CEDAR KNOX RURAL WATER PROJECT

WATER SYSTEM ANALYSIS

AND

DEVELOPMENT PLAN

PREPARED FOR:

LEWIS & CLARK NRD NATURAL RESOURCES DISTRICT

PREPARED BY:

Bartlett & West

Driving Community and Industry Forward, Together.

1200 SW EXECUTIVE DRIVE

TOPEKA, KS 6615

P.N. 19242.300

DECEMBER 2021

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PROFESSIONAL CIVIL ENGINEER
JOHN A. RUCKMAN
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12-3-21
STATE OF NEBRASKA

P.N. 19242.300

DECEMBER 2021

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1.0 GENERAL

Every business needs a plan to effectively guide investment decisions. Rural Water Systems are no different than any other business in this regard. Bartlett & West is pleased to have the opportunity to assist Cedar Knox Rural Water Project (CKRWP) in the development of a long-range growth plan. As part of our services to the CKRWP, we have created a hydraulic model of the water system and analyzed the deficiencies that currently exist and are likely to exist in the future. The purpose of this analysis was to establish a plan that will serve as a guide for the future. Phased improvements are outlined and correlated to growth projections.

CKRWP serves just north of 1,000 customers in Cedar and Knox County. The District operates and maintains a water treatment plant that utilizes Lewis & Clark Lake as the water source.

The water supply system is divided into four hydraulic service areas. There are three (3) ground storage tanks and one (1) standpipe that provide storage within the system. The fourth service area is provided an elevated hydraulic grade line through a booster pump station that meets instantaneous demands. The west tanks are filled by the high-service pumps from the water treatment plant. The remaining storage tanks are filled by in-line booster pump stations.

A hydraulic model was used to analyze the current system as well as projected demands in five-year increments over the next fifteen years. Improvements are noted and modeled as appropriate over that span. Cost estimates are provided for each proposed improvement.

This planning document should be used by the CKRWP to address current deficiencies and financially plan for the future. The specific design of each project identified in this report should be re-evaluated prior to construction. The CKRWP should understand that the recommended improvements are directly related to growth projections established during the analysis, and that actual future growth of the system may not follow the projected growth. A review of the CKRWP's growth and of the hydraulics of the system should be conducted at least every five years to determine if revisions to this report are necessary.

2.0 WATER USE SUMMARY

2.1 Existing Demand

Water demand criteria are necessary to accurately develop a hydraulic model of any water system. The criteria used in the analysis of Cedar-Knox RWP were determined using water usage data from 2011 through 2017. Cedar-Knox RWP provided monthly usage data for these years, and the annual data is summarized below in Table 2-1.

Table 2-1. Historical Water Use Data

Year	Total Produced (MG)	Community Usage (MG)	High Demand Usage (MG)	Residential/ Rural Usage (MG)	Total Meters	Active Meters	Average Daily Use (GPD)	Water Loss (%)
2011	110.9	29.9	27.3	33.1	796	562	242	18.7%
2012	146.6	40.2	42.9	37.0	804	587	276	18.2%
2013	128.5	35.3	34.4	33.4	824	587	251	19.9%
2014	122.5	33.1	32.9	32.8	838	592	239	19.4%
2015	134.9	37.5	37.3	33.8	854	609	247	19.6%
2016	137.4	37.3	37.5	34.3	869	617	251	20.7%
2017	138.9	37.5	32.2	34.9	884	625	269	24.7%
AVG	**131.4**	**35.8**	**34.9**	**34.2**	**838**	**597**	**254**	**20.2%**

A basic design parameter used in hydraulic analysis is average daily use (ADU). This value is found by dividing the total number of gallons produced by the water system by the number of residential customers served by the system. To determine a more accurate value for the ADU of a "typical" customer, it is necessary to account for the high demand users in the system separately. For the purposes of this study, customers whose monthly usage was greater than 27,000 gallons were considered high demand users.

Cedar-Knox RWP served an average of 36 customers during 2017 that satisfied the high usage criteria. The combined average monthly usage for these high demand users was just over 2.9 million gallons, which equates to roughly 50% of the total usage for all customers. As you would expect, this high quantity of water can inaccurately skew design criteria for an average residential customer in the system. Removing the high-use customers and the nearly 250 inactive customers, the average daily usage for a typical residential customer was calculated. It should also be noted that the ADU also includes water losses, which is assumed to be distributed evenly amongst all customers in the model. The water loss has historically been near 20% over the study period.

Another important parameter used to accurately model a system is the peak day factor. Peak days can severely test the System's supply capacity. To model a system under extreme conditions, a peak day demand is imposed on the system. The peak day factor is used to convert the average day demands to peak day demands. The peaking factor for a system is determined by dividing the peak day by the average annual day. Table 2-2 summarizes the peak day, annual average day, and peaking factor for the years 2011 through 2015.

Table 2-2. Peak Factors, 2011-2015

Year	Peak Day (GPD)	Average Day (GPD)	Peaking Factor
2011	600,000	303,951	1.98
2012	869,000	401,619	2.17
2013	701,000	352,140	2.00
2014	611,000	335,485	1.83
2015	699,000	369,649	1.90
AVG	**696,000**	**352,569**	**1.98**

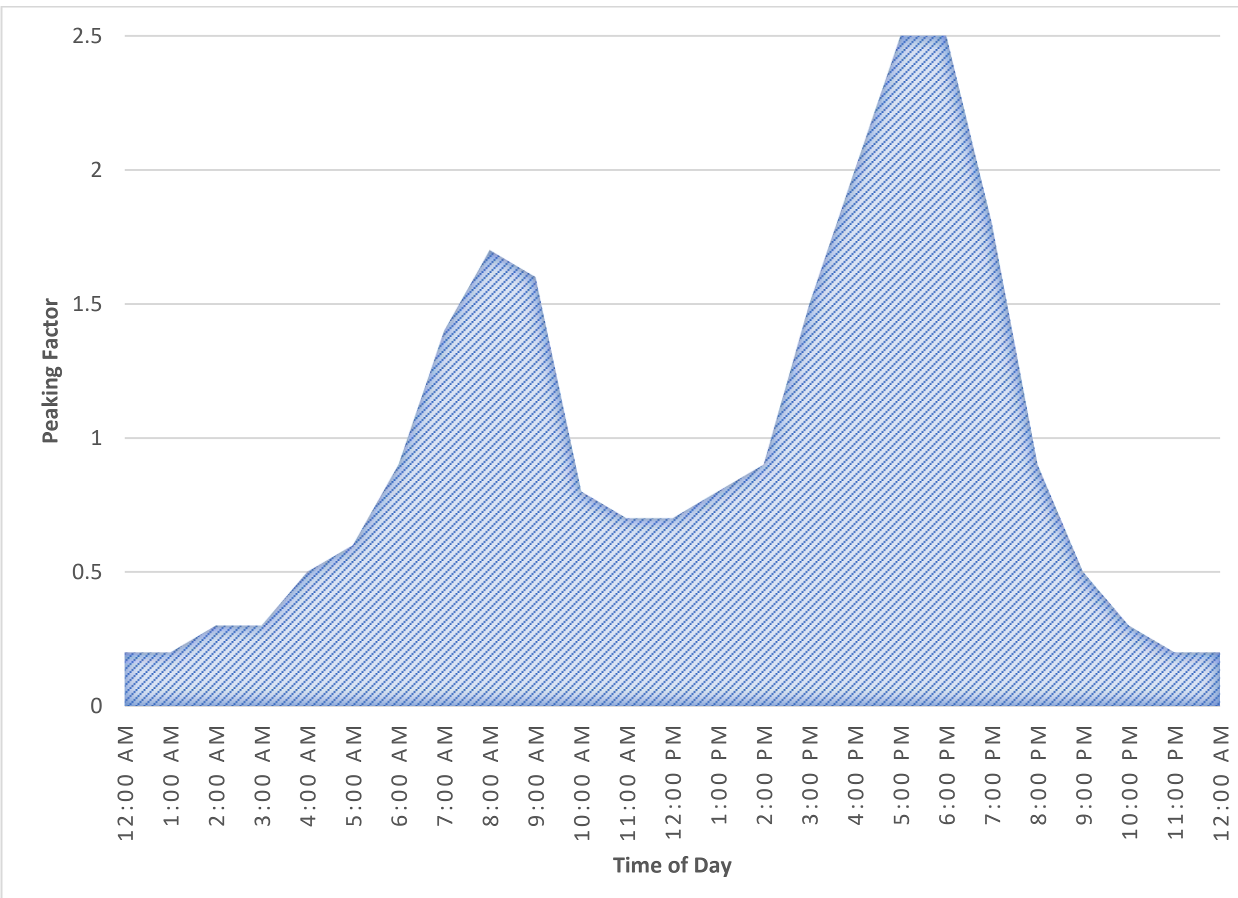
With the exception of 2012, the peaking factors range from 1.83 to 2.00. The usage during 2012 was impacted by an extremely dry year and CKRWP had a construction contractor purchasing water during the summer period. Typical peaking factors are 1.9 to 2.0. For projecting water usage, a peaking factor of 2.0 will be used.

Table 2-3. Design Criteria

Average Day Use	250 gallons per customer
Peak Day Use	500 gallons per customer

Consideration must also be given to the variation in demand over the course of a 24-hour period. Obviously, variations in demand change from day to day, but a typical pattern, such as the one shown in Figure 2-1, is often used to model the variation in demand of a rural water system during an average day. The demand for a given hour is calculated by multiplying the average hourly usage by the respective peaking factor. A larger peaking factor represents a greater demand. Consequently, the greatest demand on a system occurs during the peak hour of the peak day.

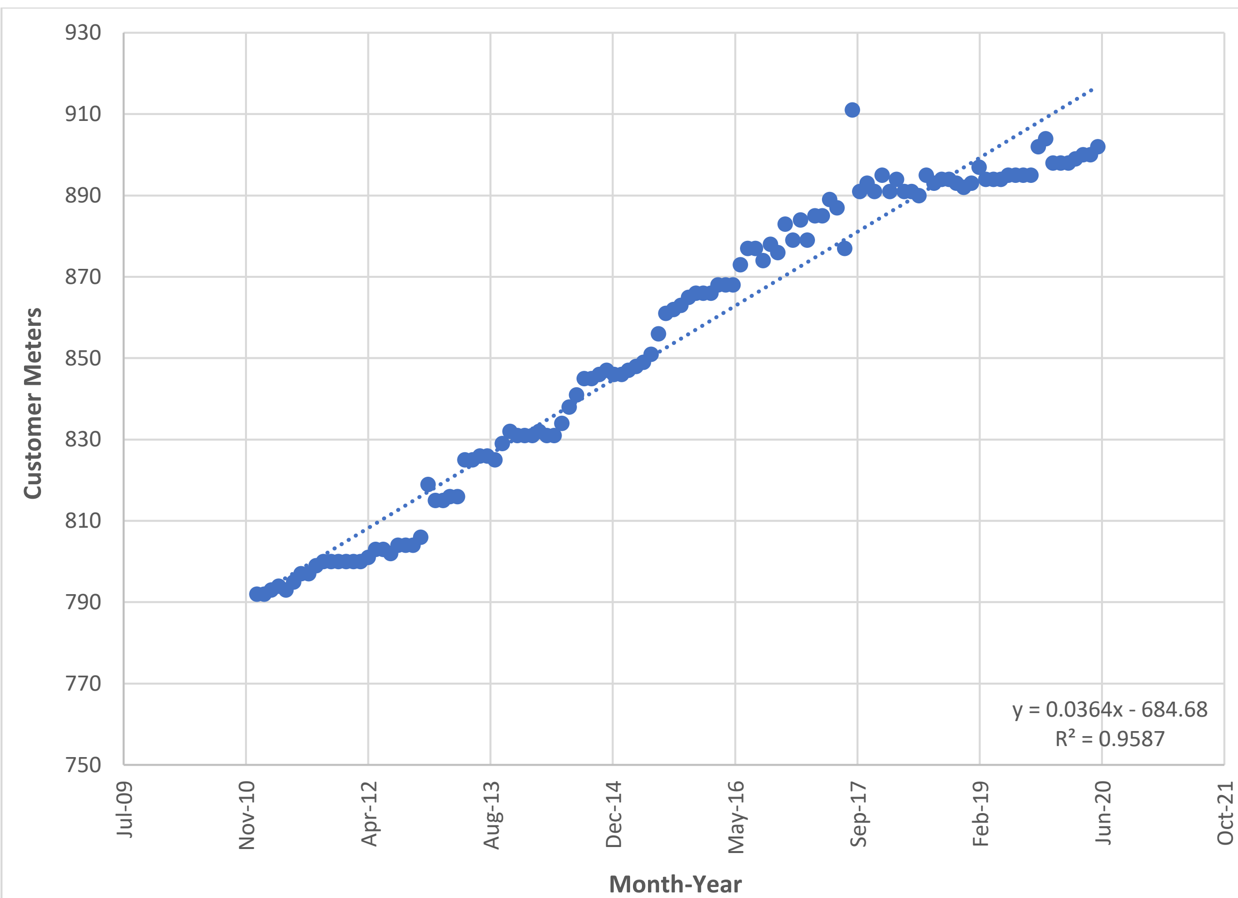
Figure 2-1. Typical Daily Demand Variations



2.2 Future Demand Projections

Population growth is typically projected in one of two ways: linear projection or curvilinear projection. Linear projections are based on a constant population increase from year to year. Curvilinear projections, on the other hand, are often based on an increase in population by a constant percentage from one year to the next. The difference is usually unnoticeable for short-range projections but can become more significant for long-range projections. Generally, curvilinear projection will increase at a greater rate than a linear projection. Over the past half-century, population growth in the United States has been quite close to a linear growth rate; therefore, residential customer will be projected in this manner. Figure 2-2 graphically depicts the historical customer growth of the CKRWP.

Figure 2-2. Historical Growth, 2011 - 2020



Predicting how bulk users will affect the future water system can be challenging, due to the random nature of where these users join the system and the demand they will put on the system. For the purpose of this study, the annual usage data for "community usage" and "high demand usage" was analyzed to determine an average increase in water usage per year. These trends were used to project future water demand for these categories.

Assuming the CKRWP has the raw water and treatment capacity to meet the demands, the future water production estimated are illustrated in Table 2-4. By 2036 the District is expected to be serving over 1,200 customers with a total annual production over 200 MGY, with a peak day demand just over 1.1 MGD. Table 2-4 summarizes the projected water demands in five-year intervals.

