FINAL
SUNDANCE MASTER PLAN LEVEL I
CROOK COUNTY, WYOMING
WYOMING WATER DEVELOPMENT COMMISSION

September 9, 2013
Project #: 23F-001-001

SUBMITTED BY: Trihydro Corporation
1252 Commerce Drive, Laramie, WY 82070
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1.0 INTRODUCTION

1.1 PROJECT OBJECTIVES

This study was undertaken to broadly identify solutions and alternatives for addressing water supply issues. This study also provides a framework for developing infrastructure improvement strategies and serves to identify and resolve water issues and concerns of the City.

Level I master plans serve as blueprints for future water supply system improvements. A master plan also serves as a framework for entities to establish project priorities, and provides financial planning needed to meet those priorities. In some cases, the master plan assists the sponsor (i.e., City of Sundance) with preparing federal funding assistance documentation. A master plan may also assist a sponsor with the preparation of federal permit documentation and, in some instances, federal funding for infrastructure components that are not eligible for WWDC funding.

From the perspective of the State of Wyoming, a master plan serves to promote the effective and efficient use of available water resources, as well as provide analysis and comparison of development alternatives. This information is used to develop cost estimates and schedules for water development improvements that benefit both the sponsor and the State, if the sponsor requests funding assistance to implement the construction of new water infrastructure or the rehabilitation of existing infrastructure.

Through initial research and extensive communications with the City of Sundance (City), it was understood, prior to the master-planning effort, that the City noted the following high-importance items:

1. Relocation of the Cole Storage Tank to a stable site
2. Combine storage, if practicable, for the Sundance Kid Tank and Underground Reservoir
3. The existing conveyance capacity of the water mains in Cleveland and Main Streets
4. Storage and pipeline capacity needed to meet current and future water demands (including fire suppression) in the Sundance West Subdivision
5. Chlorination of water from Well 6
6. Suspected leaks at wells and/or check valves in the supply and transmission system
7. Wellhead protection
8. Backup power to water supply wells
9. Contingency planning for potential interruptions in water delivery from the Cole Well Field and Well 6
10. Dead-end lines and distribution system efficiency (e.g. lack of redundancy in the water system)
11. Infrastructure age and material types
12. Improve maintenance record keeping through GIS application
13. Potential for SCADA or similar system to assist with operational concerns

The recent Cole Tank slope failure, tedious water system operations and maintenance, and other water system concerns motivated the City to seek assistance from the Wyoming Water Development Commission (WWDC) to complete a Level I Master Plan (Plan) to assist with laying out a framework for future decision-making. The WWDC entered an agreement with Trihydro Corporation (Trihydro) on June 7, 2012 to complete the following general scope of work:

- Review of existing information
- Inventory and evaluate existing water systems
- Creation of a Geographic Information System (GIS) of the City’s water system
- Hydraulic model
- Water source data and water rights
- Water quality
- Evaluation of system operations and maintenance
- Water system financing analysis
- Master Plan Report

This report describes the approach, methodology, data, ideas, concerns, and preferences gathered through the planning process and in meetings held with the Wyoming Water Development Office (WWDO) and City staff. It also describes recommendations to address immediate and future concerns for the City’s water system.

Figure 1-1 is an overall water system map to be used as a reference when reviewing this report. It presents major water system components including the municipal supply wells, storage reservoirs, chlorinator facilities, pump stations, pressure reducing valve (PRV) control stations, and other useful and pertinent information.
The City’s primary water supply source is groundwater from the Cole Well Field, located north of the community along the eastern edge of Bear Lodge Mountain. A secondary supply source is Well 6 located to the west of Sundance. Well 6 was constructed in 1986 with funding and assistance from the Wyoming Water Development Commission (WWDC). Well 6 has historically been used as a supply source principally during the summer irrigation season. High-quality groundwater is pumped from two wells (wells 3A and 3B) in the Cole Well Field. The City’s newest well, Well 3C, was completed in 2009 near wells 3 and 3A, and is not currently a reliable water supply source.

Groundwater pumped from the Cole Well Field is conveyed via the Cole Transmission Line to the Cole Tank. Until 2010, a smaller storage tank located near the current site of the Cole Tank was used to store water from the Cole Well Field. The Cole Tank was constructed at a higher elevation and provided more storage capacity; therefore, the smaller tank was removed following its construction.

In 2011 the foundation of the Cole Tank started to fail and the City has been unable to rely on this storage facility. The Cole Transmission Line is configured to allow groundwater from the Cole Well Field to bypass the Cole Tank and be conveyed directly to the City; however, facility operation without storage capacity benefit and pressure head provided by the Cole Tank constrains the customer service level the City can provide.

Water pumped from the Cole Well Field, and/or stored in the Cole Tank is chlorinated and conveyed to the City via an 8-inch asbestos-cement transmission pipeline. A small rural subdivision, the Orr Subdivision located near the Cole Tank, is also served from this transmission pipeline.

Two pressure zones; the “North Pressure Zone” and the “South Pressure Zone” serve the City proper. The areas of Sundance comprised within each of the two pressure zones is shown in Figure 1-1. The North Pressure Zone is supplied directly from the Cole Transmission Line. In the winter months, the South Pressure Zone is also supplied by the Cole Well Field via the distribution system. During the summer irrigation season when water demand increases, the distribution system is also supplied by Well 6 via a 10-inch transmission pipeline connected to the South Pressure Zone.

Additionally, there are four smaller pressure zones (Figure 1-1) associated with developments around Sundance. One is associated with the Orr Subdivision, which is located to the northeast of Sundance near the Cole Tank. The other three smaller zones are referred to as follows:

- Canyon Zone located on the City’s west side is supplied by the Canyon Tank
- Sundance West Zone located on the City’s west side is supplied by the Brewer Tank
• Policky Zone is located on the City’s south side and is supplied by the Policky Tank

• East Zone is located on the east side of town, south of the interstate, and is supplied by the Policky Tank through a pressure-reducing valve (PRV)

1.2 COLE STORAGE TANK
In addition to the assistance the WWDC provided to Sundance for this Level I water master planning study, the WWDC is also funding a Level III project to relocate the Cole Tank, whereby service from this storage tank to the community can be restored. Restoring the storage capacity that the Cole Tank provides is of critical and immediate importance to the City. The City had the Cole Tank disassembled in May 2013, during the course of this study, and is planned to be relocated in the fall of 2013.

The City requested that Trihydro provide engineering services for the relocation of the Cole Tank. This level I master planning study and Cole Tank relocation projects have been conducted simultaneously, allowing important engineering elements to be performed during the computer modeling of the City’s water system. The computer model prepared to support engineering analysis of alternative tank locations for the Cole Tank relocation project was expanded and used as part of this master planning study.

1.3 WELL 6 CHLORINATOR BUILDING
Subsequent to receiving funding to relocate the Cole Tank, the City received State Land and Investment Board (SLIB) funding to build a chlorination facility at Well 6. This was presented as an urgent matter to SLIB on August 9, 2012 due to the imminent disassembly of the Cole Tank and the requirement to maintain water quality and City water supply. The dismantled Cole Tank will be stored for a period of time while the new tank site is prepared for the tank’s relocation.

During the course of this master planning study, a new chlorinator facility has been constructed for chlorinating water from Well 6. Water chlorination will allow the City to use the well on a full-time basis and will assist the City in maintaining the water quality and supply through the Cole Tank relocation process.

1.4 SCOPING AND PROJECT MEETINGS
During the course of this study, a scoping meeting and three project progress meetings were conducted to provide the WWDO project manager and the City with progress updates and obtain input on project issues. The meetings were
scheduled based on completed work tasks and provided valuable insight and direction through the study’s progression. Appendix A provides meeting minutes and notes from the meetings.

1.5 ACKNOWLEDGEMENTS

Completion of this Plan would not have been practical without the input and data provided by numerous individuals including:

- Chace Tavelli, Wyoming Water Development Commission
- Larry Schommer, City of Sundance Public Works Director
- Kathy Lenz, City of Sundance Clerk-Treasurer
- Helen Engelhaupt, City of Sundance Clerk-Utility Billing
- Paul Brooks, City of Sundance Mayor
- Zach Steele, City of Sundance Public Works Crew Lead
- Doug Haar, City of Sundance Public Works
- Doug Adams, City of Sundance Public Works
- April Gill, City of Sundance Council Member
- Ken Denzin, City of Sundance Council Member
- Sheryl Klocker, City of Sundance Council Member
- Hugh Palmer, City of Sundance Council Member
- Steve Lenz, City of Sundance Land Use Planning
- Paul Anderson, City of Sundance Land Use Planning

Trihydro thanks these individuals and other City staff who took time out of their busy schedules to provide data, input, and access to water system components required to complete this Plan.
2.0 REVIEW OF EXISTING INFORMATION

Existing information was gathered from a variety of sources to better understand the City’s water supply system. This information was used throughout the project to assist with subsequent project tasks such as understanding current water demands, evaluating water quality, tabulating water rights, and forecasting population projections. Published reports and documentation available from outside agencies including the WWDC, Wyoming Department of Environmental Quality (WDEQ), the Wyoming State Engineer’s Office (SEO), and the Wyoming Department of Administration and Information, Economic Analysis Division (EAD/DA&I) were reviewed as part of this study, along with the City’s water system records. A summary of the information reviewed is discussed below.

2.1 WWDC – SUNDANCE NO. 6 WELL GROUNDWATER PROJECT

Only one previous report prepared for the WWDC for Sundance was available through their online documents’ database, the Water Resources Data System (WRDS). The Report for The Sundance Groundwater Project, Sundance No. 6 Well, June 24, 1986 (Well 6 Report), was prepared by Bearlodge LTD. Inc., Dr. J. Paul Gries. The Well 6 Report focused on documenting the Well 6 construction phase and testing.

The Well 6 Report included a brief project background discussion. It was stated that it became necessary to improve the City’s supply capabilities to provide adequate supply for peak summer water demands and meet fire-flow requirements. Two alternatives were evaluated to provide additional supply. One alternative was to construct a second transmission line from the Cole Well Field approximately 5 miles into town, and the other alternative was construction of a new well closer to town. Based on a comparison of estimated project costs, the City decided to pursue construction of a new well west of town.

Dr. J. Paul Gries, a geologist from Rapid City, South Dakota conducted a preliminary investigation of a water supply source west of town. His report concluded there would be reasonable potential for a municipal supply source drilled to the Madison formation at a depth between 1,200 and 1,500 feet.

To fund the new water supply project, the City applied for a grant through the WWDC Groundwater Grant Program. No previous wells had been drilled west of Sundance into the Madison formation; therefore, the City was awarded a grant of 75% of the estimated construction cost, not to exceed $200,000.

The remainder of the Well 6 Report documents the project construction phase and testing. The project was awarded to Materi Exploration from Upton, Wyoming, and construction started in January 1986. During construction, the
contractor experienced difficulties drilling due to loss of circulation at various depths. Drilling was completed to a depth of 1,184 feet, when loss of circulation prompted drilling completion. It was determined that an acceptable well could be completed at that depth, and drilling deeper into the Madison formation was not necessary.

Weston Engineering was then contracted to complete pump testing. Stepped-rate and constant-rate tests were conducted. Testing results are further discussed in Section 7.0 – Water Source Data and Water Rights.

2.2 WDEQ SOURCE WATER ASSESSMENT AND PROTECTION PROGRAM

In response to the Safe Drinking Water Act (SDWA) Amendments passed by the United States Congress in 1996, the Wyoming Legislature authorized WDEQ to develop a Source Water Assessment and Protection (SWAP) program. The SWAP program is a two-part program consisting of source water assessment and source water protection plans. WDEQ has completed source water assessments for all Wyoming public water systems that requested the voluntary assessment. The program intent is for the public water system to use the assessment to develop a source-water protection plan that outlines appropriate measures to protect the drinking water supply.

A source water assessment dated June 30, 2004 was completed for the City. The assessment included:

- Determination of a source water area
- Assessment of contamination sources within the source water area that have the potential to affect the drinking water supply
- Evaluation of water supply susceptibility to contamination from each identified contamination source
- Development of a report summarizing the information gathered during the assessment

Results of the Sundance assessment are further discussed in Section 7.0 – Water Source Data and Water Rights.

2.3 OUTSIDE AGENCY RECORDS

Information was gathered from the SEO for the City’s water supply wells. Well permits and water rights’ tabulations were reviewed, and the review results of this information are further discussed in Section 7.0 – Water Source Data and Water Rights. Population projections and state economic statistics prepared by the EAD/DA&I were used in developing population projections for the City, as further discussed in Section 5.0 – Population Growth and Water Demand Projections. Additional information used in Section 5.0 to estimate the City’s potential growth was found in documents published by Rare Element Resources and Strata Energy, estimating the impacts of potential development near the City.
2.4 CITY OF SUNDANCE RECORDS

Information was gathered from the City on the existing water system to be used throughout the study. Several discussions were held with the public works director, clerk-treasurer, and other City staff to gain a better understanding of the water system and how the City operates and maintains it. Some of the information reviewed is described in the subsections below.

2.4.1 CITY GIS AND AS-BUILT DRAWINGS

Initial information on the water system was gathered from the City’s GIS map, which included basic information regarding water line location, size, and material, and the location of wells, storage tanks, hydrants, and valves. Further discussion of the GIS information is provided in Section 4.0. GIS information was supplemented with the City’s hard copy maps of the water system, which included information on line size, storage tank locations, and capacity, and information on the pressure zones. A water system operations manual was also reviewed.

Design and as-built information for previous water-system improvements were reviewed. The City provided hard copy as-built drawings for electronic scanning for archival and review. Previous project manuals and WDEQ design reports that were available were reviewed, although this information was limited. The City maintains records of water system improvements in a hard copy map book. When water system improvements are made, notations are made by hand within the book. The City assisted with scanning the map book information to assist with system understanding.

2.4.2 STORAGE TANK INSPECTION REPORTS

The City provided reports documenting the inspection of the City’s water storage tanks for review. Two of the City’s tanks were inspected in April 2001, and three additional tanks were inspected in October 2010. The findings and recommendations from these reports are documented below. Due to City staff turnover after the reports were documented, it is difficult for current City staff to confirm whether the improvements recommended in the reports have been implemented. Based on an understanding of the condition of the storage tanks, it is believed the City has not implemented the recommended improvements.

2.4.2.1 POLICKY TANK INSPECTION REPORT

On April 24, 2001, a surface-supplied diver from the Water Technology division of Muldoon Marine Services, Inc. (Muldoon) performed an underwater video inspection of the Policky Tank. The tank walls, floor, roof, internal plumbing, and support columns were inspected. The findings and recommendations are documented in a report prepared by Candice Miller for the Town of Sundance, Wyoming dated April 24, 2001.
2.4.2.1.1 FINDINGS

- The roof was reported to be in overall good condition. Corrosion was reported on the roof panels and between the roof panels and trusses. The wall to roof seam had moderate uniform corrosion along the welded seams.

- The walls were reported to be in overall good condition. Slight corrosion and heavy delamination were reported.

- The floor was reported to be in good condition, but there was some heavy corrosion and pitting at the floor to wall seams.

- The internal plumbing was in good condition. Moderate corrosion was reported on the cleanout. Slight uniform corrosion was reported around the inlet/outlet pipe.

- Concentrated cell corrosion was reported between the column base and floor panels. Small areas of pitting were also present around the column base. Muldoon reported ice cap damage and heavy delamination at the water level. Further explanation was not provided.

2.4.2.1.2 RECOMMENDATIONS

Muldoon recommended epoxy repairs along the damaged areas of the floor, floor to wall seam, and the walls as soon as possible. Cleaning and inspection of the tank every 3 to 5 years was also recommended to monitor the corrosion and pitting.

2.4.2.2 MT. MORIAH TANK INSPECTION REPORT

On April 24, 2001, a surface-supplied diver from the Water Technology division of Muldoon Marine Services, Inc., performed an underwater video inspection of the Mt. Moriah Tank. The tank walls, floor, roof, internal plumbing, and support columns were inspected. The findings and recommendations are documented in a report prepared by Candice Miller for the Town of Sundance, Wyoming dated April 24, 2001.

2.4.2.2.1 FINDINGS

- The roof was in good condition. Some corrosion was noted on the roof panels and between the roof panels and the trusses.

- Uniform corrosion was noted on the walls throughout the tank, with more corrosion found above the water line. Rust was noted on one of the wall seams.

- The tank floors were reported to be in good condition. The lap welds contained minor staining.
• The internal plumbing was generally in good condition. The two cleanouts were in good condition, although one was cracked at the hinge.

• Some corrosion was noted on the center support column and around the column perimeter where the base and floor seams meet. Heavy corrosion and coating loss was observed along the water line.

2.4.2.2 RECOMMENDATIONS

Muldoon recommended epoxy repairs on the welded seams be completed later that year. Gel epoxy repairs were recommended around the support column base. Installation of a 6-inch riser on the inlet/outlet was recommended to avoid sediment from being pulled into the outlet.

2.4.2.3 BLUE TANK INSPECTION REPORT

A surface-supplied diver from Midco Diving & Marine Services, Inc. (Midco) inspected the Blue Tank on October 9, 2010. Findings are documented in the Report of Procedures and Findings from the Inspection of the Aquastore Water Tank, City of Sundance, Wyoming. The condition of various tank components were evaluated, and assigned a rating according to the following scale:

• Excellent – like new condition, no repairs needed
• Good – cosmetic only problems, repair if wanted
• Fair – minor problems, repairs needed, not immediate
• Poor – major problems, structural or like, immediate repairs needed

2.4.2.3.1 FINDINGS

Upon visual inspection of the tank exterior and visual inspection of the interior, both above and below the water line, Midco reported the tank to be in excellent overall condition. All but one of the tank components evaluated during the inspection received either an excellent and good rating. Sediment on the interior tank floor earned a poor rating, and it was noted that 1/8 inch of sediment was removed from the tank. It was also noted that the tank contained 4 sacrificial anodes. Two anodes were 50% used, and the other 2 were 90% used.

2.4.2.3.2 RECOMMENDATIONS

The report recommended the anodes be replaced and the City continues to clean and inspect the tank every 2 to 3 years.
2.4.2.4  SUNDANCE KID TANK INSPECTION REPORT

A surface-supplied diver from Midco Diving & Marine Services, Inc. inspected the Sundance Kid Tank on October 9, 2010. Findings are documented in the Report of Procedures and Findings from the Inspection of the Sundance Kid On-Grade Water Tank, City of Sundance, Wyoming. The condition of various tank components were evaluated, and assigned a rating according to the following scale:

- Excellent – like new condition, no repairs needed
- Good – cosmetic only problems, repair if wanted
- Fair – minor problems, repairs needed, not immediate
- Poor – major problems, structural or like, immediate repairs needed

2.4.2.4.1 FINDINGS

Upon visual inspection of the tank exterior, Midco reported the tank to be in fair condition with only cosmetic issues noted. Upon visual inspection of the tank interior, both above and below the water line, Midco reported the tank to be in fair condition, consistent with a reservoir of this age and type. Numerous holes in the roof were noted and in need of immediate repair. Interior coating failure was noted and the brackets on the interior ladder were observed to be broken.

2.4.2.4.2 RECOMMENDATIONS

The report recommended several layers of interior coating and repair to the holes in the roof. Consideration of blasting and recoating/rehabilitating the tank was discussed. The report also recommended the tank continue to be cleaned and inspected every 2 to 3 years.

2.4.2.5 UNDERGROUND RESERVOIR TANK INSPECTION REPORT

A surface-supplied diver from Mideo Diving & Marine Services, Inc. inspected the Underground Reservoir on October 9, 2010. Findings are documented in the Report of Procedures and Findings from the Inspection of the Below-Grade Water Tank, City of Sundance, Wyoming. The condition of various tank components were evaluated, and assigned a rating according to the following scale:

- Excellent – like new condition, no repairs needed
- Good – cosmetic only problems, repair if wanted
- Fair – minor problems, repairs needed, not immediate
- Poor – major problems, structural or like, immediate repairs needed
2.4.2.5.1 FINDINGS

Upon visual inspection of the tank exterior, Midco reported the tank to be in good condition. Upon visual inspection of the tank interior, both above and below the water line, Midco reported the tank to be in acceptable condition, consistent with a reservoir of this age and type. Severe chalking of interior concrete surfaces was reported. Heavy root penetration was observed, creating cracks in the perimeter.

2.4.2.5.2 RECOMMENDATIONS

The report recommended the root growth be removed, and the cracks epoxy repaired to prevent new root growth and stop seepage. The report also recommended the tank continue to be cleaned and inspected every 2 to 3 years.

2.4.2.6 LEAK DETECTION REPORT

Utility Services Associates, LLC (USA) performed a leak survey for the City on July 9th and 10th, 2009. The survey procedures, results, and recommendations are documented in the Water Line Leak Location Project Final Report. The study consisted of a survey phase and a pinpointing phase. During the surveying phase, contact was made with access points approximately every 300-400 feet along the water line to sound appurtenances and record detected leak type noises. Noises that were detected during the survey phase were then pinpointed during the second phase.

2.4.2.6.1 FINDINGS

Three leaks were pinpointed during the survey:

- The hydrant at the Green Mountain Water District was leaking. Flushing the hydrant and tightening the operating nut did not stop the leak.
- A significant main line leak was pinpointed at E. Park Street and S. 3rd Street.
- A hydrant north of the rest stop on Industrial Way was reported to be leaking. The crew shut down the hydrant valve and planned to make repairs before the turning the valve back on.

USA suspected an additional leak, although the survey was unable to pinpoint the exact leak location. USA suspected the leak at the Tastee Freez on Highway 14, and thought it linked to a recent nearby fiber-optic cable installation project.
2.4.2.6.2 RECOMMENDATIONS

The report recommended the areas of identified leaks be excavated and repaired. USA recommended potholing in several locations near the suspected leak on Highway 14 for further investigation. If no leak is found, the area should continue to be monitored. The report also noted that the City’s system mapping should be updated, as it did not accurately represent the location of system appurtenances. It is unknown whether the City has addressed these recommendations.

2.4.3 ADDITIONAL CITY DOCUMENTATION

The City provided additional documentation, which were used to assist with specific project tasks and discuss later in this report. This information includes:

- Water use records, as further discussed in Section 5.0
  - Electronic meter reading data
  - Hand-written pumping records
- Water quality documentation, as further discussed in Section 8.0
  - EPA sanitary survey
  - Consumer confidence report
  - EPA correspondence
  - Laboratory results of water quality testing
- Interviews on operation and maintenance practices, as further discussed in Section 9.0
- Financial information, as further discussed in Section 13.0
  - Previous City rate study
  - Budget work sheets
  - Billing and usage reports
  - Interviews with City staff on budgeting/finance info and rate structure
- Email correspondence
- Work orders
- City ordinance and zoning regulations
3.0 INVENTORY AND EVALUATE EXISTING WATER SYSTEMS

Existing water system(s) inventory and evaluation is an important step in verifying available water system mapping and in building a representative system hydraulic model. The purpose of this task was to identify short- and long-term water system infrastructure concerns. This task was performed to determine the existing water system’s ability to meet current and future water demands. There were several discussions with City staff regarding various water-system components and visual inspections were performed of the major components.

This section describes the City’s water supply, transmission, storage, and distribution infrastructure. Figure 1-1 identifies these primary water system components. Data presented in this section are the compilation of existing reports, as-constructed plans, City and State records, discussions with City staff, and field investigations performed with the City Staff. Key concerns are identified with respect to each of the primary system components.

3.1 WATER SOURCES

Currently, the City’s water supply is obtained from groundwater. Surface water does not represent a significant City water supply source. The following sections describe the water rights and sources from which the City obtains their municipal water supply.

The City’s municipal groundwater supply is currently produced from the Cole Well Field, located north of the City, and Well 6 located west of the City. The Cole Well Field includes wells 3, 3A, 3B, and 3C. The City regularly uses wells 3A and 3B, with Well 3 serving as a back-up supply source. Well 3C is connected to the system; however, it is not currently operational. The City has historically used Well 6 to supplement the water supply system during peak-summer water usage, but with the new chlorination building installation (further discussed below), the City intends to use this well as a full-time supply source.

In total, the City is currently adjudicated for 1,670 gpm through the SEO. Records indicating water production or supply issues since the initial 1969 completion of the Cole Well Field were not found.

Section 7 of this report provides additional information on the City’s water supply, including details on why Well 3C is not used and information on other wells within and adjacent to the City that are no longer used. Table 3-1 identifies each of the City’s wells.
Identified Concerns

- Well 3C was completed in 2009, however, it was not put into service. Appendix C provides a detailed summary of the problems encountered with the well. Section 7 provides recommendations for further investigation of Well 3C during a Level II study.

- The transmission line from the Cole Well Field appears to lose pressure at times from water draining back to the wells, but the exact cause is not known. City staff observed the sound of water running in each of the Cole Well Field well vaults when the pumps turn off. The City has since installed a check valve on the Cole Transmission Line downstream from the Cole wells connection to the transmission line. This has reportedly provided some improvement. Further study of the water transients (water hammer) is needed to understand the cause and to recommend alternative solutions.

3.1.1 TREATMENT

The City uses chlorine gas to disinfect the water supply. Water from the Cole Well Field is chlorinated at the Cole Tank Chlorinator Building and Pump Station. Historically, water was chlorinated downstream of the Cole Tank; however, with the proposed tank relocation, water will be chlorinated prior to storage in the tank.

The City has historically used water from Well 6 to supplement the water supply during peak-summer water demand, since it is not chlorinated. A new gas chlorination facility was being constructed during the course of this study, with completion planned for June 2013. Upon the facility’s completion, the City intends to use this well as a full-time supply source.

Identified Concerns

- The City’s wells do not have wellhead protection features in place. Recommendations for a wellhead protection plan are included in section 9 of this report.

3.2 TRANSMISSION

3.2.1 COLE TRANSMISSION LINE

Water is supplied from the Cole Well Field to the Cole Tank by an 8-inch transite (asbestos cement) pipe. The pipe runs approximately 8,426 ft from the Cole Well Field to the Cole Tank. From the Cole Tank, the transmission line is about 3,486 ft to the Orr Subdivision, then an additional 12,710 ft to the connection into the distribution system near the Cleveland and East Main Streets intersection. There are multiple taps located along the length of the Cole
Transmission Line. Not all tap locations are documented, but it is noted that a number of taps were given in exchange for easements in the 1950’s during the pipeline construction.

3.2.2 POLICKY TRANSMISSION LINE
Water from Well 6 is supplied to the Policky Tank by a 10-inch and 8-inch transmission line. The 10-inch pipe is approximately 9,020 ft long, and is reduced to an 8-inch pipe near the Interstate 90 and South West Street intersection. The 8-inch pipe section is about 3,552 ft long. Both the 10- and 8-inch pipelines have service taps along their lengths.

Identified Concerns

- Water transients (i.e., water hammer) have historically affected the Cole Transmission Line as the Cole Well Field turns on and off, and potentially when the altitude valve (i.e., Cla Valve), used to fill the Mt. Moriah Tank, is opened and shut. When the Cole Tank is in service, it serves as a surge protection for the transmission line; however, when it is not in service, the transmission line experiences these transients.

- The City recently replaced air release/air intake valves from the Cole Well Field to the Cole Tank and installed a check valve in the Cole Transmission Line downstream of the wells’ confluence with the transmission line. This has reportedly alleviated the water hammer problem, but has not fully addressed the issue.

- There is not a dedicated transmission line from the Cole Tank to the Mt Moriah Tank, Sundance Kid Tank, or Underground Reservoir. Water is instead supplied to the tanks through the distribution system, comprised of small diameter pipes (4- and 6-inch). The small diameter, along with the age, and water line material collectively results in a significant headloss (approximately 70 ft of head) between the Cole and Mt. Moriah tanks.

- There are multiple taps off the Cole Transmission Line between the Cole Well Field and the Cole Tank. These taps decrease the pressure in the transmission line when the pumps are not running, and are believed to contribute to water hammer at the Cole Tank Chlorinator Building.

- During the modeling process, it was noted that the 8-inch portion of the Policky transmission line nearest to the Policky Tank is a bottleneck, and is responsible for failed fire nodes in the Policky Pressure Zone.

3.3 STORAGE
There are currently 8 tanks in operation as part of the City’s domestic water system. Table 3-2 presents the storage volume, dimensions, high water elevation, and each tank pressure zone. Figure 1-1 shows the tanks physical locations within the system.
The City’s storage tanks provide a total volume storage capacity of 1,171,000 gallons. This volume was compared to the City’s average daily demand and fire flow requirements to verify the City’s compliance with storage requirements per the WDEQ Rules and Regulations. The WDEQ requires water systems serving from 50,000 to 500,000 gallons on the average day to provide system storage capacity equal to the average daily demand plus fire storage. The City’s average daily demand is 437,770 gallons per day, as discussed further in Section 5.0, and the fire storage requirement is 540,000 gallons, as discussed further in Section 3.7, therefore the total required storage volume is 977,770 gallons. Adequate storage volume is currently provided to comply with WDEQ regulations. The average day demand over a 20-year build out period is anticipated to increase by 149,993 gallons/day, requiring storage volume of 1,127,763 gallons in the year 2032. The City’s current storage volume is adequate to meet WDEQ requirements throughout the course of the study period.

The tank locations and their interaction within the system is complex and have a substantial impact on the functionality of the Sundance water system. The three tanks located in the North Zone are configured with a single inlet and outlet pipe. With this configuration, the water level of all three tanks moves together. The Policky and Blue tanks are setup to be supplied by either Well 6 or the Cole Well Field (via the Sundance Kid Pump Station). Additional discussion on the pumping configuration for Policky and Blue tanks is described in the pump station section. Each tank description and how it functions in the system is provided below.

**Cole Tank**

- The Cole Tank is located northeast of the City and in its location during the course of this study, the high-water elevation was set at 4,952.5 ft. The Cole Well Field supplies the Cole Tank, which has a 250,000-gallon capacity when full. Water stored in the tank is raw and is chlorinated immediately downstream of the tank at the Cole Tank Chlorinator Building. The Cole Tank provides water supply to fill the Mt. Moriah and Sundance Kid tanks, and the Underground Reservoir. During the majority of this study, the Cole Tank was located at an unstable site. The tank has recently been disassembled and stored until the tank is relocated in the late summer/early fall of 2013. Section 6 describes the Cole Tank in more detail.

**North Zone Tanks**

- The Mt. Moriah Tank is located on the City’s west side with a high-water elevation of 4,874.8 ft. This tank has a 250,000-gallon capacity, and receives water from the Cole Tank via the Cole Transmission Line and a series of smaller diameter water-distribution lines that are located on the City’s north edge. The Mt. Moriah Tank supplies water to the City’s northern portion. Historically the Mt. Moriah Tank was used to supply the South Zone when the system was in the winter configuration mode.
• The Underground Reservoir is located on the south side of town (south of Interstate 90 [I-90]) with a high-water elevation of 4,874.8 ft. The reservoir has a 66,000-gallon capacity, and receives water from the Cole and Mt. Moriah Tanks. The reservoir supplies water to the City’s northern portion. Historically the Underground Reservoir was used to supply the South Zone when the system was in the winter configuration mode.

• The Sundance Kid Tank is located on the City’s south side adjacent to the Underground Reservoir with a high-water elevation of 4,874.8 ft. The Sundance Kid Tank has a 105,000-gallon capacity, and receives water from the Cole and Mt. Moriah tanks. The Sundance Kid Tank supplies water to the City’s northern portion. Historically the Mt. Moriah Tank was used to supply the South Zone when the system was in the winter configuration mode.

Canyon Tank

• The Canyon Tank has a 55,000-gallon capacity, high-water elevation of about 5,135.0 ft, and is located in the Sundance West Subdivision. Water is pumped from the North Zone by the Canyon Pump Station to supply this tank. The Canyon Tank then supplies water to the Sundance West Pump Station, which lifts water to the Brewer Tank.

Brewer Tank

• The Brewer Tank has a 55,000-gallon capacity and is located in the Sundance West Subdivision with a high-water elevation of 5,244.0 ft. This tank receives water from the Canyon Tank via the Sundance West Pump Station, and supplies water to the Sundance West Subdivision.

Policky Tank

• The Policky Tank is located south of the City with a high-water elevation of approximately 5,059 ft. This tank has a 100,000-gallon capacity, and receives water from Well 6 in the summer configuration and from Cole Well Field/North Zone in the winter operating configuration. This tank is used to supply water to the Blue Tank and to water users located south of I-90.

Blue Tank

• The Blue Tank is located south of the City with a high-water elevation of approximately 4,930 ft and a 290,000-gallon capacity. Sundance Creek that runs east/west through the City bounds the tank to the north and I-90 to the south.
Identified Concerns

- Turnover in the tanks during the winter months is low. City staff observed ice buildup and complaints of unpleasant-tasting water within the water system during this period. This may be controlled by setting the operating range of the tanks to a wider range during the winter months.

- The Cole Tank has not been filled to capacity due to slope stability issues. The City disassembled the Cole Tank for storage in May 2013 and plans to relocate the tank to a stable site in the late summer/early fall 2013.

- According to the tank inspection reports discussed in Section 2.0, numerous holes are located in the Sundance Kid Tank roof, and the interior coating is failing in certain locations. It is unclear whether these items were addressed after this tank inspection.

- The Underground Reservoir was reported to contain heavy root penetration, creating cracks in the perimeter, allowing for water seepage. It is unclear whether these items were addressed after this tank inspection.

- The Mt. Moriah Tank, Sundance Kid Tank, and Underground Reservoir all function on the same hydraulic grade line; the water level for all three tanks is controlled through a single pressure switch by the Mt. Moriah Tank. During hydrant testing, a significant lag in response time was observed for the tank water levels to equalize. As a result, a heavy demand near the Mt. Moriah Tank would drop the water level in that tank causing the Cla Valve (flow control valve) to open and supply water to the entire zone. Because the water levels of all three tanks had not equalized, the Sundance Kid Tank and Underground Reservoir overflowed.

3.4 DISTRIBUTION

The water-distribution system is comprised of 7 pressure zones with approximately 5 miles of 4-inch pipe, 17 miles of 6-inch pipe, and 2 miles of 8-inch pipe (excluding the Cole and Policky transmission lines). Pipes in the distribution system are made of ductile iron, cast iron, and polyvinyl chloride (PVC) material.

3.4.1 PRESSURE ZONES

The following pressure zones divide the distribution system as shown in Figure 1-1:

- North Zone – supplied by Cole, Mt. Moriah, and Sundance Kid tanks, and the Underground Reservoir
- South Zone – supplied by Blue Tank
- Canyon Zone – supplied by Canyon Tank
- Sundance West Zone – supplied by Brewer Tank
- Orr Zone – supplied by Cole Tank
• Policky Zone – supplied by Policky Tank
• East Zone – supplied by Policky Tank, and pressure-reduced through East PRV

The Mt. Moriah Tank, Sundance Kid Tank, and Underground Reservoir supply water to the North Zone. However, when Mt. Moriah’s water level reaches its lowest operating point, the Mt. Moriah Tank’s pressure switch opens the flow-control valve near the Orr Subdivision (Cla Valve). When the Cla Valve is open, the Cole Tank supplies the North Zone filling the Mt. Moriah and Sundance Kid tanks and the Underground Reservoir. When the Cla Valve is open, the pressure in the North Zone increases by as much as 15 psi within the zone.

3.4.2 PRV STATIONS
To control distribution amongst different pressure zones, the distribution system includes four PRV stations. Table 3-3 includes the existing PRV settings. Two parallel PRVs comprise the East PRV station near the I-90 underpass on Wyoming Highway 585. The East PRV station reduces the pressure from the Policky Zone, and serves the East pressure zone. The West PRV station also contains two parallel PRV’s and is located near the I-90 underpass on South West Street. The West PRV serves as a zone break between the Policky Zone and the South Zone; in the event of pressure loss in the South Zone, it automatically opens to increase the pressure in the zone. The HWY 585 PRV serves as a zone break between the North and South zones. According to City staff, this PRV is off-line through a closed valve. The Sundance Kid PRV serves as a zone break between the Policky and North zones; it is typically off line through a closed valve, but can be opened to allow the Policky Zone to supply the North Zone.

