JEO CONSULTING GROUP

2020 Amendment #1 to Water System Preliminary Engineering Report

City of David City, Nebraska
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City of David City, Nebraska 2020 Amendment No. 1 to Water System Preliminary Engineering Report

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FOR THE
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SECTION 1

1 General

1.1 Introduction

The following report provides an amendment to a previously completed review of the water treatment system as prepared by Olsson in the 2020 Water Treatment Facility Evaluation. The focus of this review is to evaluate the existing water treatment system and components and to provide additional alternatives to supplement the alternatives presented in the previous report. Finally, this report provides recommendations for improvements, opinions of probable constructions cost(s), and opinions of added operational and maintenance (O&M) costs (if significantly different than the current O&M expenses), for the improvements to assist the city in planning and budgeting.

Recommendations for water system improvements will meet the city's projected water needs for a 20-year planning period through the year 2040.

1.2 Elements of a Public Water System

A public water supply system (PWS) is defined as a system that provides piped water for human consumption to at least 15 service connections or regularly serves at least 25 individuals. All public water supplies are required, by the Safe Drinking Water Act and Nebraska law, to be tested on a scheduled basis for potentially harmful contamination. There are specific requirements for which contaminants must be checked and the frequency of testing.

A public or municipal water system consists of numerous components that are combined to provide a community with water at the pressure, quantity, and quality necessary to meet the user's needs and the standards established by the Nebraska Department of Health and Human Services (DHHS). The primary components consist of a water source, storage tank, and distribution system.

A municipal water system provides two essential services to the community. The service that is most commonly associated with the municipal water system is providing high quality domestic, commercial, and industrial water for everyday use by the consumers. This function requires that water be chemically and bacteriologically safe for consumption. Secondly, the supply, pumping, distribution, and storage facilities must be capable of delivering sufficient quantities of water to meet the user's demands at an acceptable pressure.

The main focus of this report will be to evaluate the city's existing water treatment facility and provide additional alternatives to meet the city's goals of ease of use, reliability, and high quality water for its users. No water supply evaluations nor water distribution system evaluations are included in this amendment. Such additional evaluations have already been completed in the referenced Olsson Study.

1.3 Geographical Location

The city is located in the center of Butler County which borders the Platte River in the eastern portion of Nebraska. The city has primary access to State Highway 15 and is approximately 3 miles north of Highway 92.

Figure 1-2: Aerial Photograph of David City, Nebraska is also provided for visual reference of the area. The city is located in a predominantly agricultural area.

Figure 1-1: Aerial Photograph of David City, Nebraska

1.4 Environmental Resources Present & Environmentally Sensitive Areas

The majority of the surrounding area around the city is agricultural farmland. Keysor Creek runs through the City Park, located in the southern part of the city. While a formal environmental review has not been completed at the time of this report, it is believed that no significant environmental resources exist within the planning area.

1.4.1 Flood Plain Considerations

The City of David City does participate in National Flood Insurance Program (NFIP). The NFIP is a national organization that assists communities to reduce flood losses and disaster relief costs by guiding future development away from flood hazard areas where practical; by requiring flood resistant design and construction practices; and by transferring the costs of flood losses to the residents of floodplains through flood insurance premiums. In return for availability of federally backed flood insurance, communities applying to join the NFIP must agree to adopt and enforce minimum flood loss reduction standards to regulate proposed development in special flood hazard areas as defined by the Federal Emergency Management Agency's (FEMA) flood maps.

A FEMA designated floodplain map for the portion of the community near the existing water treatment plant is included below in **Figure 1-2: City of David City FIRM**. As can be seen, the existing water plant is not located in any mapped floodplain area.

If any structures are developed in an existing floodplain or floodway, they shall meet the "Minimum Standards for Floodplain Management Programs" as prescribed by the Nebraska Department of Natural Resources (DNR). If the construction of structures within the existing floodway is performed, it will not be permitted without showing that there will be no increase in water surface elevations along the floodway profile during the occurrence of a base flood.

Figure 1-2: City of David City FIRM

1.4.1 Historic Places and Archaeological Review

Three locations within the City of David City are listed in the National Register of Historic Places; the David City Park and Municipal Auditorium, Chauncey S. Taylor House, and Thorpe's Opera House. None of these properties is expected to be disturbed by an improvement project. In addition, there are no known significant archaeological properties within the city.

1.4.2 Groundwater

Groundwater is principally available in the area two primary aquifers, shallower alluvial deposits and the deeper Dakota Sandstone aquifer. A summary of these aquifers has been provided in the referenced report.

1.4.3 Surface Water

As previously indicated, Keysor Creek is the primary surface water feature located within the community. The closest major river within the region is the Platte River located approximately 9 miles north of the community. Water quality of local streams/tributaries is typical of that found in rural Nebraska, with elevated levels of nitrate contamination due to the agricultural practices within the area.

1.4.4 Soils

The soils in the area are principally of the Hastings Silt Loam and Hastings Silty Clay Loam type. This soil consists of moderately to highly well drained, permeable soils on uplands. The soil is typically silty clay loam, or silty loam. The soils are rarely flooded. Groundwater depths are typically far below the surface.

1.4.5 Plant and Animal Communities

A review of the Threatened and Endangered Species list showed the Pallid Sturgeon, Interior Least Tern, and the Whooping Crane as endangered species listed in the area. The threatened species listed to may exist near the city are the Piping Plover and River Otter.

1.4.6 Agricultural Areas

The area surrounding the city is primarily used as agricultural farmland. In addition, much of the surrounding land is currently farmed and designated as "Prime Farmlands" outside the city limits.