Table 2-4. Projected Future Water Demands

Year	No. of Customers	Community Usage (MG)	High Demand Usage (MG)	Residential/ Rural Usage Including Loss (MG)	Total Produced (MG)	Average Day (Gallons)	Peak Day (Gallons)
2021	918	40.0	41.9	83.7	165.6	453,774	907,547
2026	1,017	42.0	43.1	92.7	177.8	487,053	974,106
2031	1,115	43.9	44.3	101.7	189.9	520,333	1,040,666
2036	1,214	45.8	45.6	110.7	202.1	553,612	1,107,225

3.0 HYDRAULIC MODELING APPROACH

The criteria used to size pipeline in a rural water system are typically established to meet peak instantaneous demands while maintaining a minimum pressure of 20 psi. The hydraulic model used in this analysis simulates minimum and maximum pressures on all pipelines, using a non-linear peak instantaneous usage equation. This model is unique to rural water in that it captures the short-term impact imposed by a limited number of customers on small branch lines. The maximum demand by one customer may reach as high as 10 gpm. Industry-standard hydraulic models that simulate peak demands for large, looped systems would only predict an average of about 1 gpm per customer under peak demands. This difference can obviously mask problems on small branch lines.

Demands were imposed on the system to simulate both average and peak day demands. The existing system was analyzed, and improvements were incorporated into the model. Demands were increased to reflect future growth identified in the previous section. Possible areas of concern, along with solution to these problems, were identified.

4.0 ANALYSIS OF EXISTING SYSTEM

4.1 Water Supply

Parts of the Cedar Knox Water Treatment Plant are approaching fifty years old from the original construction in the early 1970's. In 1981 and 1991, the plant underwent major expansions. The plant was expanded in 1981 by an additional solids contact clarifier, and packaged medial filter. This expansion increased the capacity of the treatment plant to 0.8 MGD (560 gpm). In 1991, another parallel train consisting of a solids contact basin and package filter was added. This increased the capacity of the treatment plant to 1.0 MGD (700 gpm). A second clearwell was added in 2002 for more flexibility.

Based on the future water projections, the peak day demands of the system will exceed the existing treatment plant's capacity between 2026 and 2031. It is recommended that additional supply improvement be made in the next 5 to 7 years.

The CKRWP will need to consider how improvements to the water supply will be made. Current options being considered are making improvements to the existing water treatment plant, purchasing the water supply from the City of Yankton, developing a new horizontal collector well and water treatment plant in the South Yankton area, or developing new groundwater wells and constructing a new water treatment plant. Section 7 of this report will discuss these water supply alternatives in greater detail.

4.2 Pumping/Transmission

Table 4-1 summarizes the firm capacities (over 18 hours) of the treatment plant pumps and the existing pump stations compared to the estimated peak day demands through each. The firm capacity of each facility is determined by considering the largest pump being out of service. Higher pumping rates may not be achievable without transmission line upgrades due to the potential for excessive discharge pressures, or suction pressures below desired levels.

Due to the logistics of the water system, the peak day demand for the West service area must also include the peak demands from Tank 2, Tank 3, and Booster 2 service areas. This is also true for the Tank 2 service area, which must also supply the peak day demand for the Tank 3 service area. The current pumping capacities are illustrated in Table 4-1.

Table 4-1. Pumping Capacities – 2021

Pump Station Facility	Firm Flow Rate Capacity (GPM)	18 Hour Capacity (Gallons)	2021 Projected Peak Day (Gallons)	Percent of Capacity (%)
Treatment Plant Pumps	1,050	1,134,000	907,548	80.0%
Booster 1	140	151,200	161,763	107.0%
Booster 2	110	118,800	83,060	69.9%
Booster 3	100	108,000	56,458	52.3%

As illustrated in Table 4-1, the peak day demand for Booster 1 is greater than its 18-hour pumping capacity. The extra demand can be overcome by allowing the pump to operate approximately 19.5 hours during a peak day. The pumping capacities for each 5-year increment can be found in Appendix A.

4.3 Storage

A water storage facility should be sized to allow adequate operational drawdown, meet peak-period demands beyond the pumping capacity, and provide emergency storage for pipe breaks, pump failures, or power outages. The majority of water systems follow the general rule of thumb of having the capacity for an average day demand for the area that it serves. However, because of the nature of this system and the high bulk usage quantities, we are utilizing a more technical approach by calculating the required operational and peak equalization requirements for each storage facility in the system.

Operational storage is the volume of water required to ensure proper turnover and mixing of the water during normal fill and draw cycles. Operators can tweak the levels at which storage tanks draw down as demand increases or decreases during the year, but a general rule of thumb is 30% of the capacity of the tank.

Peak equalization storage is the volume of water required to supplement the source-pumping capacity when system demands exceed the source pumping capabilities. The volume of equalizing storage must be sufficient to meet peak system demands in excess of the pumping capabilities over a 2-hour period.

The remaining storage in an elevated storage tank can be classified as emergency storage. This quantity of water serves as a back-up in the event of a pipe break, pump failure, or power outage.

Although standpipes can contain a large volume of water, only a fraction of that storage is usable in the system. When the water level decreases in a storage tank, the reduced water level adversely impacts the pressure supplied to customers. If customers are relatively close in elevation to the ground elevation of the standpipe, approximately 46 feet of water is required just to meet a minimum standard of 20 psi. Only the water above this level is usable. The water below is simply supporting the water above. Therefore, there can be a false sense of security when viewing the capacity of a standpipe. Typically, only 25% to 20% of the water in a standpipe is usable.

Table 4-2 summarizes the storage capacities for each storage facility in the existing system. Due to the ground elevations at the locations of the ground storage tanks, a large majority of the storage at these locations are usable within the system. Only 22% of the storage in the standpipe is usable. This does not provide enough storage to meet the operational, peak equalization, and emergency storage requirements for the area being served.

Table 4-2. Storage Facility Capacities – 2021

Storage Facility	Type	Capacity (Gallons)	Usable Storage (Gallons)	Operational Storage (Gallons)	Peak Equalization Storage (Gallons)	Emergency Storage (Gallons)
West Tanks	Ground Storage	318,775	318,775	63,755	0	255,020
Tank 2	Ground Storage	59,812	38,280	11,963	10,800	15,517
Tank 3	Standpipe	233,000	51,778	51,778	4,800	0

4.4 Distribution System

The hydraulic model indicates minimum pressures below the State standard of 20 psi in a few areas of the distribution system. In many cases, the low pressures may be short-lived, as customers adjust their use to accommodate the lack of pressure. This 'self-governing' mechanism tends to hide the severity of the problem, as pressures are maintained at the expense of flow. Customers that are accustomed to inadequate volume and pressure may not complain because they have accepted the situation.

The pressure delivered to a customer is created by the combination of their home elevation in relation to the water elevation in a storage tank minus the friction loss that occurs as water moves through the pipe between the tank and their home. In general, acceptable friction loss corresponds to the flow at or below those illustrated in Table 4-3.

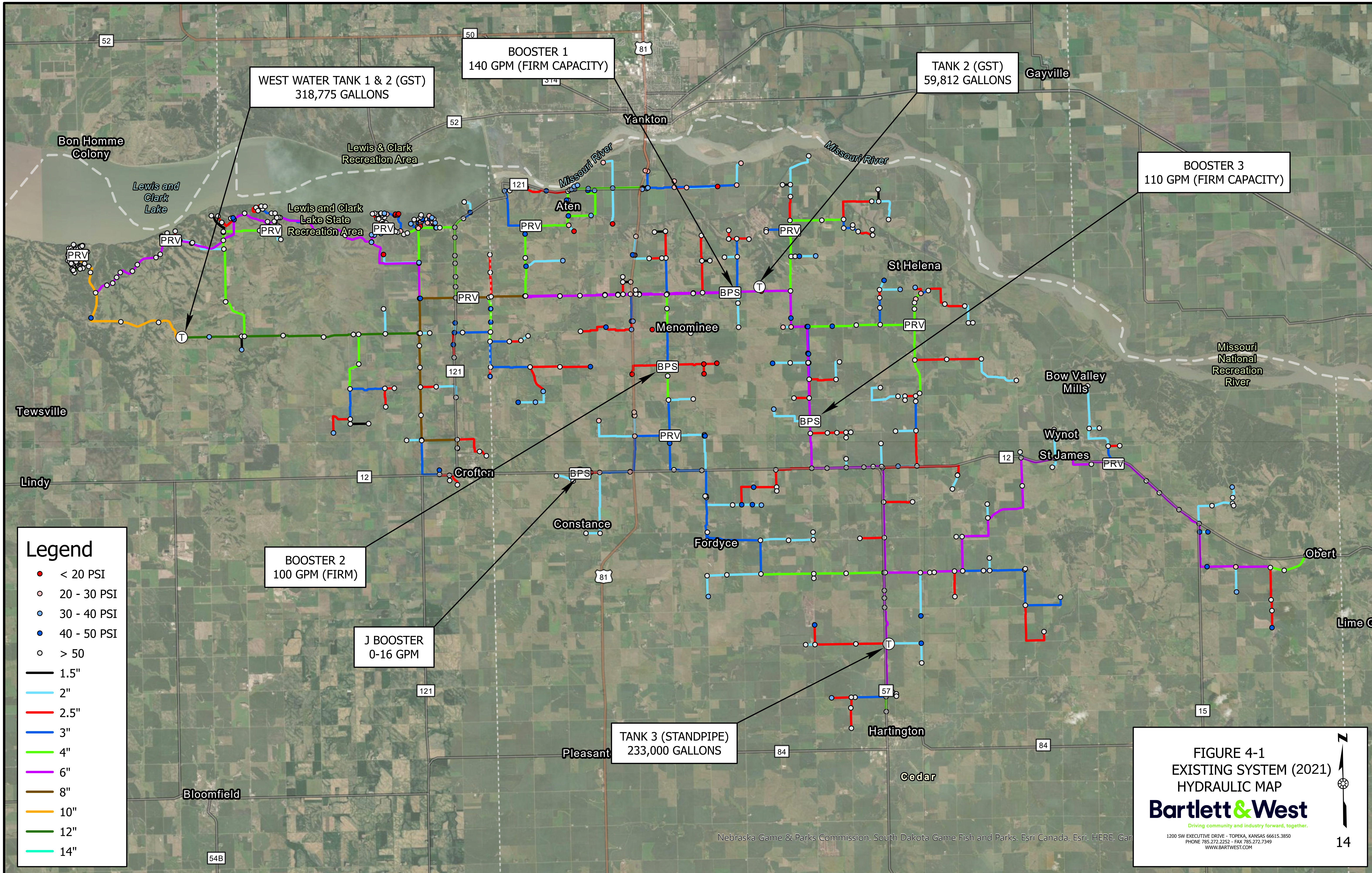
Table 4-3. Pipeline Friction Loss Targets

Pipe Size	Acceptable Friction Loss At or Below Flow of	Corresponding Number of Typical Customers
2-inch	15 gpm	5
2 ½-inch	20 gpm	10
3-inch	35 gpm	25
4-inch	60 gpm	55
6-inch	200 gpm	250
8-inch	400 gpm	500

Several segments of the distribution system have demands at least twice these target levels. Some segments of 2-inch and 2 ½-inch water lines serve 15 or more customers and have friction losses 5 times the normally acceptable levels. Segments of 3-inch pipe serve more than 30 customers, and segments of 4-inch pipe serve over 70 customers. These areas are spread throughout the distribution system. Roughly 30 miles of 1 ½-inch through 4-inch water line is considered to be above the desired friction loss levels. In addition, 1 mile of 6-inch water line and 4 miles of 8-inch water line are also experiencing flow above their desired levels. This represents roughly 13% of the system's total water line network of 280 miles. Some of these high friction loss pipes are acceptable due to the low elevations they are serving, as adequate pressures are still being delivered to customers. Other areas need to be addressed. Proposed improvements in Section 6 will address these areas.

Because of the high friction losses, approximately 6% of the CKRWP's customers are subject to inadequate service. The map in the back of the report illustrates the results of the hydraulic analysis. Shown are predicted peak flows, friction loss per 1,000 feet of pipe, and minimum pressures. Figure 4-1 on the following page illustrates the low-pressure areas, as shown by the modeled minimum "node" pressure.

Once again, the self-governing mechanism employed by customers will buffer the impact. Negative pressures are shown on the modeled results, but in reality, very few negative pressures are likely. The hydraulic model creates a peak demand commensurate with simultaneous peak household uses, such as washing machines, showers, dishwashers, etc. The model does not account for customers adjusting typical behavior by turning these appliances off during peak-demand periods. Therefore, the negative pressures shown on the map reflect a failure of volume to be supplied when it would typically be desired.



WEST WATER TANK 1 & 2 (GST)
318,775 GALLONS
BOOSTER 1
140 GPM (FIRM CAPACITY)
TANK 2 (GST)
59,812 GALLONS
BOOSTER 3
110 GPM (FIRM CAPACITY)
BOOSTER 2
100 GPM (FIRM)
J BOOSTER
0-16 GPM
TANK 3 (STANDPIPE)
233,000 GALLONS
Gayville
Yankton
Bon Homme Colony
Lewis & Clark Recreation Area
Lewis and Clark Lake
Lewis and Clark Lake State Recreation Area
Missouri River
Aten
St Helena
Menominee
Missouri National Recreation River
Bow Valley Mills
Wynot
St James
Tewsville
Lindy
Crofton
Constance
Fordyce
Obert
Lime Gro
Hartington
Pleasant
Cedar
Bloomfield
PRV
BPS
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20 - 30 PSI
30 - 40 PSI
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2.5"
3"
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10"
12"
14"
Nebraska Game & Parks Commission, South Dakota Game Fish and Parks, Esri Canada, Esri, HERE, Gar
FIGURE 4-1
EXISTING SYSTEM (2021)
HYDRAULIC MAP
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5.0 WHOLESALE WATER SALE POTENTIAL

5.1 Santee Sioux Reservation

The Santee Sioux has expressed an interest in purchasing a portion of their water supply from the CKRWP. Initial discussions have indicated that the Santee Sioux water demand would be up to 150,000 gallons on a maximum day.

As a wholesale purchaser, we would anticipate that the Santee Sioux would have a peaking factor around 1.5. This would equate to an average daily usage of 100,000 gallons per day, or an annual usage of 36.5 million gallons. This additional demand would essentially max out the CKRWP's current supply capacity, meaning that any scenario that results in providing water to the Santee Sioux should be in conjunction with a water supply improvement project. A portion of the water supply improvements capital costs should be allocated to the Santee Sioux as part of a connection fee. Water supply options are discussed in Section 7 of this report.

Transmission requirements to provide 150,000 gallons on a maximum day would require 125 gpm over a 20-hour pumping day. It is assumed that water will be provided to a Santee Sioux existing storage tank near the Ohiya Casino & Resort along Highway 12. Based on a demand of 125 gpm, it is anticipated that a 6-inch PVC transmission line would be of sufficient size to supply water.

For the purpose of this study, a preliminary transmission line route is proposed starting at the existing 12-inch PVC main at 894 Road and 544 Avenue. A new 6-inch transmission line would be installed south along 544th Avenue to Highway 12. The line would then head west along Highway 12 until reaching the Ohiya Casino & Resort. The proposed route is approximately 91,800 feet.