Identified Concerns
• In the North and South pressure zones, there are no obvious paths of least resistance to transport water from one zone to the other. Water takes complicated flow paths through a series of small diameter water lines to get to many fire hydrants.
• Fire hydrants on 4-inch waterlines throughout the system have limited pressure and flow rates.
• A number of 4- and 6-inch dead-end pipelines limits efficient water delivery to extremities of each pressure zone.
• The North Zone configuration causes wide- pressure fluctuations when the Cla Valve is open (as high as 20 psi).
• The East PRVs have failed in the past, and most downstream water users do not have point-of-use PRVs. Additionally, the PRVs do not appear to be responsive when the Croell’s ready-mix concrete plant batches concrete, resulting in some delayed response when the demands are first initiated, and when the demands are removed.
• The pressure settings on the West PRV are set too close to the normal-operating pressure range of the South Zone.
• This is particularly true in the North Zone where there are limited distribution loops, many 4-inch lines, and many dead-end lines.

3.5 PUMP STATIONS

Four pump stations are located in the distribution system to assist in water movement between pressure zones. Table 3-4 lists the pump stations and gives details on which pressure zone they pump to and from.

• The Canyon Pump Station is located along West Canyon Road and pumps water from the North Zone to the Canyon Tank. This pump station has two Grundfos CR4-80/7 pumps. This station is designed to operate only one pump at a time, with the two pumps alternating to prevent over-heating.

• The Sundance West Pump Station is located near the Canyon Tank. It pumps water from the Canyon Tank to the Brewer Tank. This pump station has two Grundfos CR5-5 pumps, and is configured similar to the Canyon Pump Station with alternating pumps.

• The Sundance Kid Pump Station is used seasonally to pump water from the North Zone to the Policky Tank. Prior to Well 6 water being chlorinated, it was only used during the peak summer season. During the winter season, Well 6 is off requiring water to be pumped to the Policky Tank. The Sundance Kid Pump Station also contains two pumps, and according to City staff, only one pump is used. During the course of this study, a chlorination facility was constructed at Well 6 and was placed into service in July 2013. The Sundance Kid Pump Station will no longer be required, since Well 6 water is chlorinated.

• A high-demand pump is located at the Cole Tank Chlorinator Building and pump station. The pump is designed to increase the flow rate from the Cole Tank to the North Zone if a high demand is experienced within the zone. Currently, the City does not use this pump station.

Identified Concerns

• During peak demand, the Canyon Pump Station cannot keep up. The station design configuration requires both tanks (Canyon and Brewer) to operate at the same time. This station will likely require further study and potential upgrades to satisfy identified water demands.

• During peak demand, the Sundance West Pump Station cannot keep up. The station design configuration requires both tanks (Canyon and Brewer) to operate at the same time. This station will likely require further study and potential upgrades to satisfy identified water demands.
3.6 WATER USERS

The City’s water system currently contains 751 meters and serves a population of approximately 1,400. The City’s water meters range in size from ¾-inch to 4-inch, and the total number of each size meter the City maintains is presented below.

- ¾-inch meters: 639
- 1-inch meters: 83
- 1 ½-inch meters: 12
- 3-inch meters: 3
- 4-inch meters: 2

The City’s largest water users include the following:

- Restaurants
- Motels
- Schools
- Churches
- Municipal facilities
- Medical facilities
- Mobile home parks
- Service stations
- Golf course

Of the City’s 751 meters, approximately 10% are located outside the city limits. The City maintains agreements with various users outside city limits to provide water service. The following users outside City limits have been identified as:

- The Green Mountain Water District. The City maintains a contract with the Green Mountain Water District to provide water to the City’s eastern edge. The district is billed for their usage in accordance with the City’s out-of-town water rates, at a quantity not to exceed 500,000 gallons/month.
• **Sundance West Subdivision.** A water supply agreement is in place between the Sundance West Subdivision and the City. It was agreed that the water system to supply the subdivision would be installed at the developer’s expense. The City agreed to take over system ownership and maintenance after the installation. In exchange, the developers agreed to sign a pre-annexation agreement allowing for annexation at the City’s option. The water supply agreement includes the stipulation that the City is responsible for installing meters at each lot within the subdivision.

• **Sierra View Estates.** A pre-annexation agreement was entered into between Clifford C. Moya and the City. Per the agreement, the landowner would receive access to the City’s water supply in exchange for a commitment to annex. The landowner was financially responsible for the water line construction cost and for installing metering equipment. Upon water line construction, the water line became the City’s property.

• **Orr Subdivision.** A water-supply agreement between the City and the Orr Subdivision for water service was not able to be located, yet this area is supplied by the City’s water system. There is speculation that the lot deeds state the City will supply water; however, this information was unable to be confirmed. Two people living in the Orr Subdivision, James and Jacqueline Daniels, have entered into a pre-annexation agreement in exchange for public water service.

**Identified Concerns:**

• There are multiple users located outside the city limits that receive water, and do not have a service agreement in place. Some of these user agreements may be a result of handshakes made during the construction of the Cole Transmission Line in the 1950’s. It is recommended the City further investigate the water supply agreements with the Orr Subdivision.

• The Bulk Water Station is not metered. Water use is estimated based on the number of coins in the control box. It is recommended that a meter be installed on the Bulk Water Station along with an updated and accounting control system.

• Construction water from the Hard Water # 5 Well is not metered. Water Use is estimated based on bills paid on the honor system. It is recommended that a metering and accounting control system be installed at the Hard Water #5 Well.

The City expends considerable effort and cost to maintain water supply to users located outside City limits. Trihydro recommends the City enter into a formal water supply agreement prior to providing water to users outside City limits. Water supplied to subdivisions outside City limits should be metered by a master meter located at the connection to the water main. The City will read the master meter and bill the respective subdivision. This may require subdivisions
located outside City limits to form a homeowner’s association or water district, which is responsible for reading individual meters within the subdivision and billing residents accordingly.

3.7 REGULATORY GUIDELINES

The WDEQ establishes minimum performance criteria in Chapter 12 of the Water Quality Division’s (WQD) rules and regulations. Performance criteria that are applicable to the City’s potable water system include:

- **Chapter 12, Section 8(d)(iii) Alternative power source.** Where the finished water storage volume that floats on the distribution system is not capable of supplying the maximum daily demand, an alternative power source shall be provided for the finished water pumps. The combined finished water storage volume and pumping capacity supplied by alternative power shall be at least adequate to provide the maximum daily demand. Acceptable alternative power sources include an engine generator, engine drive pumps, or a second independent electrical supply.

- **Chapter 12, Section 13(i)(B) of the WDEQ/WQD rules and regulations.** Define the minimum treated-water storage requirements for water systems serving 50,000 to 500,000 gallons on the design-average daily demand shall provide a minimum volume of stored treated water equal to the average daily demand plus fire storage recommended by the State Fire Marshal or local fire agency.

- **2012 International Fire Code.** The required fire storage is equivalent to the fire-flow at the highest required flow rate for the service area risk/construction type. The Crook County Courthouse is the structure governing fire flow for the town. It is the largest building not protected by an automatic sprinkler system. The building is Type III with a square footage approximately equal to 47,000. The required fire flow, based on the building type and square footage, is 3,000 gpm for 3 hours. This equates to required fire storage of 540,000 gallons.

- **Chapter 12, Section 14(b)(i) of the WDEQ/WQD rules and regulations.** This section defines the minimum operating pressures for all water mains in the system. The minimum operating pressure for a water main is 35 pounds per square inch (psi), and the minimum residual pressure under fire flow is 20 psi.

- **Chapter 12, Section 14(b)(ii) of the WDEQ/WQD rules and regulations.** This section defines the minimum pipe diameter based on the type of service. The minimum size of a water main for providing fire protection and serving fire hydrants shall be 6-inch diameter when service is provided from two directions, or where the maximum length of 6-inch pipe serving the hydrant from one direction does not exceed 250 ft, or 8 inches where service is provided from one direction only. Larger size mains shall be provided as necessary to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure of 20 psi.
• **International Fire Code fire flow requirements.** The International Fire Code outlines the fire flow requirements for individual fire hydrants and service nodes, but varies depending on operational risk factors, building contents, and construction type. For the purpose of this report, required assumed fire flow is 1,000 gpm for every fire hydrant.

**Identified Concerns:**

- The City’s well fields currently do not have an alternative power source.
- There are areas in the City that experience extremely low pressure.
- There are undersized water mains that provide fire protection.

### 3.8 CONSTRAINTS ON THE WATER SYSTEM

#### 3.8.1 USE OF HYDRAULIC MODEL IN STUDY

The hydraulic model was setup using the initial data gathered from the City records. Review of the initial data pinpoint the additional information needed to run the model including operational ranges for the tanks, PRV settings, and status of valves. Using static pressures and flow data from hydrant testing, the model was calibrated to confirm it produced similar results to conditions measured in the field. Once calibrated, the model provided a tool to evaluate the effects of system configuration changes and future water demands.

#### 3.8.2 WATER SYSTEM’S ABILITY TO ACCOMMODATE CURRENT AND FUTURE DOMESTIC AND FIRE FLOW NEEDS

Overall, the water system is able to meet average domestic demands; however, there are isolated users within the system that experience low pressures. Because the system is divided into numerous pressure zones, the effect of high water demands is dependent on the zone. The modeling analysis goes into more system deficiency detail; however, the water system’s current configuration is reaching its limit to accommodate growth in several pressure zones. The primary challenge to the system is reliable water delivery. The supply and storage components are capable of supporting additional growth. The delivery limitations also have a significant impact on the water system’s ability to provide fire protection. During hydrant testing, a substantial number of the tested hydrants failed to meet the pressure or flow rate requirements. A summary of the hydrant testing results are shown Appendix B. Additional fire flow analysis is covered in more detail in Section 6.
3.8.3 AREAS OF POTENTIAL LEAKAGE

A leak location project was completed for the City in 2009. The project team identified several significant leaks; however, those leaks were repaired. Although leaks were identified in the past, the City does not show signs of leaks in the system today.
4.0 CREATION OF GEOGRAPHIC INFORMATION SYSTEM (GIS)

4.1 DEVELOPMENT OF GIS

A Plan feature includes an enhanced geographic information system (GIS) for the City. Prior to this master plan study, the City had a GIS prepared by Geographic Innovation, a company located in South Dakota. The existing GIS was used as a starting point but it was understood through discussions with City staff that there were some inaccuracies in the existing data. Much of the City’s water infrastructure GIS layers were updated and verified through review of design and as-constructed plans, hand-drawn maps in map books, and discussions with City staff. Field data were collected at the major water system components including water storage tanks, wellheads, pump and PRV stations, some valves, and the Cole Tank Chlorinator Building so that these components would be accurately represented geospatially. As additional specific information was gathered related to the City’s water system, it was incorporated into the GIS.

Project data are displayed in the GIS as datasets. The background layers provided by ESRI© mapping services consist of DRG (topographic map) and ESRI© aerial imagery. Mapped features are labeled with appropriate nomenclature and symbols. Photos are hyperlinked to the photo point locations (i.e., water storage tanks, wellheads, pump stations, etc.) within the GIS, allowing the user to display photographs. The product available to City staff is a GIS ESRI ArcMap Project file (.mxd) and associated datasets. The GIS datasets are also available to the City via GIS Direct as a Web-based interactive-mapping application hosted by Trihydro and offered as part of Trihydro’s City Engineering contract with the City.

Base layer data are as follows:

- Crook County data
  - Ownership parcels
  - Local roads
- Wyoming Department of Transportation
  - Interstate and highways
- National Hydrography Dataset (USGS)
  - Streams
• Federal Emergency Management Agency (FEMA)
  ○ Floodplains
• U.S. Fish and Wildlife Service (USFWS)
  ○ Wetlands
• City of Sundance data
  ○ Corporate limits
  ○ Subdivisions
  ○ Zoning
• Public Land Survey System (PLSS)
• Utilities from existing City GIS:
  ○ Storage tanks
  ○ Water wells
  ○ Water valves
  ○ Water manholes/vaults
  ○ Pump stations
  ○ PRV stations
  ○ Sewer manholes
  ○ Fire hydrants
  ○ Water lines
  ○ Sanitary sewer lines
• ESRI Mapping Services
  ○ ESRI World Imagery
  ○ USA topographic maps
The WaterGEMS model data were also imported into the GIS and symbolized according to current standards for utility mapping. The hydraulic model assigned attributes for pipes, tanks, junctions, pressure relief valves, and pumps and are available for the end user to identify the feature and view the model data.

WaterGEMS layers for the City’s water system infrastructure include:

- Pipes
- Tanks
- Water wells (modeled as reservoirs)
- Junctions
- Isolation valves
- PRVs (pressure-relief valve)
- Pumps

As part of a Trihydro’s City Engineering contract, authorized City staff has the ability to access GIS Direct through a secured portal called Project Direct©. GIS Direct is an interactive map using ESRI ArcGIS Server 10.1 technology and is served from the Trihydro datacenter in Laramie, Wyoming. The module allows individuals to view the GIS data. Users can zoom in/out and pan to locate system components.

Photographs
System component photos were taken that are available to view using the document-linking tool in this master plan GIS deliverable.

Deliverable
As required by the WWDC, a GIS copy with the deliverable datasets available within an ESRI File Geodatabase are provided on CD as an ESRI ArcMap Project file (.mxd). The GIS is transmittable to computers with the ESRI ArcGIS 10.0 software.

4.2 RECOMMENDED FUTURE GIS USES
We recommend the City use GIS to enhance their water system operations and maintenance as described in Section 9.4.2 – Helpful Record Keeping Hints and Recommendations. GIS can be a powerful tool to assist the City in making important decisions for future water system components maintenance and replacement. Likewise, it serves as
an asset management tool that the City can integrate with a future SCADA system for storing the water system’s log files and data in the GIS database for long-term use.
5.0  POPULATION GROWTH AND WATER DEMAND PROJECTIONS

Population growth and water demand projections are important to comprehensive water master planning, especially when determining water system expansion and sizing to accommodate future water needs. It is important to understand the projections and geographic growth distribution to incorporate water demands into the water-system model. Population projections and future growth areas were analyzed to determine future water demand projections over a 20-year planning period. Determining future water demands and comparing them with the current available water supply is important so the City is able to plan accordingly as the population grows. Current and future water demands were calculated and used in conjunction with the hydraulic model to evaluate and make recommendations for infrastructure improvements as the demands and system footprint grow. This section describes how population growth and water demand projections were calculated.

5.1  POPULATION PROJECTIONS

Two population projection scenarios were developed to analyze the growth effects on the City’s water system. The first scenario was developed by the EAD/DA&I. The second scenario considers specific-known development projects near the City. Rare Element Resources (RER) is working on the Bearlodge Project to mine rare earth elements outside of the City, and Strata Energy, Incorporated (Strata) is working on the Lance In-Situ Uranium Recovery Project near Moorcroft, Wyoming. Both projects are expected to affect the City’s population.

5.1.1 SCENARIO 1 – EAD/DA&I PROJECTIONS

In October 2011, the EAD/DA&I published population projections for the period of 2010 through 2030 for the State of Wyoming, each Wyoming county and individual towns. The 2010 population projections are based on 2010 census data, and forecasts from 2011 through 2030 are based on demographic trends and economic variables. Municipality population forecasts were calculated by applying city/county ratios to the appropriate county population forecasts. This Plan needed additional population estimates for 2031 and 2032 to meet the master plan’s 20-year planning period. These populations were estimated by using the same growth rate forecasted for the State of Wyoming between 2029 and 2030. See Table 5-1 for EAD/DA&I estimates for the State of Wyoming, Crook County (included for reference), and the City within the corporate limits.

The population projections developed by the EAD/DA&I only account for Sundance’s population within the corporate limits; however, the City’s public water system services additional customers located outside the corporate limits. Developed lots outside the corporate limits, but within the water-service area, were counted based on aerial
photography and GIS ownership records and multiplied by the average number of people per household as determined by the United States Census Bureau (USCB) for the State of Wyoming to estimate the population. This population estimate was used for year 2010 and applied the same growth rate used by the EAD/DA&I for the population within the corporate limits. Table 5-1 includes estimates for the population located outside the corporate limits but within the water service area, and the total population assumed to be located within the water service area. Figure 5-1 shows the corporate limits boundary, developed lots located outside corporate limits and within the water service area, and approximate zoning within the corporate limits.

5.1.2 SCENARIO 2 – EAD/DA&I PROJECTIONS PLUS STRATA AND RER INFLUENCE

A second population projection scenario was developed based on information regarding development near the City by RER and Strata. RER development information from a report entitled Technical Report on the Mineral Reserves and Development of the Bull Hill Mine, dated April 2012, prepared by Roche Engineering was used. The report states that RER anticipates mining operations will create 48 hourly operating and maintenance jobs, and 19 salaried-position jobs, for 67 new jobs. Strata development information was obtained from a letter submitted by Strata to Crook County dated October 31, 2012, Re: Proposed Industrial Development Project, Strata Energy Inc – Lance In-Situ Uranium Recovery Project. This letter states that a workforce of 60 people will be contracted during the initial construction phase, and upon construction completion, 92 full-time jobs are anticipated.

Assumptions to translate the number of anticipated jobs to affects in population growth were as follows:

- Each person employed is a household member.
- There are 2.46 people per household, based on State of Wyoming averages published by the USCB.
- Each full-time job creates 2.2 indirect jobs, according to National Mining Association statistics.
- Each indirect person employed is a household member.
- Employment created by the RER development will begin in 2014 and 70% of employees (and indirect employees) will live in Sundance.
- Employment during the Strata development construction phase will begin in 2014. Construction-phase employees will leave in 2015 and full-time employment will begin. 60% of the direct and indirect employees will live in Sundance.
- Indirect jobs will incrementally increase over a 3-year time period.
The assumptions listed above were used to calculate the anticipated population increase through 2017. Next, this population was added to the total population estimated in Scenario 1. The growth rate beyond 2017, estimated by the EAD/DA&I, was used for the Scenario 2 remainder. Refer to Table 5-2 for the Scenario 2 population projection. Table 5-3 includes a graphical representation of the growth rates anticipated for Scenarios 1 and 2.

5.1.3 ANTICIPATED FUTURE GROWTH AREAS

After population projections were estimated, available land within the City’s growth areas were identified to meet the population projection needs estimated in Scenario 2, as this is the worst case scenario. The City adopted new zoning regulations during this study, which were used to assume future land uses. The City does not have additional long-range master planning documents in place governing future development. The zoning boundaries and designations used for this analysis are based on the City’s new zoning map, and density assumptions extrapolated from the new regulations and current conditions.

Future development locations, and the timeframe in which they are expected to develop, are based primarily on input from City staff and members from the City’s Land Use Planning Commission. This information was collected during a project progress meeting held in Sundance on November 16, 2012. To estimate the future development location and timing, information on preliminary plats filed with the City and the existing infrastructure availability to support these developments were considered. Estimated future growth areas for residential, commercial, and industrial uses over the next 20 years are shown on Figure 5-2.

The total population capacity of the residential parcels shown in Figure 5-2 was determined based on parcel size, land use, and maximum density assumptions. This information was compared to the overall projected population to estimate the population at specific locations. Tables 5-4 through 5-8 list specific areas identified for potential future growth, the zoning designation, area, maximum density, population capacity, and projected population. Information included in Tables 5-4 through 5-8 is based on the following assumptions:

- Zoning districts are taken from the City of Sundance Zoning Map prepared by Trihydro dated February 12, 2013
- Land anticipated for residential development outside the corporate limits has a density of 0.2 units per acre based on current development lot sizes
- Low Density Residential Districts within the corporate limits have a 1 unit/acre maximum density
- Medium Density Residential Districts within the corporate limits have a 4 units/acre maximum density
- There are 2.46 people per unit, based on State of Wyoming averages published by the USCB
5.2 HISTORICAL AND CURRENT WATER CONSUMPTION

The City’s water-use records were analyzed from January 2008 to June 2012 to determine the current water demand and establish a per-capita water usage, which was used to estimate future consumption. The City maintains an electronic meter-reading database for billing purposes. Additionally, master meters are located in the Well 6 underground vault and inside the Cole Tank Chlorinator Building, and are read on a daily basis and recorded by hand on a worksheet. Discrepancies were observed between the hand-written and electronic meter readings. After further investigation of the water-use records, it was determined that there are inconsistencies in both water-use information sources.

The total demand values from the electronic meter data are not consistent over several of the time periods reviewed. Several meter readings inconsistently recorded zero usage and others recorded very large variations from month to month. Additionally, not all of the City’s water is metered and accounted for in the electronic system; therefore, these data are not believed to provide an accurate representation of the City’s total water use over the analysis period. However, there were individual months with consistent data that could be used to identify the largest water users and establish minimum, average, and peak demands for each season. These data were used to establish the water demands for the hydraulic model, which will ultimately drive the recommendations for future improvements. The results of the hydraulic modeling efforts are also largely affected by fire flow analyses, which are independent of the City’s domestic use captured through the billing process.

The information available from the City’s hand-written pumping records more accurately captures the City’s total water use; however, there are outliers within this information that could not be explained. The hand-written pumping records available from 2008 through June 2012 were reviewed. Pumping records prior to 2008 do not reflect the City’s current water use due to irrigation changes at the golf course, which significantly effects water use. The data from 2008 to 2010 are consistent, and large outliers are located in the data from 2011 and 2012. No significant event or growth occurred during this time to explain the outlying data.

Since the pumping records from 2008 to 2010 appear to be the best representation of the City’s current water use, this information was compared to the metered data available at each of the City’s primary production wells, and the information appeared to be consistent. These values were also compared against national average per-capita water use, and again the data were consistent. The pumping records provide total water use on a daily basis in total gallons. The average daily water use for each month was calculated, and the highest monthly average is reported as the average day demand, typically occurring in either July or August. The single highest day water use was also noted, and reported as the peak day demand. The ratio of the peak day to average day demand is reported as the peaking factor. Peak day and average day demands are summarized in Table 5-9. To convert the peak day demand from gallons per day (gpd) to
gallons per minute (gpm), a run time of 16 hours per day was assumed, due to limited water use during evening hours. The average day demand in gpm was calculated using a 24-hour period.

5.3 WATER DEMAND PROJECTIONS

Due to inconsistencies in the City’s historical water use records, the per-capita water-use data were extrapolated for use in projecting future-water demands from information provided in the WDEQ Rules and Regulations Chapter 25. The sanitary sewer flow rates given in Table 1 – Quantities of Domestic Sewage Flows were divided by 0.8 (assuming sewage flow rates are 80% of domestic water flow rates). The per capita information was applied to the projected population in residential areas and the areas identified for commercial and industrial development. The assumptions listed below were used to estimate future water demand:

- Peak daily residential water demand is 188 gpd per person.
- Peak daily commercial and industrial water demands are 38 gpd per employee.
- Use a conservative peaking factor of 1.5 determined from the City’s pumping records. The peak water demand was then divided by the peaking factor to calculate an average day demand of 125 gpd per person.
- Use City of Gillette Design Standards (2005) to calculate the number of employees anticipated per acre of commercial and industrial land. The equivalent population of commercial land use is stated as 18 persons per acre, and the equivalent population of industrial land use is stated as 15 persons per acre for heavy industrial and 10 persons per acre for light industrial. The City’s current zoning map does not differentiate between light and heavy industrial use, therefore use a value of 12 persons per acre.

Peak and average daily residential, commercial, and industrial water demands for each development timeline are presented in Tables 5-10 through 5-14. A summary of forecasted water demands is presented in Table 5-15. The demands listed in Tables 5-10 through 5-15 are future demands only, and were added to the current demands shown in Table 5-9 to estimate the total water use.
6.0 HYDRAULIC MODEL

A large portion of this study’s schedule was dedicated to understanding the City’s water system. This was done in part through the hydraulic model (model) development of the City’s water system. The model provided a tool to allow simulation of the water system’s current and future operations; identification of concern areas; and analysis of proposed upgrades to address key concerns and to accommodate future growth.

This section describes the model; how it was developed and calibrated; the identified existing system concerns; and future improvement recommendations. The model is the fundamental decision-making tool prepared as part of this Plan. Since the model gives a current representation of how the water system functions and how the City operates it, the model provides a tool to compare the future system change effects. After the existing system model was prepared and calibrated, it was used to test several scenarios with separate water demand, fire flow, and physical alternatives. The model was used to evaluate alternative solutions to problematic areas and to select the most efficient solution. After solutions were determined for each problem area, the solutions were ranked based on the level of improvement they provided to the system.

6.1 HYDRAULIC MODEL DESCRIPTION

The model was assembled using Bentley’s WaterGEMS® software. This software allows the user to evaluate a water system at steady state and over an extended period to simulate diurnal patterns. The model is constructed of the following basic elements (WaterGEMS v8i SELECT series 3):

- **Junctions/nodes:** These are specific points in a system at which an event of interest is occurring. This includes points where pipes intersect; where there are major system demands such as a large industry, a cluster of houses, a fire hydrant, or critical points in the system where pressures are important for analysis purposes. Nodes have a defined location, elevation, and demand. Nodal results of interest from the project analyses performed include static pressure, available fire flow, and available residual pressure during fire flow.

- **Reservoirs and tanks:** These are boundary nodes with a known hydraulic grade, which defines the initial hydraulic grades for a computational cycle. These nodes form the baseline hydraulic constraints used to determine the other node conditions during system operation. Boundary nodes are elements such as tanks, reservoirs, and pressure sources. Tanks and reservoirs are defined by their shape, location, base elevation, minimum operating level, maximum operating level, and initial level. Tank results analyzed include outflow, inflow, and change in storage.
• **Pipes:** Transport water from one location (node) to another. Pipes are defined by their length, material type, and diameter. These definitions, along with boundary conditions, are used in the Hazen-William’s equation to calculate frictional losses across the pipe length. Pipe results analyzed include flow rate, velocity, head loss, and head loss gradient.

• **Pumps:** Represented as nodes, the purpose of pumps is to provide system energy and raise the water pressure. Pumps in this model are defined by their pump curves (see Appendix D) and logical controls. Logical controls are indication parameter sets (i.e., pressure that triggers pumps on and off). Pump results of interest may include flow rate, suction and discharge pressures, and energy costs.

• **Valves:** Mechanical devices used to stop or control the flow of water through a pipe, or to control the pressure in the pipe upstream or downstream of the valve. Valves result in a system energy loss. Valves are defined by their location, elevation, type, and setting (i.e., opened or closed). Results of interest from valves may include flow rate, velocity, head loss, pressure loss, and open/close status.

WaterGEMS uses governing equations and principals such as the Bernoulli’s equation (conservation of energy), the Hazen-Williams equation (addresses friction loss), and conservation of mass (flow in equals flow out), to develop an equation system to solve and balance across a distribution network. WaterGEMs uses a Conjugate Gradient Algorithm form to solve sparse matrices developed from the mentioned set of equations.

### 6.2 DEVELOPMENT OF HYDRAULIC MODEL

Model analyses performed for this project includes steady state and extended period. A steady-state model cannot capture fluctuations with respect to time. Using a steady-state analysis, the model fully applies water demands at a specific time and does not distribute the demands over an entire day or other pre-defined timeframe. Additionally, the calculation engine in WaterGEMS requires certain elements in the model, such as pumps and PRVs, to have time steps to change status from on to off or open to closed. An extended period simulation (EPS) captures the time-variable demand effects, and will also capture fluctuations in pressures, tank levels, and status of PRVs and pump stations.

The steady-state analysis was initially setup using the preliminary mapping and City as-constructed water system data. This preliminary model provided an initial snapshot of how the City’s water system is setup and operated. Since the steady state model only looks at a single point in time, it limits the number of variables to check and provides preliminary system configuration verification. The model results were compared with the water system’s actual pressures, using the static pressures measured at fire hydrants. Comparing the known static pressures to the modeled static pressures enables tank water level verification, isolation valve status, and PRV settings at the zone boundaries. It also provided preliminary pipe size verification.
After the model configuration is verified using the steady state model, the EPS is used to review the system’s operations in more detail. During the ESP model development, the following data were input and configured:

- Well-pump controls settings
- Tank water level operating ranges
- Flow-control valve settings
- Pressure switch setting
- Pump station logical controls

These components were configured based on design reports, as-constructed records, field inspection of the components, and discussions with City staff. Demands from meter records were distributed across the model using geocoded locations based on address, and applied using diurnal patterns. Diurnal patterns distribute the daily demands over a 24-hour time, based on the type of use (i.e., residential, commercial, industrial). After the components were setup and the water demands applied to the model, it was calibrated against fire hydrant flow-test data collected in the field, along with data from pressure transducers placed in each tank. Additional discussion on the model calibration is covered in Subsection 6.6.

6.3 ASSUMPTIONS AND METHODOLOGY
The WaterGEMS model uses the Hazen-Williams equation for frictional losses in pressurized pipes. This is an empirical equation and does not take into account the temperature or viscosity effects on water mechanics, but is considered adequate for planning level studies (Roberson et al., 1998).

The model used to analyze the City’s water system was a skeletonized model, including larger system pipes and major components. In this study’s model, some 4-inch pipes were removed, nearly all nodes were placed at pipe intersections, and some long pipe segments were collapsed into a single node. Skeletonization is the process of selecting the hydraulic network parts that have a significant effect on the water system’s behavior for model inclusion. For example, including all service connections, valves, and every minor distribution loop that make up the actual network can be a significant undertaking. The system components that are not modeled are still accounted for; the effects of these items are included within other system parts that are included in the model.
6.4 GEOMETRIC CONFIGURATION

The initial water-distribution system geometric configuration was established based on GIS mapping provided by the City. Additional water system configuration data were gathered by reviewing design and as-constructed drawings, design reports, discussions with City staff, and physical investigation. The data inventoried includes:

- Pipe size and locations
- Valve types, sizes, and locations
- Fire hydrant locations
- Tank sizes, configurations, and locations

Data collected were imported into the WaterGEMS model using the WaterGEMS model-builder tool. From this starting point, connections were verified using the City’s map books and as-constructed plans. The following assumptions were made because of data gaps:

- Although the City had a pipe size and location inventory, pipe material was only partially documented. When City staff was not able to verify pipe material, each continuous, single-diameter pipe section was assumed to be made of the same material.
- Since there was no piping-network elevation data, elevations within the model were set using National Elevation Dataset (NED) topographic data. It was assumed the piping network is parallel to the ground surface, which is generally acceptable since water pipes are typically buried at standard depth (assumed 6 ft, which is consistent with Sundance and most of Wyoming) across the work area. The node elevations were set at the ground surface rather than 6 ft below the surface; however, the tank levels were raised a uniform 6 ft to account for the offset.

6.5 WATER DEMAND ALLOCATIONS AND MODEL SCENARIO CRITERIA

6.5.1 WATER PRODUCTION COMPARED TO WATER USE

The City provided water-meter use records from September 2008 through December 2012. These water uses (i.e., water demands) were accrued and compared to well-production data for the same timeframe in an attempt to calculate the system’s net loss. Demand and production meter data review showed significant inconstancies across the data sets. There were meter readings with zero, or minimal demand. Other meter readings appeared to be double counted, or had exceptionally high demands. Since the demands were inconsistent, it was not possible to determine the actual difference between the produced and used water volumes.
The United States national water loss average due to leaks is approximately 14%, and in general, 10-20% allowances for unaccounted-for-water is considered normal (Lahlou, 2001). Some of this loss may be actual losses through leaks, apparent losses due to non-metered demands, or meter malfunctions or inaccuracies.

6.5.2 WATER DEMAND ALLOCATION

Using a GIS GeoCoding feature, demands from the meter addresses were geospatially referenced. Many of the City’s billing-record addresses were not available in the geocoding databases, and therefore, had to be manually entered. This was a time consuming task, but an important effort to help understand how the City’s meter locations were imported into the model using WaterGEMS LoadBuilder feature. Not all the meter data aligned well, as some addresses were repeated and others did not include addresses, so many of the meter locations were manually incorporated. Demands were incorporated at the nearest node with respect to the meter data point.

6.5.3 MODEL SCENARIO CRITERIA

Modeled scenarios include current minimum, average, and maximum water demands. Since water-distribution system frictional losses are larger with higher velocities, the maximum-daily demand scenario was used as a baseline for analyses with fire flow requirements. The maximum-daily demand scenario with fire flow assumes that all demand nodes are at their peak when a fire occurs.

Fire hydrants and their physical locations (i.e., cross street) were determined while collecting static pressures and hydrant-flow data August 23-24, 2012 (refer to Appendix B for actual field data collected). Fire-flow data were incorporated into the model at junctions that are within a close proximity of these fire hydrants. Fire-flow demands were developed using Appendix B of the International Fire Code (2012). For a single fire hydrant, the minimum required fire flow is 1,000 gpm for 1 hour. Some areas may require additional fire flow over a longer duration because of the building use type, construction material, or fire suppression level installed in the building. In areas with structures that have higher fire flow requirements, more than one fire hydrant is used. Flow-rate reductions and fire-flow duration can be achieved for individual buildings by adding an automatic fire-suppression system. Other fire-flow requirements include maintaining a water-system residual pressure of 20 psi during fire flow scenarios, and pipe velocities of 5 feet per second (fps) or less.

Water velocities were limited to 5 fps, since at 10 fps the possibility exists for pipe cavitation. A safety factor of 2 was chosen to provide a safeguard against cavitation and water transients. While running the model scenario, if fire flow requires water velocities in a pipe to exceed 5 fps, or if the residual pressure drops below 20 psi before the hydrant reaches the minimum required fire flow, the model identifies the node as a failed node.
6.6 HYDRAULIC MODEL DATA COLLECTION AND CALIBRATION

6.6.1 FIELD DATA COLLECTION
Collecting field data is a foundational task in creating an accurate and usable model. The data collected is used to verify the model is working correctly and accurately representing the City’s water system. Data was collected by testing fire hydrants within the system and monitoring tank water levels using pressure transducers. This information was gathered the end of August 2012, a peak summer month for the City. At the field-collection event time, the City and Crook County were experiencing drought conditions.

Fire hydrant data were collected over a 2-day period on August 23-24, 2012 and included static pressures, residual pressures, and flow rates. Data were collected between 8:00 a.m. and 5:00 p.m. on each day. City staff assisted with collection of field data in general accordance with the AWWA Manual of Water Supply Practices, M17, Installation, Field Testing, and Maintenance of Fire Hydrants guidelines (AWWA, 2006). The City’s water-distribution system has 97 fire hydrants. Each of the 97 hydrants was static pressure tested, and 23 of the hydrants were flow rated and residual pressure tested. Only 23 hydrants were flow tested, since flow-testing hydrants takes significantly more time than static-testing hydrants. Flow-testing hydrants require opening at least 2 hydrants at the same time and recording the flow rate and residual pressure. The goal is to achieve at least a 10-psi pressure drop between the 2 hydrants. It is critical to achieve the pressure drop between the hydrants to calculate the roughness coefficient in the pipe between the hydrants. The 23 hydrants selected were chosen based on their proximity to key pipes and demand nodes. The pipes selected either had high flow rate, or were anticipated to be a limiting water supply factor to key fire nodes. Key nodes were selected based on known system problems and proximity to high-importance or high-risk structures.

Water level in each of the 8 tanks was also recorded at a 30-second interval from 12:00 a.m. on August 25, 2012, to 12:00 a.m. on September 1, 2012. Trihydro rented the Solinst Level Logger 3001 to measure the water level and temperature change over the 7-day sample period for each tank. The readings recorded were consistent with observations and information gathered during this study. Graphs showing the water levels are presented in Appendix D.

6.6.2 MODEL CALIBRATION
Calibration includes verifying that the model accurately represents the water system within acceptable tolerances. The modal calibration goal is to produce results within 5 to 10% of the field data observed. Static pressures initially were compared between the hydrant nodes in the steady-state model and the static pressures observed at the 97 system hydrants. The nodes with the largest difference were addressed first, starting with verifying pressure zone boundary
conditions (tank levels, isolation valve status, and PRV settings) and working toward the node in question checking pipe configuration and sizes.

After the fire-hydrant node results within the steady state model converged to within 5 to 10% of the observed field data, EPS model calibration began. The EPS model was then calibrated using hydrant-flow data and residual pressures from the 23 field-tested hydrants to evaluate the hydraulic performance. Additionally, the transducer data from the 8 tanks were also used to verify that demands and diurnal patterns were being assigned correctly. Comparing the modeled-tank levels to the field-measured levels provided an opportunity to evaluate the tank and pump control settings. Time-dependent-control input variables were checked to confirm they correctly matched the field settings. Several of the variables could not be verified against field results. For the missing variables, common book values from manufacturers were used for the initial evaluation.