1.5 Population Trends

1.5.1 Historical City Population

A review of historical populations for a community is completed to identify population trends and help aid in projecting future growth. For this report, projected populations are also used to estimate future water demands, which will then help to determine whether the city will be prepared to serve its users with the necessary amount of water.

Gathered from a combination of both the Nebraska Department of Economic Development (NeDED) and U.S. Census, the historical populations for the city are shown in **Table 1-1: City of David City Population History (1940-2010)** below by the decade.

Table 1-1: City of David City Population History (1900-2010)

City of David City			
Year	Population	Change	Annual Percent Change
1940	2,272	-	-
1950	2,321	49	0.21%
1960	2,304	-17	-0.07%
1970	2,380	76	0.32%
1980	2,514	134	0.53%
1990	2,522	8	0.03%
2000	2,597	75	0.29%
2010	2,906	309	1.06%

Reviewing the historical populations for the city and county indicates that the population has been steady to slightly growing since 1940.

1.5.2 Projected Population

The referenced report suggests utilizing a 2040 population projection of 3,435. This value will be used in this amendment.

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SECTION 2

2 Existing Facilities and Conditions

The purpose of this section of the report is to conduct an engineering evaluation of the number of users, water usage, and the components of the water system.

The design criteria, materials, and equipment evaluated in this report and included in the final project design shall meet the requirements of State and Federal laws and regulations, including:

- Nebraska Department of Health Regulations Governing Public Water Supply Systems – Title 179 NAC2
- Great Lakes Upper Mississippi River Board of State Health and Environmental Managers Recommended Standards for Water Works (Ten State Standards)

2.1 Water System Users

As presented in the original report, there are a total of 1,269 existing water users on the city's distribution system. In addition, the city serves as a water supply source for the Lower Platte North NRD rural water district which provides water to the Village of Bruno.

2.2 Historic Water Usage

The water volume produced at the water plant as reported by the previous study is an annual average of pumpage of approximately 186.2 million gallons or an average day demand of approximately 522,000 gpd.

2.3 Existing Facilities Overview

The city owns and operates water supply and treatment facilities currently consisting of a water treatment facility, 6 groundwater supply wells, 500,000-gallon underground clearwell storage tank, 750,000-gallon elevated water storage tank, and a range of 2" to 12" diameter water distribution mains.

2.3.1 Water Supply

The water supply for the city is currently provided by four active municipal groundwater wells and additional wells that are planned to be formally abandoned. Most of the wells are located within the city limits. The active wells have a total pumping capacity of 3,700 gpm (5.328 MGD) or 2,600 gpm (3.744 MGD) with the largest well out of service. The existing wells are assumed to be in satisfactory condition and will not be further evaluated in this amendment.

2.3.2 Water Treatment Facilities

The city owns and operates a lime softening plant that is located in the east side of the city, along E Street. The plant was commissioned in 1982. The plant has a design capacity of approximately 1,800 gpm or 2.6 MGD. The following are the major components of the treatment plant:

- Aerator
- Solids Contact Basin (Upflow Unit)
- Recarbonation Basin
- Dual Media Gravity Filters
- Clearwell
- High Service Pumps
- Chemical Feed Systems
- Lime Sludge Pumps
- Backwash Water Recovery
- Lime Sludge Dewatering

2.3.3 Water Storage Facilities

The city currently utilizes two (2) water storage tanks; the buried concrete reservoir (clearwell) at the water treatment plant and an elevated water storage tank on the north side of the city.

The clearwell at the treatment plant has a capacity of approximately 500,000 gallons. The existing elevated tank is located near Road N approximately 1,250 feet north of the intersection of 11th Street and O Street. The tank was constructed in 2005 with a nominal storage capacity of approximately 750,000 gallons.

An additional elevated tank is located at 11th Street and F Street, just west of the electric plant. The tower has a volume of 125,000 gallons and was constructed in 1936; however, it is not connected to the current water system. The existing tower is currently used to house communication antenna(s).

2.3.4 Water Distribution System

The original water distribution system for the city consisted of 4” diameter unlined cast iron pipe and was likely installed in the early 1900’s (there are no immediate records of the original installation date). The city has been removing and replacing the 4” diameter unlined cast iron water mains with 8” or larger PVC water mains.