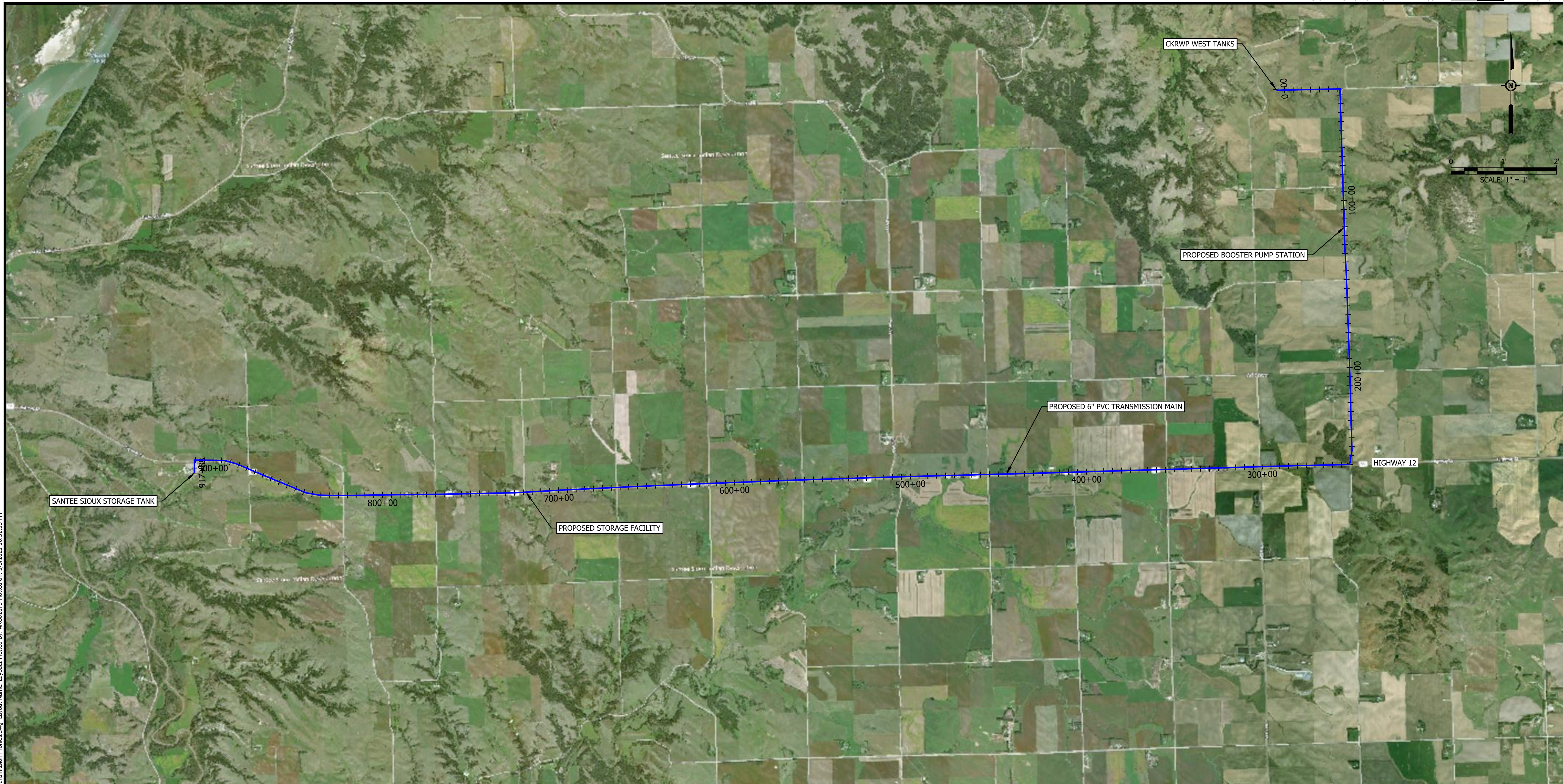
The proposed route has topographical challenges that would need to be overcome. The high-water elevation of the CKRWP's west tanks is 1,650'. It is assumed that the Santee Sioux storage tank has a high-water elevation of 1,535'. Elevations along the proposed pipeline route reach as high as 1,800’, which will require a booster pump station to increase the hydraulic grade line above these elevations.

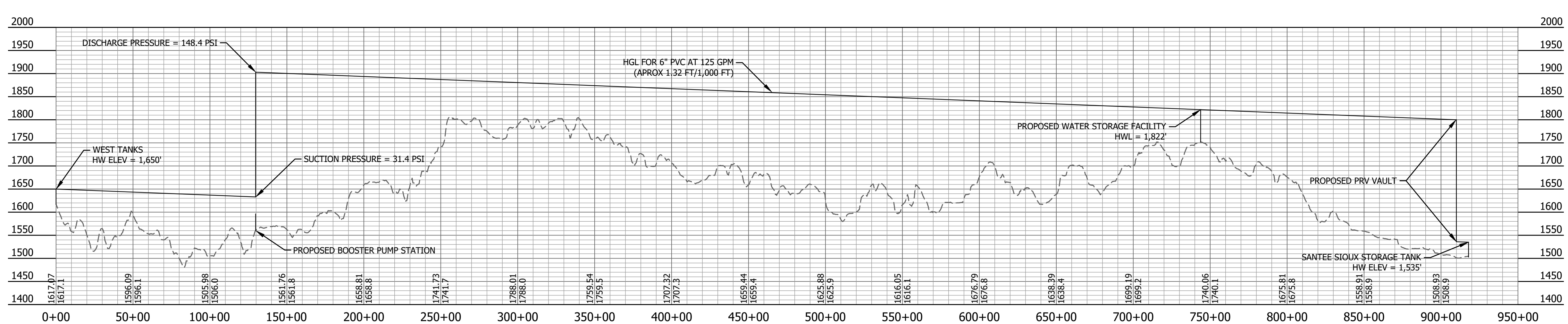
The installation of a storage tank along the proposed route is recommended. The storage tank will provide pressure between the proposed booster pump station and the Santee Sioux storage tank. The proposed pump station will pump water to a hydraulic grade line sufficient to fill the proposed storage tank. Water will then be provided to the Santee Sioux by gravity. It is recommended that a pressure reducing valve or flow control valve be installed prior to the Santee Sioux storage facility to control the water delivery rate.

Figure 5-1 on the following page shows the preliminary transmission line route, booster pump station location, storage tank location, and hydraulic profile of the proposed project.

The overall construction costs for a new booster pump station, new storage tank, and transmission piping is in the range of $1.75 to $2.25 million. The total project cost would include engineering, construction observation, legal, and contingencies. These costs are estimated at 35% of the construction costs, which makes the total project cost $2.4 to $3.0 million. The estimated costs indicated do not include the costs to purchase land to construct a new booster pump station or storage facility. Also, the estimated costs do not include any cost allocation into an improved or new CKRWP water supply.

BAR IS ONE INCH ON OFFICIAL DRAWINGS. 0 1" IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY.





PLAN AND HYDRAULIC PROFILE SANTEE SIOUX WATER SUPPLY 150,000 GALLON MAX DAY

WATER SYSTEM ANALYSIS AND DEVELOPMENT PLAN
LEWIS & CLARK NATURAL RESOURCES DISTRICT
CEDAR-KNOX RURAL WATER PROJECT

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DESIGNED BY:	
DRAWN BY:	ARO
APPROVED BY:	
DESIGN PROJ:	19242.300
CONST PROJ:	
SCALE:	AS NOTED
DATE:	MAY 2021
DRAWING NO:	FIGURE 5-1
SHEET NO:	17

6.0 PROPOSED SYSTEM IMPROVEMENTS

6.1 Immediate Improvements

As previously noted in Table 4-1, a pumping deficiency exists at Booster 1. The projected peak day for the area supplied by the Booster Station requires a firm capacity of 150 gpm over an 18-hour pumping day, compared to the current 140 gpm firm capacity. This deficiency can be overcome by allowing the pumps to operate for 20 hours during a peak day. In the next section of improvements, this deficiency will be analyzed and corrected.

Improvements recommended immediately include a few large projects and several smaller sized projects that improve pressures and supply in areas where there are currently low-pressure problems caused by high friction losses or high elevation. Improvements are also recommended to address transmission capacities to accommodate future growth. The proposed immediate improvements are as follows:

Storage

1. **Replace Tank 3 with Elevated Storage Tank.** The Tank 3 Standpipe is identified as being deficient based on current day water demands, as there is not usable storage within the standpipe for emergency situations. Based on the 15-year demands presented in this analysis it is recommended that the new elevated storage tank be sized for a minimum of 75,000 gallons, however this should be re-visited during the design process to accommodate growth for an additional 40 to 50 years.

Transmission Improvements

1. **Replace Existing 8-inch with New 12-inch PVC.** In order to accommodate additional growth to the east, transmission line improvements will be necessary to accommodate additional pumping. The proposed improvement will consist of

7,100 L.F. of new 12-inch PVC replacing the existing 8-inch along 550th Avenue from 894th Road to 895th Road.

2. **Replace Existing 8-inch with New 12-inch PVC.** This improvement will consist of 21,600 L.F. of new 12-inch PVC along 895th Road between 550th Avenue and 553rd Avenue. This installation will increase suction pressures to Booster 1 as pumping velocity increases. This improvement will also increase modeled minimum pressures to customers by approximately 40 psi during peak day demands.

Distribution Improvements

1. **Install New 6-inch PVC along 553rd Avenue.** This improvement will consist of approximately 6,200 L.F. of new 6-inch PVC to replace an existing 4-inch water line that is currently over its design capacity. The existing 4-inch water line is currently providing service to approximately 125 services , creating high friction losses during peak demand situations. In order to alleviate this “bottleneck”, it is recommended that the 4-inch water line be replaced with new 6-inch PVC. Customers in this area of the water system should experience an increase of modeled minimum pressures of approximately 15 psi.

2. **Install new 4-inch PVC along Esther Street & Oak Street.** This improvement will consist of approximately 1,000 L.F. of new 4-inch PVC along Esther Street and Oak Street between Main Street and Elm Street. This improvement will reduce high friction losses occurring in the existing 2-inch water line. This improvement will impact roughly 70 customers, increasing modeled minimum pressures by 40 psi.

3. **Install new 4-inch PVC along Oak Ridge Road.** This improvement will consist of approximately 1,700 L.F. of new 4-inch PVC along Oak Ridge Road between County Road C54 and Timberline Trail. This improvement will reduce high friction losses occurring in the existing 2 ½-inch water line. This improvement will impact roughly 30 customers, increasing modeled minimum pressures by 10 psi.

4. **Install new 6-inch PVC along 553rd Ave.** This improvement will consist of approximately 8,500 L.F. of new 6-inch PVC along 553rd Avenue between 896th Road and 897th Road. This improvement will reduce high friction losses occurring in the existing 4-inch water line. This improvement will impact roughly 100 customers, increasing modeled minimum pressures by 40 psi.

5. **Install new 8-inch PVC along 549th Avenue.** This improvement will consist of approximately 25,000 L.F. of new 8-inch PVC along 549th Road. This improvement will begin at the existing 12-inch water line at 894th Road, and end near the intersection of County Road C54 and Walker Valley Road. This improvement will impact roughly 200 customers, increasing modeled minimum pressures by 25 psi.

6. **Install new 6-inch PVC along County Road C54.** This improvement will consist of approximately 15,100 L.F. of 6-inch PVC along County Road C54 between Ridge Road and Oak Ridge Road. This improvement will reduce high friction losses occurring in the existing 4-inch water line. This improvement will impact roughly 55 customers, increasing modeled minimum pressures by 30 psi.

7. **Install new 6-inch PVC along 897th Road.** This improvement will consist of approximately 10,700 L.F. of new 6-inch PVC along 897th Road starting at 897th Road and ending along 554th Avenue. This improvement will reduce high friction losses occurring in the existing 4-inch water line. This improvement will impact roughly 110 customers, increasing modeled minimum pressures by 45 psi.

6.2 Five-Year Improvements

As alluded to in the previous section, the five-year improvements will resolve a pumping deficiency as peak day demands continue to increase as growth is applied to the hydraulic model. The remaining improvements are recommended to increase minimum system pressures to serviceable levels.

Transmission Improvements

1. **Increase Booster 1 to 200 gpm.** It is recommended that Booster 1 be improved from 140 gpm to 200 gpm to meet the 15-year projected peak day demands. This improvement will consist of replacing the existing booster pumps, and potentially mechanical and electrical improvements.

Distribution Improvements

1. **Install new 8-inch PVC along 895th Road.** This improvement will consist of approximately 6,000 L.F. of new 8-inch PVC along 895th Road from Tank 2 to 560th Avenue to increase capacity for the eastern portion of the water system. This improvement will reduce high friction losses occurring in the existing 6-inch water line. This improvement will impact roughly 100 customers, increasing modeled minimum pressures by 10 psi.

2. **Install new 6-inch PVC along 557th Avenue.** This improvement will consist of approximately 7,300 L.F. of new 6-inch PVC along 557th Avenue between 892nd Road and 891st Road. This improvement will reduce high friction losses occurring in the existing 3-inch water line. This improvement will impact roughly 50 customers, increasing modeled minimum pressures by 50 psi.

3. **Install New 6-inch PVC along 557th Avenue.** This improvement will consist of approximately 7,000 L.F. of new 6-inch PVC to replace an existing 4-inch water line that is currently over its design capacity. The existing 4-inch water line is currently providing service to approximately 20 customers, and also provides transmission capacity for Booster 2, creating high friction losses during peak demand situations. In order to alleviate these high losses, it is recommended that the 4-inch water line be replaced with new 6-inch PVC. Customers in this area of the water system should experience an increase in modeled minimum pressures of approximately 10 psi.

4. **Install New 6-inch PVC along 557th Avenue.** This improvement will consist of approximately 6,900 L.F. of new 6-inch PVC to replace an existing 4-inch water line that is currently over its design capacity. The existing 4-inch water line is currently providing service to approximately 48 customers, including Fordyce, creating high friction losses during peak demand situations. To alleviate these high losses, it is recommended that the 4-inch water line be replaced with 6-inch PVC. Customers in this area of the water system should experience an increase in modeled minimum pressures of approximately 10 psi.

6.3 Ten-Year Improvements

After an additional five years of growth is applied to the model, additional improvements are recommended to improve pressures and supply in areas where low pressure problems develop due to high friction losses. The proposed ten-year improvements are as follows:

Distribution Improvements

1. **Install new 12-inch PVC along 895th Road.** This improvement will consist of approximately 29,000 L.F. of new 12-inch PVC along 895th Road between 553rd Avenue and 557th Avenue. This improvement will reduce high friction losses occurring in the parallel 6-inch water lines. This improvement will impact roughly 100 customers, increasing modeled minimum pressures by 35 psi.

2. **Install new 8-inch PVC along 560 Avenue and 894th Road.** This improvement will consist of approximately 10,600 L.F. of new 8-inch PVC starting at the intersection of 895th Road and 560 Avenue, and ending at the intersection of 894th Road and 561st Avenue. This improvement will reduce high friction losses occurring in the existing 6-inch water line. This improvement will impact roughly 60 customers, increasing modeled minimum pressures by 10 psi.