Once the EPS was running, the WaterGEMs Darwin Calibrator was used to check the convergence of the model results with the field data. The hydraulic model performed a baseline fitness assessment prior to calibration to assess how well the model converged on observed values without modifying demands and default roughness coefficients. The system’s pipe-roughness coefficients were initially assigned based on published values for the approximate age and material.

Using the initial EPS-model analysis results, the component settings and pipe-roughness coefficients were adjusted to help the model converge on the actual field data. The number of pressure zones and the zone-boundary conditions setup required an iterative approach of looking at the boundary conditions for the out-most zones and then evaluating the impact to the neighboring pressure zone. The primary challenge was that the 7 pressure zones were not completely isolated. Under peak flow conditions, the PRV’s at the zone breaks would open to supply the additional demand to the neighboring zone. Adjustments were made to the boundary zones closest to the supply (i.e., Cole, Policky), to help them converge on the field measured data, but those adjustments then impacted the neighboring zones they supplied. After numerous iterations, the model did converge to within the 5 to 10% variance goal.

### 6.7 CURRENT WATER SYSTEM PERFORMANCE

City staff had documented deficiencies prior to the study’s commencement. Noted deficiencies were either reported by customers or observed by the Public Works’ staff. These concerns include:

- Loss of service/pressure was observed at the Sundance West Subdivision.
- The Canyon Pump Station cannot keep up with peak demand.
• Water hammer at the Cole Tank Chlorinator Building. This is believed to be the result of backflow into one or more of the Cole Well Field wells. During the latter part of this study, the City replaced air release/air intake valves on the Cole Transmission Line between the Cole Well Field and the Cole Tank and installed a new check valve on the transmission line downstream of the Cole Well Field wells confluence. This has reportedly helped the water hammer issue, but has not alleviated it completely.

• No high flow switch was observed at the Sundance West Pump Station/this station is currently operated manually.

• Low pressure was observed along Hillcrest Drive in the Southwest corner of the City.

• There are 6- and 4-inch supply pipelines from tanks south of I-90 to the North and South pressure zones that inhibit responsive water delivery.

• The gate valve that isolates the North and East zones along HWY 585, just south of I-90 is required and needs to remain closed. Review of the City’s records identified an 8-inch water line installed in the HWY 585 right-of-way to serve the East Zone. If the valve is opened between the North and East Zone, the East Zone is not able to receive enough water supply to fulfill the water demand.

• There is an unidentified water line in HWY 585, south of 21st Street. The surrounding buildings have water meters, but there are no City records of the water line location.

• The fire hydrant on North 21st Street is located on a 6-inch dead-end trailer park water line, which can lead to low pressures and water-quality concerns.

• There are unknown water-service lines near the Cole Tank and locations to single homes.

• There is an undersized transmission pipeline between Cole and Mt. Moriah tanks.

• The hospital experiences low pressure (less than 20 psi) during fire flow scenarios.

• There are long dead-end 8-inch lines (over 1 mile) in the East pressure zone.

6.8 DEFICIENCIES IDENTIFIED THROUGH HYDRAULIC MODELING

6.8.1 WATER SUPPLY

The Blue Tank currently draws water from the Policky Tank. If the Policky and the Blue tanks fill at the same time, the operational range of the Well 6 pump is exceeded. The Blue Tank has a dedicated inflow pipe and a dedicated outflow pipe, but the Policky Tank has a single inlet and outlet pipe. Since the Blue Tank is located between the Policky Tank and service nodes that the Policky Tank supplies water to, it is possible for the Blue Tank to overwhelm the Policky Tank’s main line while the Blue Tank is filling. A high demand in the Policky Zone, while the Blue Tank is filling, causes pressure fluctuations and potential service loss in the Policky Zone.
6.8.2 TRANSMISSION

The City’s water system currently has limited transmission between the supply and storage. The water lines used for transmission mains, are either undersized to be considered transmission mains, have multiple user taps along their lengths, or both. Transmission mains are typically larger diameter pipelines, designed to move large water quantities from the water supply source to a water system’s smaller diameter distribution-pipeline network. Service lines for homes and businesses are not generally connected to transmission mains, but rather to distribution water mains.

In the North Pressure Zone, the Cole Transmission Line configuration causes large pressure fluctuations on the zone’s east side. During normal operation, the North Zone operates at the same hydraulic-grade line as the Mt. Moriah and Sundance Kid tanks, and the Underground Reservoir with a high water elevation of 4,874.8 ft. When the North Zone tanks fill, the flow-control valve (Cla valve) downstream of the Cole Tank opens, exposing the North Zone to the Cole Tank head (approximately 4,951.5 ft). The pressure fluctuations occur immediately downstream of the Cole Transmission Line connection to the North Zone, and can reach up to 15 psi depending on the Cole Tank water level. Since there are significant friction losses across the North Zone, the pressure spikes are dissipated across the system from east to west.

The large frictional losses across the North Zone are the result of pushing water from the zone’s East side through a parallel network of 4- and 6-inch water lines to the storage tanks on the zone’s west and south sides. The transmission infrastructure shortage across the North Zone forces water to take complicated flow paths to get from the storage tanks to the service nodes or fire hydrants.

The Policky Transmission line, from Well 6, supplies the Policky, South and East zones. The South and East zones are connected to the transmission main prior to the Policky Tank. This configuration results in several system challenges. When Well 6 is filling, the users tapped off the transmission main experience pressure spikes. If the Blue Tank is filling at the same time as the Policky Tank, the Well 6 pump has difficulty meeting the demand as described in the supply deficiencies subsection.

The water system currently does not have dedicated transmission lines that supply the Canyon or Brewer Tanks. These tanks are served by pump stations that struggle to keep up with demands. Without dedicated transmission to tanks, the pumps are attempting to accommodate the head required to fill the tanks, while services are depleting the head between the pumps and the tanks. Additional pump station discussion is provided in subsection 6.8.5. Construction of dedicated transmission lines are recommended from the Canyon Pump Station to the Canyon Tank and from the Sundance West Pump Station to the Brewer Tank.
6.8.3 WATER STORAGE
There is a general latency and poor connectivity between the Cole, Mt. Moriah and Sundance Kid tanks, and the Underground Reservoir. Additionally, the Mt. Moriah and Sundance Kid tanks, and the Underground Reservoir configurations, with one inflow/outflow pipe, create a water-quality problem potential in these tanks. The single pipe configuration can lead to problems with circulation and stratification, ultimately leading to disinfection byproduct generation. It is recommended that the tanks with single inlet and outlet configurations be further analyzed to evaluate water quality as part of a Level II study.

6.8.4 DISTRIBUTION
The system-distribution lines are comprised of 4- and 6-inch water lines. Since these lines have a limited capacity and the majority of the water system’s fire hydrants are located along these lines, the system cannot meet fire-flow demands. Critical nodes within the system also drop below 20 psi during fire flow. To decrease pressure losses and increase capacity within the distribution system, the smaller 4- and 6-inch distribution main lines are recommended to be removed and replaced with 8-inch lines as lines are repaired. The North and South zone backbone projects also address this concern as described below.

6.8.5 PUMPS
Pump stations associated with the Sundance West and Canyon pressure zones cannot keep up during peak demand. Service loss was reported at the Brewer Tank by users and observed in the model during peak-day demands. The Brewer Tank and Canyon Tank levels only recover to full during off-peak demand, or during the night. To improve the Canyon and Brewer tanks’ supply, the larger pumps at each corresponding pump station are recommended for further evaluation as part of a Level II study.

6.9 RECOMMENDED WATER SYSTEM IMPROVEMENTS: STRUCTURAL
This subsection describes the structural improvements recommended to address concerns identified throughout the course of this study. Figure 6-1 shows each of these recommended improvements on an overall map. Sections 11 through 13 of this Plan describe the recommended prioritization of these improvements, associated estimated construction costs, and financing options, respectively.

6.9.1 COLE TRANSMISSION LINE
The Cole Transmission Line requires some improvements to stabilize the pressure fluctuations and to limit the possibility for short-circuiting in the Mt. Moriah Tank. This project consists of constructing a parallel high-capacity
transmission main from the end of the Cole Transmission Line at Hwy 14 to the Mt. Moriah Tank (Figure 6-2). The Mt. Moriah Tank will then be reconfigured to include dedicated inlet and outlet lines. This new transmission line will also connect with the Canyon Pump Station. The Cole Transmission project addresses potential water quality issues in the tanks; improves available fire flow along the transmission main route by adding dedicated hydrants; eliminates pressure fluctuations due to switching the hydraulic head source in the North Zone; and provides increased head to the Canyon Pump Station.

A short-term alternative to help increase supply to the Sundance West and Canyon subdivisions is to construct a dedicated-supply line directly from the Mt. Moriah Tank to the Canyon Pump Station. Connecting directly from the tank would increase the available supply and allow larger pumps to be installed without jeopardizing the pressures in the North Zone.

6.9.2 POLICKY/BLUE TRANSMISSION
Recommendations are to reconfigure the Policky Tank to have a dedicated inflow and outflow pipe, and construct a new transmission main along Highway 14 to the intersection of Limestone Road. Just west of the intersection, the new transmission line will be connected to the existing transmission line from Well 6 and the existing line from the intersection east will remain as part of the distribution system. This transmission line will have dedicated connections to the Policky and Blue tanks (Figure 6-3). The benefit of this project is that the new dedicated transmission main allows each tank to fill independently and allows the Blue tank to serve its own pressure zone (i.e. East Zone) as explained in the next subsection.

6.9.3 POLICKY/BLUE PRESSURE ZONE RECONFIGURATION
Currently, the Policky Tank serves the East Zone, and the Blue Tank serves the South Zone. The South Zone experiences pressures ranging from 40 to 75 psi, and the Policky Zone has pressures that range from 70 to 150 psi (with PRVs). This option would reconfigure the 2 zones such that the Policky Tank would serve the South Zone and nodes along Highway 14. The Blue Tank would serve the East Zone, which includes the area south of I-90, the Croell Subdivision, and will ultimately serve the Industrial Park, Old Highway 14, and make a loop under HWY 585 to service the Sundance High School and golf course (Figure 6-4). The configuration increases pressures in the South Zone, reduces the pressures in the East Zone, and may eliminate the need for PRVs in both zones. The recommendation is an operational change that that would occur after the East pressure zone upgrades are made. Although this is a non-structural improvement, we have listed it here with the structural improvements, since this reconfiguration cannot occur before structural improvements are made for the East pressure zone.
6.9.4 EAST PRESSURE ZONE UPGRADES
To eliminate long dead-end lines in the East pressure zone, it is proposed that the City construct an 8-inch diameter pipeline to connect the Croell Subdivision with the Industrial Park water line. Isolation valves will be placed such that the Moya Subdivision, Pleasant Valley Road, East Cleveland Street from the Fairgrounds Loop Road east, the Sundance High School, and the HWY 585 underpass will each be included in the East pressure zone (see Figure 6-4). Part of this project will also include replacing the 4-inch line along HWY 585 with a 10-inch line.

6.9.5 NORTH ZONE BACKBONE
The North Zone Backbone includes proposed transmission main construction that spans the North Pressure Zone’s length, and connects to the distribution network within the zone (see Figure 6-2). This project will improve North Zone pressure and flow stability and the system’s response during fire flows.

6.9.6 SOUTH ZONE BACKBONE
The South Zone Backbone includes proposed transmission main construction that spans the South pressure zone’s length from south to north, and connects to distribution loops within the zone (see Figure 6-2). This project will improve South Zone pressure and flow stability, and improve the system response during fire flows.

6.9.7 SUNDANCE WEST IMPROVEMENTS
The Canyon and Sundance West subdivisions do not have adequate pumping capacity with the Canyon and Sundance West pump stations. Users often experience service loss in these areas, and pumps and tanks cannot keep up with demand. The Sundance West project would increase the pump station capacities and the transmission lines connecting the pumps to the tanks (see Figure 6-5).

6.10 RECOMMENDED WATER SYSTEM IMPROVEMENTS: NON-STRUCTURAL

6.10.1 IMPROVE SYSTEM MONITORING AND CONTROLS
Install a SCADA system that monitors tank levels and production more accurately than the current systems.

6.10.2 CONSERVATION MEASURES
Implement water conservation measures during peak seasons to help limit Sundance West Subdivision demands on the Canyon and Sundance West Pump stations. A combination of the following measures should be considered during the peak demand months:
• Alternate days for landscape irrigation. We recommend that half the homes water Monday, Wednesday, and Saturday, and the other half water Tuesday, Thursday, and Sunday.

• Limit landscape irrigation to off-peak hours. We recommend curtailing irrigation between the hours of 9:00 AM and 6:00 PM by encouraging residents to water in the evenings between the hours of 6 PM and 9 AM. This will limit peak demands and decrease evaporative losses from watering during the hottest part of the day.

6.11 RECOMMENDED FUTURE USES OF HYDRAULIC MODEL

The hydraulic model is a useful master planning tool; it provides the City with the ability to evaluate near-term decisions regarding the water system. The model can assist with evaluation of the following types of scenarios:

• New taps on existing lines
• Existing pipeline extensions
• Increased demands from existing taps
• Tank operational range changes
• PRV control setting adjustments, pressure switches and flow control valves
• Effects of opening or closing isolation valves
• Construction phasing
• Effect of shutting down components for maintenance

Additionally, the model can be used to troubleshoot actual happenings in the field. Data collected in the field can be given to the City Engineer to use in the model and assist with maintenance and repair, which helps in maintaining a healthy water system.
7.0 WATER SOURCE DATA AND WATER RIGHTS

Understanding water supply sources and the water rights associated with them is important to determine if the water supply is adequate to meet current and future water demands. This approach allows for planning of alternate water supply sources if a shortage is identified. This report section provides the City with a summary of the City’s water supplies and water rights. Existing sources of water supply and their associated rights are tabulated to determine the total amount of water currently available to the City. This section also summarizes the historical use from each supply source based on season and location relative to the City. Finally, local water sources are evaluated to estimate the potential for future development to meet increased demand, if necessary.

7.1 WATER SUPPLIES

Currently, the City’s water supply is sourced from groundwater. Surface water sources do not account for any of the City’s water supply.

Based on groundwater pumping records from 2008 through 2010, the average daily demand is approximately 438,000 gallons (300 gpm). The maximum daily demand is approximately 576,000 gallons (400 gpm). These values were compared to the production capacity of the City’s water-supply wells to evaluate the viability of the City’s existing and future water supply. The pumping records for 2011 and 2012 were reviewed, but these data were not used in the demand estimates, since the data contained anomalies that could not be explained.

7.2 GROUNDWATER

The City’s municipal groundwater supply is produced from wells located north of the City and one well located west of the City. Four wells north of the City make up the Cole Well Field; the well located west of the City is named the Well 6. Other wells exist within and adjacent to the City that are no longer used by the City. In total, the City’s water supply wells are permitted and adjudicated for 1,567 gpm through the SEO.

7.2.1 GROUNDWATER DEVELOPMENT HISTORY

Water right data for the City’s current and historical water supply wells are presented in Table 7-1. Well permits for the wells described in this section are presented in Appendix C. The City has groundwater rights dating back to 1965. Well 3 (Permit No. P1544W) is adjudicated for 240 gpm with a priority of October 11, 1965. Well 3 is part of the Cole Well Field located approximately 5 miles north of the City. Three other wells were completed in the Cole Well Field between 1971 and 2009. These wells include Well 3A (Permit No. P8377W), Well 3B (Permit No. P50484W), and Well 3C (Permit No. P191655W). The location of the wells within the Cole Well Field is shown on Figure 7-1.
Wells 3A and 3B are each adjudicated for 250 gpm and currently contribute water to the City’s municipal supply. Well 3C is not used or adjudicated for municipal supply. Further discussion of Well 3C is provided in Section 7.2.2.

The wells in the Cole Well Field are completed in the Permian/Pennsylvanian-age Minnelusa Formation and the Mississippian-age Pahasapa Limestone (equivalent to the Madison Formation Limestone). Sutherland, et al. (2007) describes these formations as follows:

**Lower Permian/Pennsylvanian Minnelusa Formation:** Thick, massive, white to yellowish- and reddish-gray, varying to gray, light brown, and red, well-sorted and cemented, cross-bedded, fine- to coarse-grained sandstone accompanied by varying amounts of red and white solution breccias, purplish-gray to pink limestone and dolomite, and red, purple, and black shale. Formation thickness ranges from 650 to 800 feet (ft).

**Lower Mississippian Pahasapa Limestone:** Cliff-forming, white to light-gray and tan, very fine-grained, thick-bedded, cavernous limestone and dolomitic limestone that contains nodules and layers of chert in some outcrops. Formation thickness ranges from 300 to 630 ft with a thickness of approximately 550 ft in the Bearlodge Mountains near Sundance.

Each of these formations comprises significant aquifers in the Black Hills region near Sundance. The formations yield water through secondary permeability, caused by intense fracturing of the rock and solution cavities. Wells 3 and 3C are completed in the Minnelusa Formation at depths of 517 feet below ground surface (ft bgs) and 610 ft bgs, respectively. Wells 3A and 3B are completed in the Pahasapa Limestone at depths of 1,123 ft bgs and 1,236 ft bgs, respectively.

Well 6 (Permit No. P72179W) also currently contributes to the City’s municipal water supply. This well is located approximately 1 mile west of the City and is completed to a depth of 1,184 ft bgs in the Pahasapa Limestone. The well is adjudicated for 400 gpm as municipal use and is mostly used to augment water from the Cole Well Field during peak demand. The City anticipates pumping this well on a more frequent basis. At the time of this study, the City was building a new above-ground chlorination facility adjacent to Well 6. The City plans to use the well on a year-round basis beginning in late May or early June, 2013.

Other wells that are permitted for municipal use by the City include the Loafman #1 (Permit No. P2520W) and #2 (Permit No. P2521W) wells, and the Hard Water #5 Well (Permit No. P2523W). The Loafman wells are located southwest of the City at the location of a spring and the two wells are each adjudicated to produce 15 gpm. The Hard Water #5 Well is located in the southern portion of the City and is adjudicated for 300 gpm for municipal and
miscellaneous use. The well was originally drilled for municipal supply; however, the hardness of the water prevented its use as such. The well is now used as non-potable supply to a bulk-water filling station for local contractors.

The SEO database listed one groundwater right for the City that has been abandoned. The Lloyd Cole # 4 Well (Permit No. P2522W), which was abandoned in 1984 and assumed no longer operable, is located approximately 1 mile north of the City.

7.2.2 WELL 3C

As stated previously, the City has not used Well 3C for municipal supply since it was completed in 2009. The following sections provide background information regarding the design and completion of Well 3C, and the results of the step-rate and constant-rate pump tests performed after well completion. A summary of correspondence between the City, the WWDO, and project contractors during planning and construction of Well 3C is presented in Appendix C.

7.2.2.1 BACKGROUND

Well 3C was drilled and completed in 2009. The well was designed by Bearlodge and constructed by Weston Engineering, Inc. Tetra Tech performed analysis of the pump test data and provided the analysis to Bearlodge in a technical memorandum (Tetra Tech 2009). The well was originally intended to replace Well 3A, which was reported to have structural deficiencies that would require the well to be taken out of future service.

The Design Report for Well 3C (Bearlodge 2009) states that the City relied on four wells for their municipal water supply, and that Well 3C would provide a fifth supply source. The Design Report states that the combined capacity of the five wells is 1,290 gpm (1,857,600 gallons per day [gpd]). It further states that two of the wells (wells 3 and 3A) are producing, but appear to have structural deficiencies that may require the City to take them out of future service. The remaining three wells (wells 3B, 3C, and 6) are documented to have a combined capacity of 800 gpm, which equates to 1,152,000 gpd.

The Design Report compares the City’s source capacity (wells 3B, 3C, and 6) with the source capacity required by the WDEQ, which is twice the maximum daily demand [Chapter 12 Section 9(b)(i)]. Based on 2007 data referenced in the Design Report, the maximum daily demand reported is 343,483 gpd. The City’s source capacity (1,152,000 gpd) exceeds twice the maximum daily demand (686,966 gpd), and therefore, meets the regulatory requirements.

Understanding of the wells currently in use includes Well 3A, Well 3B, and Well 6. The total combined capacity of these three wells is 900 gpm, which equates to 1,296,000 gpd. The average daily demand based on data from 2008
through 2010 is 438,000 gpd and the maximum daily demand is 576,000 gpd. The City’s current source capacity based on the use of these three wells exceeds twice the maximum daily demand (i.e. two times the maximum daily demand equals 1,152,000 gpd, which is less than the source capacity of 1,296,000 gpd).

Well 3A is completed in the Pahasapa Formation at a depth of 1,236 ft bgs. To replace Well 3A, Well 3C was also planned to be completed in the Pahasapa Formation to a total depth of 1,240 ft bgs. During drilling of Well 3C, the driller lost circulation in the Minnelusa Formation and was unable to complete the well to the planned depth. The driller offset approximately 30 ft from the previous borehole and attempted to complete a second borehole to the planned depth. The driller again lost circulation in this borehole and stopped work. Bearlodge reported that after discussion between the City, the SEO, the WWDO, and the WDEQ, the decision was made to complete the well in the Minnelusa Formation (Goodson 2009).

Although not explicitly documented in reviewed records, a letter from WDEQ dated January 8, 2009 (Appendix C) references diesel fuel contamination in Well 3C and the Minnelusa Formation introduced during construction of the well. This information is hearsay, and it is unclear as to how much, if any, diesel fuel was introduced into the well. Water quality samples collected from Well 3C on July 24, 2009 were not analyzed for petroleum products.

Since Well 3C was not completed into the Pahasapa Formation, information in the Design Report indicates that the City intended to keep Well 3A in service and make the necessary repairs to allow them to continue to produce water from the well. The records do not provide a clear understanding of what the structural deficiencies were and what, if any, repairs were made to correct them. The City has continued to use this well (along with wells 3B and 6) for its municipal supply.

7.2.2.2 WELL AND AQUIFER CONFIGURATION

The Tetra Tech memorandum (2009) provides details of Well 3C completion and site geology. The well is constructed with an 8-inch diameter steel casing and a pipe-based, wire-wrapped screen to a total depth of 609.7 ft bgs. The well is screened with 0.020-inch slot, stainless steel screen from 494.7 to 544.6 ft bgs and 566.5 to 590.6 ft bgs (74 ft of screen over an interval of 95.9 ft). Based on data from the SEO, filter pack was not installed in the well. The annulus between the well casing and borehole wall was cemented from ground surface to a depth 461 ft bgs. The depth to the static-water level in the well was reported as 450 ft bgs.

The WDEQ permit-to-construct required that the well screen be installed so that the pumping-water level remains above the screen under operating conditions. The permit also required the well casing be installed with a bottom plate
or wash-down bottom fitting. The Design Report states that the well was not completed with a wash-down tool. The bottom of the production string was left open so that a future opportunity was provided to drill out through the bottom of the well and re-complete it in a lower zone, with a smaller casing string and screen, if the production capacity of the well was deemed inadequate.

The geologic formations (with depth to the top of the formation) encountered during drilling are listed as follows:

- Alluvium – surface
- Spearfish Formation – 38 ft bgs
- Minnekahta Formation – 179.5 ft bgs
- Opeche Shale – 212.75 ft bgs
- Minnelusa Formation – 301 ft bgs

The Tetra Tech memorandum indicates that the Minnelusa Formation is not fully saturated and is unconfined at the well site. Due to thickening of the overlying formations, the Minnelusa Formation is under confined conditions to the north and east of the well. The Minnelusa Formation crops out to the west of the well creating decreased saturated thickness. Therefore, the fully saturated portion of the formation is projected to end approximately 1.25 miles west of the well. This interpretation seems reasonable.

### 7.2.2.3 STEP TEST

A step test was conducted on July 8, 2009. The step test consisted of pumping Well 3C at 4 different pumping rates (75 gpm, 150 gpm, 225 gpm, and 300 gpm) and monitoring water levels in Wells 3C and 3. The water-level data collected from Well 3 were not precise enough to be useful other than to indicate that the pumping of Well 3C caused water-level drawdown in Well 3.

Tetra Tech’s interpretation of the results of the step test indicate that Well 3C is affected by the lack of saturated thickness to the west of the well as evidenced by excessive drawdown observed in Well 3C during later periods of pumping. This result affects the overall productiveness of the well. The pumping data also indicate that the specific capacity of the well decreased significantly when the production rate was increased to 300 gpm.
7.2.2.4 CONSTANT-RATE TEST

A constant-rate test was conducted from July 22 to July 27, 2009 using the same equipment as the step test. The driller intended to pump the well at a rate of 250 gpm. Due to excessive drawdown and other technical difficulties, the time-weighted average rate was 203 gpm over approximately 5 days of pumping. During the constant-rate test, the project team monitored water levels in Wells 3C and 3. Consistent with the observations made during the step test, the precision of the water-level measured in Well 3 was insufficient to be useful other than to indicate that the water level in Well 3 was affected by pumping in Well 3C.

The drawdown and recovery data obtained during the constant-rate test were analyzed using a variety of methods. The results and Tetra Tech’s interpretation of these analyses are summarized as follows. The well experienced an increased rate of drawdown after approximately 200 minutes due to thinning of the saturated thickness of the Minnelusa Formation to the west of the well. Based on an evaluation of the local hydrogeology, this interpretation seems reasonable.

The well experienced another increase in the rate of drawdown after 1,700 minutes and again after 2,100 minutes. These increases are attributed to thinning of the formation to the south of the well near the outcrop.

The water level in the well was maintained in a state of “quasi-equilibrium” at 43.5 feet of drawdown with a pumping rate of 150 gpm over 2,134 minutes (approximately 1.5 days) of pumping.

Based on analysis of drawdown and recovery data, transmissivity ranged from 12,087 to 28,356 gallons per day per foot (gpd/ft) with an average of 18,782 gpd/ft. Transmissivity is the ability of an aquifer to transmit water to a well throughout the entire thickness of the aquifer. Values of transmissivity range from less than 1,000 gpd/ft to more than 1 million gpd/ft. Transmissivities of less than 1,000 gpd/ft are likely only adequate for domestic wells or other low-yield uses. Transmissivities of greater than 10,000 gpd/ft are considered adequate for industrial, municipal, or irrigation purposes (Driscoll 1986).

Hydraulic conductivity ranged from 6.5 to 13.6 feet per day (ft/d) with an average of 10 ft/d. Hydraulic conductivity is the capacity of a porous media (aquifer) to transmit water. Multiplying the hydraulic conductivity by the thickness of the aquifer equals the transmissivity. Hydraulic conductivity is determined by the size and shape of the pores and their interconnectedness. The larger the pore space and the more connected the pores are, the higher the hydraulic conductivity of the aquifer (Driscoll 1986).

The Coefficient of Storage (referenced in the memorandum as storativity) was calculated to be 0.005; although this is a rough estimate since accurate determination of storativity requires data from an observation well, which was not
obtained during this test. The Coefficient of Storage can indicate whether the aquifer is unconfined (values between 0.1 and 0.001) or confined (values between 0.001 and 0.00001). The memorandum indicates that the well is located where the aquifer transitions between unconfined and confined. Therefore, this value is consistent with this interpretation.

Based on the analysis of the step and constant-rate test results, Tetra Tech suggested a safe yield for Well 3C of 150 gpm. A pumping rate up to 300 gpm was identified to be possible, but only for short periods. Based on the increased drawdowns observed in the well with pumping rates in excess of 200 gpm, this recommendation seems reasonable. The City tested the pump in Well 3C in May 2013. During the pump test, the pump was only able to run for approximately 15 minutes before shutting down. The City is investigating the cause of the shutdown.

7.2.3 GROUNDWATER PRODUCTION

The City’s water supply wells are permitted and adjudicated for 1,567 gpm. However, the City currently uses water from the Cole Well Field (Wells 3A and 3B) and Well 6 for their municipal supply. As mentioned previously, Well 3C is not used due to production issues with the well described in Section 7.3.1. The Hard Water #5 Well is not used for municipal supply due to hardness issues. Therefore, the City has approximately 900 gpm of source capacity available for municipal use.

Well 3B

Based on the pump test records from Well 3B, the well may potentially produce more than the adjudicated 250 gpm. The pump-test data indicate the well was pump tested twice, shortly after completion, at two different pumping rates with similar drawdown results. The first test was conducted for 24 hours, at a pumping rate of approximately 245 gpm, with an observed maximum drawdown of 281 ft. The well was pump tested approximately 1 month later for 24 hours at an average pumping rate of approximately 300 gpm with a maximum drawdown of 272 ft. Based on the data from the pump test, the transmissivity of the well was calculated to be 9,900 gpd/ft. This information may indicate that the well could sustain a higher pumping rate, if allowed, by an enlargement to the permit. Pump test data are not available for Well 3A, but because Wells 3A and 3B are completed in the Pahasapa Limestone with similar static-water levels, it is likely that the two wells may have similar production capabilities. Pump test data for Well 3B are presented in Appendix C.

Well 6

Well 6 is also completed in the Pahasapa Limestone, but approximately 5 miles south of the Cole Well Field. Well 6 is completed to a similar depth from ground surface, but the static water level is 370 ft deeper than at the Cole Well Field.
Well 6 was pump tested shortly after completion using the step-rate method. The well was tested at pumping rates of 100, 200, 300, 400, and 450 gpm for intervals ranging from 30 minutes to 4 hours. While testing the well at pumping rates of 100, 200, and 300 gpm, the water level stabilized after a few minutes of pumping. When the pumping rate was increased to 400 gpm, the water level stabilized after approximately one hour of pumping. The pumping rate was then increased to 450 gpm and pumped for 4 hours. The water level continued a gradual drop during the 4 hours of pumping (Bearlodge 1986).

Following the step-rate test, a continuous-discharge test was conducted. The well pumped at a rate of 435 gpm for approximately 72 hours. Maximum drawdown during the test was approximately 155 ft. Drawdown during the first 24 hours of the test was gradual. A hydrologic boundary was encountered after 24 hours causing an increase in the drawdown rate. Transmissivity was calculated using the drawdown data before and after encountering the boundary. The transmissivity calculated during the first 24 hours of the test was 14,331 gpd/ft. The transmissivity calculated after encountering the boundary was 616 gpd/ft (Bearlodge 1986). These data indicate that the well may not be capable of sustaining long term, continuous pumping at a rate that exceeds 400 gpm. If this well is to be used as a regular municipal-supply source, the City should consider pumping the well at a rate of no more than approximately 350 gpm to minimize the number start-up/shutdown cycles created from the pump shutting down due to drawdown in the well. Pump test data for Well 6 are presented in Appendix C.

Well 3
Well 3 is completed in the Minnelusa Formation. Pump test data recorded on the SEO well permit indicate that the well was pump tested for 7 hours at an average discharge rate of 301 gpm with approximately 8 feet of drawdown. The well is adjudicated for 240 gpm presumably based on the rated capacity (240 gpm) of the pump installed in the well. The main water-bearing zone is described as a limestone fracture at a depth of 505 ft bgs. These data indicate that where the Minnelusa Formation is fractured, this formation is capable of producing sufficient quantities of water for municipal supply.

7.2.4 POTENTIAL GROUNDWATER AUGMENTATION
As part of this Plan, opportunities for groundwater development are identified to meet future demands, if the City’s existing sources of supply need to be augmented. Based on the results of the population projections and future demand calculations over a 20-year period, the average daily demand is projected to increase by as much as 150,000 gpd (100 gpm). The accordant increase in maximum daily demand is 225,000 gpd (150 gpm). These projections take into account the potential for a spike in growth in the next 2 to 5 years as a result of the Strata and Rare Elements Resource (RER) developments. The City’s existing water supply is sufficient to meet these increased demands. However, if the
demand increases beyond what is projected, the City will need to consider expansion of their groundwater supply. Options for augmenting the City’s groundwater supply to accommodate the increased demand include:

1. Increasing the production capability of the existing wells
2. Developing a new well(s) in the Pahasapa and Minnelusa Formations

The City’s permitted groundwater supply (1,567 gpm) has the potential to produce approximately 2.25 million gpd. The three wells that the City uses for water supply (wells 3A, 3B, and 6) are rated for a total of 1.3 million gpd (900 gpm). Excluding the Hard Water #5 Well (238,000 gpd), the City’s other permitted wells have approximately 600,000 gpd of additional capacity. These data indicate that there may be expansion potential of the City’s water supply using the existing wells.

Based on a review of available well completion and testing records, the potential exists to increase the production capacity of the City’s existing water-supply wells. However, given the age and uncertainty about the condition of the City’s groundwater wells, additional pump testing of the wells to determine the maximum pumping rate that the well(s) could sustain over a given time period is recommended. If the maximum pumping rate is determined to be higher than the permitted production rate, then an enlargement would need to be filed with the SEO. The pump and related appurtenances may also need to be replaced to provide the increased production.

The Minnelusa and Pahasapa Formations are proven water-producing formations and are present in the subsurface under much of the area surrounding the City. Wells 3A and 3B are located relatively close to one another and completed to similar depths. The degree of hydrologic communication that exists between the two wells is unclear. It may be possible to site another well within the Cole Well Field to provide additional supply. Additional pump testing is needed to assess the degree of communication between wells and the feasibility of drilling another well in the area. This same potential exists in the area of Well 6. The Pahasapa Limestone may be able to sustain an additional well in this area, but further investigation would be needed to determine well spacing to minimize well interference between the two wells. This investigation should include a review of the geologic structure in the area to determine areas where the formation may be fractured. The fractured areas will likely have higher production potential due to increased secondary permeability in the formation.

### 7.3 WDEQ REQUIREMENTS AND SOURCE WATER ASSESSMENT

The City’s water supply was evaluated in context with the requirements for public water supplies outlined in Chapter 12 of the WDEQ Water Quality Division rules and regulations. A summary of the results of this evaluation is
included in Section 7.3.1. The Source Water Assessment and Protection (SWAP) executive summary (Trihydro 2004) for the City was also reviewed, and the results of the assessment are summarized in Section 7.3.2

### 7.3.1 WDEQ REQUIREMENTS FOR WATER SUPPLY

The City’s water supply wells were assessed to determine their compliance with Section 9(b) of Chapter 12 of the WDEQ rules and regulations. Section 9(b)(i) specifies that the total developed source should provide a combined capacity equal to or greater than the maximum daily demand. A minimum of two wells, or one well and finished water storage equal to twice the maximum daily demand is required. Where two wells are used, the sources should be capable of equaling the average daily demand with the largest producing well out of service. The three wells used by the City have a total capacity of 1,296,000 gpd (900 gpm), which meets the requirements for capacity of wells to provide or exceed twice the maximum daily demand of 576,000 gpd (400 gpm). The combination of Wells 3A (360,000 gpd) and 3B (360,000 gpd) is sufficient to meet the average daily demand (432,000 gpd), if Well 6 (576,000 gpd) is out of service. The wells exceed the minimum distances for point sources of contamination related to domestic wastewater, buildings, and property lines, as specified in the tables in Section 9(b)(i)(B).

In general, the construction and materials of the wells meet the requirements specified in Section 9(b)(iii)(C). Construction records for the wells indicate that surface casing was cemented in place. However, the three wells were not completed with surface seals to provide protection from surface contamination and flooding. Additionally, the wells are not protected from entrance by animals as specified in Section 9(b)(iii)(C)(V)(5).

### 7.3.2 SOURCE WATER ASSESSMENT

The Source Water Assessment and Protection (SWAP) Program was developed to protect public water systems (PWS) from contamination. The SWAP program consists of source water assessments and source-water protection plans for each PWS. The Source Water Assessment (Assessment) of the Sundance water supply included evaluation of four wells including Wells 3, 3A, 3B, and 6. In the Assessment, the susceptibility of the water system is evaluated based on three factors including the physical integrity of the well, intake, and conveyances; sensitivity of the land area through which potential contaminants may reach the well or intake; and the nature of the potential contaminants.

The first step of the Assessment is to evaluate the integrity of the well or intake. Each well or intake receives a score between 1 and 13 for its physical integrity. Higher scores represent higher susceptibility. The City’s Cole wells received scores of 12 due to the wells being completed prior to 1983 when more stringent construction standards were required by the State of Wyoming, long conveyance structure lengths, lack of surface seals, lack of protection around the wellhead from contaminant source, and lack of surrounding flood protection. Well 6 received a score of 11 for the
same reasons, except the well has a short conveyance structure length. The Assessment indicates Well 6 received a score of 3 for being completed prior to 1983, although the well was completed in 1986.