2.4 Water Supply

2.4.1 Construction and Condition

2.4.1.1 Existing Construction

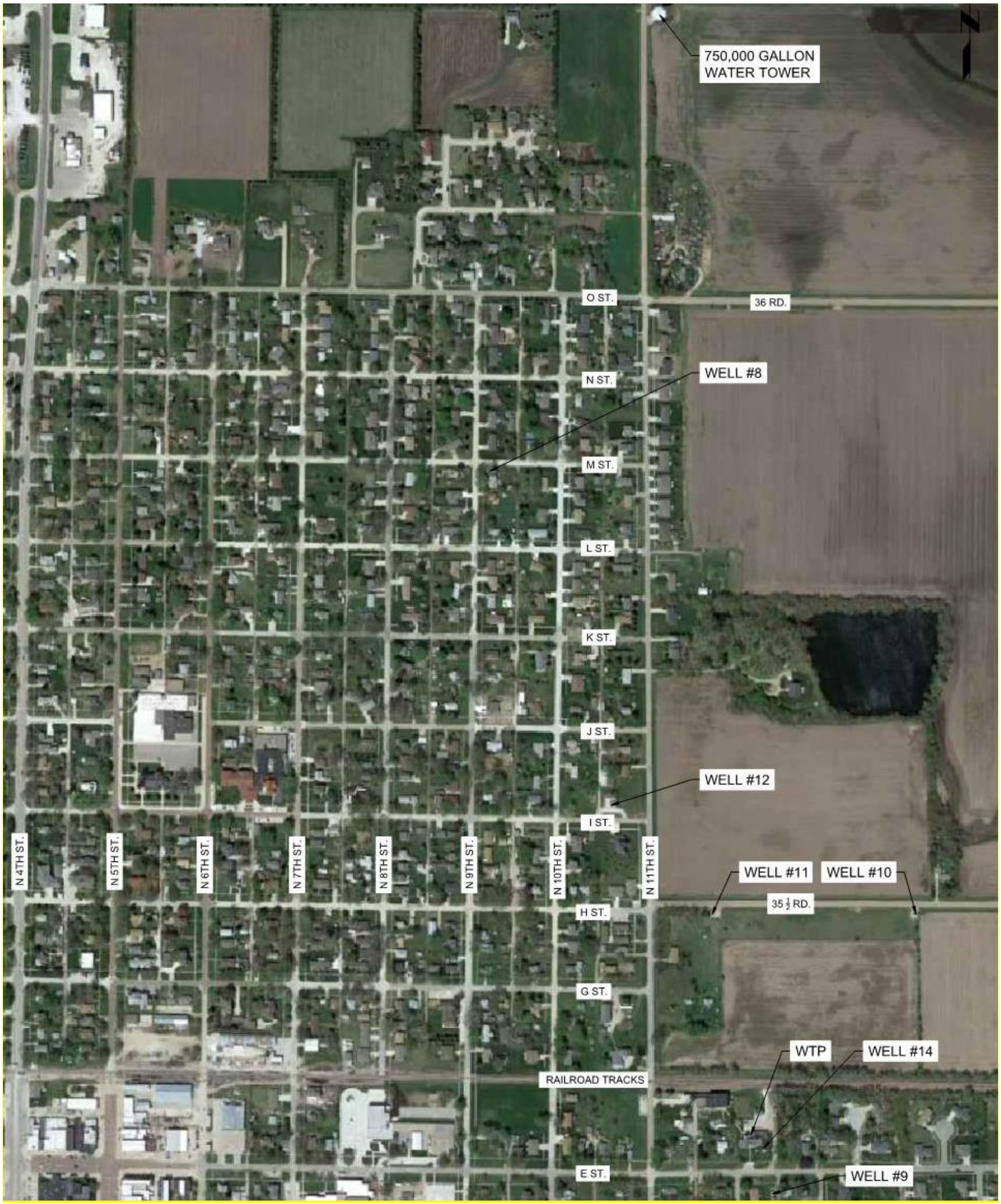
The City of David City currently utilizes four wells for primary groundwater supply, each with varying pumping capacity from 800 gpm to 1,100 gpm. Each well serves as the primary supply well on rotating intervals. If the wells are operated simultaneously, they would provide an estimated pumping capacity of approximately 3,700 gal/min.

Table 2-1: Municipal Well Information is a compilation of the information that has been provided regarding the construction of the wells for the City.

Table 2-1: Municipal Well Information

Well No.	**8**	**9**	**10**	**11**	**12**	**14**
ID No.	66-1	72-1	79-1	2002-1	2009-1	2009-2
State Registration No.	G-027410	G-076215	G-064350	G-130267	G-154854	G-154855
Street Location	9th and M Street	E Street	35 1/2 Road	35 1/2 Road	11th and I Street	E Street
Year Drilled	1966	1972	1979	2002	2009	2009
Well HP	50	50	75	75	150	125
Depth (ft)	405	431	425	427	508	427
Design Capacity (gpm)	300	350	800	800	800	800
Current Capacity (gpm)	NA	NA	800	850	1,100	950
Casing	12"	12"	16"	16"	18"	18"
Top of Screen (ft)	355	381	378	330	354	305
Status	Inactive	Inactive	Active	Active	Active	Active