3. **Install new 6-inch PVC along 894th Road.** This improvement will consist of approximately 5,000 L.F. of new 6-inch PVC starting at the intersection of 561st Avenue and end roughly 1 mile east of the intersection. This improvement will reduce high friction losses occurring in the existing 4-inch water line. This improvement will impact roughly 40 customers, increasing modeled minimum pressures by 15 psi.

4. **Install new 6-inch PVC along 557th Avenue.** This improvement will consist of approximately 7,500 L.F. of new 6-inch PVC along 557th Road between 892nd Road and 893rd Road. This improvement will reduce high friction losses occurring in the existing 3-inch water line. This improvement will impact roughly 10 customers and the suction side of Booster 3, increasing modeled minimum pressures by 35 psi.

6.4 Fifteen-Year Improvements

Various distribution line improvements will likely be necessary based on localized growth, which cannot be anticipated, specifically in this study. Applying uniform growth assumptions, however, the following distribution improvements would need to be addressed:

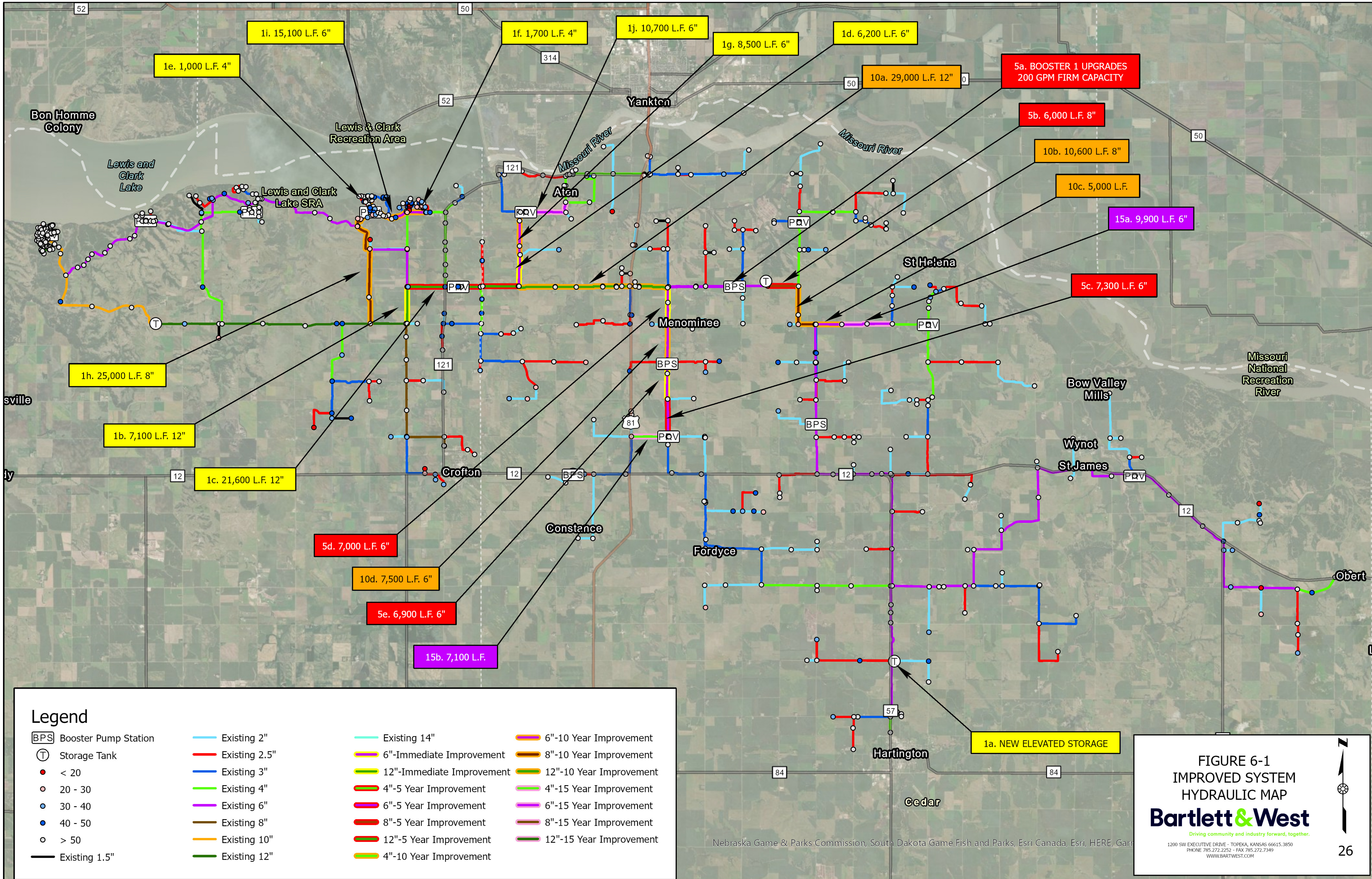
Distribution Improvements

1. **Install new 6-inch PVC along 894th Road.** This improvement will consist of approximately 9,900 L.F. of new 6-inch PVC along 894th Road beginning west of the intersection of 562nd Avenue and ending near 563rd Avenue. This improvement will reduce high friction losses occurring in the existing 4-inch water line. This improvement will impact roughly 40 customers, increasing modeled minimum pressures by 10 psi.

2. **Install new 4-inch PVC along 891st Road.** This improvement will consist of approximately 7,100 L.F. of new 4-inch PVC along 891st Road between 557th Avenue and Highway 81. This improvement will reduce high friction losses occurring in the existing 3-inch water line. This improvement will impact roughly 20 customers, increasing modeled minimum pressures by 20 psi.

6.5 Performance of Improved System

The improvements outlined were hydraulically modeled and shown to be effective at correcting system deficiencies. Minimum pressures increase dramatically leaving most customers with expected pressures above 20 psi, apart from a few small branch lines. The large map in the back folder of this report illustrates the predicted minimum pressures, flows, and friction losses for each pipe segment in the system. Figure 6-1 on the following page summarizes the proposed improvements described above.



1i. 15,100 L.F. 6"
1f. 1,700 L.F. 4"
1j. 10,700 L.F. 6"
1g. 8,500 L.F. 6"
1d. 6,200 L.F. 6"
1e. 1,000 L.F. 4"
10a. 29,000 L.F. 12"
5a. BOOSTER 1 UPGRADES
200 GPM FIRM CAPACITY
5b. 6,000 L.F. 8"
10b. 10,600 L.F. 8"
10c. 5,000 L.F.
15a. 9,900 L.F. 6"
5c. 7,300 L.F. 6"
1h. 25,000 L.F. 8"
1b. 7,100 L.F. 12"
1c. 21,600 L.F. 12"
5d. 7,000 L.F. 6"
10d. 7,500 L.F. 6"
5e. 6,900 L.F. 6"
15b. 7,100 L.F.
1a. NEW ELEVATED STORAGE
Bon Homme Colony
Lewis and Clark Lake
Lewis & Clark Recreation Area
Lewis and Clark Lake SRA
Yankton
Missouri River
Aten
St Helena
Menominee
Missouri National Recreation River
Bow Valley Mills
Wynot
St James
Crofton
Constance
Fordyce
Obert
Hartington
Cedar
BPS
PRV
Legend
BPS Booster Pump Station
Storage Tank
< 20
20 - 30
30 - 40
40 - 50
> 50
Existing 1.5"
Existing 2"
Existing 2.5"
Existing 3"
Existing 4"
Existing 6"
Existing 8"
Existing 10"
Existing 12"
Existing 14"
6"-Immediate Improvement
12"-Immediate Improvement
4"-5 Year Improvement
6"-5 Year Improvement
8"-5 Year Improvement
12"-5 Year Improvement
4"-10 Year Improvement
6"-10 Year Improvement
8"-10 Year Improvement
12"-10 Year Improvement
4"-15 Year Improvement
6"-15 Year Improvement
8"-15 Year Improvement
12"-15 Year Improvement
Nebraska Game & Parks Commission, South Dakota Game Fish and Parks, Esri Canada, Esri, HERE, Garmin
FIGURE 6-1
IMPROVED SYSTEM
HYDRAULIC MAP
Bartlett & West
Driving community and industry forward, together.
1200 SW EXECUTIVE DRIVE - TOPEKA, KANSAS 66615.3850
PHONE 785.272.2252 - FAX 785.272.7349
WWW.BARTWEST.COM
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6.6 Cost Estimates of Proposed Improvements

The cost estimates provided in this report are intended to provide a general guideline as to the magnitude of the proposed improvements. No specific field investigations were made. These estimates are based upon prices from similar, recent projects, and represent the engineer's best judgement.

The combination of impacts from the COVID-19 pandemic, and the freezing temperatures that impacted the State of Texas in February 2021 has caused the PVC market (as well as other building material markets) to become volatile. The production outages in Texas and Louisiana has significantly lowered the material supply, causing PVC prices to increase dramatically. Current supply volume is insufficient to meet domestic needs, and some reports suggest that it will remain this way until the fourth quarter of 2021. The cost estimates presented in this report do not reflect or try to anticipate the material prices of the current volatile market. The estimates reflect material pricing that would represent normal market conditions.

Actual construction prices will vary from the estimates. The preliminary cost estimates, shown on the following pages, include all construction and administration costs associated with the proposed improvements.

Immediate Improvements

	New Elevated Storage Tank				
No.	Item	Quantity	Unit	Unit Price	Extension
1	75,000 Gallon EWST		L U M P	S U M	$300,000
	Total Construction Cost				**300,000**
	Engineering, Inspection, Contingencies, Etc.				105,000
	TOTAL PROJECT COST				**$405,000**

	12" Improvement along 550th Ave between 894 RD & 895 RD				
No.	Item	Quantity	Unit	Unit Price	Extension
1	12" PVC Pipe	7,100	L.F.	$26.00	$185,000
2	Road Crossings		L U M P	S U M	19,000
3	Stream Crossings		L U M P	S U M	28,000
4	Valves, Connections, Misc.		L U M P	S U M	24,000
	Total Construction Cost				**256,000**
	Engineering, Inspection, Contingencies, Etc.				90,000
	TOTAL PROJECT COST				**$346,000**

	12" Improvement along 895 RD between 550 Ave & 553 Ave				
No.	Item	Quantity	Unit	Unit Price	Extension
1	12" PVC Pipe	21,600	L.F.	$26.00	$562,000
2	Road Crossings		L U M P	S U M	56,000
3	Stream Crossings		L U M P	S U M	84,000
4	Valves, Connections, Misc.		L U M P	S U M	73,000
	Total Construction Cost				**775,000**
	Engineering, Inspection, Contingencies, Etc.				271,000
	TOTAL PROJECT COST				**$1,046,000**

	6" Improvement along 553rd Ave between 895 RD & 896 RD				
No.	Item	Quantity	Unit	Unit Price	Extension
1	6" PVC Pipe	6,200	L.F.	$12.00	$74,000
2	Road Crossings		L U M P	S U M	7,000
3	Stream Crossings		L U M P	S U M	11,000
4	Valves, Connections, Misc.		L U M P	S U M	10,000
	Total Construction Cost				**102,000**
	Engineering, Inspection, Contingencies, Etc.				36,000
	TOTAL PROJECT COST				**$138,000**

4" Improvement along Esther St & Oak St					
No.	Item	Quantity	Unit	Unit Price	Extension
1	4" PVC Pipe	1,000	L.F.	$9.00	$9,000
2	Road Crossings		LUMP	SUM	1,000
3	Stream Crossings		LUMP	SUM	1,000
4	Valves, Connections, Misc.		LUMP	SUM	1,000
	Total Construction Cost				**12,000**
	Engineering, Inspection, Contingencies, Etc.				5,000
	TOTAL PROJECT COST				**$17,000**

4" Improvement along Oak Ridge Rd					
No.	Item	Quantity	Unit	Unit Price	Extension
1	4" PVC Pipe	1,700	L.F.	$9.00	$15,000
2	Road Crossings		LUMP	SUM	2,000
3	Stream Crossings		LUMP	SUM	2,000
4	Valves, Connections, Misc.		LUMP	SUM	2,000
	Total Construction Cost				**21,000**
	Engineering, Inspection, Contingencies, Etc.				8,000
	TOTAL PROJECT COST				**$29,000**

6" Improvement along 553 Ave between 896 Rd & 897 Rd					
No.	Item	Quantity	Unit	Unit Price	Extension
1	6" PVC Pipe	8,500	L.F.	$12.00	$102,000
2	Road Crossings		LUMP	SUM	10,000
3	Stream Crossings		LUMP	SUM	15,000
4	Valves, Connections, Misc.		LUMP	SUM	13,000
	Total Construction Cost				140,000
	Engineering, Inspection, Contingencies, Etc.				49,000
	TOTAL PROJECT COST				**$189,000**

8" Improvement along 549 Ave					
No.	Item	Quantity	Unit	Unit Price	Extension
1	8" PVC Pipe	25,000	L.F.	$15.00	$375,000
2	Road Crossings		LUMP	SUM	38,000
3	Stream Crossings		LUMP	SUM	56,000
4	Valves, Connections, Misc.		LUMP	SUM	49,000
	Total Construction Cost				518,000
	Engineering, Inspection, Contingencies, Etc.				181,000
	TOTAL PROJECT COST				**$699,000**

6” Improvement along CR C54 between Ridge Road & Oak Ridge Rd					
No.	Item	Quantity	Unit	Unit Price	Extension
1	6” PVC Pipe	15,100	L.F.	$12.00	$181,000
2	Road Crossings	L U M P	S U M		18,000
3	Stream Crossings	L U M P	S U M		27,000
4	Valves, Connections, Misc.	L U M P	S U M		24,000
	Total Construction Cost				250,000
	Engineering, Inspection, Contingencies, Etc.				88,000
	TOTAL PROJECT COST				**$338,000**

6" Improvement along 897 Rd between 897 Rd & 554 Ave					
No.	Item	Quantity	Unit	Unit Price	Extension
1	6" PVC Pipe	10,700	L.F.	$12.00	$128,000
2	Road Crossings	L U M P	S U M		13,000
3	Stream Crossings	L U M P	S U M		19,000
4	Valves, Connections, Misc.	L U M P	S U M		17,000
	Total Construction Cost				177,000
	Engineering, Inspection, Contingencies, Etc.				62,000
	TOTAL PROJECT COST				**$239,000**

Five Year Improvements

Booster 1 Improvements					
No.	Item	Quantity	Unit	Unit Price	Extension
1	BPS Improvements	L U M P	S U M		$100,000
	Total Construction Cost				100,000
	Engineering, Inspection, Contingencies, Etc.				35,000
	TOTAL PROJECT COST				**$135,000**