The second step is to evaluate the sensitivity of the water source. Water sources are scored between 1 and 10 depending on the type of aquifer system and whether contaminants have been detected in the past five years. The City’s wells received a sensitivity score of 10 because the wells are completed in aquifers that are known to be vulnerable to contamination due to unpredictable flow paths associated with conduit flow. Also, the wells received the highest score of 5 for chemical sensitivity due to documented detections in groundwater.

The third step of the assessment is to determine a well rating for each well by combining the score for integrity and the water-source sensitivity score. The well rating is based on the total score; low (2-8 points), medium (9-15 points), or high (16-23 points). The City’s four wells received ratings of high.

The final step in the assessment is to rate the potential sources of contamination located within the contaminant inventory zones delineated for each well. Three categories of contaminants were developed by WDEQ for this analysis: regulated point sources, non-point sources including land use, and transportation corridor sources. The City’s water system scored low for point source contamination susceptibility due to lack of contaminant sources in the area of the wells. The system scored high for non-point source-land use susceptibility because much of the land surrounding the wells is forested, which creates the potential risks associated with increased runoff and water quality issues associated with forest fires. The system was assigned a medium rating for transportation corridor susceptibility because the source area is in proximity to a state highway.

Overall, the Assessment completed for Sundance indicates that the City’s water supply scored high for well integrity, source sensitivity, and land use susceptibility and low for point source contaminant susceptibility. The system received a score of medium for transportation corridor susceptibility.

### 7.4 SURFACE WATER

Surface water in the Sundance area consists of two streams and three springs. Sundance Creek runs west to east through the City. Cundy Creek runs north to south approximately one mile west of the City. The three springs, Loafman, Kaiser, and Jacobson, exist south and southwest of the City. The City’s surface water rights are presented in Table 7-2 and summarized below.
The City has three surface water rights filed with the SEO. These rights are associated with the springs south and southwest of the City. The Draper Ditch (Permit No. P2705D) dates back to 1900 and is associated with the Kaiser Spring in the northwest corner of Section 26 (T51N, R63W). This right is appropriated for 0.03 cubic ft per second (cfs) for domestic and municipal use.

The Sundance Pipeline surface-water right (Permit No. P2863D) also dates back to 1900. This right is associated with the Jacobson Spring located in Section 23 (T51N, R63W). The right is adjudicated for 1 cfs for domestic, irrigation, fire protection, and municipal use.

The Loafman Ditch and Pipeline (Permit No. P12151D) is associated with Loafman Springs located in the eastern portion of Section 27 (T51N, R63W). This water right has a 1913 priority and is adjudicated for 0.03 cfs as municipal use.

The City does not currently utilize surface water as a source of municipal supply. The existing water rights summarized above could be used to augment the City’s water supply for uses other than potable water supply such as raw water irrigation.

7.5 SUMMARY

The City has surface and groundwater rights to provide a source of municipal water supply. The City obtains the majority of its municipal supply from three groundwater wells. Groundwater may be produced from other wells to augment the City’s municipal supply. Available production from the City’s existing municipal supply wells is adequate to satisfy the current and predicted future demand of the City’s water system. If future demand increases beyond what is predicted in this plan, the following alternatives should be considered to meet the demand:

1. Evaluate the production capacity of the existing wells and determine if the production capacity of the wells can be increased.

2. Develop a new well in the area and formation of the existing wells.

3. Investigate and identify other sources of groundwater such as the Deadwood Formation.

Surface water could be used to augment the City’s water supply for non-potable uses such as raw-water irrigation.
7.6 RECOMMENDATIONS

Based on the information summarized above, the following activities are recommended for consideration and implementation into a Level II study to address issues described above:

- Contract a pump-service contractor to pull the pump, video log the well casing, and inspect the pump, controls, and other appurtenances for Wells 3, 3A, 3B, and 3C to determine their condition and perform maintenance that may be identified. The condition and reliability of the wells and appurtenances is in question due to the age of the wells in the Cole Well Field and considering the structural issues with Wells 3 and 3A referenced in permitting Well 3C.

- Construct surface seals for and fencing around Wells 3, 3A, 3B, 3C, and 6 to protect the wells from surface contamination and animals to meet the requirements of WDEQ Chapter 12 Rules and Regulations described in Section 7.3.1 of this report.

- If Well 3C is consistently operable, collect a water-quality sample to determine the water quality. The analytical suite should include the EPA Primary and Secondary Drinking water constituents, oil and grease, total petroleum hydrocarbons as diesel range organics, and total petroleum hydrocarbons as gasoline range organics.

- If Well 3C is consistently operable, perform a 48-hour pump test to determine the production capacity of the well. The results from this test should be compared to the 2009 pump test to verify the production capacity of the well.
8.0 WATER QUALITY

This section of the report provides a summary of the City’s potable water system from a water quality standpoint. Current and proposed water quality regulations were referenced to determine if water at the source and within the water-distribution system complies with Environmental Protection Agency (EPA) drinking water standards. This section summarizes the City’s historical water quality data in relation to current and proposed EPA regulations, provides operational, and design recommendations to protect water quality at the source and within the water-distribution system.

8.1 WATER TREATMENT REGULATIONS

The Safe Drinking Water Act (SDWA) was established by Congress in 1974 to protect public health by regulating the public drinking water supply. The EPA was tasked to establish national health-based standards for drinking water to protect against natural and anthropogenic contaminants. National Primary Drinking Water Regulations set maximum contaminant levels (MCLs) for certain constituents to prevent the known or anticipated occurrence of adverse health effects. The SDWA also established a secondary set of standards to prescribe MCLs for constituents that affect the aesthetic attributes (e.g., taste, color, and odor) of drinking water but that do not impart adverse health effects. Lists of Primary and Secondary Drinking Water Standards are included as Appendix D. National drinking water standards are legally enforceable, which means that the EPA and individual states can take actions against public water systems (PWS) not meeting standards. Therefore, it is important that the City is aware of these standards and takes appropriate actions to monitor and safeguard its drinking water supply.

8.2 DISINFECTION BY-PRODUCTS RULE

Chlorine (in the form of chlorine gas) is used by the City to protect water system users from microbial pathogens. Disinfection by-products (DBPs) are formed when the disinfectant (i.e., chlorine) reacts with organic and inorganic materials in source waters (EPA 2007). Natural organic matter (NOM) is an important factor that affects the levels of DBPs formation and monitoring NOM (as total organic carbon or TOC) can serve as a precursor to DBPs. The levels of DBPs can vary from one point in the distribution system to another and must be monitored at multiple locations within the system. DBP monitoring is critical to protect the City’s water system users. Long-term exposure to DBPs has been linked to cancer of the human digestive system. Acute exposure to DBPs may be associated with adverse reproductive and developmental health effects. The presence of DBPs is determined by monitoring the levels of five haloacetic acids (HAA5) and total trihalomethanes (TTHM) (EPA 2007).
To reduce potential human health risks from DBPs, the EPA established a DBP Rule (DBPR). Stage 1 was introduced in December 1998, and was subsequently enhanced to Stage 2 in January 2006. The EPA has indicated in a 2006 letter (Appendix D) that the City is to begin Stage 2 DBPR monitoring on October 1, 2013. To comply with Stage 2 DBPR, the City must complete the following (EPA 2010):

- Conduct an initial evaluation of their distribution system (IDSE)
- Use a locational running annual average (LRAA) calculation to determine compliance with the Stage 2 DBPR MCLs of:
  - 0.08 milligrams per liter (mg/L) TTHM
  - 0.06 mg/L HAA5
- Monitor for Stage 2 compliance at the required number of locations
- Identify when TTHM or HAA5 levels exceed the operational evaluation level and, if this happens, find ways to reduce TTHM and HAA5 concentrations in the distribution system
- Continue to comply with other requirements for Stage 1 DBPR, which includes compliance with maximum residual disinfectant levels (MRDLs) and total organic carbon (TOC) removal requirements

In a letter dated December 21, 2006 (Appendix D), the EPA granted the City a 40/30 Certification Waiver for the Stage 2 DBPR IDSE. The 40/30 Certification Waiver indicates that the City submitted eight consecutive quarters of sampling results below 0.040 mg/L TTHM and 0.030 mg/L HAA5. These samples should be referenced to determine the locations of highest TTHM/HAA5 concentrations. Currently, the City is collecting TTHM/HAA5 samples at the Cole Tank Chlorinator Building and at the Well 6 meter vault. These locations may or may not be consistent with the DBPR monitoring requirements. The determination of proper sampling locations is critical to protect the health of drinking water system users.

TTHM/HAA5 samples should be taken at a location that reflects the system’s maximum residence time during the month with the warmest water temperature. EPA monitoring requirements for the City (Appendix D) indicate that one pair of TTHM/HAA5 samples be collected between 2011 and 2013. Because the formation of DBPs is governed by the source water and the degree of chlorination, it is recommended the City conduct DBP sampling at the location of maximum residence time for the North Zone (supplied by the Cole Well Field) and the South Zone (supplied by Well 6). Since water system operations may change after the Cole Tank is relocated and the Well 6 Chlorinator Building is online, it is recommended to use the water model to determine locations of maximum residence time during a Level II study. The determination of these locations will assist the City to prepare a Stage 2 DBPR Monitoring Plan,
which must include when and where TTHM/HAA5 will be monitored and the compliance calculations that will be used (LRAA). Worksheets to organize monitoring data and calculate LRAA are included as part of the Stage 2 DPBR Compliance Guide (Appendix D).

8.3 WATER QUALITY RECORDS

Water quality records obtained from the City were reviewed. The following subsections describe the findings.

8.3.1 ORGANIC COMPOUNDS

The most recent sampling event for volatile organic compounds (VOCs) was performed in September 2012. Non-detect levels for all VOCs analyzed were reported for samples taken at the Cole Tank Chlorinator Building and at Well 6. Historical data (i.e., June 2010 data) also reported non-detect levels for VOCs and synthetic organic compounds at samples collected from the Cole Tank Chlorinator Building and Well 6.

8.3.2 INORGANIC COMPOUNDS AND METALS

The most recent sampling event for inorganic compounds and metals was performed in September 2012 at the Cole Tank Chlorinator Building and at Well 6. Inorganic compound and metal levels were reported at non-detect levels at the Cole Tank Chlorinator Building with the exception of arsenic (0.003 mg/L) and barium (0.21 mg/L), which were below MCLs of 0.01 and 2 mg/L, respectively. Inorganic compound and metal levels were reported at non-detect levels at Well 6 with the exception of arsenic (0.002 mg/L) and selenium (0.001 mg/L), which were below MCLs of 0.01 and 0.05 mg/L, respectively.

8.3.3 DISINFECTANTS AND DISINFECTION BY-PRODUCTS

Chlorine gas is used by the City for disinfection purposes. Chlorine residual is required to inhibit the growth of bacteria and pathogens within the distribution system. Chlorine residual should remain above 0.2 mg/L to prevent the growth of microorganisms and below 4.0 mg/L to prevent adverse effects due to chlorine over-exposure. The City records residual chlorine levels at two locations, one from the North Zone and one from the South Zone, per month. The sampled locations rotate each month throughout the City. Figure 8-1 shows a count of residual chlorine levels from 2008 to 2012 that have been below recommended residual concentration. No readings collected were above maximum residual disinfectant levels.

Proper disinfection is the City’s primary defense to protect its users from harmful pathogens entering the water supply. Currently, the City controls its chlorine dosage manually which can be labor intensive and often lags behind required
adjustments. The required chlorine dose is dependent upon system water demands and the level of reducing agents (i.e., chlorine consumers) in the source water and distribution system. These parameters can fluctuate seasonally or daily. Automatic dosing can be installed to respond to environmental and system changes but comes at added cost and complexity. It is suggested that a chlorine residual study be performed to determine 1) the areas that exhibit the lowest levels of chlorine residual, and 2) how each area responds to chlorine dose changes. This study will be most effective following the installation, start-up, and stabilized operation of the Well 6 Chlorinator Building.

DBPs are monitored by testing for TTHM and HAA5. The MCLs for HAA5 and TTHM are 60 and 80 micrograms per liter (µg/L), respectively. Samples analyzed from Well 3C in July 2009 reported non-detect levels of HAA5 and 0.54 µg/L TTHM. Samples analyzed from the Cole Tank Chlorinator Building and Well 6 in September 2012, reported non-detect levels of TTHM. See “Disinfection By-Products Rule” section for more information on DBP monitoring requirements and recommendations.

8.3.4 BACTERIA
The City collects bacteriological samples twice a month at locations that should represent high risk areas as identified during the IDSE. These samples are analyzed for total coliforms (including E-coli and fecal coliform). Non-detect levels for these compounds have been reported in recent analysis; the results indicate successful chlorination within the system. To maintain a bacteria-free environment, it is important for the City to monitor the system’s residual chlorine levels. As part of a healthy monitoring program, the City should measure chlorine residual at the same location each time a bacteriological sampling is performed. The chlorine residual level should be documented on the sampling sheet and a request made to the lab to forward this information to the EPA.

8.3.5 COPPER AND LEAD
The City is on a triennial schedule for copper and lead monitoring. The next sampling event is required between June 1 and September 30, 2014 (Appendix D). The previous copper and lead sampling event occurred in August 2011. Results from this sampling event indicated non-detect levels of lead and a maximum concentration of 0.20 mg/L of copper. Reported copper levels were below MCL of 1.3 mg/L.

8.4 NATIONAL SECONDARY DRINKING WATER STANDARDS
Although constituents listed under Secondary Drinking Water Standards do not jeopardize the health of consumers, these characteristics affect the aesthetic qualities (e.g., color, clarity, and taste) of the system’s water, which can result in an increased number of consumer complaints. Correspondence with the City indicates that the majority of consumer complaints have been related to physical characteristics (e.g., particulates and cloudiness) of the City’s drinking water.
supply. Therefore, it is in the best interest of the City to monitor these water quality parameters and take steps so that they remain within desired operational ranges.

8.4.1 HARDNESS
The transition of Well 6 to full-time operation introduces a challenge to the City. Historically, this water source has been shown to contain hard water, which poses the risk of scaling and/or producing mineral precipitates. It is recommended that the City perform a Langelier Saturation Index to determine the likelihood of scaling and/or the formation of mineral precipitates. Water softening design options may be explored at the City’s request.

8.4.2 MANGANESE
Historic sampling data have shown elevated levels of manganese at 0.30 and 0.02 mg/L in Wells 3A and 6, respectively. The secondary MCL for manganese is 0.05 mg/L. Manganese is often present in significant amounts in groundwater (Davis 2011). Manganese over-exposure (mainly through inhalation) has been determined to target the nervous system but is not considered a high human health risk (EPA 2004a). However, manganese levels as low as 0.02 mg/L have been shown to form coatings on water pipes that may later slough off as a black precipitate (Bean 1974). The precipitates, in addition to being an aesthetic problem, can interfere with the disinfection process. Manganese levels can be reduced through the formation of precipitates (a result of oxidation) and subsequent settling. Manganese reduction can be explored at the City’s request.

8.5 SYSTEM OPERATION
The operation of a water system can have direct and indirect affects to the water quality maintained within the system. The following subsections describe items that are related to system operation and water quality, review findings, and recommendations.

8.5.1 SAMPLING PROGRAM, PROCEDURES, AND RECORDATION
The City follows an EPA-provided sampling schedule, which is included as Appendix D and is considered the minimum requirements. Recommendations were provided to the City to sample beyond these requirements to protect the quality of the City’s water supply and distribution system. As part of a future Level II study, the City may wish to explore the implementation of a Sampling and Analysis Plan (SAP) to determine gaps in the City’s data analyses and provide the most effective sample times and locations.
In a 2011 EPA Sanitary Survey (Appendix D), the surveyor described the City’s record keeping as “immaculate.” Based on documentation the City provided, it appears that the City’s record keeping involves the storage of physical documentation. It is recommended that the City transfer collected information into an electronic database (e.g., Excel table). Electronic documentation and data tracking will allow the City to quickly analyze historical data, identify trends, and make proactive systematic adjustments. The EPA requires the City to provide an annual Consumer Confidence Report to their customers and to EPA Region 8. Currently, this report is produced by Energy Laboratories, Inc.

8.5.2 SYSTEM COMPONENTS
The effect on water quality caused by the configuration and operation of system components was considered. Storage tanks turnover rates and water drawdowns are critical to determine water age throughout the distribution system and to identify the locations where water quality analyses should be performed. Inlet/outlet configuration of storage tanks may produce short-circuiting within the tank, which may create aged-water “dead-zones.” Water quality may be adversely affected when storage tanks are emptied, and aged-water is introduced to the distribution system.

8.5.3 WELLHEAD PROTECTION PROGRAM
The principal objective of a wellhead protection (WHP) plan is to prevent the contamination of groundwater resources that supply public water systems. Contamination is possible from a variety of sources and can be introduced to the system through multiple pathways, including percolation, infiltration, injection, and leakage. Typical sources of groundwater contamination are highlighted in Table 8-1. This report documents that the City’s water supply is of high quality; protection of this clean, high-quality groundwater cannot be underestimated. The immense cost of aquifer remediation and/or the development of an alternative water supply highlight the necessity to appropriate resources for groundwater protection.

WHP plans range across various degrees of complexity. The City can tailor its WHP plan to the level it deems most appropriate. A basic WHP plan includes the routine inspection and maintenance of well casings and covers. Protection of groundwater can be achieved through the installation of security fencing around exposed well sites. Security fencing limits access by the public, reduces incidental damage, and influences livestock roaming patterns. Identification and classification of contaminant sources and vulnerable locations allow the City to focus efforts on high-risk areas. Susceptibility assessment forms are available from the WDEQ to assist in classification of each groundwater source and associated wells. Formal WHP plans have also been established by the State of Wyoming, which provide guidance to develop a robust and WDEQ-approved WHP program.
In 1986, amendments to the SDWA established the WHP program, which called upon each state to develop a plan that would protect groundwater that provides public drinking water. The Wyoming WHP program is voluntary and intended to serve as an aid in the development of a local WHP plan to meet the minimum criteria set forth by the WDEQ and EPA. Implementation of a WDEQ- and EPA-approved WHP plan reduces the potential need for costly treatment of contaminated drinking water sources and assists in obtaining monitoring waivers that allow the City to reduce the degree of monitoring required. To meet minimum standards for approval by WDEQ, the City’s WHP plan must include the following elements:

- **Section I:** Formation of a community planning team (Wellhead Protection Management Committee) that includes members of the public to initiate, lead, and oversee the development and implementation of a local WHP plan
- **Section II:** Delineation of local Wellhead Protection Areas (WHPAs)
- **Section III:** Identification and location of potential sources of contamination
- **Section IV:** Development and implementation of a Contaminant Source Management Plan
- **Section V:** Development of a Contingency Plan to ensure an alternate public water supply if contamination occurs, and a New Well Siting Plan for development of new wells in the event that replacement or additional supplies are needed

The Wyoming WHP Program explains these minimum required elements in detail.

The decision to implement a WHP plan is dependent upon the benefits derived from the development and implementation of the plan and if the City can justify it economically. Table 8-2 illustrates costs/benefits for the implementation of a local WHP plan. WHP plan development has been implemented in communities throughout the state, including Cheyenne and Casper. Laramie and Torrington have each received EPA grants (Wellhead Protection Demonstration Projects) to develop WHP plans. It is recommended the City determine the most economically effective WHP plan to maintain the City’s high-quality groundwater.

### 8.5.4 2011 SANITARY SURVEY

The significant deficiencies identified by the EPA during a sanitary survey performed on February 23, 2011 were addressed according to an email the previous Sundance Public Works Director sent on April 20, 2011 to the EPA (Appendix D).
8.6 SUMMARY

The research conducted indicates clean, high-quality source waters and a healthy, well-maintained treatment and distribution system. Recommendations are limited to practices that further protect the City’s water quality and maintain compliance with regulating agencies. These recommendations include the following:

- Determine location of highest TTHM/HAA5 as determined from samples submitted for 40/30 Certification Waiver
- Consult Water Model developed as part of the Plan to determine locations of maximum residence time in the North and South Zones
- Prepare Stage 2 Disinfection By-Products Monitoring Plan
- Develop a chlorine residual monitoring plan to ensure proper distribution system disinfection
- Perform a Langelier Saturation Index to determine the likelihood of scaling and/or mineral precipitation at current and future water sources
- Explore manganese removal options
- Develop and implement a WHP plan to protect source water quality
9.0 EVALUATION OF SYSTEM OPERATIONS AND MAINTENANCE

Current City water system O&M practices were evaluated to determine areas where operational changes may benefit the City. Discussions were held with the Public Works Director and water system operators to understand the City’s current procedures. This section presents information on industry standard O&M best practice procedures, specific recommendations for operational changes that may benefit the City based on review of current practices.

The ultimate goal of water system operation is to deliver safe drinking water efficiently to the system’s customers. Several key responsibilities are required to accomplish this goal, including:

- Maintaining effective functioning of system components
- Complying with relevant regulations to protect the customer’s health by maintaining water quality
- Providing system security
- Maintaining useful records
- Continuously evaluating and understanding the system’s operation

9.1 SYSTEM OPERATIONS AND MAINTENANCE

A properly maintained distribution system allows for high-quality water delivery, uninterrupted service during an emergency, and safeguarding against contamination events. A properly maintained distribution system will also extend equipment lifecycles and minimize problems related to equipment failures.

9.1.1 PREVENTATIVE MAINTENANCE AND ROUTINE OPERATION TASKS

The following list includes typical routine operation and preventative maintenance tasks.

- **Exercising valves.** This process familiarizes crews with the location of valves and identifies inoperable and/or obstructed valves and valve boxes, so that sections of the distribution system can be isolated when needed. Knowledge of water system valving facilitates emergency shutdowns and expedites maintenance within areas controlled by those valves. It is recommended this task be performed on all mainline valves on a regular basis. Sundance can benefit from a planned valve-exercising program so that each valve receives attention within a reasonable time. A schedule is recommended to address system valves within a 5-year period be set as a goal.

- **Flushing the distribution-system using hydrant and blow-off valves.** Appendix E includes best management practice (BMP) techniques to complete this task. It is recommended that the City conduct planned and systematic
flushing for all pipelines that have presented water quality issues, and especially more often in areas where dead-end lines present water quality concerns. Furthermore, a flushing protocol developed that initiates upstream (high pressure area) and proceeds systematically downstream to remove accumulated debris is recommended.

- **Inspecting and flushing hydrants and valves.** Fire protection is a paramount responsibility for a municipal water system; therefore, the auxiliary valves and hydrants must be in working order. It is recommended the City complete this inspection at least annually on all fire hydrants to maintain hydrant and valve operation, check susceptibility to tampering, and check for the potential of system water losses through leaking hydrants.

- **Reading and inspecting meters and gauges regularly and making adjustments as needed.** It is recommended that Sundance initiate regular annual testing on all production meters to validate comparisons between consumption and production records.

- **Repairing water mains.** Best management practices to reduce the possibility of introducing contamination during repairs are included in Appendix E.

- **Inspecting storage tanks and providing routine maintenance.** The quality of available coatings for storage tanks (tank) is a factor in providing long-term protection for the tanks. Tanks are critical system components to maintain water quality and regular inspections should be conducted. Biennial cleaning with inspection of the interior coating for each tank is recommended. Appendix E includes best management practices (BMPs) relating to the operation of system storage tanks.

- **Assessing efficiency in system components periodically (e.g., pumps and valves).** Determination of pumping efficiency at least annually provides valuable information about the need to introduce maintenance or replace of units. Appendix E includes BMP techniques for assessing pump efficiency.

- **Maintaining the operating pressure range of the distribution system.** This should be monitored continuously to provide adequate service to customers, reduce infrastructure damage caused by excess pressure, and reduce the risk of backflow contamination. It is recommended that Sundance install and monitor pressure-recording devices at critical pressure junctures as determined by the system model.

- **Checking for normal wear.** Instead of reacting to failure of system components, mechanical parts found in pumps and control valves can have an extended useful life and unnecessary replacement or operational costs may be avoided.

- **Monitoring corrosion.** Corrosion can indicate the need to modify treatment, conduct flushing, and/or install cathodic protection.
9.1.1.1 HELPFUL O&M HINTS AND RECOMMENDATIONS

- **Evaluate system water losses.** Identifying locations of water losses will benefit the system. Determination of meter inaccuracies of production meters located at the water sources and residential meters should be conducted. Most residential meters have been recently replaced; however, it is recommended that the City replace the remaining older meters as soon as feasible. To successfully evaluate water loss, all water uses need to be metered. Currently the bulk water supply system is coin operated, but no water meter is in use to track water usage at this location. The water can be accounted for by comparing the revenue collected to the amount of water dispensed for a single delivery. One common area of unaccounted water is illegal access to fire hydrants, usually by contractors. When this occurs, it is necessary to establish systematic control, (e.g., renting fire hydrant valves to users). Other areas of unaccounted water should also be identified. Although some systems can accept losses of 15% of annual production, it is recommended that Sundance strive to limit annual losses to less than 5% of annual production. This report includes additional information to conduct an analysis in Appendix E.

- **Implement measures to reduce the need for manual operation.** With a small workforce, automating system operation will provide substantial benefit to the operation efficiency. For example, installing sensors to automatically control the pump station to fill the Canyon and Brewer Tanks, rather than requiring manual operation, would benefit the system overall. Additionally, implementation of a system-wide SCADA system will greatly affect operation efficiency.

- **Control construction water sales.** Use of water from the City’s Hard water well does not directly affect the remainder of the distribution system. The City operates the well, however, without a method in place to receive payment for water use. This places a financial burden on the City to provide maintenance. Typically, the City provides this water at either cost or out of city rates.

- **Develop a water distribution system maintenance plan.** A maintenance plan can be a useful tool to help complete routine maintenance activities at the recommended frequency.

9.1.2 ADDRESSING UNPLANNED MAINTENANCE NEEDS

In addition to the routine O&M tasks listed above, a number of unplanned maintenance tasks are regularly performed in response to deficiencies noted during daily operation or in response to customer complaints. It is recommended the City implement a standard protocol to record system deficiencies noted during fieldwork; log customer complaints; track necessary repairs; develop a work order system to address known deficiencies; and maintain a log of completed activities with information on date, location, and type of work performed. See the Record Keeping and System Evaluation section below for additional information on recording maintenance information.
9.2 REGULATORY COMPLIANCE

Owners of water distribution systems in the State of Wyoming must operate their system in compliance with requirements set forth by the WDEQ and the EPA. WDEQ monitors whether system operators are knowledgeable on operational requirements, while the EPA monitors national drinking water quality standards. To operate a water-distribution system, an understanding of regulatory requirements is required.

9.2.1 WDEQ OPERATOR REQUIREMENTS

Chapter 5 of the WDEQ Water Quality Rules and Regulations (Rules and Regulations) requires all public water supplies to be operated by a certified operator. The experience, training, and certification requirements specified in Chapter 5 are dependent upon the classification of the water treatment and water-distribution systems. An evaluation of the City’s water system was recently completed by WDEQ staff, and the system was classified as a Level 1 Water and Level 1 Distribution System. The Rules and Regulations were updated in July 2012, and it should be noted that Level 1 Water Systems certificates will be converted to Level 1 Water Treatment certificates upon the first renewal cycle after final adoption of the rule, which occurred July 31, 2012. If the operator prefers to be certified as a Level 1 Water Distribution or as both Level 1 Water Treatment and Level 1 Distribution, then the operator will need to request the alternate certification prior to the first renewal after final adoption of the rule. The Rules and Regulations are available from the WDEQ Web site at http://deq.state.wy.us/wqd/WQDrules/index.asp.

9.2.2 EPA COMPLIANCE AND WATER QUALITY

The EPA has provided the City with monitoring and reporting requirements necessary to comply with drinking water regulations. System operation includes understanding the sampling requirements; collecting required samples; filing, maintaining, and reporting results; and quickly addressing problems detected and taking required follow-up steps. The EPA has informed the City that they will need to begin the Initial Distribution Evaluation Sampling (IDES) during 2013. Section 8.0 (Water Quality) provides more detailed information on water quality sampling and EPA compliance.

Additionally, it is recommended the City conduct the following O&M tasks to maintain adequate water quality:

- Monitor chemical feed and other chlorination system components.
- Monitor effectiveness of treatment (e.g., chlorine residual).
- Test for the presence of excess bio-films in conjunction with total coliform sampling. Bio-film can indicate inadequate chlorine residual and water stagnation. Testing the water system more frequently than the minimum monthly requirement will provide advance warning of potential problems and could eliminate the need for repeat testing.
• Routinely inspect wellheads for adequate protection and to identify potential sources of contamination. Secure all wellheads to avoid either casual or intentional intrusion.

• Evaluate adequate backflow prevention placement at locations susceptible to fertilizer use, such as the golf course, funeral parlors, and public parks.

• Perform a Langlier Saturation Index test. This test will provide an indication of source water corrosivity and could provide insight into chemical incompatibility between sources.

• Perform breakpoint chlorination test. This test provides information to optimize chlorine dosage to prevent over chlorinating.

9.3 SAFETY AND SYSTEM SECURITY
Maintaining system security is important for continuing system operation during an emergency; protecting the integrity of water quality provided on a daily basis; and providing a safe working environment for staff. Recommendations to enhance the safety and security of the water distribution system include:

• Develop a plan to protect City facilities in case of an emergency.

• Keep system components locked to protect from public tampering. Conduct frequent security inspections of door locks, storage tank lids, and fencing.

• Store chlorine gas cylinders and other harmful chemicals in locked areas with proper safety equipment.

• Exercise valves on a routine basis, and verify there are enough valves in appropriate locations to isolate system parts in the event of contamination.

• Maintain a list of written contacts and understand whom to contact in the event of an emergency.

• Educate staff on emergency procedures.

• Develop a health and safety plan and familiarize staff with the document and recommended practices.

• Create and follow standard operating procedures (SOPs).

9.4 RECORD KEEPING AND SYSTEM EVALUATION
Maintaining records of historical data, customer complaints, and completed maintenance activities can help improve water system operation and management. Conducting record keeping in a way that provides easy access and use of historical information will help the City staff to gain system understanding and determine operational patterns. If used effectively, records can be used to:
• Guide staff in recognizing problems and providing possible solutions
• Document changes that occur in water use, water quality, and water availability
• Help resolve customer complaints
• Identify and plan for future equipment repairs or replacements
• Comply with regulatory requirements to secure future funding

9.4.1 WWDC REQUIREMENTS
In order for the City to receive WWDC funding for a Level III project, the City must maintain a repair and maintenance account that is specifically reserved for the maintenance and replacement of water system components that are eligible and funded through the WWDC Level III project agreement. This is further discussed in Section 13.0 – Water System Financing.

9.4.2 HELPFUL RECORD KEEPING HINTS AND RECOMMENDATIONS
Helpful hints for maintaining records to provide usable information are provided below.

• **Log information into a searchable database.** Maintaining information in a searchable database allows for the use of historical information to help develop solutions to current issues. Recording routine maintenance logs and customer complaints electronically allows information to be searchable by date, location, and/or description. Reviewing previous issues may help address current problems. Coding existing historical data by placing it into a database can be used to initiate a basis for issue trends. The practice of filing hardcopy information does not currently lend itself to review or developing issue trends.

• **Create tools to help recognize system trends.** Mapping of maintenance activities or customer complaints may help provide insight to diagnose problems. For example, City staff can track locations of similar customer complaints on a system pin map using color-coded pins to represent time of year. Public works can visually see if there is a correlation with this tool.

• **Record information consistently.** Consistent recording is important when multiple staff members are responsible for tracking and recording the same information. If a staff member discovers an anomaly, consistent recording can increase confidence that the difference is due to a system change versus a difference in recording. In the case of unplanned maintenance activities, all staff should have the same understanding of what work needs to be tracked and recorded on a daily basis. This process may require additional work effort.
• **Use the water system hydraulic model.** Work performed to complete this Level 1 Master Plan includes the development of a water-distribution system model. The water model can be a useful tool to analyze system operations. Temporary impacts to the system caused by maintenance work or permanent impacts created by system improvements can be modeled and results can be analyzed. Impacts of future development on the remainder of the water system can also be evaluated. As updates are made to the City’s water system, the model should also be updated to reflect these changes.

• **Update system mapping.** Information from the water-distribution system model discussed above can be uploaded into GIS format to create a map of the current water-distribution system. As changes are made to the water system, the GIS map should be updated to reflect these changes.

### 9.4.3 RECORDS TO KEEP ON FILE

The EPA enforces reporting and record-keeping requirements in conjunction with required water quality sampling. Refer to Appendix E for a complete list of information the EPA requires the water system entity to keep on file including the required duration to keep the information. The following additional items are useful for keeping effective records:

- Information on system infrastructure (e.g., up to date as-built engineering drawings, maps of valve and hydrant locations, pipe sizes and locations, permits, etc.)
- Equipment purchase and repair records
- Routine maintenance log sheets
- Locations and dates of leak repairs
- Records of chemical purchase
- Records on source production, including static and pumping water levels, flow, and water use
- Records of customer complaints, reason for the complaint, findings, and resolution
- Public meeting and board meeting minutes
- Records of operator certification
- Correspondence with regulators
- Meter reading reports
- Financial information, including budgets, customer billing records, and a system depreciation schedule
9.5 ASSET MANAGEMENT

Asset management is a prescribed methodology that uses some of the techniques discussed above. It presents a process to inventory water system components, prioritize improvements, evaluate financing, record maintenance activities, evaluate life expectancy, and help plan for future replacements and repairs.

Asset management can help increase the system knowledge, allowing for prioritization of repairs and time to research available funding. Planning for the replacement and/or rehabilitation of system components will reduce the number of emergency repairs and potential system down time. A specific methodology to evaluate and prioritize system improvements will help communicate with the public and potential funding sources that money is being used effectively and efficiently. This may create public tolerance of rate increases or other funding sources more likely to increase their investments. The main steps to asset management are discussed below.

9.5.1 CONDUCTING A THOROUGH ASSET INVENTORY

Information on system assets and their condition will help schedule rehabilitation and replacement. Tracking this information in a computer spreadsheet or a GIS will allow City staff to search information and analyze it later. Information to be recorded for each asset includes:

- Condition
- Age
- Service history
- Useful life
- An estimate of the remaining useful life

The EPA has compiled a table of estimated useful lives of various water system components, based on a variety of sources. This EPA table is included in Appendix E that also has an example worksheet to log information.

9.5.2 PRIORITIZING THE REHABILITATION AND REPLACEMENT OF ASSETS

Prioritization allows effective allocation of limited funds to rehabilitate or replace the system’s most important assets. There is no correct way to prioritize improvements, but items to consider include:
• Assets with a shorter remaining useful life should have a higher priority, as these items will need replacement sooner than others will.

• Assets, which are more important than others in accommodating the delivery of safe drinking water, should have a high priority, due to the impact on public health.

• Assets with less redundancy in the system than others should have a higher priority; the system would have a difficult time operating without them.

• Development planning should be considered. Planned road repairs and areas of expected growth may affect decisions.

• Recommendations made in the Master Plan.

Appendix E includes an example worksheet to assist with system prioritization.

9.5.3 ASSET MANAGEMENT PLAN DEVELOPMENT

An asset management plan should include a funding estimate for yearly system maintenance, budget development, and required reserves calculations. It is important to determine how much money should be set aside each year to fund the highest priority projects, and protect the money from other uses. Estimates should be for a 5-year period with yearly updates, as changes in finances and new asset costs can change from year to year. Appendix E includes an example worksheet to estimate the necessary required reserves.

9.5.4 ASSET MANAGEMENT PLAN IMPLEMENTATION

Work to secure additional funding if needed, and coordinate with management, customers, and regulators to implement the plan. Prepare a 5-year budgeting worksheet to assess the financial situation and plan for future needs. This will help identify whether the reserve account is adequately funded, or whether additional funding sources may be required. System budgeting will provide information on:

• Annual revenues from fees, loans and grants, interest from accounts, and other sources of income.

• Annual expenditures on maintenance, utilities, salaries and benefits, office supplies, professional services, taxes, and loan payments.

• Net income.

• Additional funding needed to continue to operate and maintain the system and replace and repair assets.
If additional funding is needed, the City may create an additional reserve account, increase rates, and submit an application for financial assistance. Appendix E includes an example budgeting worksheet.