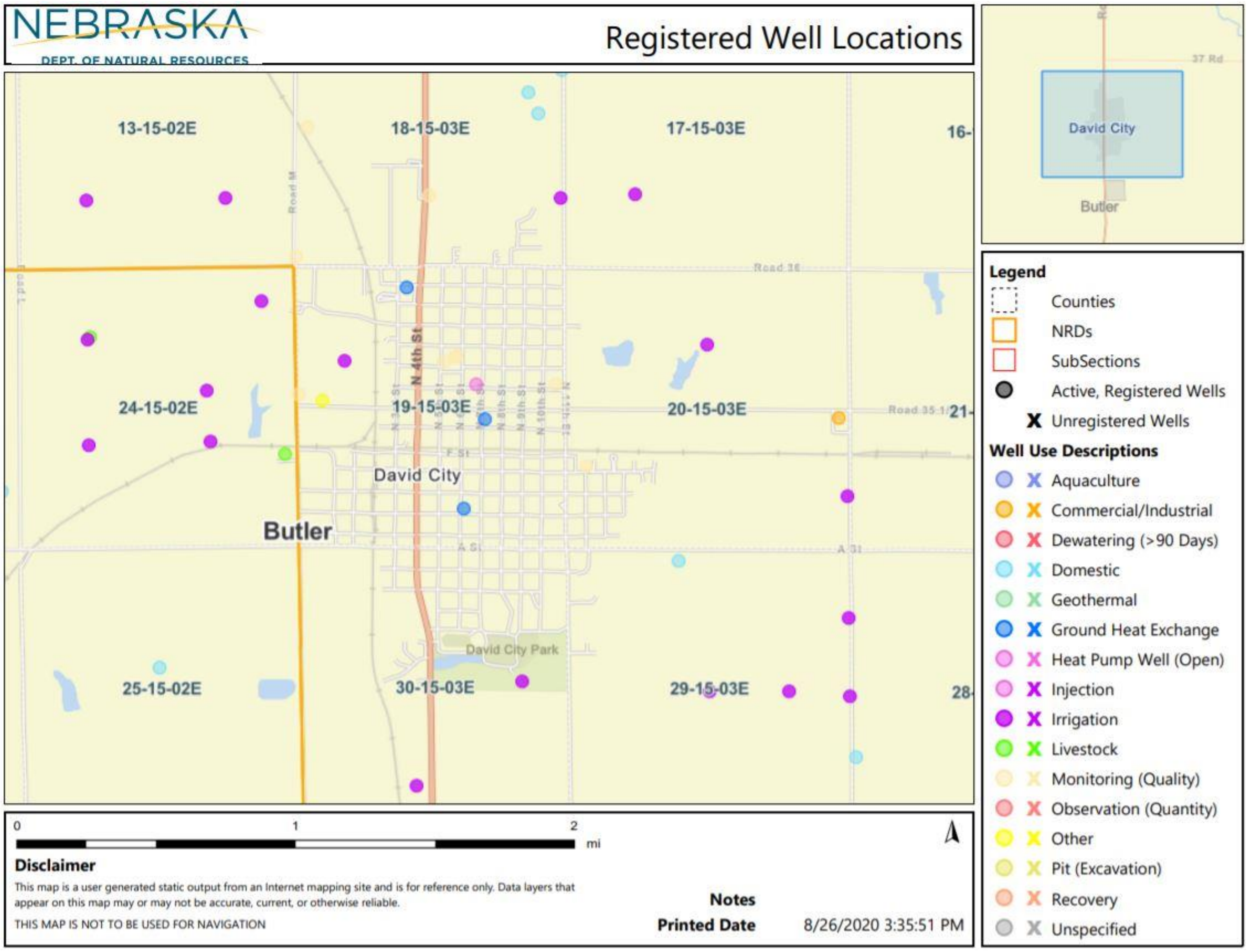
Figure 2-1: Existing Well Locations



2.4.2 Water Quantity

With exception of public water supply wells, the location and design information of all registered wells in and around David City are available from the Nebraska Department of Natural Resources (DNR) public information. **Figure 2-2: Registered Well Locations** illustrates the general location of registered wells in the area around the city. Please note that there may be other wells that are located in the area but are not registered with the DNR.

Figure 2-2: Registered Well Locations



2.4.3 Raw Water Quality

The quality of natural groundwater varies dramatically throughout Nebraska. The materials it must pass through on its way to and within the groundwater aquifers affect the water's natural quality. In some areas, the groundwater contains minerals in concentrations high enough to warrant treatment before domestic uses.

The EPA uses primary and secondary standards to distinguish between contaminants in water. Primary standards are set to provide the maximum feasible protection to public health. They regulate contaminant levels based on toxicity and adverse health effects. The goal of standard setting is to identify maximum contaminant levels (MCLs) which prevent adverse health effects. Secondary standards regulate contaminant levels based on aesthetics such as color and odor, which do not pose a risk to health. These secondary maximum contaminant levels (SMCLs) are guidelines, not enforceable limits. They identify concentrations of contaminants which cause unpleasant tastes, odors, or colors in the water. SMCLs are for contaminants that will not cause adverse health effects.

Some of the naturally occurring minerals found in groundwater include iron, manganese, chloride, total dissolved solids, and sulfate. While some of these chemicals reduce the quality of the water, the effects are generally minor. These chemicals fall under the U.S. Environmental Protection Agency's (EPA) Secondary Water Quality Standards because they have been shown not to have a detrimental effect to human health, but are primarily an aesthetic concern. Iron and manganese are the leading secondary water quality contaminants within the State of Nebraska.

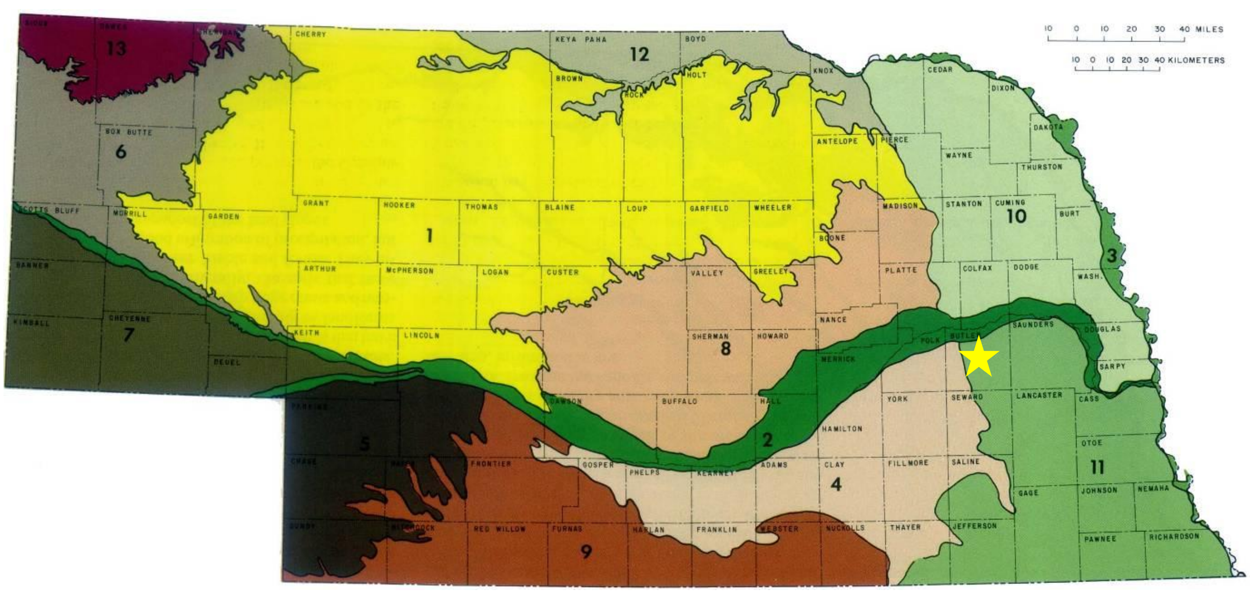
In Nebraska, the most common pollutant found in excess of EPA's public Primary Drinking Water Regulations is nitrate-nitrogen. Unlike the secondary pollutants, nitrates in the groundwater pose a significant health risk to infants and other vulnerable individuals. A municipal water system with nitrate concentrations greater than the MCL of 10 mg/l (NO_3-N) is required to take steps to mitigate the issue. Common steps include supplying bottled water to at risk individuals, developing a wellhead protection plan, blending the raw water supplies, finding another source of water, or treating the water, as a last resort.