8" Improvement along 895 RD between Tank 2 & 560 Ave					
No.	Item	Quantity	Unit	Unit Price	Extension
1	8" PVC Pipe	6,000	L.F.	$15.00	$90,000
2	Road Crossings	L U M P	S U M		9,000
3	Stream Crossings	L U M P	S U M		14,000
4	Valves, Connections, Misc.	L U M P	S U M		12,000
	Total Construction Cost				125,000
	Engineering, Inspection, Contingencies, Etc.				44,000
	TOTAL PROJECT COST				**$169,000**

6" Improvement along 557 Ave between 892 RD & 891 RD					
No.	Item	Quantity	Unit	Unit Price	Extension
1	6" PVC Pipe	7,300	L.F.	$12.00	$88,000
2	Road Crossings	L U M P	S U M		9,000
3	Stream Crossings	L U M P	S U M		13,000
4	Valves, Connections, Misc.	L U M P	S U M		11,000
	Total Construction Cost				121,000
	Engineering, Inspection, Contingencies, Etc.				42,000
	TOTAL PROJECT COST				**$163,000**

6" Improvement along 557 Ave between 895 RD & 894 RD					
No.	Item	Quantity	Unit	Unit Price	Extension
1	6" PVC Pipe	7,000	L.F.	$12.00	$84,000
2	Road Crossings	L U M P	S U M		8,000
3	Stream Crossings	L U M P	S U M		13,000
4	Valves, Connections, Misc.	L U M P	S U M		11,000
	Total Construction Cost				**116,000**
	Engineering, Inspection, Contingencies, Etc.				41,000
	TOTAL PROJECT COST				**$157,000**

6" Improvement along 557th Ave between 893 RD & 892 RD					
No.	Item	Quantity	Unit	Unit Price	Extension
1	6" PVC Pipe	6,900	L.F.	$12.00	$83,000
2	Road Crossings		LUMP SUM		8,000
3	Stream Crossings		LUMP SUM		12,000
4	Valves, Connections, Misc.		LUMP SUM		11,000
	Total Construction Cost				**114,000**
	Engineering, Inspection, Contingencies, Etc.				40,000
	TOTAL PROJECT COST				**$154,000**

Ten Year Improvements

No.	Item	Quantity	Unit	Unit Price	Extension
	12" Improvement along 895 RD between 553 Ave & 557 Ave				
1	12" PVC Pipe	29,000	L.F.	$26.00	$754,000
2	Road Crossings	LUMP	SUM		75,000
3	Stream Crossings	LUMP	SUM		113,000
4	Valves, Connections, Misc.	LUMP	SUM		98,000
	Total Construction Cost				1,040,000
	Engineering, Inspection, Contingencies, Etc.				364,000
	TOTAL PROJECT COST				**$1,404,000**

No.	Item	Quantity	Unit	Unit Price	Extension
	8" Improvement along 560 Ave & 894 Rd				
1	8" PVC Pipe	10,600	L.F.	$15.00	$159,000
2	Road Crossings	LUMP	SUM		16,000
3	Stream Crossings	LUMP	SUM		24,000
4	Valves, Connections, Misc.	LUMP	SUM		21,000
	Total Construction Cost				220,000
	Engineering, Inspection, Contingencies, Etc.				77,000
	TOTAL PROJECT COST				**$297,000**

No.	Item	Quantity	Unit	Unit Price	Extension
	6" Improvement along 894 Rd near 561st Ave				
1	6" PVC Pipe	5,000	L.F.	$12.00	$60,000
2	Road Crossings	LUMP	SUM		6,000
3	Stream Crossings	LUMP	SUM		9,000
4	Valves, Connections, Misc.	LUMP	SUM		8,000
	Total Construction Cost				83,000
	Engineering, Inspection, Contingencies, Etc.				29,000
	TOTAL PROJECT COST				**$112,000**

6" Improvement along 557 Ave between 892 Rd & 893 Rd					
No.	Item	Quantity	Unit	Unit Price	Extension
1	6" PVC Pipe	7,500	L.F.	$12.00	$90,000
2	Road Crossings	L U M P	S U M		9,000
3	Stream Crossings	L U M P	S U M		14,000
4	Valves, Connections, Misc.	L U M P	S U M		12,000
	Total Construction Cost				125,000
	Engineering, Inspection, Contingencies, Etc.				44,000
	TOTAL PROJECT COST				**$169,000**

Fifteen Year Improvements

6" Improvement along 894 Rd between 562 Ave & 563 Ave					
No.	Item	Quantity	Unit	Unit Price	Extension
1	6" PVC Pipe	9,900	L.F.	$12.00	$119,000
2	Road Crossings		L U M P	S U M	12,000
3	Stream Crossings		L U M P	S U M	18,000
4	Valves, Connections, Misc.		L U M P	S U M	15,000
	Total Construction Cost				164,000
	Engineering, Inspection, Contingencies, Etc.				57,000
	TOTAL PROJECT COST				**$221,000**

4" Improvement along 891 Rd between 557 Ave & Hwy 81					
No.	Item	Quantity	Unit	Unit Price	Extension
1	4" PVC Pipe	7,100	L.F.	$9.00	$64,000
2	Road Crossings		L U M P	S U M	6,000
3	Stream Crossings		L U M P	S U M	10,000
4	Valves, Connections, Misc.		L U M P	S U M	8,000
	Total Construction Cost				88,000
	Engineering, Inspection, Contingencies, Etc.				31,000
	TOTAL PROJECT COST				**$119,000**

7.0 WATER SUPPLY ALTERNATIVES

7.1 Improvements to Existing Supply & Water Treatment Plant

The preliminary engineering report for the intake evaluation identified alternatives for intake modifications and an overall evaluation of the intake options in conjunction with water treatment plant expansion costs. Based on the evaluation in the report, a potential option for the water supply is installing a horizontal collector well with an expansion of the existing water treatment plant.

7.1.1 Intake

As detailed in the report, additional investigation is recommended to determine the potential and location of coarse-sand and/or gravel formations under Lewis and Clark Lake. On the low end of the cost scale, the additional investigative testing could be in the $35,000 to $45,000 range (likely not provide enough information). If the complete investigative testing is completed as outlined in Section 3.1.4 of the intake evaluation report, the additional costs would be in the range of $500,000 to $600,000.

If the additional testing indicates the potential for coarse-sand and/or gravel formations and suggests a horizontal collector well would provide a minimum intake capacity of 1,200 gpm, the anticipated construction costs for a HCW with a caisson, lateral(s), vertical turbine pumps, piping, pump building, etc. is in the $6 million to $7.5 million range. This cost is highly dependent on the depth of the caisson and the distance of the lateral(s) to reach the coarse-sand and/or gravel formations.

7.1.2 Water Treatment Plant Expansion

The preliminary engineering report for the water treatment plant identified an alternative for expanding the facility to 800 gpm. Based on feedback from CKRWP, the desired capacity to account for future growth is 1,050 gpm. The preferred alternative for expanding the existing water treatment plant is the retrofit of the existing Contrafast

Clarifies with plate settlers, the addition of a new media filters in the location of the existing Permutit circular filters, and the installation of a new lime feed system. The costs have been adjusted to account for the higher capacity of the facility and the addition of granular activated carbon to the new filters. The anticipated water treatment plant expansion construction costs are in the range of $2.1 million to $2.2 million.

7.1.3 Overall Capital Costs

The total construction costs for the new HCW and water treatment plant improvements is in the range of $8.1 to $9.7 million. The total project cost would include engineering, construction observation, legal, and contingencies. These costs are estimated at 35% of the construction costs, which makes the total project cost $10.9 million to $13.1 million. These project costs do not include the additional investigation costs as noted above.

7.1.4 Operation and Maintenance

The annual operation and maintenance costs will be like the costs associated with the existing intake, water treatment plant, and distribution system. An annual increase of $10,000 is assumed to account for granular activated carbon replacement.

7.2 New Surface Water Intake and Water Treatment Plant in the South Yankton Area

As identified in the preliminary report for the water treatment plant, the potential for growth within the CKRWP system is primarily the seasonal homes along the Missouri River in the general area near and west of South Yankton. This alternative identifies the ballpark cost for the construction of a new surface water intake along the Missouri River (downstream of Gavins Point Dam) and the construction of a new water treatment facility in the South Yankton area. The estimated costs indicated do not include the costs to purchase land to construct the intake and water treatment plant.

7.2.1 New Water Treatment Plant

It is assumed the source water for the new water treatment facility will be a surface water with similar quality as the existing water treatment facility. The anticipated peak processing rate will be 1,050 gpm (1.5 million gallons over 24 hour, 1.26 million gallons over 20 hours). The treatment process will consist of chlorine dioxide feed at the intake, powdered activated carbon (PAC) contactor, two lime softening clarifiers (lime, coagulant, and polymer addition), recarbonation (carbon dioxide addition), mixed media filters with granular activated carbon (GAC) in lieu of anthracite. Fluoride and chlorine addition would be prior to the approximately 500,000 gallons of finished water storage, and high service pumps. The facility will include a separate storage area for the powdered activated carbon, bulk lime handling facility (bulk lime silo with transfer system), and dedicated space for the liquid chemicals. The layout of the building will include a control room and restrooms. Waste handling (sludge blowdown and filter backwash) will consist of construction of at least two on-site lagoons and a septic system to handle domestic waste. The anticipated construction costs for a new water treatment plant are in the range of $11.0 million to 11.5 million.

7.2.2 High Service/Transmission Piping

For estimating the high service/distribution piping, it is assumed the new water treatment plant will be located in an area west of Highway 81 just south of the new Missouri River bridge. The estimated distance of 12-inch PVC piping from the new water treatment facility to tie into the existing CKRWP distribution system is approximately 65,000 feet. The estimated cost for pipeline, appurtenances (valves, cleanouts, etc.), road crossings, stream crossings, and SCADA improvements is in the range of $2.5 to $2.75 million.

7.2.3 Overall Capital Costs

The overall construction costs for the new intake, new water treatment plant, and transmission piping total in the range of $13.5 million to $15.25 million. The total project cost would include engineering, construction observation, legal, and contingencies. These costs are estimated at 35 percent of the construction costs, which makes the total project cost $18.3 million to $20.6 million.

7.2.4 Operation and Maintenance

It is anticipated the operating and maintenance of the intake, water treatment facility, and distribution system will be similar to the existing process. An annual increase of $10,000 is assumed to account for granular activated carbon replacement.

7.3 Purchase Finished Water from Yankton

The preliminary engineering report for the water treatment plant discussed alternatives for purchasing 0.33 MGD of water from Yankton during peak usage periods, with the remainder of the system demand being served by the existing water treatment plant (would not require plant expansion) with lesser amounts during the cold weather periods. Also discussed was an alternative to purchase all water (800 gpm) from Yankton.

For the purposes of this report, it is assumed the only alternative relative to purchasing water from the City of Yankton would be with the intent of purchasing all of the water from the City of Yankton.

7.3.1 Overall Capital Cost

The costs identified in the previous report have been adjusted to account for increased construction costs associated with the various facilities required to purchase water from the City of Yankton. While the identified capacity in which water would be purchased in the previous report was 800 gpm, the suggested line size of 12-inch will allow for an increased capacity of 1,050 gpm. The Missouri River crossing was originally an 8-inch crossing but will need to be increased to a 12-inch crossing to account for the increased capacity. The anticipated costs for the Missouri River crossing, approximately 65,000 feet of 12-inch PVC pipe, appurtenances, road crossings, stream crossings, a booster station, and telemetry upgrades is $5.0 to $5.2 million. The total project costs including engineering, construction observation, legal, and contingencies is in the range of $6.7 to $7.0 million.

7.3.2 Operation and Maintenance

It is estimated that the annual operating expenses will be reduced by approximately 35 to 37 percent due to the reduction in power, chemicals, and labor. For fiscal year 2019-20, this reduction is equivalent to $290,000 to $300,000. The purchase of water for Yankton needs to account for losses in the system, so the purchase amount would be equivalent to the quantity of water pumped from the existing water treatment plant. For fiscal year 2019-20, this amount was 122,156,000. At a purchase price of $3.38/1,000, the cost to purchase water from Yankton would be approximately $413,000. The cost figure of $3.38/1,000 was supplied by the City of Yankton for this report.

7.4 Develop Groundwater Supply and New Water Treatment Plant

7.4.1 Summary of Groundwater Search

Over the past several years the CKRWP has spent significant time and money working to identify potential groundwater supplies in areas of northeast Nebraska in and around the District. These searches have included aerial conductivity analysis, research and analysis of existing groundwater studies and test borings, and new test wells and test holes across the District providing data on both quality and quantity of water available.

The most recent test borings were completed in conjunction with Sue Lackey, a hydrologist with the Conservation and Survey Division in the School of Natural Resources at the University of Nebraska. As a part of the report, we have reviewed this information in conjunction with the previous data collected to help make a preliminary recommendation about the possible areas to seek a ground water supply for the District. The most recent field work and data collection was conducted in five (5) distinct areas across the water district. Those location are referred to as the Aten, Dolphin, Lindy, Menominee, and Obert target areas. These areas are shown in Figure 7-1. No screening will occur above 50.1 ft for these locations.

Figure 7-1. Groundwater Supply Target Areas

Figure 7-1 provided by Sue Lackey of the Conservation and Survey Division in the School of Natural Resources at the University of Nebraska

Aten – Missouri Alluvial
Dolphin – Quaternary S&G and Ogallala
Menominee – Quaternary S&G in narrow paleovalley
Lindy – Quaternary S&G
Obert – Quaternary S&G

Generalized characteristics of these five regions regarding ground water quality and quantity are highlighted in Table 7-1.

Table 7-1. Groundwater Search Data

Area	Quality				Quantity	Location
	Fe (µg/L)	Mn (µg/L)	Nitrates (mg/L)	Hardness (mg/L)		
Aten	< 300	> 2500	20 - 30	800 - 1300	Good volume with construction of a collector well	North Edge of District. Centrally located east to west.
Dolphin	< 300	210 - 540	< 2 lower screen 10 - 16 upper screen	300 - 500	Good volume with broader are to find aquifer	South of District. Centrally located east to west.
Lindy	< 300	< 50	8 - 10 (minimal data)	350	Low volume to north with irrigation wells to the south	West of District. Centrally located north to south.
Menominee	< 300	135	2 - 4	350 - 400	Potential for good volume but very narrow channel with potential for interference from other wells	East 1/2 of District. Centrally located north and south.
Obert	No data available at this time				Potential for good volume due to range of saturated thickness	South and East of District. Distance from any existing sizable infrastructure would make this location problematic.

From this preliminary data we can begin to draw some conclusions surrounding areas that may be more suitable for a potential ground water supply to serve the District's water demands over the coming years and decades. After reviewing this data, reviewing treatment options available and having discussions with Sue Lackey and District staff, the most reasonable areas to consider collecting additional water quality and quantity data from are either the Dolphin or Aten Area.