9.5.5 REVIEWING AND REVISING THE ASSET MANAGEMENT PLAN
It is recommended that City staff continually review and update the asset management plan as additional information is gained and priorities shift. An asset management plan can help plan for the water system’s future.

9.6 AVAILABLE RESOURCES
A number of industry standard technical resources are available to provide additional information on O&M. A few examples include:

• American Water Works Association Annual Conference and Exposition (AWWA ACE) 92236 Preparing O&M Manuals for Water Treatment Plants and Water Distribution Systems
• AWWA DSS58696 Developing Distribution System Optimization Plans for Water Quality and Operations

These documents are published by AWWA and are available for purchase. A complete listing of available resource documents can be viewed at: [http://www.techstreet.com/cgi-bin/results?searchText=distribution operations&startAt=1&publisherFilter=44&searchHistorical=0](http://www.techstreet.com/cgi-bin/results?searchText=distribution operations&startAt=1&publisherFilter=44&searchHistorical=0).
10.0 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) EVALUATION

The City’s water system and its major components (i.e., wells, storage tanks, pumps, and PRVs) were evaluated for a system-wide SCADA monitoring, managing, and reporting system. The evaluation is divided into two parts 1) the physical features of the water system, and 2) managing, reporting, and planning needs of the Public Works Department.

The physical features that were considered include the water system layout, major components, topography of the area/system, and telecommunication options. The second part of the evaluation included an interview with the public works director, Larry Schommer, and the Mayor, Paul Brooks, to gather information about the current issues and needs of the City to improve efficiencies in managing the overall water system. The following subsections provide the water system network evaluation, proposed schedule of implementation, and cost estimates for hardware, software, and SCADA system components.

10.1 WATER SYSTEM NETWORK EVALUATION

A SCADA system for the City has several objectives. Based on discussions with City staff, a prioritized list of the goals was developed as follows:

- Manage water supply
- Manage water storage
- Manage water delivery
- Use man power more efficiently
- Record system operations to support future design decisions
- Notify operations staff of system conditions that require corrective actions
- Generate informational reports that can be used to optimize system operation

Recommendations to address each of these objectives are made, keeping in mind the following criteria: simple configuration of software, cost-effective system using generic vendors for hardware and open source software, and operations and maintenance of system by City staff requiring no specialist or vendor for support.

Evaluation of the existing SCADA system components in place at the City provided information about the current communications network. The terrain in and around Sundance will make radio telemetry complicated with repeaters.
required to transmit information across the system. There are existing dry-cable pairs to each of the sites. The modems required to transmit information on the dry-cable pairs are expensive and require controlled environments. The communications network is one of the most common problem points and can be one of the most difficult areas to trouble shoot.

The existing telemetry system in Sundance consists of a point-to-point radio link that transmits the Policky Tank level to a touch panel display located at the Public Works Department office. There is also a discrete control of the Cole Well Field, Cole Tank Chlorinator Building, and Cole Tank through dry-cable pairs leased from Range Telephone. These current components and communications network can be used with the integration of a system-wide SCADA.

10.2 RECOMMENDATIONS FOR SCADA SYSTEM INTEGRATION

The following subsections describe recommendations for SCADA system integration based on information from staff interviews, review of water system components, review of GIS mapping for topology and layout, pictures of the system components, and existing system telemetry.

Recommendations considered the City’s priority objectives list outlined above. These recommendations provide a basis to fully develop and design a SCADA system for the City that uses the criteria listed above to address monitoring, maintaining, and planning for future water system usage.

10.2.1 SCOPE OF WORK REQUIRED TO INTEGRATE SCADA

The recommendations provided give guidance to the City to prepare for SCADA implementation. A phased approach is recommended. The first phase requires the City to contract with a technical consultant with SCADA experience to visit each of the system component locations identified in Table 10.1 and verify that the recommended SCADA devices listed in Table 10-1 are appropriate for SCADA implementation. The site visit should be structured to provide enough information to start working on design of the SCADA system engineering figures and piping and instrumentation diagrams (P&ID). This planning and design phase is important to finalize the cost estimate and prepare an implementation plan.

The second phase includes implementation of the SCADA system. Based on the size and scope of this project, it is recommended the City approach this implementation with multiple stages over a period to address the highest priority needs first and then lower priority needs as budget allows. Based on evaluation, a hybrid system with dry-cable pair modems to create an Ethernet bridge at data collection points at each of the locations listed later in this section of the report is recommended. The SCADA system will use input/output (IO) radios for short one-way links back to the
programmable logic controllers (PLC) at the data collection sites communicating data back to the central computer at city hall. The SCADA system will use the IO radios to transmit tank level to data collectors. The IO radios will be solar powered, since most sites do not have metered electrical service. At the central office, a PLC will serve as a data concentrator and traffic controller. The traffic controller will use an open source generic protocol such as Modbus TCP, Modbus RTU, or Modbus ASCII. Data will be in a 16-bit integer format for analog data and set points, which are settings for the operating ranges of system components. The SCADA software will arrange data in continuous blocks and is accessible using Modbus TCP protocol. The communication network will support remote-virtual private network (VPN) connections that allow access to the SCADA central computer and all the PLC’s on the network. Ethernet switches at the data collector sites will allow remote SCADA terminal access to the SCADA system.

The SCADA host (i.e., the central computer), will be located at the central office. A SCADA terminal also located at the central office will serve as an additional workstation and as a simple secure gateway for smartphone and tablet access from the internet to the SCADA software interface. All the PLC sites will have uninterruptable power supplies (UPS batteries) capable of maintaining the PLC and communication for 2 hours in case of interrupted power supply at the central office.

Data collector sites include:

- Cole Well Field
- Cole Tank Chlorinator Building
- CLA Valve
- Canyon Pump Station
- Sundance Kid Pump Station
- Policky Tank
- Well 6 Chlorinator Building
- Waste Water Lift Station
- West PRV
- East PRV
- 585 PRV (near City pool)
- Sundance West Pump Station
10.2.1.1 MANAGE WATER SUPPLY

The current water supply comes from two production wells, Wells 3A and 3B, located at the Cole Well Field north of Sundance, and Well 6 located west of Sundance. Based on the interview with the Public Works Director, a bubbler tube is attached to each well so that a water level indicator can measure the water level in the well. Motor savers attached to the pumps at each well protect the pump by monitoring the power drawn by the pump.

Long-term monitoring of the well water levels and production flow rates will provide information about the available water supply. Recording of drawdown and recovery cycles will support operational decision-making and provide diagnostic information about the wells’ health and structure. To accomplish management of the water supply, the SCADA system will record the following:

- Well water levels
- Well field production
- Pump run time
- Pump cycles
- Pump power consumption

Additionally, the SCADA system will issue start and stop commands to the well pumps based on tank level and aquifer level set points or limitations.

10.2.1.1.1 RECOMMENDATIONS

New pressure transmitters connected to the exiting bubbler tubes for measuring well water levels are recommended. Air supply to the bubbler tubes will be provided by an oil-free compressor fitted with a desiccant system capable of producing compressed air without condensate. New pump savers with digital communication capabilities that are supported by the data collector PLCs will replace the existing pump savers. Installation of a magnetic flow meter (mag meter) in the well-field discharge line is recommended for monitoring flow rates for water production. This will assist with installing discrete outputs to start and stop the well pumps on demand. The SCADA system will record well levels, pump run time and cycles, power consumption, and water production at the central computer tracking and reporting.
10.2.1.2 MANAGE WATER STORAGE

Sundance has eight storage reservoirs to serve seven primary pressure zones within the City’s service area.

- Brewer Tank 40K 5225.0 HWL
- Canyon Tank 40K 5076.0 HWL
- Policky Tank 100K 5059.0 HWL
- Cole Tank 275K 4952.5 HWL
- Blue Tank 290K 4930.0 HWL
- Mt Moriah Tank 250K 4874.8 HWL
- Sundance Kid Tank 105K 4874.8 HWL
- Underground Reservoir 66K 4847.8 HWL

The City will be able to adapt storage tank operations using SCADA, based on seasonal demands and water quality. Management of fill and drain cycles is one of the best tools for maintenance of proper stored reserves for fire protection and prevention of stagnation. Additionally, fill rates are useful in preventing stagnation. The City can use fill and drain rates to calculate system demands and identify operational deficiencies. The inter-connectivity between the storage tanks is not completely understood at this time which creates some operational and system development decision problems. One of the objectives of the SCADA system is to clarify the connectivity relationships between the tanks.

10.2.1.2.1 RECOMMENDATIONS

The recommended SCADA system will record storage tank levels and the rates at which tank levels change. The SCADA software will trend levels and rates in real time. Trending and tabular reporting is retrievable for recorded levels and rates from within the SCADA software. The recommended software will transmit storage-tank level information to pump stations and well fields. The software will also use this information as a feedback for start and stop commands controlling the water feed. Pressure transmitters, which the City taps into the influent pipe near each storage tank to measure tank levels, are recommended. Telemetry using solar powered IO radios will transmit tank level data to a nearby PLC site. The PLC will calculate flow rate from the tank using tank geometry and the rate of change in tank level over the previous 30 minutes. The software will update calculated flow rates every minute for tracking and trending purposes. Leased dry-cable pairs fitted with Ethernet modems will transmit this data from the PLC site to the central computer. Additional parameters the SCADA transmits will include tank-access hatch status and IO radio link status.
The surrounding topography and water system layout limits the ability to have direct line of sight for radio telemetry. Due to these factors, the following telemetry is recommended with repeater stations to link the entire system via IO radios. The Blue and Sundance Kid tanks and the Underground Reservoir levels will be transmitted by IO radio to Policky Tank. The existing PLC will transmit to the central office over the existing link. An IO radio will transmit Mt. Moriah Tank water level to a PLC located in Canyon Pump Station. Brewer and Canyon Tanks will transmit levels by IO radio to a PLC located at the Sundance West Pump Station. Cole Tank will transmit water level by IO radio to a PLC at the Cole Tank Chlorination Building.

### 10.2.1.3 MANAGE WATER DELIVERY

The water distribution in the water system occurs in part through pump and PRV stations. Management of water movement around the system involves balancing pumping costs and water quality. Too little circulation within the system will detrimentally affect water quality, while too much circulation will increase operational costs. Key parameters for managing water delivery are pressure and flow rates. The recommended SCADA system will record pressure and flow rates at each pump and PRV station. The City can use this information to monitor zone capacity and support future development decisions.

#### 10.2.1.3.1 RECOMMENDATIONS

Installation of mag meters and pressure transmitters at each PRV and pump station is recommended. This will allow the SCADA software to record and trend pressures and flow rates at the PRVs and pump stations. To alert operations staff of conditions outside desired operating ranges, setting up set point logic within the software will allow for these notifications. The recommended software will totalize flows through each site to account for pressure zone usage. This information is useful in management of disinfection residuals and documenting operating costs. The system data will allow reporting on peak day and peak hour conditions. This information is critical for making decisions concerning system development, expansion, and project scheduling.

### 10.2.1.4 USE MAN POWER MORE EFFICIENTLY

A SCADA system can save utility staff time, if the benefits received exceed the maintenance that is required to keep the system running. Some benefits of a SCADA system include:

- Remote monitoring and feedback of distant facilities
  - Saves travel time
  - Arrive on site with proper equipment for the situation
• Simultaneous monitoring of separate sites
  ○ Single staff member can observe multiple sites at the same time
• Trend system performance
  ○ Frees staff time from constant monitoring
  ○ Improves system monitoring
  ○ Makes cause and effect relationships easier to identify
• Records data in a retrievable format
  ○ Speeds up system performance analysis
  ○ Supports decision making
• Remote notification
  ○ Frees staff from system monitoring when system is functioning properly
  ○ Provides early warning before system failures become critical
• Process control
  ○ Routine tasks can be automated
  ○ System can be adapted for seasonal variations

SCADA systems can drain workers in the following areas:
• Training on excessively complicated systems
• Calibration and maintenance on unnecessary primary devices
• Unreliable communication network
• Insufficient information from field devices
• Insufficient training on how to use the system

10.2.1.4.1 RECOMMENDATIONS

It is recommended the City contract with Range Telephone to provide and maintain communications between the data collector sites and the central office. Communication will be a transparent flat Ethernet network capable of minimum 2 Megabits per second (Mbps) upload and download speeds to all the data collector sites. This will allow terminal
access to the SCADA system from the field. The City should use the recommended field devices that are stable and require infrequent calibration, such as mag meters and low-drift pressure transmitters. The City should also contract with a system integrator to provide extended training in short blocks over several months. This will allow operations staff to develop an understanding of the system and the integrator the opportunity to correct inaccurate assumptions. Over this extended training period, staff may request modifications to the system to clarify understanding and improve overall system operation.

10.2.1.5 RECORD SYSTEM OPERATIONS TO SUPPORT FUTURE DESIGN DECISIONS

As the water system expands, required improvements to the water supply and distribution network will occur. System operation data recorded by the SCADA system will provide the information required to make development decisions.

10.2.1.5.1 RECOMMENDATIONS

Record the following parameters:

- Well levels
- Well production
- Pump hours
- Pump cycles
- Flow rates
- System pressures
- Tank levels

Recording analog data in 5-minute intervals is recommended. Each interval record will contain the following information:

- Running summation of the process signal
- High value for the interval
- Time when the high value occurred in the interval
- Low value for the interval
- Time when the low value occurred in the interval
- The clock-cycle count for the interval
The SCADA will record discrete data in one-hour blocks. Each interval will contain the process-variable set time for the interval, the process-variable cycle count for the interval, and the clock-cycle count for the interval.

### 10.2.1.6 NOTIFY OPERATIONS STAFF OF SYSTEM CONDITIONS THAT REQUIRE CORRECTIVE ACTIONS

The water system is spread out over a large area and operation’s staff is typically unaware of water system component failures or needed maintenance of these systems until these issues cause an interruption in the system. There is limited notification currently in place for the City staff. Notifications that are in place are not categorized as a high or a system low threat. City staff therefore responds to every notification as if it is an emergency. This takes time and labor for each notification call out. Most of the time these notifications are a low threat and do not need to be attended to immediately. Time management and prioritization of notifications can occur as described below.

#### 10.2.1.6.1 RECOMMENDATIONS

The remote notification component of the SCADA system will relay system messages to the operator through a cell phone. Remote notification processes will be integral to the SCADA software and not a “third party” add-on to the software. These notifications can be configured to feed the City staff more information about the current issue with the system component. The SCADA system will detect problems based on the set point ranges that are setup during system implementation. The City staff notification will allow them to respond to the high priority issues with the appropriate personnel and equipment, while a low priority issue with system components can be setup as a scheduled maintenance task saving City staff time and labor.

### 10.2.1.7 GENERATE INFORMATIONAL REPORTS THAT CAN BE USED OPTIMIZE SYSTEM OPERATION

The good way to monitor a water system and its components is through the ability to review data for many parameters such as tank levels, flow, pressure, and pump run times. Operators with the ability to trend this information and report on current system conditions are able to make informed decisions regarding management and maintenance of the overall water system. The planning of repair and/or replacement of system components can be tracked and reported through SCADA software.
10.2.1.7.1 RECOMMENDATIONS

SCADA software with basic report generation is recommended. Report format will be in a standard comma-separated values CSV format that is importable by most software packages, such as Microsoft Excel or Word.

10.2.2 PROPOSED SCHEDULE OF IMPLEMENTATION

It is recommended that SCADA implementation occur over a 1- to 2-year schedule allowing adequate time for design, implementation, and training. After the first year, the SCADA contractor should provide technical support and training to City staff as needed. Over the 2-year period, the SCADA system should have a configuration and dataset that allows the City to make decisions for operations and maintenance of the system. As mentioned above, it is recommended this project be implemented through multiple phases, addressing the higher priority water system components information first. From there, implement the lower priority components when time and budget allow.

10.2.3 COST ESTIMATES FOR HARDWARE, SOFTWARE, AND SYSTEM COMPONENTS

Table 10-1 shows SCADA devices and system controls for the identified components and locations within the water system. An estimated cost for each device with a total hardware, software, and system component cost estimate is included in the Table 10-1.
11.0 PRIORITIZATION OF RECOMMENDATIONS

Throughout the course of this study, discussions were held with the WWDO Project Manager and the City staff. During the final progress meeting held on April 8, 2013, recommendations for improvements to issues and concerns brought forth at previous progress meetings were presented. The structural recommendations presented are primarily discussed in Section 6 Hydraulic Modeling. At the last progress meeting, improvement prioritization recommendations were presented, and input and direction were received for incorporation into this Plan. The following describes the prioritization of recommendations for structural and non-structural improvements to the City’s water system and recommended timelines for implementation.

11.1 STRUCTURAL IMPROVEMENT RECOMMENDATIONS AND TIMELINE

Structural improvements include modifications, expansion, and upgrades to the existing infrastructure of the City’s water system. Seven projects are recommended to improve water system concerns. The projects are described in more detail in the Hydraulic Modeling section of this Plan. It is recommended that the water-system structural improvement projects occur in the following order:

   1a. Upgrade Canyon Pump Station (short-term solution) – recommended for further study
2. East (Blue Tank) Pressure Zone Improvements (with option to divide into two phases)
3. Policky/Blue Pressure Zone Reconfiguration (take PRV out of service, after item 2 is completed)
4. Policky/Blue Transmission
5. North Zone Backbone
6. South Zone Backbone
7. Sundance West Subdivision

The recommended timeline to construct these projects is listed in Table 11-1. The projects are recommended to occur over the 20-year period required for the Master Plan starting in 2012 to year 2032.

11.2 NON-STRUCTURAL IMPROVEMENT RECOMMENDATIONS AND TIMELINE

Non-structural improvement recommendations include items that pertain to water system operations and maintenance and other miscellaneous items. These items are more difficult to prioritize as many of them can be performed immediately without cost, while others will need to be worked into the City’s budgeting as time allows. Table 11-2 provides a list of recommended non-structural improvements.
12.0 COST ESTIMATES

Construction cost estimates for the improvement recommendations presented in Section 11.0 were prepared as a critical Plan component. This cost information was used to prepare the financial planning and funding options presented in Section 13.0 Water System Financing. The cost estimates were divided into WWDC eligible and non-eligible costs. The cost estimates were prepared based on unit rates obtained for similar Wyoming projects. Table 12-1 through 12-7 present costs (i.e., 2013) and incorporates a 2.5% inflation rate per year as provided by the WWDO Project Manager. The total project construction cost estimates in present dollars (i.e., 2013) by priority order are as follows:

1. Cole/Mt. Moriah Transmission Line: $1.07 Million
   1a. Upgrade Canyon Pump Station (short-term solution): $0.07 Million
2. East (Blue Tank) Pressure Zone Improvements (with option to divide into two phases): $1.64 Million
3. Policky/Blue Zone Reconfiguration (Take PRV out of service, after item 2 is completed): Operational, no cost, but may not be accomplished until East Pressure Zone improvements are made
4. Policky/Blue Transmission: $1.20 Million
5. North Zone Backbone: $0.50 Million
6. South Zone Backbone: $0.40 Million
7. Sundance West Subdivision: $1.54 Million
13.0 WATER SYSTEM FINANCING

This section evaluates the City’s current and anticipated future water system revenues and expenses. Information presented is based on financial data provided by the City and dialog with the City Clerk-Treasurer and the Deputy Clerk-Treasurer. The financing recommendations made in this study are intended to complement the 2009 rate study prepared for the City by Carl Brown Consulting (Brown study). Recommendations are provided to update the current water rate structure to sustain the City’s existing infrastructure, upgrade the existing system, and make the enterprise fund financially self-supporting. Additional sources of revenue available from outside funding agencies are also identified, and scenarios contrasting the City’s financial obligations and impacts to water rates are presented. Accounting practices are also reviewed, and recommendations made to better track the City’s expenses and to comply with funding agency requirements. The objective of this process is to provide the City with suggestions to pursue funding to develop, construct, operate, maintain, and manage their water system.

13.1 EXISTING ACCOUNTING

The City maintains an enterprise fund that is separate from the general fund. This enterprise fund separates water, wastewater, and sanitation. Following the Brown study, accounting/collection charges and support services were moved from the general fund to each corresponding enterprise fund.

The City’s historical operating revenue and expenses, from fiscal years 2007/2008 through 2011/2012 are presented in Table 13-1 and further discussed below. The City’s historical revenues and expenses were projected five years into the future, assuming no additional capital improvements would occur. The City’s existing revenue structure, without modification, is sufficient to support projected expenses through 2017 as seen in Table 13-2.

13.1.1 EXPENSES

The water enterprise fund accounting does not appear to follow Generally Accepted Accounting Principles (GAAP) as established by the Governmental Accounting Standards Board (GASB) guidelines. The budgeting format is not sufficiently detailed to identify where charges may occur during the year. Existing headings do not isolate service functions, which makes it difficult to understand the actual cost of service. The City does not separate debt repayment and capital projects from the functional budgeting worksheets, which track O&M expenses. For the purpose of this study, the City’s existing expenses have been grouped into the following categories:

- Operations, Maintenance, and Administration
- Capital Replacements
• Capital Projects
• Debt Service
• Sewer Enterprise Fund Loan

Historical data for the period of fiscal years 2007 through 2012 were used for this study. During this period, utility operations, population, and economic conditions were relatively stable. New capital expenditures for a well and a storage tank resulted in debt service annual payments of $16,618 at 4.0% interest though 2031 on a State Revolving Fund loan. Also during this study period, a loan of $100,000 was made from the water enterprise fund (water fund) to the sewer enterprise fund (sewer fund). Since the sewer fund is barely solvent, repayment terms have not been finalized. The charges for intra-city transfer (enterprise to general fund) for support functions appear to be under-valued.

The existing budget does not provide a fund reserve line-item expense; however, it appears the City’s budget currently has the ability to provide a reserve. Reserve accounts are vital to a water system’s financial health and important to potential loan providers, and are typically set aside for:

• Working capital
• Repair and replacement
• Emergencies (2% of O&M costs)
• New capital projects

The reserves in the water fund are not identified in budget summaries. It is unclear whether interest income from these funds is restricted to the water fund. The fund maintains a fund-equity balance that the City could maintain, by annually spending the reserve set-aside.

13.1.2 REVENUES
The City’s financial statements are prepared on a cash receipts and disbursements basis. Cash receipts and disbursements can be adequate for tracking straightforward accounting, particularly when there is minimal change occurring year to year; however, as Sundance pursues grants and loans to improve the water system as this study suggests, the existing accounting methodology may become overburdened tracking multiple grants and loans.

For the purpose of this study, the City’s existing revenue has been grouped into the following categories:
• Water Sales
• Interest
• Grants and Loans

The monthly and annual billing and usage summaries may provide accurate data on billing receipts; however, the usage totals include pumping records and potentially other data not associated with the billing. Typical billing and usage data will reflect only water metered for billing and the billing paid. Production metering records should be separate and compared against the metered billing records to determine system loss.

13.1.3 ACCOUNTING SUGGESTIONS

• Sundance should consider adopting the GAAP as soon as practical and provide staff the necessary training to maintain the accounting system.

• Trihydro recommends restructuring the budget worksheets to identify cost centers and allocation of expenses to specific functions. Functional budgeting parallels specific services (e.g. source of water supply, treatment, pumping, transmission and meters) and will identify how much of the total annual expense is represented by each system function. An example water-system budget, with detailed cost-center line items is included in Appendix F. This structure provides a transparent tracking of expenses and revenues, and provides insight into pattern changes that may need to be addressed.

• Trihydro recommends the City create a water system reserve fund, and review it every 3 to 5 years. The City currently maintains reserves, but they are held as a combined cash fund, which makes it difficult to track. We recommend water system reserves be tracked separately from other reserve accounts, and subsections to the water fund reserve be created. We recommend establishing separate reserve funds for operating expenses, repair and replacement costs, emergency costs (which should accrue at the least 1.5% – 2.5% of the operating expenses), new capital, and debt. Additionally, WWDC contract provisions for Level III projects require the City to maintain a reserve specifically for the repair and maintenance of components constructed with WWDC Level III funding. Identification for WWDC constructed projects needs to be listed in a subset line item under the new capital reserve fund.

13.2 EXISTING WATER RATE STRUCTURE
The City’s water rate structure has been in place for more than a decade and the community is comfortable with the format. The Brown study suggests modifications to allow the City to sustain the water enterprise fund following
historical practices. The City adjusted the basic monthly charges and the commodity charges in 2010 following the Brown study. The City’s existing rate structure, based upon the recommendations in the Brown Study, is as follows:

- **Monthly Minimum Charge:** Sundance’s existing charge is $11.60 for 1,000 gallons of water, which has no established rationale.
- **Commodity Charge:** Each 1,000 gallons of water used in addition to the minimum use of 1,000 gallons is charged at a rate of $4.45 per 1,000 gallons.
- **Method of Increase:** Both the monthly minimum charge and the commodity charge are increased annually by 4% January 1st of each year.

New water customers pay a water-deposit fee of $100, which the reserve account holds until they discontinue service. Out-of-City service has historically been billed at 1.33 times the in-City rate. The state statute was revised several years ago, limiting the multiplier to 1.25, unless municipalities can provide supporting evidence to justify a higher multiplier.

The data in Table 13-1 indicate that water sales revenue has steadily increased since the adoption of the Brown study recommendations. The O&M expenses have paralleled these revenue increases.

### 13.2.1 ANCILLARY CHARGES

Water utility entities commonly gain supplementary revenue by charging tap fees for system connections, system development fees (SDFs), and interest earnings. The City’s annual revenue did not indicate interest earnings on reserve investments. Tap fees and SDFs are discussed below.

#### 13.2.1.1 TAP FEES

Tap fees are intended to cover the actual labor and material costs to provide a water service. Sundance currently charges a range of fees depending on the meter size and the fees appears to cover labor and material costs for services. When calculating the labor costs the tap fee should recuperate, it is important to include the employee’s labor-benefit package. A suggested methodology for calculating tap fees is included in Appendix F.

#### 13.2.1.2 SYSTEM DEVELOPMENT FEES (WATER AVAILABILITY CHARGE)

The purpose of SDFs (or buy-in fees), is to cover user charges that would result from system expansion necessary to accommodate growth. SDFs are charged to re-pay the investment made by existing system users. Water utility entities have used SDF’s to fund the expansion of utility services to meet area growth since the 1930’s. Fees are designed to
cover prior, current, and/or future costs of system expansion. SDFs prevent or reduce inequity to existing rate payers that could occur when rate increases for added facility costs are required as a result of new customer demand. The funds collected are incorporated into the working revenues of the fund. Typically, these revenues are held in reserve and applied to system-capital expansion. A common use of these funds is to “piggy-back” developers’ projects by increasing water main pipeline sizes for anticipated growth and therefore only having to pay the difference for the increase in pipe and connection sizes.

The typical approach for determining SDFs assigns equitable costs for new growth to the responsible party using system-depreciation values and system-capacity units. Depreciation values are determined based on the previous investment made in the existing infrastructure. It is also important to identify the cost for system expansion that is required for growth. This approach limits system expansion expenses and subsequent rate hikes to long-term users.

It is noteworthy that Sundance has adopted a specific SDF for system expansion, referred to as a “water availability charge.” The underlying methodology for determining the fee was not readily evident during this study. The typical approach for determining this fee was presented and discussed during a City Council work session on November 6, 2012. The Council decided the existing water availability charge reflects regional thinking and is consistent with nearby communities; and was not interested in revising the fee structure. Trihydro recommends that water availability charges be removed from the operations budget and retained for capital expansion.

### 13.3 SUGGESTED WATER RATE STRUCTURE

#### 13.3.1 BACKGROUND AND REASONING

Trihydro noted the following observations upon review of the City’s existing method of rate adjustment:

- It assumes the base monthly charges were equitably distributed at the start of the rate structure
- It assumes this distribution of base monthly charges accurately reflects primary expense elements of the fund
- It is sensitive to the amount of water that is annually consumed, making budgeting forecasts unreliable
- It applies an annual 4% to the base figure, which has distorted the true cost of water

Water-rate sensitivity occurs because water consumption varies annually. Therefore, as water consumption varies, the revenue stream varies and becomes the sensitive element of the rate structure. However, because the water enterprise fund is currently profitable, water consumption is not expected to decrease (i.e. water use patterns go unchanged), and since 4% exceeds the current inflation rate, the rate structure can be expected to meet O&M expenses. The goal of the
suggested water-rate structure is to minimize expense or revenue swings and maintain a single-digit percentage rate increase.

The City’s existing rate structure places the City at risk of reduced revenue, since the City depends on metered water as the primary source of revenue and is at the control of the consumer. Modifying the rate structure to a more standard “cost of service” methodology, as further discussed below, places the volatility element at 20 to 25%, rather than the current 72%.

### 13.3.2 COST OF SERVICE METHODOLOGY

An alternative water-rate structure is suggested based on the utility standard approach of “cost of service” methods provided by the American Water Works Association, Manual M1, 2000, *Principles of Water Rates, Fees, and Charges*, and manual M54, 2004, *Developing Rates for Small Systems*. This method is based on the cost of service to provide water to the consumer. It determines the Service Availability Charge (SAC) to establish the monthly minimum charge which is made up of two components:

- The Customer Service Charge, which reflects the accounting, billing, meter reading, and inter-city transfer expenses that are necessary for all customers.
- The Demand Charge, which recognize the investment in the system necessary to provide water on call to all customers, and is typically a percentage of the debt service and capital programs.

The remaining revenue required to cover other expenses not covered by the SAC is determined by the commodity charge, or cost per thousand gallons. AWWA recommends that the minimum monthly charge include the commodity charge for all water furnished.

It is essential to review water rates on an annual basis and revise the structure at least biennially to reflect current trends to maintain customer equity (AWWA, 2004). The “cost of service” rate strives to minimize volatility and emphasizes consumer fairness with a pragmatic approach to develop the minimum monthly charge.

### 13.3.3 SUGGESTED STRUCTURE

Trihydro recommends that the City consider establishing a rate structure to follow accepted industry practices that set rates based upon cost of service. Water rate adjustment using this system will typically adjust the commodity rate more frequently than the monthly minimum, because the SAC is based upon the less volatile fixed costs of the fund. The average water-use pattern can effectively provide the ability to forecast annual usage and the revenue that might be
expected. To establish an alternative comparable “cost of service” rate structure, the historical water use and collections were analyzed for sustainability.

The amount of water furnished with the SAC is the prerogative of the water utility. Average households require 4,000 to 6,000 gallons per month for normal sanitary living. Standard practice is to include the charge for this water in the SAC, therefore, we recommend that the rate structure be revised with a system-specific SAC to include 4,000 gallons of water with the minimum monthly charge. The suggested SAC developed for the City to cover existing expenses is $26.35, which includes 4,000 gallons of water for the water meters inside the city limits.

The uniform commodity rate is computed from the historical cash needs of the utility necessary to satisfy the cost of service, less water furnished at the commodity price, and the monies generated by the SAC. This amount divided by the historical average water sold provides the uniform commodity rate. A commodity charge of $2.50 per thousand gallons would support the City’s existing expenses.

Table 13-3 shows the cost to users of various water use amounts for the existing rate structure versus the suggested “cost of service” rate.

13.3.4 COMPARISON TO MEDIAN ANNUAL INCOME
The median family annual income in Crook County for 2011 (eadiiv.state.wy.us/ACS/ACS07_11Income_Poverty) was $49,757 which is the latest available data for the Sundance area. Computing the allowable maximum monthly bill as 2.5% of $49,757, it is found that $103.66 per month is the maximum billing for water use. The residential average monthly water used, according to the Brown study, is 6,300 gallons. At existing billing, this user would pay $33.85 per month and under the suggested rate, this user would pay $31.35. This comparison indicates that there is some flexibility for rate increases necessary to fund additional capital improvements.

13.3.5 OTHER CONSIDERATIONS
There is one caveat to the above approach that will cause some adjustments. The Brown study indicates that 51.5% of system users will require 4,000 or less gallons of water per month, 41.6% use 3,000 gallons or less and 31.7% use 2,000 gallons or less. These percentages seem high compared to national averages; however, with a multitude of retired couples on fixed income, this condition could exist.

Design guidelines estimate 150 gpd per bedroom or 400 gpd per household (Salvato, 1972). Assuming one bedroom and one month’s time, 150 gpd multiplied by 30 days equals 4,500 gallons. The City has reported that some users have
managed to circumvent their meters or that meters have worn severely and under register actual water used. Combining 4,000 gallons of water with the minimum monthly bill will likely create a hardship for users who regularly use less. The City will need to be prepared to make considerations or exceptions for these users.

The City is also concerned about the large amount of treated water that is used to irrigate the Sundance Country Club golf course. Daily demands have been reported to be 80,000 to 90,000 gallons and possibly up to 12 million gallons in a season. There has been discussion about providing untreated water from Loafman Springs; however, the two wells at this location are only adjudicated at 15 gpm each, which would require on-site storage and additional engineering. This location is also distant from the golf course. Furnishing treated water for golf course irrigation is often a divisive issue and solutions to the problem are community specific and of a political nature. This additional problem is beyond the scope of this study; however, the City could pursue this concern during future studies.

13.3.6 CONSERVATION

A part of the financial plan includes a conservation element to the rate structure as directed by the WWDC. Effective conservation practices can postpone necessary system expansion or development of additional supply. A common misconception by many water utilities is that conservation only occurs when there is a water shortage. Water conservation is a mindset that should be integrated into the system consciousness. An effective conservation program is much broader than an increase in water cost to reduce demand. Water is a finite resource that deserves to be used wisely; however, making water rates punitive to the point that customers make substantial life-style changes can reduce consumption so drastically that necessary revenue becomes insufficient. The City’s water rates do not encourage conservation. Trihydro recommends a rate structure be developed that will alert consumers that conservation is a City priority.

According to the AWWA publication Long Term Effects of Conservation Rates published in 1997, cities that employed water conservation enforcement using only a rate structure have not been uniformly successful. The conservation rate could set block increases for usage that exceed minimum sanitary needs based upon a recognized step formula, with the increases applied to the uniform commodity rate or a seasonal rate (i.e., 1.2 times off-season rates) could be imposed. Trihydro recommends a conservation rate structure be combined with a customer awareness and education campaign that communicates the target that the City wishes to accomplish. Appendix F includes some suggestions for approaches to customer awareness and education efforts.

A conservation rate that is tiered, using blocks of water between 0 and 10,000 gallons, 10,000 to 40,000 gallons, and use greater than 40,000 gallons might be a starting point. The lower use at the prevailing commodity rate, the second
tier charged at 1.15 times the prevailing commodity rate, and the third tier charged at 1.25 times the prevailing commodity rate. This approach would be incorporated year round.

Another approach that is used is to set an additional “seasonal charge” during the highest usage months. During the months of July, August, and September, the Sundance users typically consume 45.5% of their annual consumption. If these conservative rate changes are made part of the rate structure, allowances must be made for industry and other large water users that do not have control on seasonal water demands.

13.4 FUTURE PROJECT PLANNING

Seven primary structural improvement projects have been recommended in this Study, as summarized in Section 11. Table 11-1 lists the identified projects, estimated construction costs, and recommended timeline to construct the projects. Tables 12-1 through 12-7 provide cost estimates for each recommended structural improvement project, including identification of WWDC eligible and non-eligible components. Financing scenarios were evaluated to support the construction of these projects.

13.4.1 WATER RATE STRUCTURE

The suggested Cost of Service water rate methodology, as discussed above in Sections 13.3.2 and 13.3.3, was presented to the Sundance City Council during the City Council work session held November 6, 2012. The City stated that their existing rate structure was consistent with surrounding jurisdictions and was acceptable to the community. The City expressed they are not interested in revising their water rate structure.

The cost of service methodology was again presented to the City during the Master Plan results’ presentation held in Sundance on July 15, 2013. The City again expressed they are not interested in adopting the suggested structure, but stated there may be room for compromise. Therefore, the assumption that the City maintains their existing rate structure was used in conjunction with different funding scenarios to evaluate the impacts to the City. The City’s existing rate structure is presented in Table 13.4, including the monthly minimum charge, commodity charge, and the calculated water bill assuming use of 1,000 and 6,300 gallons of water throughout the study period, through year 2032.