Other primary pollutants of concern in Nebraska are arsenic, radium, radon, uranium, selenium, and in some cases VOC's, SOC's, and other man made contaminants.

2.4.3.1 Nebraska Groundwater Regions

Nebraska is typically divided into thirteen (13) groundwater regions, as shown in **Figure 2-3: Nebraska Groundwater Regions** and described in The Groundwater Atlas of Nebraska. Within each region, groundwater passes through soil with similar characteristics. Boundaries between these regions represent zones of gradual change. As seen in **Figure 2-3**, the area around David City is located within groundwater region 11.

Figure 2-3: Nebraska Groundwater Regions



The Groundwater Atlas of Nebraska

Region 11 (Southeastern Nebraska): This region contains limited areas of sand and gravel deposits in paleovalleys for groundwater supply. Other parts of the region include deposits of

Dakota Group sandstone. The capacity to yield groundwater from this sandstone can differ over short distances and consequently, well yields can be difficult to predict. Depth to the regional water table varies as a function of topographic location. However, typical depths to groundwater are 50 – 200 feet. The water quality for groundwater in Dakota Sandstone will typically have elevated levels of iron, manganese and Total Dissolved Solids (TDS). The level of TDS in the source water ranges between 200 mg/l to over 1,000 mg/l.

2.4.3.2 Water Supply Water Quality

A water sample was taken from each of the municipal wells on June 13th, 2019. The results of this analysis are shown in **Table 2-2: Water Quality Analysis**.

The water results for the samples taken for the city's wells indicated that the water is very hard, has elevated levels of iron and manganese, and one well has elevated levels of arsenic which is over the MCL. The city's water treatment plant (WTP) is designed to remove arsenic, iron, and manganese and with the use of lime in the process, it also softens the raw water.

Table 2-2: Water Quality Analysis

Analysis	Unit	Well #10 79-01	Well #11 2002-01	Well #12 2009-01	Well #14 2009-02	EPA Limits/Guidelines[1]	
Sodium	mg/L	25.1	23.4	23.2	23.5	-	
Calcium	Mg Ca/L	87.0	18.8	16.2	81.8	-	
Magnesium	Mg Ca/L	23.7	16	15.8	21.7	-	
Alkalinity	Mg $CaCO_3$/L	323	103	97	295	-	
pH	pH Units	7.15	7.42	7.41	7.22	6.5-8.5	SMCL
Nitrate	mg/L	n.d.	n.d.	n.d.	n.d.	10	MCL
Sulfate	mg/L	72	67	66	64	250	SMCL
Conductivity	mmhos/cm	723	364	353	678	-	
TDS	mg/L	470	237	229	441	500	SMCL
Hardness	Mg $CaCO_3$/L	314.6	112.9	106.0	294.1	-	
Total Iron	mg/L	**0.56**	n.d.	n.d.	0.21	0.3	SMCL
Manganese	mg/L	**0.47**	**0.101**	0.17	**0.136**	0.05	SMCL
Chloride	mg/L	3	6	6	3	250	SMCL
Fluoride	mg/L	0.2	0.2	0.2	0.3	4	MCL
Ammonia	mg/L	n.d.	n.d.	n.d.	n.d.	**-**	
T.O.C	mg/L	n.d.	n.d.	n.d.	n.d.	-	
Arsenic (Total)	mg/L	**0.0128**	0.0033	0.003	0.0069	0.01	MCL
Flow Rate	gpm	800	850	1,100	950	-	

[1]:MCL – Maximum Contaminant Level; SMCL – Secondary Maximum Contaminant Level
[2]: Highlighted values indicate contaminants over the associated MCL/SMCL

2.4.3.3 Iron and Manganese

The natural elements of Iron (Fe) and manganese (Mn) are abundantly found in the earth's crust and routinely present a problem for communities using groundwater as their primary source of drinking water in certain areas of the State. When found in drinking water, iron and low levels of manganese are not considered a health risk, but rather an aesthetic concern. These elements in public water supplies may discolor water, stain plumbing fixtures and laundry, and cause undesirable taste and odor problems.