We have prepared a water supply scenario based on taking ground water from those 2 areas and constructing new WTPs in the vicinity to treat for the water quality issues at each site including potential nitrates, manganese, TDS, and relatively high hardness levels. The following estimates are based on these broad water treatment requirements and will continue to be modified over time as new water quality data is collected. Be aware that this recommendation is based on an analysis of this preliminary data and will require more focused test drilling, additional water quality data collection, and review before this option is fully understood. It is anticipated that additional testing costs would be in the range of $100,000 to $150,000.

7.4.2 Aten Site New Water Treatment Facility

Based on the preliminary water quality data available, the following is a list of constituents that will impact the selected treatment process:

- Manganese
- Nitrates (potential)
- Total Dissolved Solids (TDS)
- Hardness

The anticipated peak processing rate will be 1,050 gpm (1.5 million gallons over 24 hour, 1.26 million gallons over 20 hours). The treatment process would consist of the addition of potassium permanganate and/or chlorine (oxidants) into the raw water to oxidize manganese, followed by pressure filtration (to ensure manganese is lowered prior to RO), reverse osmosis membrane treatment for softening and nitrate removal, fluoride and chlorine addition prior to the approximately 500,000 gallons of finished water storage, and high service pumps. See Appendix C for a schematic diagram of the Aten Site WTP. The facility will include a separate storage area for the liquid chemicals. The layout of the building will include a control room and restrooms. Waste handling for RO concentrate will consist of assumed surface discharge to the Missouri river, filter backwash will be discharged to an on-site lagoon, and a septic system will be used to handle domestic waste. A key factor in the use of the Aten location will be the ability to discharge the RO concentrate to the Missouri River. If that is not possible, this location may be unfeasible. By using groundwater and a RO WTP, organics will be removed from the water thereby decreasing the production of disinfection byproducts. It is expected that this water supply will comply with Disinfection Byproducts Rules currently and for the foreseeable future. The anticipated construction costs for a new water treatment plant are in the range of $9.8 to $10.2 million. For a breakdown of the groundwater and WTP costs see Appendix D.

7.4.2.1 High Service/Transmission Piping

For estimating the high service/distribution piping, it is assumed the new water treatment plant will be located in an area west of Highway 81 just south of the new Missouri River bridge. The estimated distance of 12-inch PVC piping from the new water treatment facility to tie into the existing CKRWP distribution system is approximately 65,000 feet. The estimated cost for pipeline, appurtenances (valves, cleanouts, etc.), road crossings, stream crossings, and SCADA improvements is in the range of $3.0 to $3.5 million.

7.4.2.2 Overall Capital Costs

The overall construction costs for developing a new groundwater supply, raw water piping, new water treatment plant, and distribution piping is in the range of $12.8 to $13.7 million. The total project cost would include engineering, construction observation, legal, and contingencies. These costs are estimated at 35% of the construction costs, which makes the total project cost $17.3 to $18.5 million. The estimated costs indicated do not include the costs to purchase land to construct the new water treatment plant.

7.4.2.3 Operation and Maintenance

The main cost to the CKRWP would be the power costs associated with operating the groundwater wells to the new treatment facility and the feed pumps for the RO membrane. The proposed reverse osmosis process generates a concentrate waste stream, which will require extra raw/well water. To account for the 25% loss of water through the RO membranes, the total water pumped from the wells will be greater than the current water pumped for the existing water treatment plant. Waste disposal is anticipated to be handled by discharge to the Missouri River.

7.4.3 Dolphin Site Groundwater Supply and New Water Treatment Facility

Based on the preliminary water quality data available, the following is a list of constituents that will impact the selected treatment process:

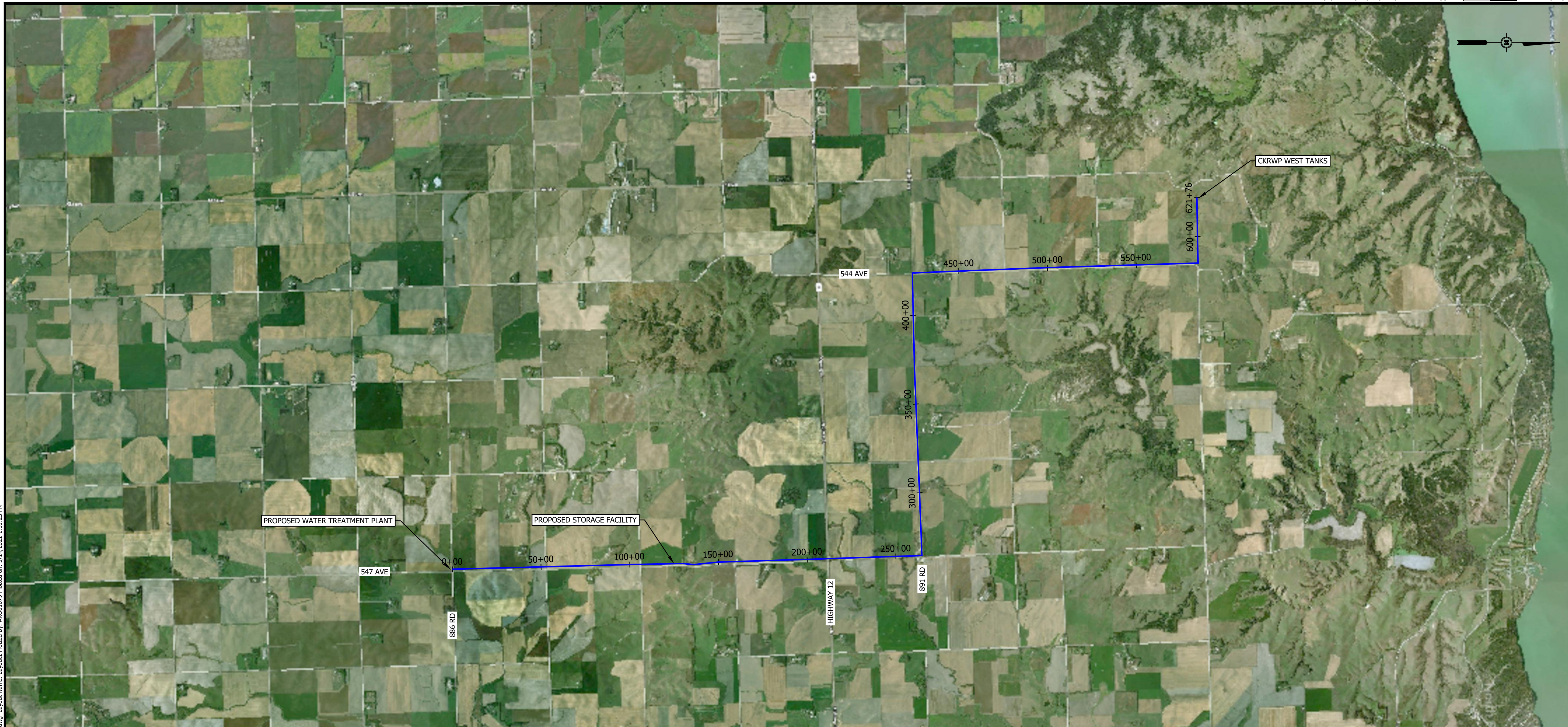
- Manganese
- Nitrates (potential)
- Total Dissolved Solids (TDS)
- Hardness

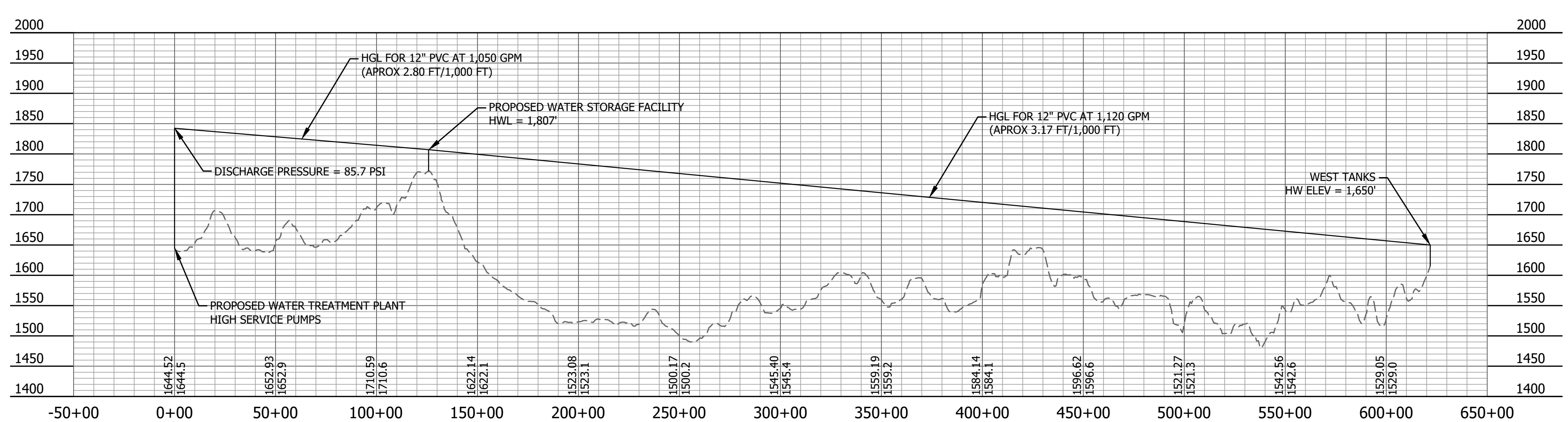
The anticipated peak processing rate will be 1,050 gpm (1.5 million gallons over 24 hour, 1.26 million gallons over 20 hours). The treatment process would consist of the addition of potassium permanganate and/or chlorine (oxidants) into the raw water to oxidize manganese, followed by high rate lime softening with the addition of soda ash, recarbonation, and media filtration, fluoride and chlorine addition prior to the approximately 500,000 gallons of finished water storage, and high service pumps. If nitrate removal becomes necessary additional equipment will be required for removal potential options include anion exchange, or biological removal at the head of the plant. See Appendix C for a schematic diagram of the Dolphin WTP. The facility will include a separate storage area for the liquid chemicals. The layout of the building will include a control room and restrooms. Waste handling (sludge blowdown from the clarifiers and backwash from the filters) will consists of the construction of a least two on-site lagoons, and a septic system to handle domestic waste. By using groundwater and a Lime Softening WTP, organics will be reduced thereby decreasing the production of disinfection byproducts. It is expected that this water supply will comply with Disinfection Byproducts Rules currently and for the foreseeable future. The anticipated construction costs for a new water treatment plant are in the range of $10.2 to $10.6 million. For a breakdown of the groundwater and WTP costs see Appendix D.

7.4.3.1 High Service/Transmission Piping

For estimating the high service/distribution piping, it is assumed the new water treatment plant will be located in an area generally described as the intersection of 547 Avenue and 886 Road. The transmission system was sized using peak day design capacity of 1,050 gpm. The estimated distance of 12" PVC piping from the new water treatment facility to the tie into the existing CKRWP distribution system is approximately 12 miles. Figure 7-2 highlights the proposed pipeline routing and hydraulic profile.

BAR IS ONE INCH ON OFFICIAL DRAWINGS. 0 1" IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY.





#	DATE	DESCRIPTION	BY

Bartlett & West

1200 SW EXECUTIVE DRIVE - TOPEKA KS - 66615
PH 785.272.2252 - FAX 785-228-6210
www.bartlettwest.com

PLAN AND HYDRAULIC PROFILE WATER TREATMENT PLANT GROUND WATER SUPPLY

WATER SYSTEM ANALYSIS AND DEVELOPMENT PLAN LEWIS & CLARK NATURAL RESOURCES DISTRICT CEDAR-KNOX RURAL WATER PROJECT

DESIGNED BY:	
DRAWN BY:	ARO
APPROVED BY:	
DESIGN PROJ:	19242.300
CONST PROJ:	
SCALE:	AS NOTED
DATE:	MAY 2021
DRAWING NO:	FIGURE 7-2
SHEET NO:	46

Also installed at the time of the pipeline improvements is the wellfield piping. Groundwater well pumps will utilize 8-inch diameter raw water piping to deliver water to the treatment plant. The costs for this portion of the project have been included with the transmission system cost estimate.

The estimated cost for pipeline, appurtenances (valves, cleanouts, etc.), road crossings, stream crossings, and SCADA improvements is in the range of $3.75 to $4.0 million.

7.4.3.2 Overall Capital Costs

The overall construction costs for developing a new groundwater supply, raw water piping, new water treatment plant, and distribution piping is in the range of $13.95 to $14.6 million. The total project cost would include engineering, construction observation, legal, and contingencies. These costs are estimated at 35% of the construction costs, which makes the total project cost $18.8 to $19.7 million. The estimated costs indicated do not include the costs to purchase land to construct the new water treatment plant.

7.4.3.3 Operation and Maintenance

The main cost to the CKRWP would be the power costs associated with operating the groundwater wells to the new treatment facility. Waste disposal is anticipated to be handled by large evaporative lagoons, or by hauling of concentrated waste off-site.

7.5 Summary of Costs

A comparison of the capital costs and the O&M costs aids in determining the most viable option for CKRWP. The capital improvement costs are based on the engineer’s opinion of probable costs as identified in previous sections. The O&M costs are based on production information for the fiscal year 2019-2020. During this period, the system pumped 128.9 million gallons from the intake, 122.1 million gallons were pumped from the water treatment plant, and 95.4 million gallons were sold to customers. The debt repayment is assuming a 40-year loan at an interest rate of 3%. Table 7-2 summarizes the costs.

Table 7-2. Summary of Capital and Annual O&M Costs

	HCW & WTP Imp	HCW & New WTP near South Yankton	Purchase Finished Water from Yankton	Aten Site Groundwater Supply & New WTP	Dolphin Site Groundwater Supply & New WTP
Capital Improvements	$14,700,000	$20,600,000	$7,900,000	$18,500,000	$19,700,000
Annual Debt Repayment	$635,957	$891,205	$341,773	$800,354	$852,269
Estimated Annual O&M	$855,000[1]	$855,000[1]	$550,000[2]	$830,000[3*]	$850,000[3]

1 Based on 2019-2020 expenses (not including amortization, depreciation, project improvements, replacement purchases, and system hook-up expenses) plus additional annual costs assumed for granular activated carbon replacement.
2 Does not include water purchased from City of Yankton.
3 Based on 2019-2020 expenses (not including amortization, depreciation, project improvements, replacement purchases, and system hook-up expenses)
* Decrease due to treatment process and reduced labor.

7.6 Financial Analysis

It is important for CKRWP to consider the long-term financial benefit versus the initial capital costs of each of the proposed supply options previously described. In order to understand this, a 40-year lifecycle analysis was completed for each supply option.

The lifecycle analysis assumes an annual inflation rate for operational costs at 3.1%, which represents the increase in operational costs between FY 2019-2020 and FY 2012-2013. The analysis also assumes an annual rate increase from the City of Yankton of 3%. Water production (purchased) quantities utilize the water projections presented in this report.

In addition to the financial comparison, CKRWP will need to consider the potential additional costs associated with unforeseen variables, such as more stringent water quality regulations that may cause a major expense in updating the treatment process or premature failure of parts of the system.