The water bill assuming water use of 1,000 gallons per month was calculated (which represents the largest percentage of water users) and the water bill assuming the use of 6,300 gallons per month (which was determined in the Brown study to be the average water use). The water bill, assuming a usage of 6,300 gallons per month, was compared to the allowable maximum monthly bill based on the median annual income as identified in Section 13.3.4. None of the average bills exceeded the acceptable limits.
13.4.2 AVAILABLE FUNDING SOURCES

There are multiple outside funding sources available to supplement the City’s water system revenues to support construction of the recommended projects. Each program contains unique requirements and limits on eligible project components. Some of the potential funding agencies that Sundance may pursue are listed below, including a few of their special requirements. Table 13-5 presents a matrix of the funding agencies, comparing which water system components are eligible for funding under each agency. A list of contact information for the funding agencies listed below is included in Appendix F.

- Abandoned Mine Land (AML): AML funding is typically available in areas that have been impacted by mining. The application requires a letter demonstrating impacts from mineral development. According to a phone conversation on July 8, 2013 held with Alan Edwards, AML Administrator, AML funding for mine reclamation has been cut back by 90% and as a result AML will not be offering assistance in the drinking water arena for water system projects.

- Community Development Block Grant (CDBG): CDBG funding is available for most water system improvements; however there is typically strong competition with other municipal needs. CDBG funding is intended to maximize job creation, increase economic efficiency, and foster energy independence. This funding may be available to complete energy efficiency retrofits.

- State Loan and Investment Board (SLIB): SLIB administers multiple programs:
  - County Wide Consensus Funding: Consensus funding is available from the state annually.
  - Drinking Water State Revolving Fund (DWSRF): DWSRF funding may be used for drinking water facilities in rural areas, source water protection, and technical assistance. Priority listing is required. The program prioritizes projects based upon regulatory non-compliance or health risks, and awards projects on a point’s basis. It requires an Intended Use Plan and is a loan only, no grant program. The DWSRF program, currently working with a $7 Million fund for drinking water in the “loan forgiveness policy,” is operating like a grant. This funding provides a 50% loan with 50% local funding. The forgiveness is pro-rated based upon the percentage of population that falls below the median household income. Our investigation shows that Sundance could be eligible for 25% forgiveness. Loans from DWSRF are currently available for a 20-year period at 2.5% interest and forgiveness is intact for the near term. The current deadline for project submittal is September 18th with a January 2014 award.
  - Joint Powers Act (JPA): Loans must be for a revenue-generating project.
  - Mineral Royalty Grant (MRG): MRG funding is typically available for most water system projects. It requires sales taxes less than 70% of the State average or a population less than 1300. It can be used to
alleviate an emergency or health and safety issue, comply with a federal or state mandate, address an essential service, or aide a community impacted by mineral development. Grants are awarded up to 50%.

- United States Department of Agriculture (USDA), Rural Development Water and Environmental Programs (RD WEP): This federal program incorporates many features not followed by state agencies, which can be cumbersome.

- USDA, Rural Utility Systems (RUS): USDA-RUS funding has limited availability, and we recommend that this funding source only be pursued when other financing is unavailable. It can be used for emergency or health and safety needs, and requires a population less than 10,000 people. The largest deterrent to RUS funding is the need to provide loan repayment through a bond issue and the need to provide pre-construction costs prior to accessing any loan funds. RUS funding also requires an environmental document be completed before funding is provided. Completing the required environmental documentation can potentially delay and lengthen project timelines, and should be considered when pursing this funding source.

- Wyoming Business Council (WBC), Business Ready Communities (BRC) Grant and Loan Program: The BRC program focuses on economic development and enhancement.

- Wyoming Water Development Commission (WWDC): WWDC funding is for water-related projects and typically associated with water supply, water rights, storage, and transmission. It takes the form of a 67% grant and 33% loan, with and interest rate of 4%.

### 13.4.3 POTENTIAL FUNDING SCENARIOS

The water system improvements proposed in this Study will require funding assistance from one or more of the agencies listed above to supplement the City’s water revenue generated from their existing rate structure. We evaluated a scenario assuming no state or federal funding assistance is available. Assuming only the City’s existing rate structure to fund projects, the Cole/Mt. Moriah Transmission Line with the Canyon Pump Station upgrade and the East Pressure Zone Improvements could be accomplished within the 20-year study period. It may be possible for the City to float a bond issue for a loan to cover the remaining costs of the recommended projects; however, this would cause the City’s debt service to rise to unacceptable limits.

Four additional scenarios, using some of the funding sources listed above to supplement the City’s water revenues, were evaluated. It should be noted that conditions change and the information submitted here is subject to change; however, this information is considered valid for the near term. The four scenarios are further discussed below, and Scenarios 1-3 have been summarized in tabular format in Tables 13-6 through 13-8. These tables for Scenarios 1-3 include the following information:
- The projects proposed in this Study and the year anticipated to begin construction.
- The portion of project funding that is assumed to be covered by the various funding sources evaluated (further described below), and the portion of project funding that the City will be responsible for contributing.
- The City’s financial contribution to fund the proposed projects, calculated on an annual basis, and a summation of debt service the City will accrue over the next 20 years.

13.4.3.1 SCENARIO 1 – WWDC FUNDING
This scenario assumes funding for WWDC eligible components will be in the form of a 67% grant and a 33% loan, and funding for WWDC non-eligible components will be in the form of loans from other programs. This scenario is presented in Table 13-6. It appears that all identified projects, except the Canyon Pump Station Upgrade, may be eligible for WWDC funding. The City’s existing rate structure and method of rate increases is adequate to support the implementation of the first six proposed projects under this scenario. In order for the City to implement the Sundance West Subdivision Improvements, Trihydro recommends a $5/month surcharge be added to customer’s water bills. The anticipated debt service will increase nearly tenfold from the existing liability. The City will determine whether this is a workable condition to achieve these projects.

13.4.3.2 SCENARIO 2 – WWDC FUNDING PLUS FEDERAL LOANS
Scenario 2 assumes federal loans from RUS or the DWSRF are available to replace half of the loan available through the Water Development Program for WWDC eligible components, and the entire amount of non-eligible improvements. We have assumed the available loans will be provided with a 50% loan and 50% local match requirement. The City’s existing rate structure and method of rate increases is adequate to support the implementation of the first six proposed projects under this scenario. In order for the City to implement the Sundance West Subdivision Improvements, Trihydro recommends a $5/month surcharge be added to customer’s water bills. Scenario 2 is presented in Table 13-7.

13.4.3.3 SCENARIO 3 – COUNTY 1% SALES TAX
Another funding approach currently under consideration by the City is to commit potential revenues from a County 1% sales tax to water system upgrades, in conjunction with WWDC funding. The vote for the sales tax funding is scheduled for 2014 and the City could realize this money (about $300,000) by the end of 2015. We have assumed this money, when combined with the City’s existing rate structure, would be used to fund the first project identified in the Study. The addition of the 1% sales tax money under this scenario allows the City to maintain some additional reserve money for unforeseen projects and reduce the debt service.
In this scenario, we have also assumed DWSRF loan funding will be available to replace the portion of the WWDC loan for eligible projects, and the project cost for WWDC non-eligible improvements, to fund the remainder of the projects without any contribution from the sales tax money. The DWSRF program is currently operating under a “loan forgiveness policy,” and we estimate that Sundance may be eligible for loan forgiveness on up to 25% of their loan amount, however this was not assumed in the calculations presented in Table 13-8. Similar to Scenario 1, the City’s existing rate structure allows for the first six recommended projects to be funded when paired with WWDC funding. In order for the City to implement the Sundance West Subdivision Improvements, Trihydro recommends a $5/month surcharge be added to customer’s water bills.

13.4.3.1 SCENARIO 4 – WWDC FUNDING PLUS GRANTS
The last scenario assumes there will be grants from RUS, DWSRF, SLIB, WBC, and/or AML to replace part of the loan available through the Water Development Program for WWDC eligible improvements, and/or a portion of the non-eligible improvements. Grant monies from these agencies are generally limited and difficult to obtain. Available funds have recently been reduced due to congressionally mandated state and federal sequestration budget cuts. Due to the unlikelihood of obtaining additional grant funding, this scenario has not been evaluated further.
14.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Trihydro recommends the City pursue funding for a Level II study. The typical Level II process consists of two phases 1) to address project feasibility and then 2) if the project is determined feasible to refine the project to the status needed for a Level III funding request. Sponsors seeking WWDC assistance for Level II funding need to have applications submitted to the WWDC by October 1st of each year. Application fees are not required. Sponsors of continuing projects must submit an application with a copy of a resolution of the governing body. During its November meeting, the Commission reviews the findings of the Level I report, considers the sponsor’s input, and makes its preliminary recommendation. The WWDC will determine if the sponsor should be required to pay a portion of the Level II study costs incurred to develop the recommended alternative needed to secure funding for Level III construction. Typically, the WWDC is the lead agency in developing Level I and Level II reports. The Commission solely funds the studies so that they are unbiased (WWDC 2011).

Trihydro’s recommendation for WWDC Level II funding includes further evaluation for the following:

- Cole transmission line
- Improved Canyon pump station
- Cole Well Field evaluation including pulling the pumps and video-logging the well casings for the four wells to inspect and determine the condition of each
- Conduct a 3-day pump test of Well 3C in the Cole Well Field

14.1 SUMMARY OF CONCLUSIONS

The following is a list of primary conclusions made after analyzing the data presented in this Plan.

- Water Supply:
  - In total, the City is currently adjudicated for 1,670 gpm through the SEO. Since the completion of the Cole Well Field in 1969, the City has not experienced significant water supply production issues.
  - The City is currently adjudicated for 1,670 gpm through the SEO. However, the City currently uses only water from the Cole Well Field (wells 3A and 3B) and Well 6 for their municipal supply. Therefore, the City has 900 gpm available for municipal use.
  - The City does not currently utilize surface water as a municipal supply source.
- There is sufficient water supply for the 20-year planning period.
- Information regarding Well 3C is inconclusive as to why the well cannot be used and further physical investigation is recommended.
- Cole Well Field Wells 3, 3A, and 3B should be physically evaluated by pulling the pumps and videoing the wells to verify well integrity.
- If future demand increases beyond what is predicted in this plan, and the City needs additional supply, the following alternatives should be considered to meet the demand:
  - Evaluate the existing well production capacities and determine if the well production capacities can be increased.
  - Develop a new well in the area and formation of the existing wells.
  - Investigate and identify other groundwater sources such as the Deadwood Formation.

**Water Treatment:**
- The City’s groundwater supply is of high quality.
- Water should be chlorinated prior to entering the Cole Tank after the Cole Tank is relocated.
- Well 6 water will be chlorinated starting in approximately June 2013 after the Well 6 Chlorinator Building is complete.
- There are no wellhead protection measures in place at the City’s well fields.

**Transmission:**
- The Cole Transmission Line has historically been affected by water transients (i.e., water hammer) as the Cole Well Field turns on and off, and potentially when the Cla Valve, used to fill the Mt. Moriah Tank, is opened and shut. When the Cole Tank is in service, it serves as a surge protection for the transmission line; however, when it is not in service, the transmission line experiences these transients.
- The City recently replaced air release/air intake valves from the Cole Well Field to the Cole Tank and installed a check valve in the Cole Transmission Line downstream of the wells’ confluence with the transmission line. This has reportedly alleviated the water hammer problem, but has not fully addressed the issue.
- There is not a dedicated transmission line from the Cole Tank to the Mt Moriah Tank, Sundance Kid Tank, or the Underground Reservoir. Water is instead supplied to the tanks through the distribution system, comprised of small diameter pipes (4- and 6-inch). The small diameter, along with the age, and water line material...
collectively results in a significant head loss (approximately 70 ft of head) between the Cole and Mt. Moriah tanks.

- There are multiple taps off the Cole Transmission Line between the Cole Well Field and the Cole Tank. These taps decrease the pressure in the transmission line when the pumps are not running, and are believed to contribute to water hammer at the Cole Tank Chlorinator Building.

- During the modeling process, it was noted that the 8-inch portion of the Policky transmission line nearest to the Policky Tank is a bottleneck, and is responsible for failed fire nodes in the Policky pressure zone.

### Storage:

- Some system-water storage tanks are aged and may need combined/replaced.

- Tank inspections are needed in the next 1 to 2 years to confirm prior inspection recommendations were completed.

- Turnover in the water storage tanks during the winter months is low. City staff observed ice buildup and complaints of unpleasant-tasting water within the system during this period.

- The Cole Tank has not been filled to capacity due to slope stability issues. The City recently disassembled this tank for storage in May 2013, and plans to relocate it to a stable site in the late summer/early fall of 2013.

- The Mt. Moriah Tank, Sundance Kid Tank, and Underground Reservoir all function on the same hydraulic grade line; the water level for all three tanks is controlled through a single pressure switch by the Mt. Moriah Tank. During hydrant testing, a significant lag in response time was observed for the tank water levels to equalize. As a result, a heavy demand near the Mt. Moriah Tank would drop the water level in that tank causing the Cla Valve (flow control valve) to open and supply water to the entire zone. Because the water levels of all three tanks had not equalized, the Sundance Kid Tank and Underground Reservoir overflowed.

### Distribution:

- Bottlenecks in Sundance’s transmission between storage tanks and distribution results in:
  - Unreliable water delivery during a fire flow scenario
  - Pressure fluctuations on the City’s east side
  - Low pressure at the hospital

- In the North and South pressure zones, there are no obvious paths of least resistance to transport water from one zone to the other. Water takes complicated flow paths through a series of small diameter water lines to get to many fire hydrants.
• Fire hydrants on 4-inch waterlines throughout the system have limited pressure and flow rates.

• A large number of 4- and 6-inch dead-end lines limit efficient water delivery to the extremities of several pressure zones.

• The North zone configuration causes wide-pressure fluctuations when the Cla Valve is open (as high as 20 psi).

• The East PRVs have failed in the past, and most downstream water users do not have point-of-use PRVs. Additionally, the PRVs do not appear to be responsive when the Croell’s ready-mix concrete plant batches concrete, resulting in some delayed response when the demands are first initiated, and when the demands are removed.

• The pressure settings on the West PRV are set too close to the normal-operating pressure range of the South zone.

• **Pump Stations:**
  
  • During peak demand, the Canyon Pump Station cannot keep up. The station design configuration requires both tanks (Canyon and Brewer) to operate at the same time. This station will require upgrades and additional study.

  • During peak demand, the Sundance West Pump Station cannot keep up. The station design configuration requires both tanks (Canyon and Brewer) to operate at the same time. This station will require upgrades and additional study.

• **Water Users:**
  
  • There are multiple users located outside the city limits that receive water, and do not have a service agreement in place. Some of these user agreements may be a result of handshakes made during the construction of the Cole Transmission Line in the 1950’s.

• **Operations and Maintenance:**
  
  • Better maintenance records can improve the City’s ability to limit service loss due to breaks through planning preventative measures.

### 14.2 SUMMARY OF RECOMMENDATIONS

This section’s purpose is to summarize recommendations made throughout the Plan into one location. Water system structural improvements are listed by recommended priority. Other recommendations including structural and non-structural are provided below based on the recommendation sections of this Plan.
- **Structural Improvements by Priority:**
  - Priority 1: Cole/Mt. Moriah transmission line – Recommended for a 2014 Level II study
    - Upgrade Canyon Pump Station (short-term solution) – recommended for further study in a Level II evaluation
  - Priority 2: East (Blue Tank) pressure Zone improvements (with option to divide into two phases)
  - Priority 3: Policky/Blue Pressure Zone Reconfiguration (take PRV out of service, after item 2 is completed)
  - Priority 4: Policky/Blue Transmission
  - Priority 5: North Zone Backbone
  - Priority 6: South Zone Backbone
  - Priority 7: Sundance West Subdivision

- **Other Structural and Non-Structural Improvements:**
  - Section 2 – Review of Existing Information
    - Based on inspections performed in 2001 and 2010, tank inspections are recommended every 3 to 5 years. The City is not sure if the inspection recommendations made in 2001 and 2010 have been addressed. Tank inspections are recommended within the next 1 to 2 years to verify if recommendations were addressed and to determine if new items need to be addressed.
  - Section 3 – Inventory and Evaluate Existing Water Systems
    - Further study of the water transients is needed to understand the cause and to recommend alternative solutions.
    - Evaluate pump sizes for the Canyon Pump Station in a Level II study and incorporate a duplex controller with a high-demand sensor into the control system.
    - Evaluate pump sizes for the Sundance West Pump Station in a Level II study and incorporate a duplex controller with a high-demand sensor into the control system.
    - Conduct further investigation of the water supply agreements with the Orr Subdivision.
    - Complete meter installation on the Bulk Water Station with an updated accounting control system.
    - Install a metering and accounting control system at the Hard Water #5 Well.
- Prior to providing water to users outside the City limits, enter into a formal water supply agreement between the water user and City (the City currently does this, with some exceptions). Water supplied to subdivisions and/or multiple users in a concentrated area located outside the City limits are recommended to be metered by one master meter, with the subdivision responsible for individual water meter readings. This may require the water users to form a water district.

- Section 4 – Creation of Geographic Information System (GIS)
  - Use the GIS to enhance City operations and maintenance of its water system as described in Section 9.4.2 – Helpful Record Keeping Hints and Recommendations.

- Section 6 – Hydraulic Model
  - Construct dedicated transmission lines between the Cole and Mt. Moriah tanks.
  - Construct dedicated transmission from the Canyon Pump Station to Canyon Tank and from the Sundance West Pump Station to the Brewer Tank.
  - Evaluate the tanks with single inlet and outlet configurations for water quality as part of a Level II study.
  - To decrease pressure losses and increase capacity within the distribution system, it is recommended that the smaller 4- and 6-inch distribution main lines be increased in diameter to 8-inch lines as lines are repaired and replaced.
  - To improve the Canyon and Brewer tanks’ supply, it is recommended that larger pumps be evaluated for both pump stations as part of a Level II study.
  - Install a SCADA system that monitors tank levels and production more accurately than the current systems.
  - Implement water conservation measures during peak seasons to help limit Sundance West Subdivision demands on the Canyon and Sundance West Pump stations. A combination of the following measures should be considered during the peak demand months:
    - Alternate days for landscape irrigation. It is recommended that half the homes water Monday, Wednesday, and Saturday, and the other half water Tuesday, Thursday, and Sunday.
    - Limit landscape irrigation to off peak hours. It is suggested to limit irrigation between the hours of 9:00 a.m. and 6:00 p.m. This will limit peak demands and decrease evaporative losses from watering during the hottest part of the day.
- The hydraulic model is a useful master planning tool; it provides the City with the ability to evaluate near-term decisions regarding the water system. The following list provides a brief evaluation of what the model can help with:
  
  - New taps on existing lines
  - Existing pipeline extensions
  - Increased demands from existing taps
  - Tank operational range changes
  - PRV control setting adjustments, pressure switches and flow control valves
  - Effects of opening or closing isolation valves
  - Construction phasing
  - Effects of shutting down components for maintenance

  ○ Section 7 – Water Source Data and Water Rights
    - Contract a pump-service contractor to pull the pump, video log the well casing, and inspect the pump, controls, and other appurtenances for wells 3, 3A, 3B, and 3C to determine their condition and perform maintenance that may be identified. The condition and reliability of the wells and appurtenances is in question due to the age of the wells in the Cole Well Field and considering the structural issues with wells 3 and 3A referenced in permitting Well 3C.

    - Construct surface seals for and fencing around Wells 3, 3A, 3B, 3C, and 6 to protect the wells from surface contamination and animals to meet the requirements of WDEQ Chapter 12 Rules and Regulations described in Section 7.3.1 of this report.

    - If Well 3C is operable, collect a water-quality sample to determine the water quality. The analytical suite should include the EPA Primary and Secondary Drinking water constituents, oil and grease, total petroleum hydrocarbons as diesel range organics, and total petroleum hydrocarbons as gasoline range organics.

    - If Well 3C is operable, perform a 48-hour pump test to determine the production capacity of the well. The results from this test should be compared to the 2009 pump test to verify the production capacity of the well.
Section 8 – Water Quality
- Determine location of highest TTHM/HAA5 as determined from samples submitted for 40/30 Certification Waiver
- Consult hydraulic model to determine locations of maximum residence time in the North and South zones
- Prepare Stage 2 Disinfection By-Products Monitoring Plan
- Develop a chlorine residual monitoring plan to ensure proper distribution system disinfection
- Perform a Langelier Saturation Index to determine the likelihood of scaling and/or mineral precipitation at current and future water sources
- Explore manganese removal options
- Develop and implement a wellhead protection plan to protect source water quality

Section 9 – Evaluation of System Operations and Maintenance
- Exercise mainline valves on a regular basis. Prepare a schedule, and set a goal to address system valves within a 5-year period.
- Flush the distribution system by using hydrant and blow-off valves. Conduct planned and systematic flushing for pipelines that have presented water quality issues, and especially more often in areas where dead-end lines present water quality concerns. Furthermore, it is recommended that a flushing protocol be developed that initiates upstream (high-pressure area) and proceeds systematically downstream to remove accumulated debris.
- Inspect and flush hydrants and valves. Complete this inspection at least annually on all fire hydrants to maintain hydrant and valve operation, check susceptibility to tampering, and check for the potential of system water losses through leaking hydrants.
- Read, inspect, and make adjustments as needed to meters and gauges regularly. Initiate regular annual testing on all production meters to validate comparisons between consumption and production records.
- Use best management practices to reduce the possibility of introducing contamination during repairs (included in Appendix E).
- Inspect storage tanks and provide routine maintenance. Biennial cleaning with inspection of the interior coating for each tank is recommended. Appendix E includes BMPs relating to the system-storage tank operation.
- Assess efficiency in system components periodically (e.g., pumps and valves). Determination of pumping efficiency at least annually provides valuable information about the need to introduce unit maintenance or replacement. Appendix E includes BMP techniques for assessing pump efficiency.

- Maintain the operating pressure range of the distribution system. Installation and pressure-monitor recording devices are recommended at critical pressure junctures as determined by the system model.

- Check for normal wear. Instead of reacting to failure of system components, mechanical parts found in pumps and control valves can have an extended useful life and unnecessary replacement or operational costs may be avoided.

- Monitor corrosion. Corrosion can indicate the need to modify treatment, conduct flushing, and/or install cathodic protection.

- It is recommended that the City replace the remaining older meters as soon as feasible.

- Strive to limit annual losses to less than 5% of annual production.

- Implement a standard protocol to record system deficiencies noted during fieldwork; log customer complaints; track necessary repairs; develop a work order system to address known deficiencies; and maintain a log of completed activities with information on date, location, and type of work performed.

- The EPA has informed the City that they will need to begin the Initial Distribution Evaluation Sampling (IDES) during 2013.

- Monitor chemical feed and other chlorination system components.

- Monitor effectiveness of treatment (e.g., chlorine residual).

- Test for the presence of excess bio-films in conjunction with total coliform sampling. Bio-film can indicate inadequate chlorine residual and water stagnation. Testing the water system more frequently, than the minimum monthly requirement, will provide advance warning of potential problems and could eliminate the need for repeat testing.

- Routinely inspect wellheads for adequate protection to identify potential sources of contamination. Secure all wellheads to avoid either casual or intentional intrusion.

- Evaluate adequate backflow prevention placement at locations susceptible to fertilizer use, such as the golf course, funeral parlors, and public parks.

- Perform a Langlier Saturation Index test. This test will provide an indication of source water corrosivity and could provide insight into chemical incompatibility between sources.
- Perform breakpoint chlorination test. This test provides information to optimize chlorine dosage to prevent over chlorinating.

- Develop a plan to protect City facilities in case of an emergency.

- Keep system components locked to protect from public tampering. Conduct frequent security inspections of door locks, storage tank lids, and fencing.

- Store chlorine gas cylinders and other harmful chemicals in locked areas with proper safety equipment.

- Exercise valves on a routine basis, and verify there are enough valves in appropriate locations to isolate system parts in the event of contamination.

- Maintain a list of written contacts and understand whom to contact in the event of an emergency.

- Educate staff on emergency procedures.

- Develop a health and safety plan (HASP), familiarize staff with the document, and recommended practices.

- Create and follow standard operating procedures (SOPs).

- Log information into a searchable database.

- Create tools to help recognize system trends.

- Record information consistently.

- Use the water system hydraulic model.

- Update system mapping.

- Continually review and update the asset management plan as additional information is gained and priorities shift.

- **Section 10 - Supervisory Control and Data Acquisition (SCADA) Evaluation**

  - SCADA implementation with multiple stages over a specific period to address the highest priority needs first and then lower priority needs as budget allows.

  - A hybrid system with dry-cable pair modems to create an Ethernet bridge at data collection points at each of the locations identified in Section 10.0.

  - Installation of new pressure transmitters connected to the exiting bubbler tubes for measuring well-water levels is recommended.
- Installation of a magnetic flow meter (mag meter) in the well-field discharge line for monitoring flow rates for water production is recommended.

- Installation of pressure transmitters tapped into the influent pipe near each storage tank to measure tank levels is recommended.

- The following telemetry with repeater stations to link the entire system via IO radios are recommended. The Blue and Sundance Kid tanks and the Underground Reservoir levels will be transmitted by IO radio to the Policky Tank. The existing PLC will transmit to the central office over the existing link. An IO radio will transmit Mt. Moriah Tank water level to a PLC located in the Canyon Pump Station. Brewer and Canyon tanks will transmit levels by IO radio to a PLC located at the Sundance West Pump Station. The Cole Tank will transmit water level by IO radio to a PLC at the Cole Tank Chlorination Building.

- It is recommended to install mag meters and pressure transmitters at each PRV and pump station.

- Section 13 – Water System Financing
  - Initiate reserve fund planning necessary for grant/loan matching, separate from other reserve accounts.
  - Consider establishing a rate structure to follow accepted industry practices that sets rates based upon cost of service.
  - It is recommended that the rate structure be revised with a system specific SAC to include 4,000 gallons of water with the minimum monthly charge and a commodity charge that supports the anticipated capital program.
  - It is recommended that a rate structure be developed that will alert consumers that conservation is a City priority.
  - Separation of grant/loan project funding into a subsection and elimination of non-operational items into another subsection would provide clearer information about functional performance.
  - Production metering records should be separate and compared against the metered billing records to determine system loss.
  - Availability charges should be removed from the operations budget and retained for capital expansion.
  - A subsection budget should be established to exclusively track grant and loan liability.
  - Investigate the number of users, which appear to use minimal water, to validate the conditions, whether it is life style, worn meters, or compromised reading.
15.0 REFERENCES


EPA. 2007. Complying with the Stage 2 Disinfectant and Disinfection Byproducts Rule: Small Entity Compliance Guide. EPA 815-R-07-014.
EPA. 2010. DBPR 1 and 2 Quick Reference Guide. EPA 816-F-10-080.


TABLES
TABLE 3-1. SUNDANCE WATER SUPPLY WELLS  
SUNDANCE MASTER PLAN LEVEL I  
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Capacity (GPM)</th>
<th>Used for Domestic Supply</th>
<th>Pump Details</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOAFMAN #1</td>
<td>15</td>
<td>NO</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>LOAFMAN #2</td>
<td>15</td>
<td>NO</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>COLE #3</td>
<td>240</td>
<td>YES</td>
<td>Goulds 150L 40</td>
<td>50 HP Franklin 4600</td>
</tr>
<tr>
<td>COLE #3A</td>
<td>250</td>
<td>YES</td>
<td>Goulds 7CLC-8A</td>
<td>75 HP Hitachi VTI</td>
</tr>
<tr>
<td>COLE #3B</td>
<td>250</td>
<td>YES</td>
<td>Goulds 7CLC-7</td>
<td>75 HP Hitachi, 460 Volt</td>
</tr>
<tr>
<td>COLE #3C</td>
<td>200</td>
<td>NO</td>
<td>Franklin FET0401506</td>
<td>40 HP Franklin 2366178125</td>
</tr>
<tr>
<td>HARD WATER #5</td>
<td>197</td>
<td>NO</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>LLOYD COLE #4</td>
<td>20</td>
<td>NO</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>SUNDANCE #6</td>
<td>400</td>
<td>YES</td>
<td>Sulzer 7H400-14A</td>
<td>150 HP Franklin 8” Submersible</td>
</tr>
</tbody>
</table>
**TABLE 3-2. STORAGE TANK SUMMARY**  
**SUNDANCE MASTER PLAN LEVEL I**  
**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

<table>
<thead>
<tr>
<th>Tank Name</th>
<th>Capacity (gal)</th>
<th>Diameter</th>
<th>Height</th>
<th>Base Elevation</th>
<th>High Water Line (ft)</th>
<th>Existing Pressure Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cole</td>
<td>250,000</td>
<td>39</td>
<td>28</td>
<td>4,923.5</td>
<td>4952.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>North/Orr</td>
</tr>
<tr>
<td>Mt. Moriah</td>
<td>250,000</td>
<td>39</td>
<td>28</td>
<td>4,845.0</td>
<td>4874.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>North</td>
</tr>
<tr>
<td>Underground</td>
<td>66,000</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>North</td>
</tr>
<tr>
<td>Sundance Kid</td>
<td>105,000</td>
<td>30</td>
<td>22</td>
<td>4,852.5</td>
<td>4874.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>North</td>
</tr>
<tr>
<td>Canyon</td>
<td>55,000</td>
<td>24</td>
<td>16</td>
<td>5,119.0</td>
<td>5135.0</td>
<td>Canyon</td>
</tr>
<tr>
<td>Brewer</td>
<td>55,000</td>
<td>24</td>
<td>16</td>
<td>5,228.0</td>
<td>5244.0</td>
<td>Sundance West</td>
</tr>
<tr>
<td>Blue</td>
<td>290,000</td>
<td>42</td>
<td>28</td>
<td>4,903.0</td>
<td>4931.0</td>
<td>South</td>
</tr>
<tr>
<td>Policky</td>
<td>100,000</td>
<td>28</td>
<td>22</td>
<td>5,040.0</td>
<td>5059.0</td>
<td>Policky/East</td>
</tr>
</tbody>
</table>

<sup>a</sup> - Elevation of current Cole Tank (It will be relocated in the Summer of 2013 to a new site and elevation).

<sup>b</sup> - The Mt. Moriah, Sundance Kid and Underground tanks have a single inlet-outlet pipe, which allows them to all operate at the same high water level.
## TABLE 3-3. PRV SETTINGS
SUNDANCE MASTER PLAN LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Valve Size (in)</th>
<th>Pressure Reduction (PSI)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>East PRV</td>
<td>2.5</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>West PRV</td>
<td>2</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>585 PRV</td>
<td>2.5</td>
<td>Unknown</td>
<td>Appears to be Valved Off</td>
</tr>
<tr>
<td>Sundance Kid PRV</td>
<td>2.5</td>
<td>74</td>
<td></td>
</tr>
</tbody>
</table>
# TABLE 3-4. PUMP STATION SUMMARY
## SUNDANCE MASTER PLAN LEVEL I
## WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Pump Station</th>
<th>Pumping Operation</th>
<th>Number of Pumps</th>
<th>Pump Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canyon Pump Station</td>
<td>North Pressure Zone</td>
<td>2</td>
<td>Grundfos CR4-80/7</td>
</tr>
<tr>
<td>Sundance West Pump Station</td>
<td>Canyon Tank</td>
<td>2</td>
<td>Grundfos CR5-5</td>
</tr>
<tr>
<td>Sundance Kid Pump Station</td>
<td>Canyon Tank</td>
<td>2</td>
<td>Berkeley L1027</td>
</tr>
<tr>
<td>Cole Tank Chlorinator Building</td>
<td>North Pressure Zone</td>
<td>1</td>
<td>Missing Data Plate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pump Station</th>
<th>From</th>
<th>To</th>
<th>Pump Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canyon Pump Station</td>
<td>North Pressure Zone</td>
<td>Canyon Tank</td>
<td></td>
</tr>
<tr>
<td>Sundance West Pump Station</td>
<td>Canyon Tank</td>
<td>Brewer Tank</td>
<td></td>
</tr>
<tr>
<td>Sundance Kid Pump Station</td>
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<td>Cole Tank Chlorinator Building</td>
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## TABLE 5-1. GROWTH RATE SCENARIO 1, EAD/DA&I PROJECTIONS
SUNDANCE MASTER PLAN LEVEL 1
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

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<td>Sundance Population (Within Corporate Limits)</td>
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**Notes:**
- 2010-2030 Estimates Prepared by Wyoming Department of A & I, Economic Analysis Division (http://eadiv.state.wy.us)
- 2010 state, county, and municipality population are 2010 Census data
- 2011 to 2030 state and county population forecasts were developed based on trends of demographic and economic variables
- Municipality population forecasts calculated by applying the place/county ratios to the appropriate county forecasts
- * = Population forecast were not available for these periods. Assume forecasted state growth rate of 0.8% estimated between 2029 and 2030

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**TABLE 5-1. GROWTH RATE SCENARIO 1, EAD/DA&I PROJECTIONS**

**SUNDANCE MASTER PLAN LEVEL 1**

**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**
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<tbody>
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<td>Growth Rate</td>
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<tr>
<td>Population Increase</td>
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</tr>
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<tr>
<td>Sundance Population (Within Corporate Limits)</td>
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<td>1,270</td>
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<td>0.80%</td>
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</tr>
<tr>
<td>Population Increase</td>
<td>80</td>
<td>50</td>
<td>60</td>
<td>60</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td><strong>Sundance Population (Within Corporate Limits)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population Increase</td>
<td>1,367</td>
<td>1,375</td>
<td>1,385</td>
<td>1,395</td>
<td>1,405</td>
<td>1,417</td>
<td>1,427</td>
<td>1,438</td>
<td>1,450</td>
<td>1,462</td>
<td>1,473</td>
<td></td>
</tr>
<tr>
<td>Growth Rate</td>
<td>1.03%</td>
<td>0.59%</td>
<td>0.73%</td>
<td>0.72%</td>
<td>0.85%</td>
<td>0.71%</td>
<td>0.77%</td>
<td>0.83%</td>
<td>0.80%</td>
<td>0.80%</td>
<td>0.80%</td>
<td></td>
</tr>
<tr>
<td>Population Increase</td>
<td>14</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>Sundance Population (Outside Corporate Limits, Within Water Service Area)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population Increase</td>
<td>231</td>
<td>233</td>
<td>234</td>
<td>236</td>
<td>238</td>
<td>240</td>
<td>241</td>
<td>243</td>
<td>245</td>
<td>247</td>
<td>249</td>
<td></td>
</tr>
<tr>
<td>Growth Rate</td>
<td>1.03%</td>
<td>0.59%</td>
<td>0.73%</td>
<td>0.72%</td>
<td>0.85%</td>
<td>0.71%</td>
<td>0.77%</td>
<td>0.83%</td>
<td>0.80%</td>
<td>0.80%</td>
<td>0.80%</td>
<td></td>
</tr>
<tr>
<td>Population Increase</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Sundance Total Population</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population Increase</td>
<td>2,108</td>
<td>2,117</td>
<td>2,129</td>
<td>2,140</td>
<td>2,152</td>
<td>2,166</td>
<td>2,178</td>
<td>2,191</td>
<td>2,205</td>
<td>2,218</td>
<td>2,232</td>
<td></td>
</tr>
<tr>
<td>Population Increase (yearly)</td>
<td>16</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>14</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Population Increase (cumulative)</td>
<td>726</td>
<td>735</td>
<td>747</td>
<td>758</td>
<td>770</td>
<td>784</td>
<td>796</td>
<td>809</td>
<td>823</td>
<td>836</td>
<td>850</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
2010-2030 Estimates Prepared by Wyoming Department of A & I, Economic Analysis Division (http://eadiv.state.wy.us)
2010 state, county, and municipality population are 2010 Census data
2011 to 2030 state and county population forecasts were developed based on trends of demographic and economic variables
Municipality population forecasts calculated by applying the place/county ratios to the appropriate county forecasts
* = Population forecast were not available for these periods. Assume forecasted state growth rate of 0.8% estimated by Wyoming Department of A & I, Economic Analysis Division
** = Total population values include anticipated population impacts from Strata and RER developments
TABLE 5-3. CITY OF SUNDANCE POPULATION PROJECTIONS
SUNDANCE MASTER PLAN LEVEL 1
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Year</th>
<th>EAD/DA&amp;I Projections</th>
<th>EAD/DA&amp;I Projections plus RER and Strata Energy Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2035</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## TABLE 5-4. 2-5 YEAR RESIDENTIAL GROWTH
SUNDANCE MASTER PLAN LEVEL 1
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Anticipated Zoning</th>
<th>Property Description (Map Designation*)</th>
<th>Area (Acre)</th>
<th>Density (Units/Acre)</th>
<th>Number of Dwelling Units</th>
<th>Population Capacity</th>
<th>Projected Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Density Residential (LDR) (Outside City Limits)</td>
<td>50% of Undeveloped Lots in Sundance West (1)</td>
<td>32.5</td>
<td>0.2</td>
<td>6.5</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Low Density Residential (LDR) (Inside City Limits)</td>
<td>50% of Undeveloped Lots in Sundance View Estates (2)</td>
<td>7.7</td>
<td>1.0</td>
<td>7.7</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>Medium Density Residential (MDR)</td>
<td>South Side Meadows Subdivision (3)</td>
<td>22.0</td>
<td>4.0</td>
<td>88.0</td>
<td>216</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>Lot 3, South of South Side Meadows Subdivision (4)</td>
<td>10.5</td>
<td>4.0</td>
<td>42.0</td>
<td>103</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>Parcels South of I-90, West of 21st Street (5)</td>
<td>18.5</td>
<td>4.0</td>
<td>74.0</td>
<td>182</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>Parcels North of I-90, West of 21st Street (6)</td>
<td>12.7</td>
<td>4.0</td>
<td>50.8</td>
<td>125</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Parcels North of I-90, East of 21st Street (7)</td>
<td>30.0</td>
<td>4.0</td>
<td>120.0</td>
<td>295</td>
<td>184</td>
</tr>
<tr>
<td></td>
<td>Parcels North of Cleveland Street, East of 21st Street (8)</td>
<td>10.0</td>
<td>4.0</td>
<td>40.0</td>
<td>98</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Misc. Undeveloped Lots in Town (9)</td>
<td>2.0</td>
<td>4.0</td>
<td>8.0</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>145.9</strong></td>
<td></td>
<td><strong>437.0</strong></td>
<td><strong>1,040</strong></td>
<td><strong>650</strong></td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number
### TABLE 5-5. 5-10 YEAR RESIDENTIAL GROWTH  
**SUNDANCE MASTER PLAN LEVEL 1**  
**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