In 1987, the U.S. Environmental Protection Agency established unregulated secondary drinking water standards for iron and manganese. The purpose of these standards is to assist communities in eliminating the problems caused by these elements. The secondary drinking water standard for iron is 0.30 mg/l and the standard for manganese is 0.05 mg/l. These standards are considered to be threshold values. When these values are exceeded, iron and manganese may begin to cause problems in the drinking water and distribution system.

In 2004, The EPA issued a health advisory to provide guidance to communities that may be exposed to drinking water contaminated with high manganese concentrations. The advisory provides guidance on the concentrations below which potential health problems would unlikely occur. This Drinking Water Health Advisory does not mandate a standard for action; rather it provides practical guidelines for addressing manganese contamination problems.

Though manganese is an essential nutrient for humans, the EPA has determined that chronic overexposure to high levels of manganese in drinking water may cause negative health effects. Adults drinking water with high levels of manganese may develop impacts to the nervous system and behavioral changes. In addition, infants are particularly at risk from high manganese levels which may cause learning and behavioral problems.

The EPA has established a short-term Health Advisory level of 1.0 mg/L for adults. The advisory level for infants has been established at 0.3 mg/L. For community water systems with manganese levels above these advisory limits, the EPA will require public notifications and recommend a plan of action to reduce the manganese concentrations in the public water supply.

Community water systems typically treat groundwater that contains high levels of iron and manganese. **Figure 2-4: Iron levels in State of Nebraska** and **Figure 2-5: Manganese Levels in State of Nebraska** illustrate the respective average iron and manganese levels found in the groundwater across the State.

According to the figures, the groundwater in the area around the city is susceptible to elevated levels of both iron and manganese. These illustrations do not indicate the exact contaminant levels, but rather that the aquifer is subject to the presence of high iron and manganese concentrations. As seen in **Table 2-2**, the water quality analysis shows that one well is over the SMCL for iron and three wells are over SMCL manganese.

Figure 2-4: Iron Levels in State of Nebraska

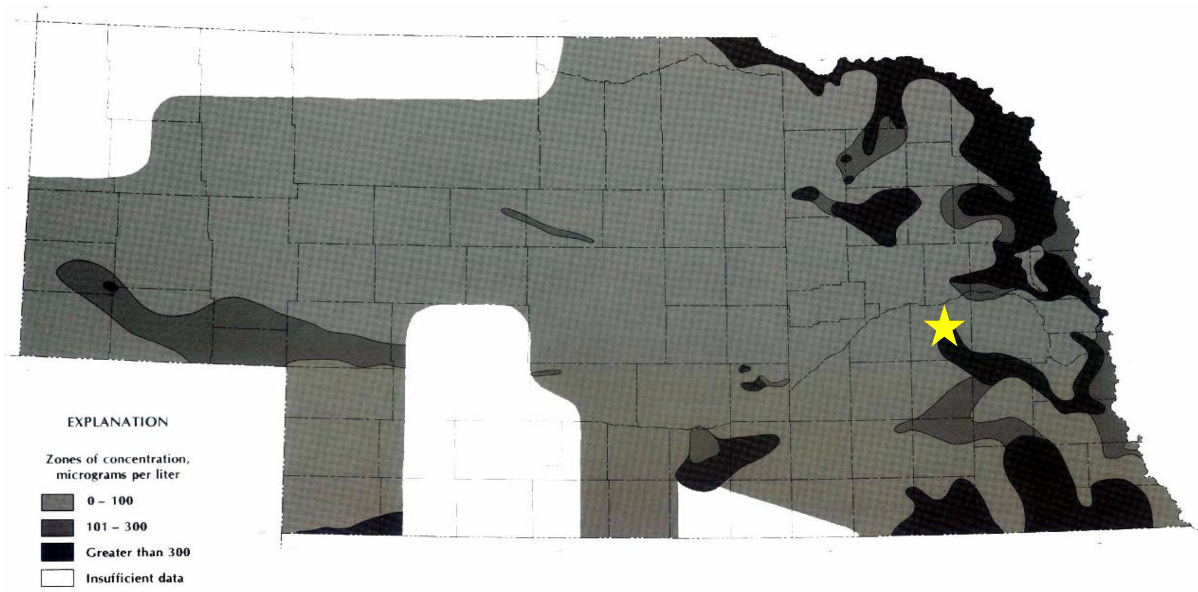
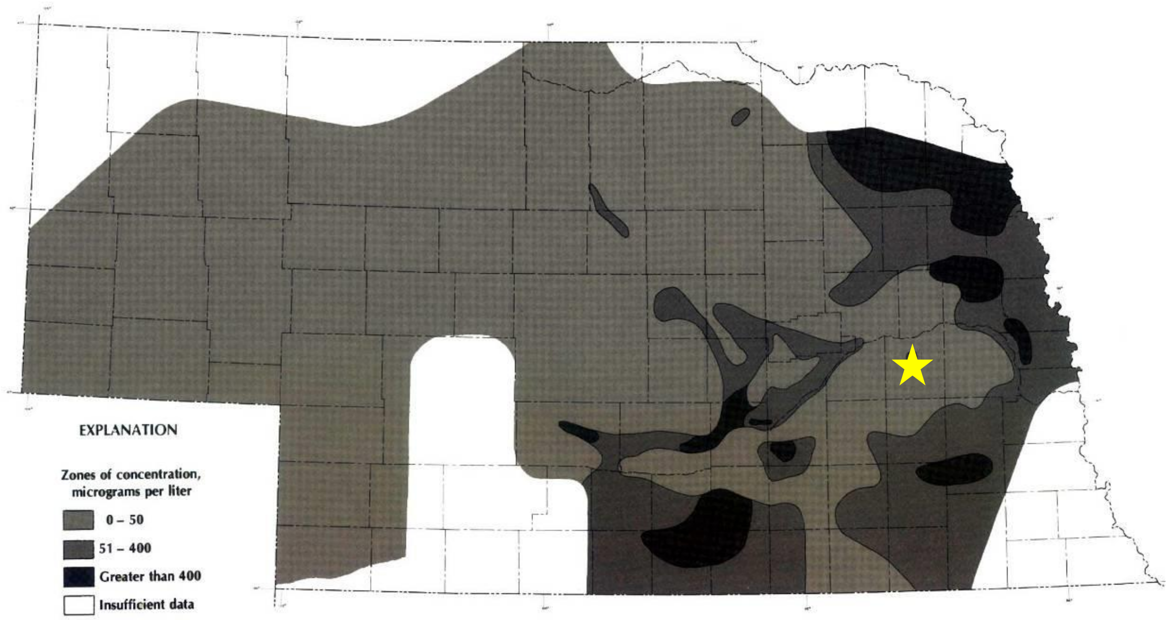