Figure 7-3. Present Value Cost / 1,000 Gallons Purchased or Produced

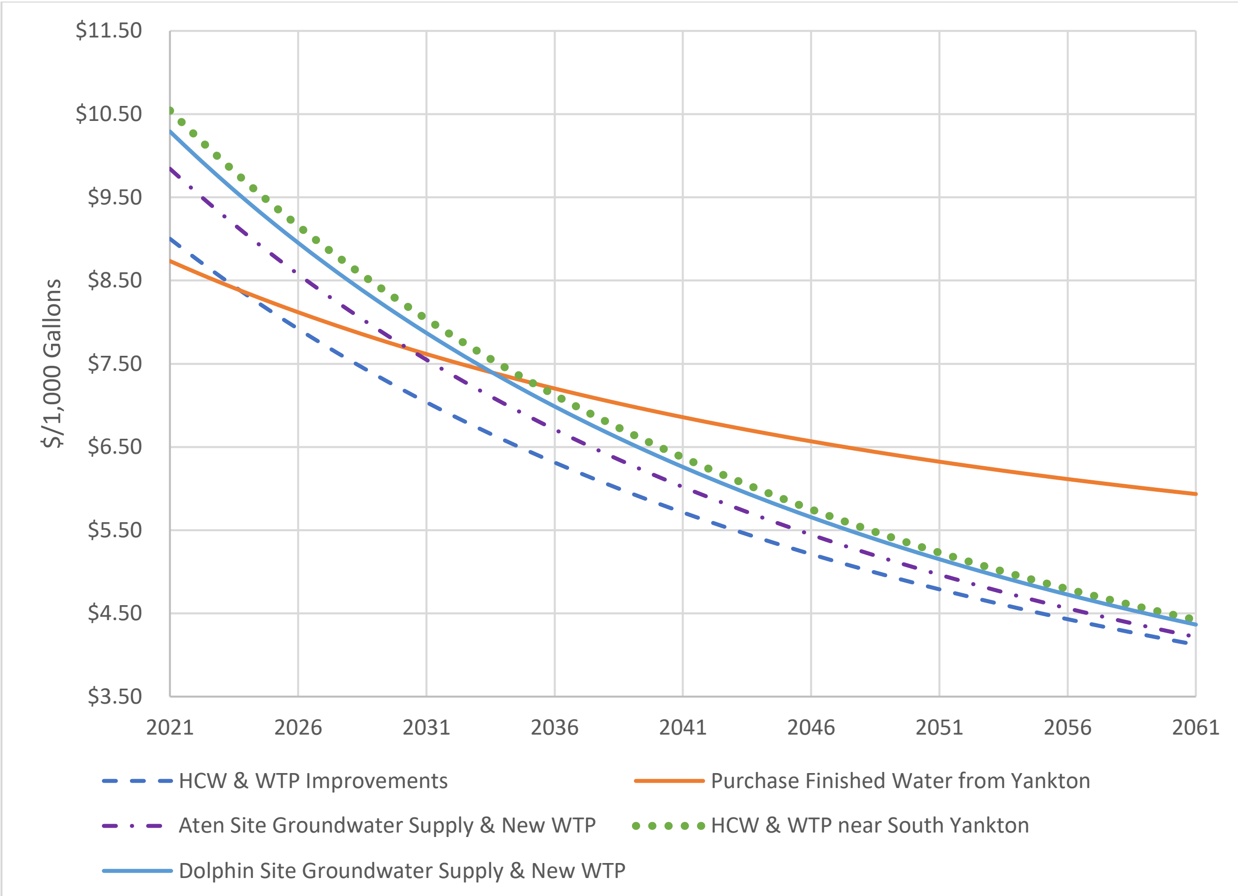
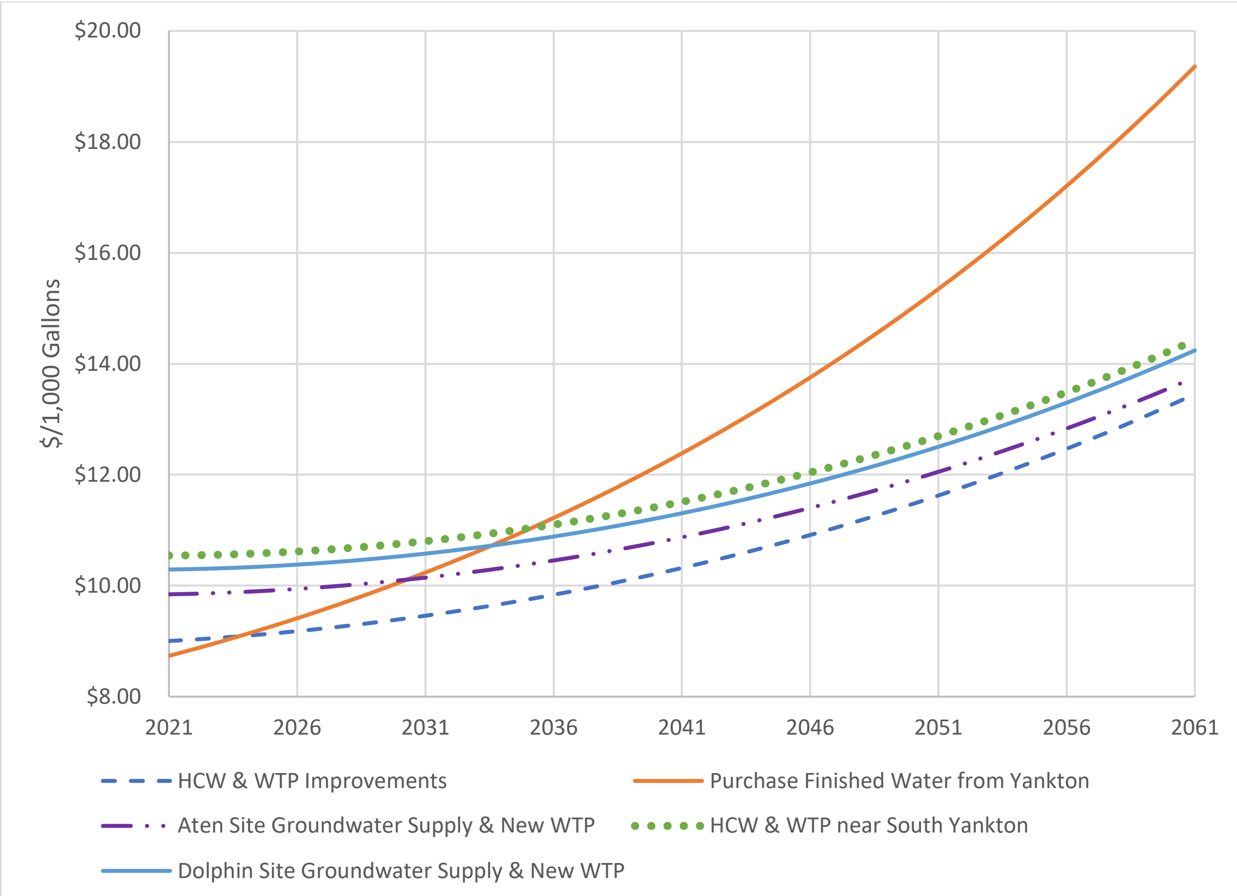


Figure 7-3 shows the cost, corrected to present value, for the three options discussed. Figure 7-4 shows the projected cost each year for water production or purchase in future dollars. The advantage shown in this picture is that economies of scale are seen when operating a treatment plant, but when purchasing water, there is little dilution of fixed costs, so increased water demand will not necessarily result in any increased efficiency.

Figure 7-4. Future Value Cost of Production or Purchase / 1,000 Gallons



8.0 FINANCIAL IMPACT

With nearly $2.5 million in improvements proposed over the next five years, and close to $5.8 million over the next ten years, the CKRWP may be faced with challenges in financing these projects. The District currently budgets for "project upgrades", or capital improvement, with approximately $110,000 budgeted in FY 2019-2020. These funds could be used to defray new construction or to fund small improvement projects as a strategy to minimize rate increases. The immediate, five-year, and ten-year incremental improvements will likely need a portion to be funded over several years. The least impact on water rates would be through a 40-year USDA loan, with interest rates currently around 1.5 – 2.0 percent. Table 8-1 on the following page illustrates the financial burden.

Table 8-1 is a summary of future projects, their cost, annual loan payment for those financed, annual deposits to a capital improvement fund, and the impact on water rates. It is assumed that the current budgeted allotment for capital improvements of roughly $100,000 annually. The amount listed in the "deposit to capital improvement fund" are amounts required in addition to the budgeted $100,000. The two columns on the far right show the necessary increase in monthly minimum or increase in water rate necessary to recover the new debt. Due to the high bulk usage in the water system, the CKRWP may consider a balance between an increase in the monthly minimum and the water rate to recover expenses.

For example, referring to only increasing the monthly minimum, currently set at $40 per month, would need to be increased by roughly $3.50 initially, then by another $3.25 over the next five years. Annual rate increases of 2.5 percent are proposed over the next ten years. After that, annual rate increases of under 1.5 percent are shown. It is important to note that inflationary adjustments are not included in this analysis and would still be required as they occur.

CEDAR KNOX RURAL WATER PROJECT

Table 8-1. Improvement and Budgeting Schedule

Year	Improvement Project	Estimated Construction Cost, present day values	Portion Financed through Loan*	Portion Paid from Cap. Improv. Fund	Deposit to Capital Improve. Fund	New Loan Payment, assume USDA	Year-End Cap. Improv. Fund Balance	Monthly Minimum Increase above Present	Monthly Rate Increase above Present	Rate Increase above Present
							$110,000			
2022	New Elevated Storage Tank	$405,000	$295,000	$110,000		$12,762	$0	$0.97	$0.09	2.4%
2022	12" Improvement along 550th Ave between 894 RD & 895 RD	$346,000	$346,000			$27,731		$2.10	$0.20	5.1%
2022	12" Improvement along 895 RD between 550 Ave & 553 Ave	$1,046,000	$1,046,000			$72,984		$5.53	$0.52	13.5%
2022	6" Improvement along 553rd Ave between 895 RD & 896 RD	$138,000	$138,000			$78,954		$5.98	$0.57	14.6%
2022	4" Improvement along Esther St & Oak St	$17,000	$17,000			$79,689		$6.04	$0.57	14.7%
2022	4" Improvement along Oak Ridge Rd	$29,000	$29,000			$80,944		$6.13	$0.58	15.0%
2022	6" Improvement along 553 Ave between 896 Rd & 897 Rd	$189,000	$189,000			$89,120		$6.75	$0.64	16.5%
2022	8" Improvement along 549 Ave	$112,000	$112,000			$93,966		$7.12	$0.67	17.4%
2022	6" Improvement along 897 Rd between 897 Rd & 554 Ave	$239,000	$239,000			$104,306		$7.90	$0.75	19.3%
2022	TOTAL	$2,521,000	$2,411,000	$110,000		$104,306	$0	**$7.90**	$0.75	19.3%
2026	Booster 1 Improvements	$135,000		$135,000	$550,000	$104,306	$415,000	$7.44	$0.75	18.2%
2026	8" Improvement along 895 RD between Tank 2 & 560 Ave	$169,000		$169,000		$104,306	$246,000	$7.44	$0.75	18.2%
2026	6" Improvement along 557 Ave between 892 RD & 891 RD	$163,000		$163,000		$104,306	$83,000	$7.44	$0.75	18.2%
2026	6" Improvement along 557 Ave between 895 RD & 894 RD	$157,000	$74,000	$83,000		$107,507	$0	$7.67	$0.75	18.7%
2026	6" Improvement along 557th Ave between 893 RD & 892 RD	$154,000	$154,000			$114,169	$0	$8.15	$0.77	19.9%
2026	TOTAL (reflects savings in production cost with new wells)	$778,000	$228,000	$550,000		$114,169	$0	**$8.15**	$0.77	19.9%
2031	12" Improvement along 895 RD between 553 Ave & 557 Ave	$1,404,000	$854,000	$550,000	$550,000	$151,115	$0	$10.01	$0.95	24.4%
2031	8" Improvement along 560 Ave & 894 Rd	$297,000	$297,000	$0	$0	$163,964	$0	$10.86	$1.03	26.5%
2031	6" Improvement along 894 Rd near 561st Ave	$112,000	$112,000	$0	$0	$168,810	$0	$11.18	$1.06	27.3%
2031	6" Improvement along 557 Ave between 892 Rd & 893 Rd	$169,000	$169,000	$0	$0	$176,121	$0	$11.67	$1.11	28.5%
2031	TOTAL	$1,982,000	$1,432,000	$550,000		$176,121	$0	**$11.67**	$1.11	28.5%
2036	6" Improvement along 894 Rd between 562 Ave & 563 Ave	$221,000		$221,000	$550,000	$176,121	$329,000	$10.83	$1.10	26.4%
2036	4" Improvement along 891 Rd between 557 Ave & Hwy 81	$119,000		$119,000		$176,121	$210,000	$10.83	$1.10	26.4%
2036	Total	$340,000	$0	$340,000		$176,121		**$10.83**	$1.03	26.4%

9.0 SUMMARY

With a history of residential growth and large users, the Cedar Knox Rural Water Project is nearing capacity in several aspects of the water system. Immediate improvements are recommended to address these deficiencies. Approximately $2.6 million in new construction is recommended over the next five years. However, the improvements improve the service and reliability to a large portion of the existing customers in the system. This report identified improvements in five-year increments, generally described as follows:

Year	Project Cost
2022	$1,062,180
2026	$1,523,475
2031	$3,207,870
2036	$579,285

Without these improvements, the CKRWP is vulnerable to loss of service to customers in emergencies or under peak demand conditions. It will also be difficult to accommodate growth with the current hydraulic limitations.

Rates would have to be increased by about 16% over the next five years to assist in financing the proposed construction, equal to about $6.75 per month, on average, for each customer.

High priority should be given to the CKRWP water supply alternatives. Based on the historical and project water usage, the demands of the system will reach or exceed the existing water treatment plant's capacity in the next five to seven years. The direction that the CKRWP proceeds in terms of water supply will be crucial in order to continue to provide water to existing customers. This report identified four water supply improvement alternatives, generally described as follows:

Supply Alternative	**Project Cost**
Horizontal Collector Well & Water Treatment Plant Improvements	$14,700,000
Horizontal Collector Well & New Water Treatment Plant near South Yankton	$20,600,000
Purchase Finished Water from Yankton	$7,900,000
Aten Site Groundwater Supply & New Water Treatment Plant	$18,500,000
Dolphin Groundwater Supply & New Water Treatment Plant	$19,700,000

Based on the water quality at each of the potential locations, the treatment processes reviewed, and the overall impact on rates, we recommend the groundwater supply at the Dolphin Site and treatment with a high-rate lime softening process followed by filtration, described in Section 7.4.3. See the *Water Supply & Water Treatment Plant Site Selection Memorandum* in Appendix E. If the CKRWP decides to pursue this recommended water supply option, the next step will be to complete additional groundwater testing in the Dolphin area and have a detailed design memo prepared.