<table>
<thead>
<tr>
<th>Anticipated Zoning</th>
<th>Property Description (Map Designation*)</th>
<th>Area (Acre)</th>
<th>Density (Units/Acre)</th>
<th>Number of Dwelling Units</th>
<th>Population Capacity</th>
<th>Projected Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Density Residential (LDR) (Outside City Limits)</td>
<td>50% of Undeveloped Lots in Sundance West (10)</td>
<td>32.5</td>
<td>0.2</td>
<td>6.5</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Low Density Residential (LDR) (Inside City Limits)</td>
<td>50% of Undeveloped Lots in Sundance View Estates (11)</td>
<td>7.7</td>
<td>1.0</td>
<td>7.7</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Medium Density Residential (MDR)</td>
<td>South of Southside Meadows, North of Proposed Croell Industrial Development (12)</td>
<td>56.0</td>
<td>4.0</td>
<td>224.0</td>
<td>551</td>
<td>41</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>96.2</td>
<td>-</td>
<td>238.2</td>
<td>586</td>
<td>76</td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number.
### TABLE 5-6. 10-20 YEAR RESIDENTIAL GROWTH  
SUNDANCE MASTER PLAN LEVEL 1  
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Anticipated Zoning</th>
<th>Property Description (Map Designation*)</th>
<th>Area (Acre)</th>
<th>Density (Units/Acre)</th>
<th>Number of Dwelling Units</th>
<th>Population Capacity</th>
<th>Projected Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Density Residential (LDR)</td>
<td>Between Sundance West and Hwy 14 (13)</td>
<td>430.0</td>
<td>0.2</td>
<td>86.0</td>
<td>212</td>
<td>26</td>
</tr>
<tr>
<td>Medium Density Residential (MDR)</td>
<td>West of Southside Meadows (14)</td>
<td>82.0</td>
<td>1.0</td>
<td>328.0</td>
<td>807</td>
<td>98</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>512.0</strong></td>
<td><strong>-</strong></td>
<td><strong>414.0</strong></td>
<td><strong>1,018</strong></td>
<td><strong>124</strong></td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number
**TABLE 5-7. 2-5 YEAR COMMERCIAL AND INDUSTRIAL GROWTH**
SUNDANCE MASTER PLAN LEVEL 1
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Anticipated Zoning</th>
<th>Property Description (Map Designation*)</th>
<th>Area (Acre)</th>
<th>Employees / Acre</th>
<th>Number of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway Business District (HBD)</td>
<td>South of Cleveland Street, East Side of Town (15)</td>
<td>22</td>
<td>12</td>
<td>264</td>
</tr>
<tr>
<td></td>
<td>North of Hwy 14, West Side of Town (16)</td>
<td>26</td>
<td>12</td>
<td>312</td>
</tr>
<tr>
<td>Industrial District (ID)</td>
<td>Croell Ready Mix (17)</td>
<td>20</td>
<td>12</td>
<td>240</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>68</td>
<td></td>
<td>816</td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number
<table>
<thead>
<tr>
<th>Anticipated Zoning</th>
<th>Property Description (Map Designation*)</th>
<th>Area (Acre)</th>
<th>Employees / Acre</th>
<th>Number of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway Business District (HBD)</td>
<td>West of Sundance View Estates, South of Frontage Road (18)</td>
<td>13</td>
<td>12</td>
<td>156</td>
</tr>
<tr>
<td>Industrial District (ID)</td>
<td>Southeast of Industrial Road (19)</td>
<td>25</td>
<td>12</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>Parcel West of Croell Industrial Development (20)</td>
<td>37</td>
<td>12</td>
<td>444</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>75</td>
<td></td>
<td>900</td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number
### TABLE 5-9. CURRENT WATER DEMAND
SUNDANCE MASTER PLAN LEVEL 1
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Year</th>
<th>Peak Usage Month</th>
<th>Peak Day Demand (gal/day)</th>
<th>Peak Day Demand (gal/min)</th>
<th>Average Day Demand (gal/day)</th>
<th>Average Day Demand (gal/min)</th>
<th>Peaking Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>August</td>
<td>587,000</td>
<td>611</td>
<td>465,000</td>
<td>323</td>
<td>1.26</td>
</tr>
<tr>
<td>2009</td>
<td>July</td>
<td>578,000</td>
<td>602</td>
<td>439,000</td>
<td>305</td>
<td>1.32</td>
</tr>
<tr>
<td>2010</td>
<td>August</td>
<td>563,000</td>
<td>586</td>
<td>409,310</td>
<td>284</td>
<td>1.38</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>576,000</td>
<td>600</td>
<td>437,770</td>
<td>304</td>
<td>1.32</td>
</tr>
</tbody>
</table>
### TABLE 5-10. 2-5 YEAR RESIDENTIAL FUTURE WATER DEMAND
SUNDANCE MASTER PLAN LEVEL 1
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Property Description (Map Designation*)</th>
<th>Projected Population</th>
<th>Per Capita Water Demand (gpd/person)</th>
<th>Peak Daily Water Demand (gpd)</th>
<th>Average Daily Water Demand (gpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% of Undeveloped Lots in Sundance West (1)</td>
<td>10</td>
<td>188</td>
<td>1,878</td>
<td>1,252</td>
</tr>
<tr>
<td>50% of Undeveloped Lots in Sundance View Estates (2)</td>
<td>12</td>
<td>188</td>
<td>2,210</td>
<td>1,473</td>
</tr>
<tr>
<td>South Side Meadows Subdivision (3)</td>
<td>135</td>
<td>188</td>
<td>25,419</td>
<td>16,946</td>
</tr>
<tr>
<td>Lot 3, South of South Side Meadows Subdivision (4)</td>
<td>65</td>
<td>188</td>
<td>12,132</td>
<td>8,088</td>
</tr>
<tr>
<td>Parcels South of I-90, West of 21st Street (5)</td>
<td>114</td>
<td>188</td>
<td>21,375</td>
<td>14,250</td>
</tr>
<tr>
<td>Parcels North of I-90, West of 21st Street (6)</td>
<td>78</td>
<td>188</td>
<td>14,674</td>
<td>9,783</td>
</tr>
<tr>
<td>Parcels North of I-90, East of 21st Street (7)</td>
<td>184</td>
<td>188</td>
<td>34,663</td>
<td>23,109</td>
</tr>
<tr>
<td>Parcels North of Cleveland Street. East of 21st Street (8)</td>
<td>61</td>
<td>188</td>
<td>11,554</td>
<td>7,703</td>
</tr>
<tr>
<td>Misc. Undeveloped Lots in Town (9)</td>
<td>12</td>
<td>188</td>
<td>2,311</td>
<td>1,541</td>
</tr>
<tr>
<td>TOTAL</td>
<td>650</td>
<td>122,129</td>
<td>81,419</td>
<td></td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number
<table>
<thead>
<tr>
<th>Property Description (Map Designation*)</th>
<th>Projected Population</th>
<th>Per Capita Water Demand (gpd/person)</th>
<th>Peak Daily Water Demand (gpd)</th>
<th>Average Daily Water Demand (gpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% of Undeveloped Lots in Sundance West (10)</td>
<td>16</td>
<td>188</td>
<td>3,006</td>
<td>2,004</td>
</tr>
<tr>
<td>50% of Undeveloped Lots in Sundance View Estates (11)</td>
<td>19</td>
<td>188</td>
<td>3,538</td>
<td>2,359</td>
</tr>
<tr>
<td>South of Southside Meadows, North of Proposed Croell Industrial Development (12)</td>
<td>41</td>
<td>188</td>
<td>7,744</td>
<td>5,162</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>76</strong></td>
<td><strong>14,288</strong></td>
<td><strong>9,525</strong></td>
<td></td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number
<table>
<thead>
<tr>
<th>Property Description (Map Designation*)</th>
<th>Projected Population</th>
<th>Per Capita Water Demand (gpd/person)</th>
<th>Peak Daily Water Demand (gpd)</th>
<th>Average Daily Water Demand (gpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Sundance West and Hwy 14 (13)</td>
<td>26</td>
<td>188</td>
<td>4,853</td>
<td>3,236</td>
</tr>
<tr>
<td>West of Southside Meadows (14)</td>
<td>98</td>
<td>188</td>
<td>18,511</td>
<td>12,341</td>
</tr>
<tr>
<td>TOTAL</td>
<td>124</td>
<td>23,364</td>
<td></td>
<td>15,576</td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number
**TABLE 5-13. 2-5 YEAR COMMERCIAL AND INDUSTRIAL FUTURE WATER DEMAND**  
**SUNDANCE MASTER PLAN LEVEL 1**  
**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

<table>
<thead>
<tr>
<th>Property Description (Map Designation*)</th>
<th>Number of Employees</th>
<th>Per Capita Water Demand (gpd/employee)</th>
<th>Peak Daily Water Demand (gpd)</th>
<th>Average Daily Water Demand (gpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South of Cleveland Street, East Side of Town (15)</td>
<td>264</td>
<td>38</td>
<td>10,032</td>
<td>6,688</td>
</tr>
<tr>
<td>North of Hwy 14, West Side of Town (16)</td>
<td>312</td>
<td>38</td>
<td>11,856</td>
<td>7,904</td>
</tr>
<tr>
<td>Croell Ready Mix (17)</td>
<td>240</td>
<td>38</td>
<td>9,120</td>
<td>6,080</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>816</strong></td>
<td><strong>31,008</strong></td>
<td><strong>20,672</strong></td>
<td></td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number
<table>
<thead>
<tr>
<th>Property Description (Map Designation*)</th>
<th>Number of Employees</th>
<th>Per Capita Water Demand (gpd/employee)</th>
<th>Peak Daily Water Demand (gpd)</th>
<th>Average Daily Water Demand (gpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West of Sundance View Estates, South of Frontage Road (18)</td>
<td>156</td>
<td>38</td>
<td>5,928</td>
<td>3,952</td>
</tr>
<tr>
<td>Southeast of Industrial Road (19)</td>
<td>300</td>
<td>38</td>
<td>11,400</td>
<td>7,600</td>
</tr>
<tr>
<td>Parcel West of Croell Industrial Development (20)</td>
<td>444</td>
<td>38</td>
<td>16,872</td>
<td>11,248</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>900</strong></td>
<td><strong>34,200</strong></td>
<td><strong>22,800</strong></td>
<td><strong>22,800</strong></td>
</tr>
</tbody>
</table>

* = Refer to Figure 5-2 for property location, identified by the map designation number
<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Residential Demands</th>
<th>Commercial and Industrial Demands</th>
<th>Total Water Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak Daily Water Demand (gpd)</td>
<td>Average Daily Water Demand (gpd)</td>
<td>Peak Daily Water Demand (gpd)</td>
</tr>
<tr>
<td>2-5 Years</td>
<td>122,129</td>
<td>81,419</td>
<td>31,008</td>
</tr>
<tr>
<td>5-10 Years</td>
<td>14,288</td>
<td>9,525</td>
<td>34,200</td>
</tr>
<tr>
<td>10-20 Years</td>
<td>23,364</td>
<td>15,576</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>159,781</td>
<td>106,521</td>
<td>65,208</td>
</tr>
<tr>
<td>Permit #</td>
<td>Priority</td>
<td>Status</td>
<td>Township</td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>--------</td>
<td>---------------</td>
</tr>
<tr>
<td>P1544W</td>
<td>10/11/1965</td>
<td>ADJ</td>
<td>T52N, R63W</td>
</tr>
<tr>
<td>P8377W</td>
<td>2/19/1971</td>
<td>ADJ</td>
<td>T52N, R63W</td>
</tr>
<tr>
<td>P50484W</td>
<td>10/15/1979</td>
<td>ADJ</td>
<td>T52N, R63W</td>
</tr>
<tr>
<td>P72179W</td>
<td>1/6/1986</td>
<td>ADJ</td>
<td>T51N, R63W</td>
</tr>
<tr>
<td>P2523W</td>
<td>4/29/1969</td>
<td>ADJ</td>
<td>T51N, R63W</td>
</tr>
<tr>
<td>P2520W</td>
<td>4/29/1969</td>
<td>ADJ</td>
<td>T51N, R63W</td>
</tr>
<tr>
<td>P2521W</td>
<td>4/29/1969</td>
<td>ADJ</td>
<td>T51N, R63W</td>
</tr>
</tbody>
</table>

Notes:
- Qtrqtr - Quarter-quarter section
- Yld Act - Yield Actual (gallons per minute)
- Mwbz Top - Main water-bearing zone top (feet below ground surface)
- Mwbz Bottom - Main water-bearing zone bottom (feet below ground surface)
- Well depth and static depth are shown in feet below ground surface
- ADJ - adjudicated
- COM - complete
- ABA - abandoned
- MUN - municipal
- MIS - miscellaneous
<table>
<thead>
<tr>
<th>Permit #</th>
<th>Priority Date</th>
<th>Status</th>
<th>Applicant</th>
<th>Facility Name</th>
<th>Uses</th>
<th>Township</th>
<th>Section</th>
<th>Qtr-Qtr</th>
<th>Appropriation (cfs)</th>
<th>Stream Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2705D</td>
<td>5/31/1900 ADJ</td>
<td>City of Sundance</td>
<td>Draper Ditch</td>
<td>IRR</td>
<td>T51N, R63W</td>
<td>22</td>
<td>SESE</td>
<td>1</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>P2863D</td>
<td>10/17/1900 ADJ</td>
<td>City of Sundance</td>
<td>Sundance Pipe Line</td>
<td>DOM, FIR, IRR, MUN</td>
<td>T51N, R63W</td>
<td>23</td>
<td>SENW</td>
<td>1</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>P12151D</td>
<td>11/01/1913 ADJ</td>
<td>City of Sundance</td>
<td>Loafman Ditch and Pipe Line</td>
<td>MUN</td>
<td>T51N, R63W</td>
<td>27</td>
<td>NESE</td>
<td>0.03</td>
<td>Spring</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- Qtr - quarter
- cfs - cubic feet per second
- ADJ - adjudicated
- IRR - irrigation
- DOM - domestic
- MUN - municipal
### TABLE 8-1. TYPICAL SOURCES OF POTENTIAL GROUNDWATER CONTAMINANTS BY LAND USE CATEGORY

**SUNDANCE MASTER PLAN LEVEL I**

**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

<table>
<thead>
<tr>
<th>Category</th>
<th>Contaminant Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agriculture</strong></td>
<td>Animal burial areas</td>
</tr>
<tr>
<td></td>
<td>Animal feedlots</td>
</tr>
<tr>
<td></td>
<td>Fertilizer storage/use</td>
</tr>
<tr>
<td><strong>Commercial</strong></td>
<td>Airports</td>
</tr>
<tr>
<td></td>
<td>Auto repair shops</td>
</tr>
<tr>
<td></td>
<td>Construction areas</td>
</tr>
<tr>
<td></td>
<td>Car washes</td>
</tr>
<tr>
<td></td>
<td>Cemeteries</td>
</tr>
<tr>
<td></td>
<td>Dry cleaners</td>
</tr>
<tr>
<td></td>
<td>Gas stations</td>
</tr>
<tr>
<td></td>
<td>Golf courses</td>
</tr>
<tr>
<td><strong>Industrial</strong></td>
<td>Asphalt plants</td>
</tr>
<tr>
<td></td>
<td>Chemical manufacture/storage</td>
</tr>
<tr>
<td></td>
<td>Electroplaters</td>
</tr>
<tr>
<td></td>
<td>Machine/metalworking shops</td>
</tr>
<tr>
<td></td>
<td>Mining and mine drainage</td>
</tr>
<tr>
<td><strong>Residential</strong></td>
<td>Fuel oil</td>
</tr>
<tr>
<td></td>
<td>Furniture stripping/refinishing</td>
</tr>
<tr>
<td></td>
<td>Household hazardous products</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>Municipal landfills</td>
</tr>
<tr>
<td></td>
<td>Municipal sewer lines</td>
</tr>
<tr>
<td></td>
<td>Open burning sites</td>
</tr>
</tbody>
</table>

- **Contaminant Source**
  - Irrigation sites
  - Manure spreading areas
  - Pesticide storage/use
  - Jewelry/metal plating
  - Laundromats
  - Medical institutions
  - Paint shops
  - Railroad tracks and yards
  - Research laboratories
  - Scrap and junkyards
  - Storage tanks
  - Petroleum production/storage
  - Pipelines
  - Seepage lagoons
  - Wells (operating/abandoned)
  - Septic systems
  - Sewer lines
  - Household lawns
  - Recycling facilities
  - Road maintenance depots
  - Storm water drains/basins

Source: EPA, 1991
**TABLE 8-2. BENEFIT/COST ACCRUING FORM**
**IMPLEMENTATION OF LOCAL WHP PLANS**
**SUNDANCE MASTER PLAN LEVEL I**
**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

<table>
<thead>
<tr>
<th></th>
<th>Benefit (Savings)</th>
<th>Period</th>
<th>Cost</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring Waivers</td>
<td>$33K*</td>
<td>5 Years</td>
<td>$5K</td>
<td>7:1</td>
</tr>
<tr>
<td>Treatment Plant</td>
<td>$506K*</td>
<td>Once</td>
<td>$5K</td>
<td>100:1</td>
</tr>
<tr>
<td>Replacement Well</td>
<td>$650K*</td>
<td>Once</td>
<td>$5K</td>
<td>130:1</td>
</tr>
</tbody>
</table>

Source: WDEQ
<table>
<thead>
<tr>
<th>Location</th>
<th>Component</th>
<th>Command</th>
<th>Device</th>
<th>Telemetry SCADA</th>
<th>Primary Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cole Well Field</td>
<td>Data Collector Site</td>
<td>DIN</td>
<td>Touch screen</td>
<td>$4,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>Cole Well 3 Pump Running</td>
<td>DIN Running DIN</td>
<td>Contact</td>
<td>$100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cole Well 3 Pump Command</td>
<td>DOUT Contact</td>
<td>$150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cole Well 3 Well Level</td>
<td>AIN</td>
<td>$1,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cole Well 3A Pump Running</td>
<td>DIN Contact</td>
<td>$100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cole Well 3A Pump Command</td>
<td>DOUT Contact</td>
<td>$150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cole Well 3A Well Level</td>
<td>AIN</td>
<td>$1,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cole Well 3B Pump Running</td>
<td>DIN Contact</td>
<td>$100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cole Well 3B Pump Command</td>
<td>DOUT Contact</td>
<td>$150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cole Well 3B Well Level</td>
<td>AIN</td>
<td>$1,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Rate</td>
<td>AIN</td>
<td>$7,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump and Chlorination Station</td>
<td>Data Collector Site</td>
<td>DIN</td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
</tr>
<tr>
<td>Chlorine leak</td>
<td>DIN Contact</td>
<td>$2,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>DIN</td>
<td>$800</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injector Pump Run status</td>
<td>DIN Contact</td>
<td>$100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injector Pump Run Command</td>
<td>DOUT Contact</td>
<td>$150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suction Pressure</td>
<td>AIN</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Discharge Pressure</td>
<td>AIN</td>
<td>$1,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow rate</td>
<td>AIN</td>
<td>$7,000</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cl2 dose control</td>
<td>AOUT Control valve</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump and PRV CLA Valve</td>
<td>Data Collector Site</td>
<td>DIN</td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
</tr>
<tr>
<td>High side Pressure</td>
<td>AIN</td>
<td>$1,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low side Pressure</td>
<td>AIN</td>
<td>$1,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow rate</td>
<td>AIN</td>
<td>$7,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Booster Pressure</td>
<td>AIN</td>
<td>$1,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Booster flow</td>
<td>AIN</td>
<td>$7,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low temperature</td>
<td>DIN</td>
<td>$200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water on floor</td>
<td>DIN</td>
<td>$200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**TABLE 10-1. SCADA HARDWARE, SOFTWARE, AND COMPONENT ESTIMATED COSTS**

**SUNDANCE MASTER PLAN LEVEL I**

**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

<table>
<thead>
<tr>
<th>Location</th>
<th>Component</th>
<th>Command</th>
<th>Device</th>
<th>Telemetry SCADA</th>
<th>Primary Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canyon Booster Station</strong></td>
<td>Data Collector Site</td>
<td></td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 1 Run Status</td>
<td>DIN</td>
<td>PLC &amp; Enet modem</td>
<td>$40,000</td>
<td>$100</td>
</tr>
<tr>
<td></td>
<td>Pump 1 Run Command</td>
<td>DOUT</td>
<td>relay</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 2 Run Status</td>
<td>DIN</td>
<td>contact</td>
<td>$100</td>
<td>$150</td>
</tr>
<tr>
<td></td>
<td>Pump 2 Run Command</td>
<td>DOUT</td>
<td>relay</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow rate</td>
<td>AIN</td>
<td>Mag Meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suction Pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td>$1,500</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Discharge Pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low Temperature</td>
<td>DIN</td>
<td>Thermostat</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water on Floor</td>
<td>DIN</td>
<td>Float Switch</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$44,000</strong></td>
</tr>
<tr>
<td><strong>Sundance Kid Booster</strong></td>
<td>Data Collector Site</td>
<td></td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 1 Run Status</td>
<td>DIN</td>
<td>PLC &amp; Enet modem</td>
<td>$40,000</td>
<td>$100</td>
</tr>
<tr>
<td></td>
<td>Pump 1 Run Command</td>
<td>DOUT</td>
<td>relay</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 2 Run Status</td>
<td>DIN</td>
<td>contact</td>
<td>$100</td>
<td>$150</td>
</tr>
<tr>
<td></td>
<td>Pump 2 Run Command</td>
<td>DOUT</td>
<td>relay</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow rate</td>
<td>AIN</td>
<td>Mag Meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suction Pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td>$1,500</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Discharge Pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low Temperature</td>
<td>DIN</td>
<td>thermostat</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water on Floor</td>
<td>DIN</td>
<td>float switch</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bypass flow</td>
<td>AIN</td>
<td>Mag Meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$44,000</strong></td>
</tr>
<tr>
<td><strong>Well 6</strong></td>
<td>Data Collector Site</td>
<td></td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump run Status</td>
<td>DIN</td>
<td>PLC &amp; Enet modem</td>
<td>$40,000</td>
<td>$100</td>
</tr>
<tr>
<td></td>
<td>Pump run Command</td>
<td>DOUT</td>
<td>relay</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Level</td>
<td>AIN</td>
<td>bubbler/transmitter</td>
<td>$3,500</td>
<td>$3,500</td>
</tr>
<tr>
<td></td>
<td>Well Flow Rate</td>
<td>AIN</td>
<td>mag meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$44,000</strong></td>
</tr>
</tbody>
</table>
### Table 10-1. SCADA Hardware, Software, and Component Estimated Costs

**Sundance Master Plan Level I**

**Wyoming Water Development Commission, Crook County, Wyoming**

<table>
<thead>
<tr>
<th>Location</th>
<th>Component</th>
<th>Command</th>
<th>Device</th>
<th>Telemetry SCADA</th>
<th>Primary Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Water Lift Station</td>
<td>Data Collector Site</td>
<td></td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wet well Level</td>
<td>AIN</td>
<td>PLC &amp; Enet modem</td>
<td>$40,000</td>
<td>$3,500</td>
</tr>
<tr>
<td></td>
<td>Pump 1 Run Status</td>
<td>DIN</td>
<td>bubbler/transmitter</td>
<td></td>
<td>$100</td>
</tr>
<tr>
<td></td>
<td>Pump 1 run command</td>
<td>DOUT</td>
<td>relay</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 2 Run Status</td>
<td>DIN</td>
<td>contact</td>
<td>$100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 2 run command</td>
<td>DOUT</td>
<td>relay</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow rate</td>
<td>AIN</td>
<td>mag meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combustible Gas Level</td>
<td>AIN</td>
<td>gas meter</td>
<td>$3,200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>H2S Level</td>
<td>AIN</td>
<td>gas meter</td>
<td>$3,200</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Subtotal</strong> $44,000</td>
<td><strong>$17,400</strong></td>
</tr>
<tr>
<td>West PRV</td>
<td>Data Collector Site</td>
<td></td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low side pressure</td>
<td>AIN</td>
<td>PLC &amp; Enet modem</td>
<td>$40,000</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>High Side pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td></td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Top PRV Flow rate</td>
<td>AIN</td>
<td>mag meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bottom PRV flow rate</td>
<td>AIN</td>
<td>mag meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low temperature</td>
<td>DIN</td>
<td>thermostat</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water on Floor</td>
<td>DIN</td>
<td>float switch</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Subtotal</strong> $44,000</td>
<td><strong>$17,400</strong></td>
</tr>
<tr>
<td>East PRV</td>
<td>Data Collector Site</td>
<td></td>
<td>Touch screen</td>
<td>$4,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low side pressure</td>
<td>AIN</td>
<td>PLC &amp; Enet modem</td>
<td>$40,000</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>High Side pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td></td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Top PRV Flow rate</td>
<td>AIN</td>
<td>mag meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bottom PRV flow rate</td>
<td>AIN</td>
<td>mag meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low temperature</td>
<td>DIN</td>
<td>thermostat</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water on Floor</td>
<td>DIN</td>
<td>float switch</td>
<td>$200</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Subtotal</strong> $44,000</td>
<td><strong>$17,400</strong></td>
</tr>
</tbody>
</table>
### TABLE 10-1. SCADA HARDWARE, SOFTWARE, AND COMPONENT ESTIMATED COSTS

**SUNDANCE MASTER PLAN LEVEL I**

**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

<table>
<thead>
<tr>
<th>Location</th>
<th>Component</th>
<th>Command</th>
<th>Device</th>
<th>Telemetry SCADA</th>
<th>Primary Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Near Pool PRV</strong></td>
<td>Data Collector Site</td>
<td>Touch screen PLC &amp; Enet modem</td>
<td>$4,000</td>
<td>$40,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low side pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Side pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow rate</td>
<td>AIN</td>
<td>mag meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flood alarm prv pit</td>
<td>DIN</td>
<td>float switch</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flood alarm meter pit</td>
<td>DIN</td>
<td>float switch</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td>$44,000</td>
<td>$10,400</td>
</tr>
<tr>
<td></td>
<td>Data Collector Site</td>
<td>Touch screen PLC &amp; Enet modem</td>
<td>$4,000</td>
<td>$40,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 1 Run Status</td>
<td>DIN</td>
<td>Contact</td>
<td>$100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 1Run Command</td>
<td>DOUT</td>
<td>relay</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 2 Run Status</td>
<td>DIN</td>
<td>Contact</td>
<td>$100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump 2 Run Command</td>
<td>DOUT</td>
<td>relay</td>
<td>$150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow rate</td>
<td>AIN</td>
<td>Mag meter</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suction Pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discharge Pressure</td>
<td>AIN</td>
<td>transmitter</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low Temperature</td>
<td>DIN</td>
<td>thermostat</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water on Floor</td>
<td>DIN</td>
<td>float switch</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td>$44,000</td>
<td>$10,900</td>
</tr>
<tr>
<td></td>
<td>Remote IO</td>
<td>AIN</td>
<td>IO radio Pair with solar Transmitter</td>
<td>$8,500</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Hatch open</td>
<td>DIN</td>
<td>Switch</td>
<td>$1,000</td>
<td></td>
</tr>
<tr>
<td><strong>Underground Reservoir 66K</strong></td>
<td></td>
<td></td>
<td></td>
<td>$8,500</td>
<td>$2,500</td>
</tr>
<tr>
<td></td>
<td>Remote IO</td>
<td>AIN</td>
<td>IO radio Pair with solar Transmitter</td>
<td>$8,500</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Hatch open</td>
<td>DIN</td>
<td>Switch</td>
<td>$1,000</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td>$8,500</td>
<td>$2,500</td>
</tr>
<tr>
<td></td>
<td>Remote IO</td>
<td>AIN</td>
<td>IO radio Pair with solar Transmitter</td>
<td>$8,500</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Hatch open</td>
<td>DIN</td>
<td>Switch</td>
<td>$1,000</td>
<td></td>
</tr>
<tr>
<td><strong>Policky Reservoir 100K 5059 HWL</strong></td>
<td></td>
<td></td>
<td></td>
<td>$8,500</td>
<td>$2,500</td>
</tr>
</tbody>
</table>
# TABLE 10-1. SCADA HARDWARE, SOFTWARE, AND COMPONENT ESTIMATED COSTS
## SUNDANCE MASTER PLAN LEVEL I
### WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Location</th>
<th>Component</th>
<th>Command</th>
<th>Device</th>
<th>Telemetry SCADA</th>
<th>Primary Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Moriah Reservoir 250K 4874.8 HWL</td>
<td>Remote IO</td>
<td>AIN</td>
<td>IO radio Pair with solar Transmitter</td>
<td>$8,500</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Level Hatch open</td>
<td>DIN</td>
<td>Switch</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Subtotal</td>
<td>$8,500</td>
<td>$2,500</td>
</tr>
<tr>
<td>Blue Tank 301K 4930 HWL</td>
<td>Remote IO</td>
<td>AIN</td>
<td>IO radio Pair with solar Transmitter</td>
<td>$8,500</td>
<td>$1,500</td>
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<tr>
<td></td>
<td>Level Hatch open</td>
<td>DIN</td>
<td>Switch</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Subtotal</td>
<td>$8,500</td>
<td>$2,500</td>
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<tr>
<td>Sundance Kid Reservoir 105K 4874.8 HWL</td>
<td>Remote IO</td>
<td>AIN</td>
<td>IO radio Pair with solar Transmitter</td>
<td>$8,500</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Level Hatch open</td>
<td>DIN</td>
<td>Switch</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Subtotal</td>
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<td>$2,500</td>
</tr>
<tr>
<td>Brewer Reservoir 40K 5225 HWL</td>
<td>Remote IO</td>
<td>AIN</td>
<td>IO radio Pair with solar Transmitter</td>
<td>$8,500</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Level Hatch open</td>
<td>DIN</td>
<td>Switch</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Subtotal</td>
<td>$8,500</td>
<td>$2,500</td>
</tr>
<tr>
<td>Canyon Reservoir 40K 5076 HWL</td>
<td>Remote IO</td>
<td>AIN</td>
<td>IO radio Pair with solar Transmitter</td>
<td>$8,500</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>Level Hatch open</td>
<td>DIN</td>
<td>Switch</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Subtotal</td>
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<tr>
<td>Cole Reservoir 275K 4952.5 HWL</td>
<td>Remote IO</td>
<td>AIN</td>
<td>IO radio Pair with solar Transmitter</td>
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<td>$1,500</td>
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<tr>
<td></td>
<td>Level Hatch open</td>
<td>DIN</td>
<td>Switch</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Subtotal</td>
<td>$8,500</td>
<td>$2,500</td>
</tr>
<tr>
<td>Location</td>
<td>Component</td>
<td>Command</td>
<td>Device</td>
<td>Telemetry SCADA</td>
<td>Primary Devices</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------</td>
<td>---------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>SCADA</td>
<td>Office PLC</td>
<td></td>
<td>Upgrade PLC</td>
<td>$5,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Office SCADA PC</td>
<td></td>
<td>PC</td>
<td>$3,500</td>
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</tr>
<tr>
<td></td>
<td>SCADA Software</td>
<td></td>
<td>$15,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PLC Programming Software</td>
<td></td>
<td>$4,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Communication</td>
<td></td>
<td>$4,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enet Modem</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subtotal  $32,500
Subtotals $584,500 $187,250

GRAND TOTAL $771,750

Notes:
DIN = Discrete input
DOUT = Discrete output
AIN = Analog input
AOUT = Analog output
<table>
<thead>
<tr>
<th>Priority</th>
<th>Recommendation</th>
<th>Construction Year Cost Estimate</th>
<th>Estimated Construction Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cole - Mt. Moriah Transmission Line</td>
<td>$1,147,300</td>
<td>2016</td>
</tr>
<tr>
<td>1a</td>
<td>Upgrade Canyon Pump Station replace 2 - 3 HP Pumps with 2 - 7.5 HP Pumps</td>
<td>$77,025</td>
<td>2018</td>
</tr>
<tr>
<td>2</td>
<td>East (Blue Tank) Pressure Zone Improvements (option to divide into 2 phases)</td>
<td>$2,051,865</td>
<td>2020/2022</td>
</tr>
<tr>
<td>3</td>
<td>Policky/Blue Pressure Zone Reconfiguration (remove PRV out of service - operational)</td>
<td>$0</td>
<td>2020</td>
</tr>
<tr>
<td>4</td>
<td>Policky/Blue Transmission</td>
<td>$1,579,960</td>
<td>2024</td>
</tr>
<tr>
<td>5</td>
<td>North Zone Backbone</td>
<td>$685,227</td>
<td>2026</td>
</tr>
<tr>
<td>6</td>
<td>South Zone Backbone</td>
<td>$608,336</td>
<td>2030</td>
</tr>
<tr>
<td>7</td>
<td>Sundance West Subdivision Improvements</td>
<td>$2,526,128</td>
<td>2032</td>
</tr>
</tbody>
</table>
TABLE 11-2. NON-STRUCTURAL IMPROVEMENT RECOMMENDATIONS
SUNDANCE MASTER PLAN LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Priority</th>
<th>Recommendation</th>
<th>Cost</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pull and inspect well pumps, video log four wells in the Cole well field - Level II study</td>
<td>$18,000</td>
<td>2014</td>
</tr>
<tr>
<td>2</td>
<td>Conduct 3-day pump test of Cole #3C well - Level II study</td>
<td>$25,000</td>
<td>2014</td>
</tr>
<tr>
<td></td>
<td>Develop a Well Head Protection Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide Back-up Power at City Wells</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Handheld GPS Data Collection (during maintenance activities - no cost)</td>
<td></td>
<td>immediate</td>
</tr>
<tr>
<td></td>
<td>Install a SCADA System (cost shown for full system, see table 10-1 for system component options)</td>
<td>$771,750</td>
<td>ongoing</td>
</tr>
<tr>
<td></td>
<td>Maintain and Update Water System Mapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planned Valve Exercising</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conduct Systematic Hydrant Flushing</td>
<td></td>
<td>annual</td>
</tr>
<tr>
<td></td>
<td>Conduct Annual Fire Hydrant Inspections</td>
<td></td>
<td>annual</td>
</tr>
<tr>
<td></td>
<td>Evaluate System Water Losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evaluate Meter Inaccuracies (rent Mag meter to perform testing)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Replace Older Residential Water Meters</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Install Automatic Sensors to Limit Workforce Involvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Implement a Payment Method for Construction Water Sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Develop a Maintenance Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Perform a Langlier Saturation Index water quality test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Implement System Security Measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Log Information in a Searchable Data Base (customer complaints, maintenance logs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Create Tools to Recognize System Trends</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Develop an Asset Management Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prepare a Stage 2 Disinfection By-Products Monitoring Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete Corrective Action for Deficiencies Identified in the 2011 EPA Sanitary Survey</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 12-1. PRIORITY 1: COLE TRANSMISSION LINE
SUNDANCE MASTER PLAN LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Pre-Construction Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td>Preparation of Final Designs and Specifications(^1)</td>
</tr>
<tr>
<td>Permitting and Mitigation</td>
</tr>
<tr>
<td>Legal Fees</td>
</tr>
<tr>
<td>Acquisition of Access and Rights of Way</td>
</tr>
<tr>
<td>Pre-Construction Costs (Subtotal #1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost of Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td>Item</td>
</tr>
<tr>
<td>Mobilization/Demobilization(^2)</td>
</tr>
<tr>
<td>8-inch PVC C900 Class 200 (DR14)</td>
</tr>
<tr>
<td>Removal of Pipe</td>
</tr>
<tr>
<td>Trench Excavation with Pavement</td>
</tr>
<tr>
<td>8-inch Gate Valve</td>
</tr>
<tr>
<td>Fire Hydrant</td>
</tr>
<tr>
<td>Connection to Tank</td>
</tr>
<tr>
<td>Total Component Cost (Subtotal #2)</td>
</tr>
</tbody>
</table>

| Construction Engineering Cost\(^3\)         |      |          |            | $74,733.78   |

| Components and Engineering Costs (Subtotal #3)|      |          |            | $822,071.58  |

| Contingency\(^4\)                           |      |          |            | $123,310.74  |

| Construction Cost Total (Subtotal #4)        |      |          |            | $945,382.32  |

| Total Project Cost (Present Cost) (Subtotal #1 + Subtotal #4) |      |          |            | $1,065,382.32|

| Total Project Cost With Inflation To Bid Date For Year 2016 (+3 Years @ 2.5%/YR)\(^5\) |      |          |            | $1,147,300.23|