Figure 2-5: Manganese Levels in State of Nebraska



2.4.3.4 Arsenic

The MCL for Arsenic is 10 µg/L (0.010 mg/L). The primary concern with this contaminant is skin disease and cancer. The raw water quality results presented in **Table 2-2** indicate that one well (Well #10) is over the MCL for arsenic. Thus, any future project completed at the water treatment plant must also account for arsenic removal to comply with EPA regulations.

2.4.3.5 Other contaminants

Based upon the raw water results presented, no other contaminants are noted as an issue for David City. Uranium, Nitrates, Selenium, VOC's, SOC's, and other regulated contaminants are not present in amounts to cause any water quality violations.

2.4.4 Water Supply Conclusion

The existing wells provide a reliable water supply for the city and will continue through the design period. The existing well pumps were inspected and serviced in 2018. All of the pumps had a high efficiency and are in good shape. The firm pumping capacity with the largest pump out of service is still above the required design flow. These components do have sufficient capacity to meet future projected demands.

Arsenic, iron, and manganese are present in the groundwater within this area in moderate to high levels. The raw water supply is also very hard.

Based on recent sample results, nitrate, selenium, and uranium concentrations are not a concern at this time; but it is noted that these elements occur naturally, and regular monitoring must be continued in accordance with DHHS rules and regulations.

2.5 Water Treatment System

The city owns and operates a lime softening plant that is located in the east side of the city, along E Street. The plant was constructed in 1982 with a design capacity of approximately 1,800 gpm (2.6 MGD). The following are the major components of the treatment plant:

- Aerator
- Solids Contact Basin (Upflow Unit)
- Recarbonation Basin
- Dual Media Gravity Filters
- Clearwell
- High Service Pumps
- Chemical Feed Systems
- Lime Sludge Pumps
- Backwash Water Recovery
- Lime Sludge Dewatering

The floor plan of the WTP can be viewed in **Figure 2-6: Water Treatment Plant Floor Plan** following along with a schematic of the facility in **Figure 2-7**.

