of seepage loss, operational waste, and evaporation should be developed and integrated into the program to obtain the consolidated diversion estimate at each lateral headgate as well as the diversion from Alcova Reservoir.
   • An interface between the existing proprietary software for placement of water orders/accounting and the program provided by Dr. Reddy should be developed to avoid duplication of effort and cost with respect to data entry.
   • Pending future automation of headgates and real-time data collection with respect to water measurement at the v-notch weir from Alcova Reservoir as well as laterals and operational spills, the capability to incorporate this data to promote management of the water supplies should be integrated into the program.
   • Pending placement of automated weather stations within the CAID, the capability to access this data to obtain estimates of crop evapotranspiration and promote irrigation scheduling should be integrated into the program.
6. Improvements to the water ordering program were identified. The total project cost to implement these improvements was estimated to be $25,500. Assuming a 50% grant/50% loan from the WWDC, the annual payment for this improvement becomes $1,112 and results in an increase in the annual assessment of $0.04 per irrigated acre.

7. Three levels of implementation were identified for the development and utilization of a water operation and management program. For all levels, it is assumed that the water orders reflect the actual deliveries at each turnout structure. If this is not a valid assumption, then actual delivery records should be input into the model and utilized.

   The total project cost to implement the Level I improvements was estimated to be $23,000. Assuming a 50% grant/50% loan from the WWDC, the annual payment for this improvement becomes $1,003 and results in an increase in the annual assessment of $0.04 per irrigated acre.

   The total project cost to implement the Level II improvements was estimated to be $312,000. Assuming a 50% grant/50% loan from the WWDC, the annual payment for this improvement becomes $13,603 and results in an increase in the annual assessment of $0.56 per irrigated acre.

   The total project cost to implement the Level III improvements was estimated to be $686,000. Assuming a 50% grant/50% loan from the WWDC, the annual payment for this improvement becomes $29,910 and results in an increase in the annual assessment of $1.23 per irrigated acre.

   The benefits derived from installation of an Internet-based water administrative and operation program depend on utilization by the water users as well as the administrative staff of the CAID. The survey questionnaire attempted to gauge the interest of the water users for a new system of placing water orders. Based on the limited response to the questionnaire, one may conclude that limited interest exists to change the present system. Furthermore, many water users will need to acquire computers and incur a monthly charge to access the Internet to place the orders.

   Discussions with the administrative staff of the CAID have indicated a reluctance to change from the current system unless it can be demonstrated that data only needs to be input one time and the same capability is provided in the new program. Consequently, it will be essential to interface the existing assessment program to the Internet-based system or simply develop software to replicate the existing assessment program.

   The issues identified above must be addressed more fully before this program will be acceptable to the CAID. Based on this information, additional effort by the developers of the program is warranted to address these issues as well as the need to provide software development to tailor the existing program to reflect the CAID irrigation system. It is recommended that this effort be completed prior to potential funding of project improvements identified in this report.