Notes:
\(^1\) Assume 10% of Total Construction Cost
\(^2\) Assume 10% of component costs
\(^3\) Assume 10% of subtotal #2
\(^4\) Assume 15% of subtotal #3
\(^5\) Eligible for WWDC Funding
# TABLE 12-2. PRIORITY 1A: CANYON PUMP STATION UPGRADE
SUNDANCE MASTER PLAN LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

## Pre-Construction Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of Final Designs and Specifications³</td>
<td>$ 5,000.00</td>
</tr>
<tr>
<td>Permitting and Mitigation</td>
<td>$ 20,000.00</td>
</tr>
<tr>
<td>Legal Fees</td>
<td>$ 1,000.00</td>
</tr>
<tr>
<td>Acquisition of Access and Rights of Way</td>
<td>-</td>
</tr>
<tr>
<td>Pre-Construction Costs (Subtotal #1)</td>
<td>$ 26,000.00</td>
</tr>
</tbody>
</table>

## Cost of Components

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization/Demobilization²</td>
<td>LS</td>
<td>LUMP SUM</td>
<td>$ 3,024.00</td>
<td>$ 3,024.00</td>
</tr>
<tr>
<td>7.5HP Centrifugal pump³</td>
<td>LF</td>
<td>2</td>
<td>$ 7,620.00</td>
<td>$ 15,240.00</td>
</tr>
<tr>
<td>Pump Station Reconfiguration⁴</td>
<td>FT</td>
<td>1</td>
<td>$ 15,000.00</td>
<td>$ 15,000.00</td>
</tr>
<tr>
<td>Total Component Cost (Subtotal #2)</td>
<td></td>
<td></td>
<td></td>
<td>$ 33,264.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Engineering Cost³</td>
<td>$ 3,326.40</td>
</tr>
<tr>
<td>Components and Engineering Costs (Subtotal #3)</td>
<td>$ 36,590.40</td>
</tr>
<tr>
<td>Contingency³</td>
<td>$ 5,488.56</td>
</tr>
<tr>
<td>Construction Cost Total (Subtotal #4)</td>
<td>$ 42,078.96</td>
</tr>
<tr>
<td>Total Project Cost (Present Cost) (Subtotal #1 + Subtotal #4)</td>
<td>$ 68,078.96</td>
</tr>
<tr>
<td>Total Project Cost With Inflation To Bid Date For Year 2018 (+5 Years @ 2.5%/YR)⁷</td>
<td>$ 77,025.09</td>
</tr>
</tbody>
</table>

Notes:
- ¹Assume 10% of Total Construction Cost
- ²Assume 10% of component costs
- ³Assume 2% of component costs
- ⁴Assume 1% of component costs
- ⁵Assume 10% of subtotal #2
- ⁶Assume 15% of subtotal #3
- ⁷NOT eligible for WWDC funding
**TABLE 12-3. PRIORITY 2: EAST PRESSURE ZONE IMPROVEMENTS**

**SUNDANCE MASTER PLAN LEVEL I**

**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

### Pre-Construction Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of Final Designs and Specifications¹</td>
<td>$ 146,000.00</td>
</tr>
<tr>
<td>Permitting and Mitigation</td>
<td>$ 20,000.00</td>
</tr>
<tr>
<td>Legal Fees</td>
<td>$ 8,000.00</td>
</tr>
<tr>
<td>Acquisition of Access and Rights of Way</td>
<td>$ 15,000.00</td>
</tr>
<tr>
<td><strong>Pre-Construction Costs (Subtotal #1)</strong></td>
<td>$ 189,000.00</td>
</tr>
</tbody>
</table>

### Cost of Components

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization/Demobilization²</td>
<td>LS</td>
<td>LUMP SUM</td>
<td>$104,490.60</td>
<td>$104,490.60</td>
</tr>
<tr>
<td>10-inch PVC C900 Class 200 (DR14)</td>
<td>LF</td>
<td>6921</td>
<td>$32.00</td>
<td>$221,472.00</td>
</tr>
<tr>
<td>8-inch PVC C900 Class 200 (DR14)</td>
<td>LF</td>
<td>5059</td>
<td>$26.00</td>
<td>$131,534.00</td>
</tr>
<tr>
<td>Removal of Pipe</td>
<td>FT</td>
<td>6910</td>
<td>$10.00</td>
<td>$69,100.00</td>
</tr>
<tr>
<td>Trench Excavation with Pavement</td>
<td>FT</td>
<td>650</td>
<td>$55.00</td>
<td>$35,750.00</td>
</tr>
<tr>
<td>Trench Excavation without Pavement</td>
<td>FT</td>
<td>11330</td>
<td>$45.00</td>
<td>$509,850.00</td>
</tr>
<tr>
<td>10-inch Gate Valve</td>
<td>EA</td>
<td>16</td>
<td>$1,075.00</td>
<td>$17,200.00</td>
</tr>
<tr>
<td>Bore and Case Under I-90</td>
<td>LF</td>
<td>300</td>
<td>$200.00</td>
<td>$60,000.00</td>
</tr>
<tr>
<td><strong>Total Component Cost (Subtotal #2)</strong></td>
<td></td>
<td></td>
<td></td>
<td>$1,149,396.60</td>
</tr>
</tbody>
</table>

### Construction Engineering Cost³

| Components and Engineering Costs (Subtotal #3)| $ 1,264,336.26 |

### Contingency⁴

| Construction Cost Total (Subtotal #4)         | $ 1,453,986.70 |

### Total Project Cost (Present Cost) (Subtotal #1 + Subtotal #4)

| Total Project Cost With Inflation To Bid Date For Year 2022 (+9 Years @ 2.5%/YR)⁵ | $ 2,051,865.25 |

**Notes:**

¹Assume 10% of Total Construction Cost
²Assume 10% of component costs
³Assume 10% of subtotal #2
⁴Assume 15% of subtotal #3
⁵Eligible for WWDC Funding
<table>
<thead>
<tr>
<th>Pre-Construction Costs</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of Final Designs and Specifications¹</td>
<td>$ 108,000.00</td>
</tr>
<tr>
<td>Permitting and Mitigation</td>
<td>$ 20,000.00</td>
</tr>
<tr>
<td>Legal Fees</td>
<td>$ 6,000.00</td>
</tr>
<tr>
<td>Acquisition of Access and Rights of Way</td>
<td>$ -</td>
</tr>
<tr>
<td>Pre-Construction Costs (Subtotal #1)</td>
<td>$ 134,000.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost of Components</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Unit Quantity</td>
</tr>
<tr>
<td>Mobilization/Demobilization²</td>
<td>LS LUMP SUM</td>
</tr>
<tr>
<td>10-inch PVC C900 Class 200 (DR14)</td>
<td>LF 9909</td>
</tr>
<tr>
<td>Trench Excavation without Pavement</td>
<td>FT 9909</td>
</tr>
<tr>
<td>Connection to Tank</td>
<td>LS 1</td>
</tr>
<tr>
<td>10-inch Gate Valve</td>
<td>EA 1</td>
</tr>
<tr>
<td>Total Component Cost (Subtotal #2)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Construction Engineering Cost²</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Components and Engineering Costs (Subtotal #3)</td>
<td>$ 930,572.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contingency²</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Cost Total (Subtotal #4)</td>
<td>$ 1,070,158.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Project Cost (Present Cost) (Subtotal #1 + Subtotal #4)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Project Cost With Inflation To Bid Date For Year 2024 (+11 Years @ 2.5%/YR)⁵</td>
<td>$ 1,579,959.81</td>
</tr>
</tbody>
</table>

Notes:
¹Assume 10% of Total Construction Cost
²Assume 10% of component costs
³Assume 10% of subtotal #2
⁴Assume 15% of subtotal #3
⁵Eligible for WWDC Funding
### TABLE 12-5. PRIORITY 5: NORTH ZONE BACKBONE
SUNDANCE MASTER PLAN LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

#### Pre-Construction Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of Final Designs and Specifications</td>
<td>$44,000.00</td>
</tr>
<tr>
<td>Permitting and Mitigation</td>
<td>$20,000.00</td>
</tr>
<tr>
<td>Legal Fees</td>
<td>$3,000.00</td>
</tr>
<tr>
<td>Acquisition of Access and Rights of Way</td>
<td>-$</td>
</tr>
<tr>
<td><strong>Pre-Construction Costs (Subtotal #1)</strong></td>
<td>$67,000.00</td>
</tr>
</tbody>
</table>

#### Cost of Components

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization/Demobilization</td>
<td>LS</td>
<td>LUMP SUM</td>
<td>$30,907.50</td>
<td>$30,907.50</td>
</tr>
<tr>
<td>10-inch PVC C900 Class 200 (DR14)</td>
<td>LF</td>
<td>3865</td>
<td>$32.00</td>
<td>$123,680.00</td>
</tr>
<tr>
<td>Trench Excavation with Pavement</td>
<td>FT</td>
<td>932</td>
<td>$55.00</td>
<td>$51,260.00</td>
</tr>
<tr>
<td>Trench Excavation without Pavement</td>
<td>FT</td>
<td>2933</td>
<td>$45.00</td>
<td>$131,985.00</td>
</tr>
<tr>
<td>10-inch Gate Valve</td>
<td>EA</td>
<td>2</td>
<td>$1,075.00</td>
<td>$2,150.00</td>
</tr>
<tr>
<td><strong>Total Component Cost (Subtotal #2)</strong></td>
<td></td>
<td></td>
<td></td>
<td>$339,982.50</td>
</tr>
</tbody>
</table>

| Construction Engineering Cost                   |       |          |            | $33,998.25 |

| Components and Engineering Costs (Subtotal #3)  |       |          |            | $373,980.75|

| Contingency                                    |       |          |            | $56,097.11 |

| **Construction Cost Total (Subtotal #4)**       |       |          |            | $430,077.86|

| Total Project Cost (Present Cost) (Subtotal #1 + Subtotal #4) |       |          |            | $497,077.86 |

| **Total Project Cost With Inflation To Bid Date For Year 2026 (+13 Years @ 2.5%/YR)** |       |          |            | $685,227.32 |

Notes:

1. Assume 10% of Total Construction Cost
2. Assume 10% of component costs
3. Assume 10% of subtotal #2
4. Assume 15% of subtotal #3
5. Eligible for WWDC Funding
TABLE 12-6. PRIORITY 6: SOUTH ZONE BACKBONE  
SUNDANCE MASTER PLAN LEVEL I  
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of Final Designs and Specifications¹</td>
<td></td>
<td></td>
<td></td>
<td>$33,000.00</td>
</tr>
<tr>
<td>Permitting and Mitigation</td>
<td></td>
<td></td>
<td></td>
<td>$20,000.00</td>
</tr>
<tr>
<td>Legal Fees</td>
<td></td>
<td></td>
<td></td>
<td>$2,000.00</td>
</tr>
<tr>
<td>Acquisition of Access and Rights of Way</td>
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<td></td>
<td></td>
<td>$15,000.00</td>
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<tr>
<td><strong>Pre-Construction Costs (Subtotal #1)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$70,000.00</strong></td>
</tr>
</tbody>
</table>

**Pre-Construction Costs**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization/Demobilization²</td>
<td>LS</td>
<td>LUMP SUM</td>
<td>$23,700.70</td>
<td>$23,700.70</td>
</tr>
<tr>
<td>10-inch PVC C900 Class 200 (DR14)</td>
<td>LF</td>
<td>2061</td>
<td>$32.00</td>
<td>$65,952.00</td>
</tr>
<tr>
<td>Trench Excavation with Pavement</td>
<td>FT</td>
<td>1201</td>
<td>$55.00</td>
<td>$66,055.00</td>
</tr>
<tr>
<td>Trench Excavation without Pavement</td>
<td>FT</td>
<td>460</td>
<td>$45.00</td>
<td>$20,700.00</td>
</tr>
<tr>
<td>10-inch Gate Valve</td>
<td>EA</td>
<td>4</td>
<td>$1,075.00</td>
<td>$4,300.00</td>
</tr>
<tr>
<td>Bore and Case Under I-90</td>
<td>LF</td>
<td>400</td>
<td>$200.00</td>
<td>$80,000.00</td>
</tr>
<tr>
<td><strong>Total Component Cost (Subtotal #2)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$260,707.70</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Engineering Cost³</td>
<td></td>
<td></td>
<td></td>
<td>$286,778.47</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingency²</td>
<td></td>
<td></td>
<td></td>
<td>$43,016.77</td>
</tr>
<tr>
<td><strong>Construction Cost Total (Subtotal #4)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$329,795.24</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Project Cost (Present Cost) (Subtotal #1 + Subtotal #4)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$399,795.24</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Project Cost With Inflation To Bid Date For Year 2030 (+17 Years @ 2.5%/YR)⁵</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$608,335.74</strong></td>
</tr>
</tbody>
</table>

Notes:
¹Assume 10% of Total Construction Cost
²Assume 10% of component costs
³Assume 10% of subtotal #2
⁴Assume 15% of subtotal #3
⁵Eligible for WWDC Funding
## TABLE 12-7. PRIORITY 7: SUNDANCE WEST IMPROVEMENTS

**SUNDANCE MASTER PLAN LEVEL I**

**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

### Pre-Construction Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of Final Designs and Specifications(^1)</td>
<td>$136,000.00</td>
</tr>
<tr>
<td>Permitting and Mitigation</td>
<td>$20,000.00</td>
</tr>
<tr>
<td>Legal Fees</td>
<td>$7,000.00</td>
</tr>
<tr>
<td>Acquisition of Access and Rights of Way</td>
<td>$24,000.00</td>
</tr>
<tr>
<td><strong>Pre-Construction Costs (Subtotal #1)</strong></td>
<td><strong>$187,000.00</strong></td>
</tr>
</tbody>
</table>

### Cost of Components

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization/Demobilization(^2)</td>
<td>LS</td>
<td>LUMP SUM</td>
<td>$97,349.80</td>
<td>$97,349.80</td>
</tr>
<tr>
<td>8-inch PVC C900 Class 200 (DR14)</td>
<td>LF</td>
<td>12499</td>
<td>$32.00</td>
<td>$399,968.00</td>
</tr>
<tr>
<td>Trench Excavation with Pavement</td>
<td>CY</td>
<td>12499</td>
<td>$45.00</td>
<td>$562,455.00</td>
</tr>
<tr>
<td>8-inch Gate Valve</td>
<td>EA</td>
<td>2</td>
<td>$5,000.00</td>
<td>$10,000.00</td>
</tr>
<tr>
<td>Connection to Tank</td>
<td>LS</td>
<td>1</td>
<td>$1,075.00</td>
<td>$1,075.00</td>
</tr>
<tr>
<td><strong>Total Component Cost (Subtotal #2)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$1,070,847.80</strong></td>
</tr>
<tr>
<td>Construction Engineering Cost(^3)</td>
<td></td>
<td></td>
<td></td>
<td>$107,084.78</td>
</tr>
<tr>
<td><strong>Components and Engineering Costs (Subtotal #3)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$1,177,932.58</strong></td>
</tr>
<tr>
<td>Contingency(^4)</td>
<td></td>
<td></td>
<td></td>
<td>$176,689.89</td>
</tr>
<tr>
<td><strong>Construction Cost Total (Subtotal #4)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$1,354,622.47</strong></td>
</tr>
<tr>
<td><strong>Total Project Cost (Present Cost) (Subtotal #1 + Subtotal #4)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$1,541,622.47</strong></td>
</tr>
<tr>
<td><strong>Total Project Cost With Inflation To Bid Date For Year 2033 (+20 Years @ 2.5%/YR)(^5)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$2,526,127.92</strong></td>
</tr>
</tbody>
</table>

### Notes:

\(^1\) Assume 10% of Total Construction Cost  
\(^2\) Assume 10% of component costs  
\(^3\) Assume 10% of subtotal #2  
\(^4\) Assume 15% of subtotal #3  
\(^5\) Eligible for WWDC Funding
<table>
<thead>
<tr>
<th></th>
<th>2007-08</th>
<th>2008-09</th>
<th>2009-10</th>
<th>2010-11</th>
<th>2011-12</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenue</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Sales</td>
<td>211.8</td>
<td>192.0</td>
<td>222.9</td>
<td>251.5</td>
<td>286.8</td>
<td>233.0</td>
</tr>
<tr>
<td>Interest</td>
<td>2.2</td>
<td>2.4</td>
<td>2.1</td>
<td>0.8</td>
<td>0.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Grants/Loans</td>
<td>127.2</td>
<td>260.5</td>
<td>611.8</td>
<td>347.1</td>
<td>1.3</td>
<td>n/a</td>
</tr>
<tr>
<td>Totals</td>
<td>368.3</td>
<td>471.1</td>
<td>874.7</td>
<td>625.6</td>
<td>312.2</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Expenses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations, Maintenance, &amp; Administration</td>
<td>154.5</td>
<td>155.4</td>
<td>139.8</td>
<td>174.4</td>
<td>197.1</td>
<td>164.2</td>
</tr>
<tr>
<td>Capital Replacement</td>
<td>35.1</td>
<td>99.8</td>
<td>19.8</td>
<td>33.0</td>
<td>28.6</td>
<td>43.3</td>
</tr>
<tr>
<td>Capital Projects</td>
<td>127.2</td>
<td>288.9</td>
<td>731.8</td>
<td>390.6</td>
<td>48.2</td>
<td>317.3</td>
</tr>
<tr>
<td>Debt Service</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>28.2</td>
<td>n/a</td>
</tr>
<tr>
<td>Sewer Enterprise Fund Loan</td>
<td>-</td>
<td>-</td>
<td>50.0</td>
<td>-</td>
<td>50.0</td>
<td>n/a</td>
</tr>
<tr>
<td>Totals</td>
<td>316.8</td>
<td>544.1</td>
<td>941.4</td>
<td>598.0</td>
<td>352.1</td>
<td>550.5</td>
</tr>
<tr>
<td>Difference</td>
<td>51.5</td>
<td>(73.0)</td>
<td>(66.7)</td>
<td>27.6</td>
<td>(39.9)</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

Water sales were determined from the actual water use billed plus the monthly minimum.
TABLE 13-2. TEST YEAR (FIVE YEAR AVERAGE HISTORICAL REVENUE AND EXPENSES) WITH CURRENT RATE PROJECTIONS AND NO ADDITIONAL CAPITAL IMPROVEMENT

SUNDANCE MASTER PLAN LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Revenue</th>
<th>Test Year</th>
<th>2012-13</th>
<th>2013-14</th>
<th>2014-15</th>
<th>2015-16</th>
<th>2016-17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Sales</td>
<td>286.8</td>
<td>301.1</td>
<td>316.2</td>
<td>332.0</td>
<td>348.6</td>
<td>366.0</td>
</tr>
<tr>
<td>Interest</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Grants/Loans</td>
<td>1.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>288.4</td>
<td>302.7</td>
<td>317.8</td>
<td>333.6</td>
<td>350.2</td>
<td>367.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expenses</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations, Maintenance, &amp; Admin.</td>
<td>164.2</td>
<td>172.6</td>
<td>181.2</td>
<td>190.3</td>
<td>199.8</td>
<td>209.8</td>
</tr>
<tr>
<td>Capital Replacement</td>
<td>43.3</td>
<td>45.5</td>
<td>47.7</td>
<td>50.1</td>
<td>52.6</td>
<td>55.3</td>
</tr>
<tr>
<td>Debt Service</td>
<td>16.6</td>
<td>16.6</td>
<td>16.6</td>
<td>16.6</td>
<td>16.6</td>
<td>16.6</td>
</tr>
<tr>
<td>Reserves</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sewer Enterprise Fund Loan</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>224.1</td>
<td>234.7</td>
<td>245.5</td>
<td>257.0</td>
<td>269.0</td>
<td>281.7</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>64.3</td>
<td>68.0</td>
<td>72.3</td>
<td>76.6</td>
<td>81.2</td>
<td>85.9</td>
</tr>
</tbody>
</table>

Notes:
Water sales was determined from the actual water use billed plus the monthly minimum
Revenue projections are based upon $11.60 monthly minimum, $4.45 per thousand gallons after first 1000 gallons
It is assumed there will be no new capital improvement projects during this projection, therefore a Capital Projects line item expense is not included.

1) 1% Growth + 4% inflation
2) 0.2% inflation
3) 5% inflation
4) No inflation increase
5) Reserves are held as combined cash fund; in FY 2012 this amount was $243,550. Annual minimum combined reserve for the water fund is $59,800.
### TABLE 13-3. MONTHLY RESIDENTIAL BILL COMPARISON
SUNDANCE MASTER PLAN LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Monthly Use, Gal</th>
<th>Existing Structure</th>
<th>Suggested Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
<td>$11.60</td>
<td>$26.35</td>
</tr>
<tr>
<td>2,000</td>
<td>$16.05</td>
<td>$26.35</td>
</tr>
<tr>
<td>3,000</td>
<td>$20.50</td>
<td>$26.35</td>
</tr>
<tr>
<td>4,000</td>
<td>$24.95</td>
<td>$26.35</td>
</tr>
<tr>
<td>7,000</td>
<td>$38.30</td>
<td>$33.85</td>
</tr>
<tr>
<td>9,000</td>
<td>$47.20</td>
<td>$38.85</td>
</tr>
<tr>
<td>20,000</td>
<td>$96.15</td>
<td>$66.35</td>
</tr>
<tr>
<td>28,000</td>
<td>$131.75</td>
<td>$86.35</td>
</tr>
<tr>
<td>42,000</td>
<td>$194.05</td>
<td>$121.35</td>
</tr>
<tr>
<td>80,000</td>
<td>$363.15</td>
<td>$216.35</td>
</tr>
<tr>
<td>120,000</td>
<td>$541.15</td>
<td>$316.35</td>
</tr>
</tbody>
</table>

Notes:

1 Monthly minimum is $11.60, includes 1,000 gal; Commodity rate is $4.45
2 Monthly minimum is $26.35, includes 4,000 gal; Commodity rate is $2.50
**TABLE 13-4. EXISTING WATER RATE STRUCTURE**
**SUNDANCE MASTER PLAN LEVEL I**
**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

<table>
<thead>
<tr>
<th>Year</th>
<th>Monthly Min. Charge</th>
<th>Commodity Charge</th>
<th>Water Bill for 1,000 gal</th>
<th>Water Bill for 6,300 gal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>$11.60</td>
<td>$4.45</td>
<td>$11.60</td>
<td>$33.85</td>
</tr>
<tr>
<td>2013</td>
<td>$13.05</td>
<td>$5.00</td>
<td>$13.05</td>
<td>$38.05</td>
</tr>
<tr>
<td>2014</td>
<td>$14.10</td>
<td>$5.40</td>
<td>$14.10</td>
<td>$41.10</td>
</tr>
<tr>
<td>2015</td>
<td>$15.30</td>
<td>$5.85</td>
<td>$15.30</td>
<td>$44.55</td>
</tr>
<tr>
<td>2016</td>
<td>$16.55</td>
<td>$6.35</td>
<td>$16.55</td>
<td>$48.30</td>
</tr>
<tr>
<td>2017</td>
<td>$17.90</td>
<td>$6.85</td>
<td>$17.90</td>
<td>$52.15</td>
</tr>
<tr>
<td>2018</td>
<td>$19.35</td>
<td>$7.40</td>
<td>$19.35</td>
<td>$56.35</td>
</tr>
<tr>
<td>2019</td>
<td>$21.00</td>
<td>$8.05</td>
<td>$21.00</td>
<td>$61.25</td>
</tr>
<tr>
<td>2020</td>
<td>$22.65</td>
<td>$8.70</td>
<td>$22.65</td>
<td>$66.15</td>
</tr>
<tr>
<td>2021</td>
<td>$24.50</td>
<td>$9.40</td>
<td>$24.50</td>
<td>$71.50</td>
</tr>
</tbody>
</table>

Notes
1. Max. allowable water bill = 2.5% of median annual income = $103.66
2. Existing water rate structure includes 1,000 gallons of use in the monthly minimum charge
3. The water bill for 1,000 gallons represents the largest percentage of system users
4. The water bill for 6,300 gallons represents the average bill per the Brown Study
## TABLE 13-5. FUNDING MATRIX
SUNDANCE MASTER PLAN LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Source Program</th>
<th>Water Distribution</th>
<th>Water Treatment</th>
<th>Water Transmission</th>
<th>Raw Water Sources &amp; Intakes</th>
<th>Wells, Pumps &amp; Control</th>
<th>Water Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wyoming Water Development</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Drinking Water State Revolving Fund</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mineral Royalty Grant</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Joint Powers Act</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Business Ready Communities Grant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Communities Development Block</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>USDA Rural Development Water and</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
### TABLE 13-6. FUNDING SCENARIO 1 - WWDC FUNDING ONLY
SUNDANCE MASTER PLAN LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

<table>
<thead>
<tr>
<th>Proposed Projects</th>
<th>WWDC Funding</th>
<th>City's Financial Obligation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Construction Year Cost Estimate</td>
<td>WWDC Grant Funding (67%)</td>
</tr>
<tr>
<td><strong>Year</strong></td>
<td><strong>Project Recommendation</strong></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>Cole Transmission</td>
<td>$1,147,300</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>Canyon Pump Station</td>
<td>$77,025</td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>East Zone</td>
<td>$2,051,865</td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td>Policky/Blue Transmission</td>
<td>$1,579,960</td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2026</td>
<td>North Backbone</td>
<td>$685,227</td>
</tr>
<tr>
<td>2027</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2028</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2029</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>South Backbone</td>
<td>$608,336</td>
</tr>
<tr>
<td>2031</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2032</td>
<td>Sundance West</td>
<td>$2,526,128</td>
</tr>
</tbody>
</table>

**Notes**

1. Canyon Pump Station project not eligible for WWDC Funding; assume the City will pay for it from reserves
2. City's annual payment costs assume WWDC loan financing of 4% interest for 20 years
3. * The water rate structure cannot support this project without subsidy; suggest $5 per user per month surcharge
### TABLE 13-7. FUNDING SCENARIO 2 - WWDC FUNDING PLUS FEDERAL LOANS

**SUNDANCE MASTER PLAN LEVEL I**

**WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING**

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Recommendation</th>
<th>Construction Year Cost Estimate</th>
<th>WWDC Funding</th>
<th>WWDC Loan Funding (33%)</th>
<th>RUS/DWSRF Funding (50% of WWDC Loan)</th>
<th>RUS/DWSRF Local Match (50%)</th>
<th>City's Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>Cole Transmission</td>
<td>$1,147,300</td>
<td>$768,691</td>
<td>$378,609</td>
<td>$189,305</td>
<td>$94,652</td>
<td>$77,025</td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>Canyon Pump Station</td>
<td>$77,025</td>
<td>$0</td>
<td>$0</td>
<td>$77,025</td>
<td>$38,513</td>
<td>$38,513</td>
</tr>
<tr>
<td>2019</td>
<td>East Zone</td>
<td>$2,051,865</td>
<td>$1,374,730</td>
<td>$677,115</td>
<td>$338,558</td>
<td>$169,279</td>
<td>$77,115</td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td>Policky/Blue Transmission</td>
<td>$1,679,660</td>
<td>$1,058,573</td>
<td>$521,387</td>
<td>$260,893</td>
<td>$130,347</td>
<td>$521,387</td>
</tr>
<tr>
<td>2025</td>
<td>North Backbone</td>
<td>$685,227</td>
<td>$459,102</td>
<td>$226,125</td>
<td>$113,062</td>
<td>$55,531</td>
<td>$226,125</td>
</tr>
<tr>
<td>2026</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2027</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2028</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2029</td>
<td>South Backbone</td>
<td>$608,336</td>
<td>$407,585</td>
<td>$200,751</td>
<td>$100,375</td>
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<td>$200,751</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2031</td>
<td>Sundance West</td>
<td>$2,528,128</td>
<td>$1,692,506</td>
<td>$833,622</td>
<td>$416,811</td>
<td>$208,406</td>
<td>$208,406</td>
</tr>
<tr>
<td>2032</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes**
1. Canyon Pump Station project not eligible for WWDC Funding
2. WWDC loan financing assumes 4% interest for 20 years
3. RUS/DWSRF Loan financing assumes 2.5% interest for 20 years
4. Local match assumes bond issue at 4% for 30 years
5. Assume O&M + Capital Replacement inflate at 5% annually
6. Assume water use increases proportionally to growth
7. Water rates have been adjusted from the City's existing structure to help offset the increase in debt service.
8. * The water rate structure cannot support this project without subsidy; suggest $5 per user per month surcharge
### Table 13-8: Funding Scenario 3 - WWDC Funding Plus 1% County Sales Tax and DWSRF Loan Funding

**Sundance Master Plan Level I**

**Wyoming Water Development Commission, Crook County, Wyoming**

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Recommendation</th>
<th>Construction Year Cost Estimate</th>
<th>WWDC Grant Funding (67%)</th>
<th>WWDC Loan Funding (33%)</th>
<th>County 1% Sales Tax Funding &amp; DWSRF</th>
<th>DWSRF Funding (50% of WWDC Loan)</th>
<th>DWSRF Loan (100%)</th>
<th>City's Contribution</th>
<th>City's Annual Payment (Per Project)</th>
<th>Debt Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td></td>
<td>$1,147,300</td>
<td>$1,147,300</td>
<td>$678,691</td>
<td>$378,609</td>
<td>$0</td>
<td>$0</td>
<td>$78,609</td>
<td>$0</td>
<td>$16,600</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>Cole Transmission</td>
<td>$1,147,300</td>
<td>$768,691</td>
<td>$378,609</td>
<td>$300,000</td>
<td>$0</td>
<td>$0</td>
<td>$78,609</td>
<td>$0</td>
<td>$16,600</td>
</tr>
<tr>
<td>2017</td>
<td>Canyon Pump Station</td>
<td>$77,025</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$77,025</td>
<td>$77,025</td>
<td>$4,698</td>
<td>$21,298</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>East Zone</td>
<td>$2,051,865</td>
<td>$1,374,750</td>
<td>$677,115</td>
<td>$0</td>
<td>$338,558</td>
<td>$338,558</td>
<td>$677,115</td>
<td>$46,830</td>
<td>$67,928</td>
</tr>
<tr>
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<td>$833,622</td>
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**Notes**

1. Canyon Pump Station project not eligible for WWDC Funding.
2. WWDC loan financing assumes 4% interest for 20 years.
3. Assume 1/2 loan WWDC & 1/2 loan DWSRF at 2.5% for 20 years.
4. Assume O&M + Capital Replacement inflates at 5% annually.
5. Assume water use increases proportionally to growth.
6. The water rate structure cannot support this project without subsidy; suggest $5 per user per month surcharge.
FIGURES
FIGURE 5-1 APPROXIMATE CITY ZONING AND WATER SERVICE AREA SUNDANCE MASTER PLAN LEVEL I WYOMING WATER DEVELOPMENT COMMISSION CROOK COUNTY, WYOMING

DEVELOPED LOT OUTSIDE CORPORATE LIMITS WITHIN WATER SERVICE AREA
PARCEL BOUNDARY
CORPORATE LIMITS
EXISTING WATER MAIN

EXPLANATION
MHP - MOBILE HOME AND TRAVEL TRAILER PARK
GS - GREEN SPACE
GB - GENERAL BUSINESS
HB - HIGHWAY BUSINESS
I - INDUSTRIAL
LDR - LOW DENSITY RESIDENTIAL
HDR - HIGH DENSITY RESIDENTIAL

Trihydro CORPORATION
1862 Carambola Drive
Laramie, WY 82070
www.trihydro.com
(307) 745-7474 (FAX) 745-7729

Drawn By: JDF  Checked By: KG  Date: 8/13/13  File: SundanceZoning1.mxd
FIGURE 5-2 FUTURE DEVELOPMENT AREAS SUNDANCE MASTER PLAN LEVEL I WYOMING WATER DEVELOPMENT COMMISSION CROOK COUNTY, WYOMING

EXPLANATION

CORPORATE LIMITS
EXISTING WATER MAIN
DEVELOPED LAND WITHIN WATER SERVICE AREA

ZONING ABBREVIATIONS:
MHP = MOBILE HOME PARK AND TRAVEL TRAILER PARK
GB = GENERAL BUSINESS
HB = HIGHWAY BUSINESS
GS = GREEN SPACE
I = INDUSTRIAL
LDR = LOW DENSITY RESIDENTIAL
HDR = HIGH DENSITY RESIDENTIAL

1 " = 2,250 '

# = REFER TO TABLES 4-13 FOR PROPERTY DESCRIPTIONS
FIGURE 6-3

POLICKY-BLUE TRANSMISSION
SUNDANCE MASTER PLAN LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION
CROOK COUNTY, WYOMING

EXPLANATION

EXISTING 2" WATER LINE
EXISTING 4" WATER LINE
EXISTING 6" WATER LINE
EXISTING 8" WATER LINE
EXISTING 10" WATER LINE
EXISTING 12" WATER LINE
EXISTING WATER LINE UNKNOWN SIZE
EXISTING LOT LINES

CITY LIMITS
SECTION LINES
EXISTING 2" WATER LINE
EXISTING 4" WATER LINE
EXISTING 6" WATER LINE
EXISTING 8" WATER LINE
EXISTING 10" WATER LINE
EXISTING 12" WATER LINE
EXISTING WATER LINE UNKNOWN SIZE
EXISTING LOT LINES

POLICKY AND BLUE TRANSMISSION PROJECT

POLICKY-BLUE TRANSMISSION
SUNDANCE MASTER PLAN LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION
CROOK COUNTY, WYOMING

FIGURE 6-3

POLICKY-BLUE TRANSMISSION
SUNDANCE MASTER PLAN LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION
CROOK COUNTY, WYOMING

POLICKY-BLUE TRANSMISSION
SUNDANCE MASTER PLAN LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION
CROOK COUNTY, WYOMING

POLICKY-BLUE TRANSMISSION
SUNDANCE MASTER PLAN LEVEL I

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CROOK COUNTY, WYOMING

POLICKY-BLUE TRANSMISSION
SUNDANCE MASTER PLAN LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION
CROOK COUNTY, WYOMING
FIGURE 8-1. CITY OF SUNDANCE
DISTRIBUTION SYSTEM CHLORINE RESIDUAL READINGS, 2008-2012
SUNDANCE MASTER PLAN LEVEL I, WYOMING WATER DEVELOPMENT COMMISSION, CROOK COUNTY, WYOMING

Number of Readings

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North Pressure Zone

South Pressure Zone