With the completion of this study, the CKRWP has a valuable resource to guide future activities. The hydraulic model will be maintained by Bartlett & West and can be analyzed or updated regularly. Collaboration can and should occur prior to any specific improvement is initiated.

APPENDIX A

PUMPING CAPACITY ANALYSIS

Pumping Capacities, Existing System

Pump Station Facility	Firm Flow Rate Capacity (GPM)	18 Hour Capacity (Gallons)	2021 Projected Peak Day (Gallons)	Percent of Capacity (%)
Treatment Plant Pumps	1,050	1,134,000	907,548	80.0%
Booster 1	140	151,200	161,763	107.0%
Booster 2	110	118,800	83,060	69.9%
Booster 3	100	108,000	56,458	52.3%

Pumping Capacities, Immediate Improvements

Pump Station Facility	Firm Flow Rate Capacity (GPM)	18 Hour Capacity (Gallons)	2021 Projected Peak Day (Gallons)	Percent of Capacity (%)
Treatment Plant Pumps	1,050	1,134,000	907,548	80.0%
Booster 1	140	168,000[A]	161,763	96.3%
Booster 2	110	118,800	83,060	69.9%
Booster 3	100	108,000	56,458	52.3%

[A]168,000 gallons based on 20 hour pump day

Pumping Capacities, 5-Year Improvements

Pump Station Facility	Firm Flow Rate Capacity (GPM)	18 Hour Capacity (Gallons)	2026 Projected Peak Day (Gallons)	Percent of Capacity (%)
Treatment Plant Pumps	1,050	1,134,000	974,108	85.9%
Booster 1	200[A]	216,000	171,816	79.5%
Booster 2	110	118,800	88,278	74.3%
Booster 3	100	108,000	59,793	55.4%

[A]200 gpm based on booster pump station improvements

Pumping Capacities, 10-Year Improvements

Pump Station Facility	Firm Flow Rate Capacity (GPM)	18 Hour Capacity (Gallons)	2031 Projected Peak Day (Gallons)	Percent of Capacity (%)
Treatment Plant Pumps	1,050	1,134,000	1,040,667	91.8%
Booster 1	200	216,000	181,868	84.2%
Booster 2	110	118,800	93,997	79.1%
Booster 3	100	108,000	63,128	58.5%

Pumping Capacities, 15-Year Improvements

Pump Station Facility	Firm Flow Rate Capacity (GPM)	18 Hour Capacity (Gallons)	2036 Projected Peak Day (Gallons)	Percent of Capacity (%)
Treatment Plant Pumps	1,050	1,134,000	1,107,226	97.6%
Booster 1	200	216,000	191,921	88.9%
Booster 2	110	118,800	99,215	83.5%
Booster 3	100	108,000	66,463	61.5%

APPENDIX B

STORAGE CAPACITY ANALYSIS

Storage Facility Capacities, Existing System

Storage Facility	Type	Capacity (Gallons)	Usable Storage (Gallons)	Operational Storage (Gallons)	Peak Equalization Storage (Gallons)	Emergency Storage (Gallons)
West Tanks	Ground Storage	318,775	318,775	63,755	0	255,020
Tank 2	Ground Storage	59,812	38,280	11,963	10,800	15,517
Tank 3	Standpipe	233,000	51,778	51,778	4,800	-4,800

Storage Facility Capacities, Immediate Improvements

Storage Facility	Type	Capacity (Gallons)	Usable Storage (Gallons)	Operational Storage (Gallons)	Peak Equalization Storage (Gallons)	Emergency Storage (Gallons)
West Tanks	Ground Storage	318,775	318,775	63,755	0	255,020
Tank 2	Ground Storage	59,812	38,280	11,963	10,800	15,517
Tank 3	Elevated Storage	75,000	75,000	22,500	4,800	47,700

Storage Facility Capacities, 5-Year Improvements

Storage Facility	Type	Capacity (Gallons)	Usable Storage (Gallons)	Operational Storage (Gallons)	Peak Equalization Storage (Gallons)	Emergency Storage (Gallons)
West Tanks	Ground Storage	318,775	318,775	63,755	0	255,020
Tank 2	Ground Storage	59,812	38,280	11,963	11,300	15,017
Tank 3	Elevated Storage	75,000	75,000	22,500	5,500	47,000

Storage Facility Capacities, 10-Year Improvements

Storage Facility	Type	Capacity (Gallons)	Usable Storage (Gallons)	Operational Storage (Gallons)	Peak Equalization Storage (Gallons)	Emergency Storage (Gallons)
West Tanks	Ground Storage	318,775	318,775	63,755	7,900	247,120
Tank 2	Ground Storage	59,812	38,280	11,963	12,100	14,217
Tank 3	Elevated Storage	75,000	75,000	22,500	6,700	45,800

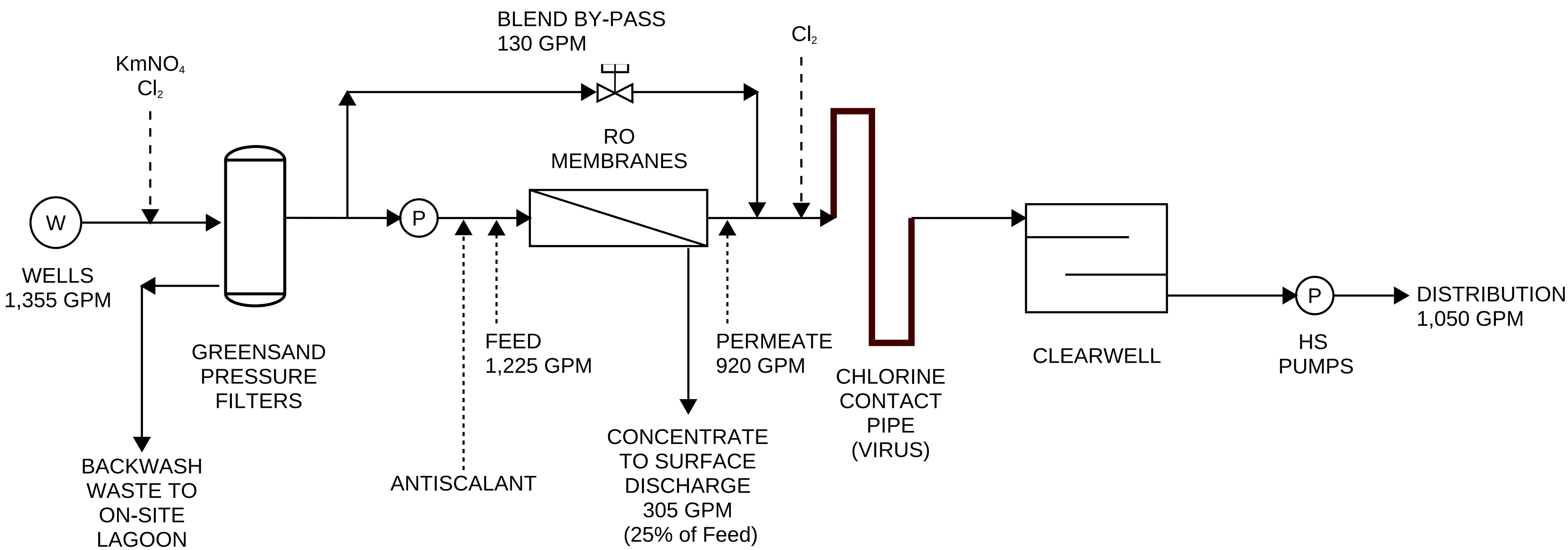
Storage Facility Capacities, 15-Year Improvements

Storage Facility	Type	Capacity (Gallons)	Usable Storage (Gallons)	Operational Storage (Gallons)	Peak Equalization Storage (Gallons)	Emergency Storage (Gallons)
West Tanks	Ground Storage	318,775	318,775	63,755	17,700	237,320
Tank 2	Ground Storage	59,812	38,280	11,963	13,000	13,317
Tank 3	Elevated Storage	75,000	75,000	22,500	7,700	44,800

APPENDIX C

Water Treatment Plant Schematics

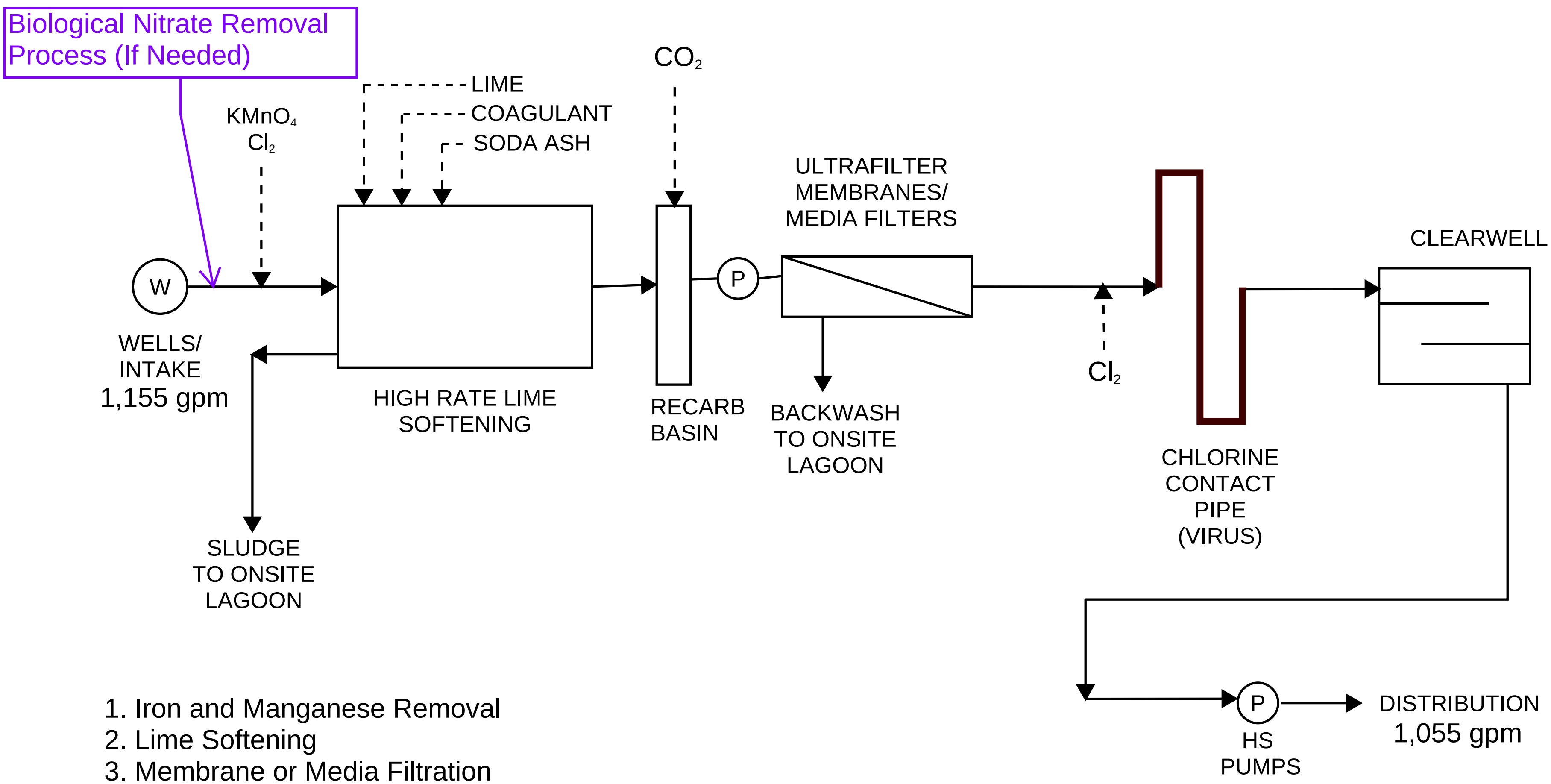
SCHEMATIC NO. 1
ATEN SITE GROUNDWATER FOR 1.5 MGD FINISHED WATER SUPPLY



1. Iron and Manganese Removal
2. RO Membrane Softening
3. RO Membrane Nitrate Removal
4. Modular Allows for Ease of Expansion

Bartlett&West

SCHEMATIC NO. 2
DOLPHIN SITE GROUNDWATER FOR 1.5 MGD WATER SUPPLY



1. Iron and Manganese Removal
2. Lime Softening
3. Membrane or Media Filtration
4. Pre-Manufactured Tanks and Modular Filters

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APPENDIX D

Groundwater Supply & Water Treatment Plant Cost Estimates

Aten Site Groundwater and WTP		
GENERAL REQUIREMENTS	$	460,000.00
CONCRETE	$	880,000.00
METALS	$	440,000.00
WOOD, PLASTICS & COMPOSITES	$	20,000.00
THERMAL AND MOISTURE PROTECTION	$	50,000.00
OPENINGS	$	66,000.00
FINISHES & DIVISION 10 - SPECIALTIES	$	210,000.00
SPECIALTIES	$	210,000.00
FURNISHINGS	$	25,000.00
PLUMBING	$	200,000.00
HEATING, VENTILATING AND AIR-CONDITIONING	$	420,000.00
ELECTRICAL	$	1,100,000.00
EARTHWORK	$	200,000.00
EXTERIOR IMPROVEMENTS	$	150,000.00
UTILITIES	$	350,000.00
PROCESS INTEGRATION	$	1,100,000.00
PROCESS GAS & LIQUID HANDLING, PURIFICATION, & STORAGE EQUIPMENT	$	350,000.00
WATER EQUIPMENT	$	2,300,000.00
Well Field	$	600,000.00
HSPS/Clearwell	$	950,000.00
Construction Total	$	10,000,000.00

Dolphin Site Groundwater and WTP		
GENERAL REQUIREMENTS	$	460,000.00
CONCRETE	$	980,000.00
METALS	$	440,000.00
WOOD, PLASTICS & COMPOSITES	$	20,000.00
THERMAL AND MOISTURE PROTECTION	$	50,000.00
OPENINGS	$	66,000.00
FINISHES & DIVISION 10 - SPECIALTIES	$	210,000.00
SPECIALTIES	$	1,000.00
FURNISHINGS	$	25,000.00
PLUMBING	$	200,000.00
HEATING, VENTILATING AND AIR-CONDITIONING	$	420,000.00
ELECTRICAL	$	1,100,000.00
EARTHWORK	$	300,000.00
EXTERIOR IMPROVEMENTS	$	150,000.00
UTILITIES	$	350,000.00
PROCESS INTEGRATION	$	1,100,000.00
PROCESS GAS & LIQUID HANDLING, PURIFICATION, & STORAGE EQUIPMENT	$	1,300,000.00
WATER EQUIPMENT	$	1,700,000.00
Well Field	$	600,000.00
HSPS/Clearwell	$	950,000.00
Construction Total	$	10,400,000.00