Figure 2-6: Water Treatment Plant Floor Plan

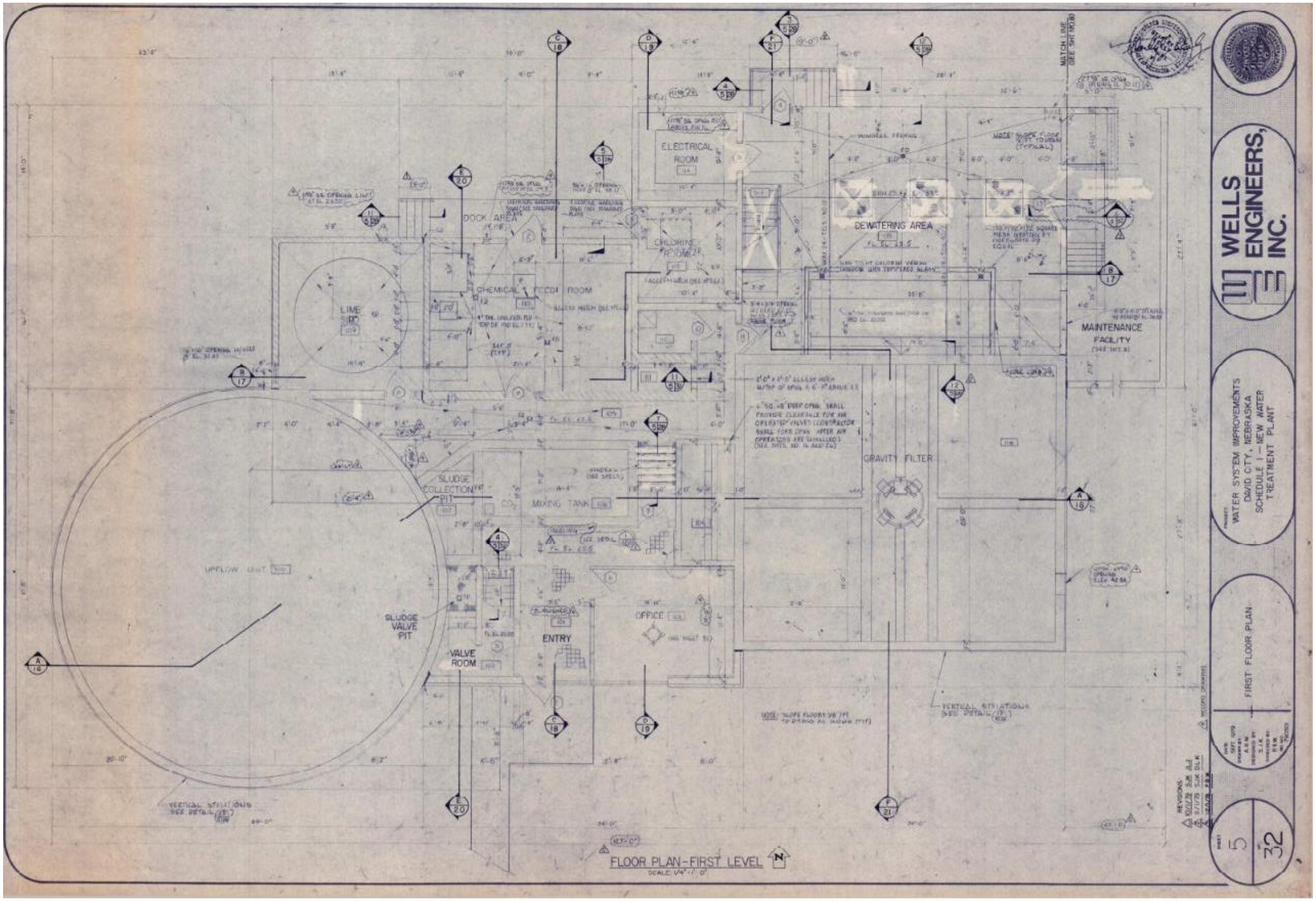
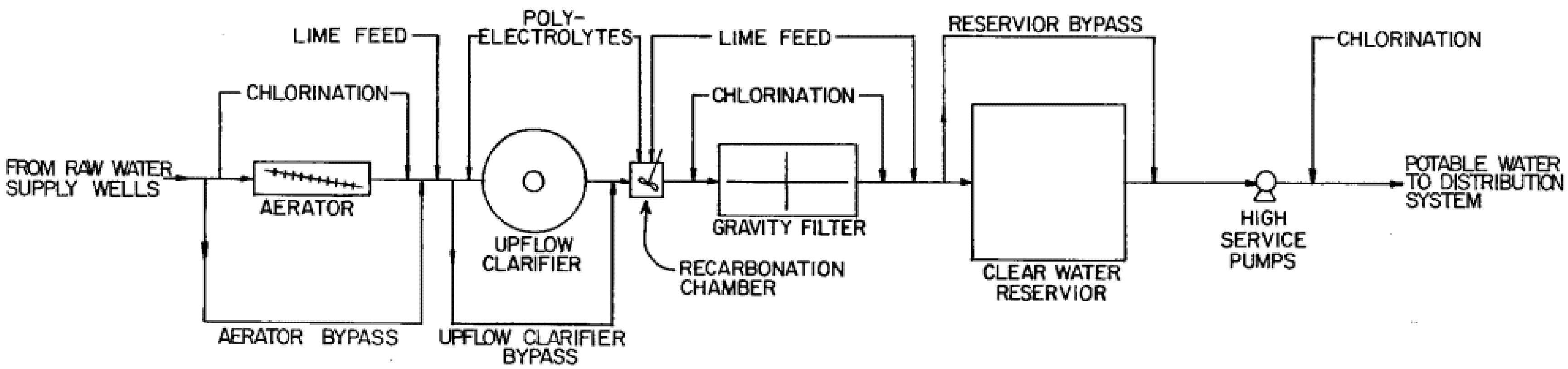


Figure 2-7: Existing Water Treatment Plant Schematic



A picture of the exterior of the water plant can be seen in the following figures. These figures are provided to give an idea of the current condition of the treatment plant. The overall exterior condition is fair with some minor cracking and spalling of the pre-cast concrete exterior especially around the Solids Contact Unit (SCU). Repair and waterproofing of this area is recommended to prolong its lifespan.

Figure 2-8: Water Treatment Plant Exterior

Figure 2-9: Exterior Wall Section of the SCU

2.5.1 Aerator

The normal treatment process starts with raw water from the wells (approximately 800-1,100 gpm each) pumped through a 12" transmission main to the WTP. The raw water can be injected with chlorine (although not currently in use) before entering the two existing aerator units, as manufactured by Kelly Well (KW). The aerators are located atop the WTP roof. Each rectangular aerator has a total rated flow of 900 gpm. The raw water can bypass the aerators through existing valves and pipes directly to the solids contact unit or recarbonation basin, if necessary.

Aeration is utilized to begin the process of oxidation of dissolved iron in the raw water supply. When exposed to air, the raw water absorbs oxygen which in turns binds with dissolved iron to change its form to a solid particulate. This inexpensive process helps oxidize between 75% and 85% of the iron in the raw water. The existing aerators utilize a simple fan and series of stacked trays or slats to allow the water to fall, separate, and be in contact with the countercurrent of airflow. If aeration is not working well due to poor air flow or clogged trays, more chemical usage is required in subsequent processes which reduces performance and increases chemical costs.

It is currently unknown the last time the aerators have been opened and inspected. Given the overall age of the facility, it is anticipated that the existing aerators are at least partially full of accumulated iron and sediment. It is recommended that each aerator be inspected, cleaned and fully rehabilitated to prolong their lifespan. Poorly operating aerators put strain on downstream processes when they are not operating effectively to oxidize iron in the raw water.

Figure 2-10: Existing Aerator Units presents a photo of the existing aerator on the roof of the water treatment building. The dimensions of the existing aerator are approximately 7' square, mounted on four steel support legs.

Figure 2-10: Existing Aerator Units

2.5.2 Solids Contact Unit (SCU)

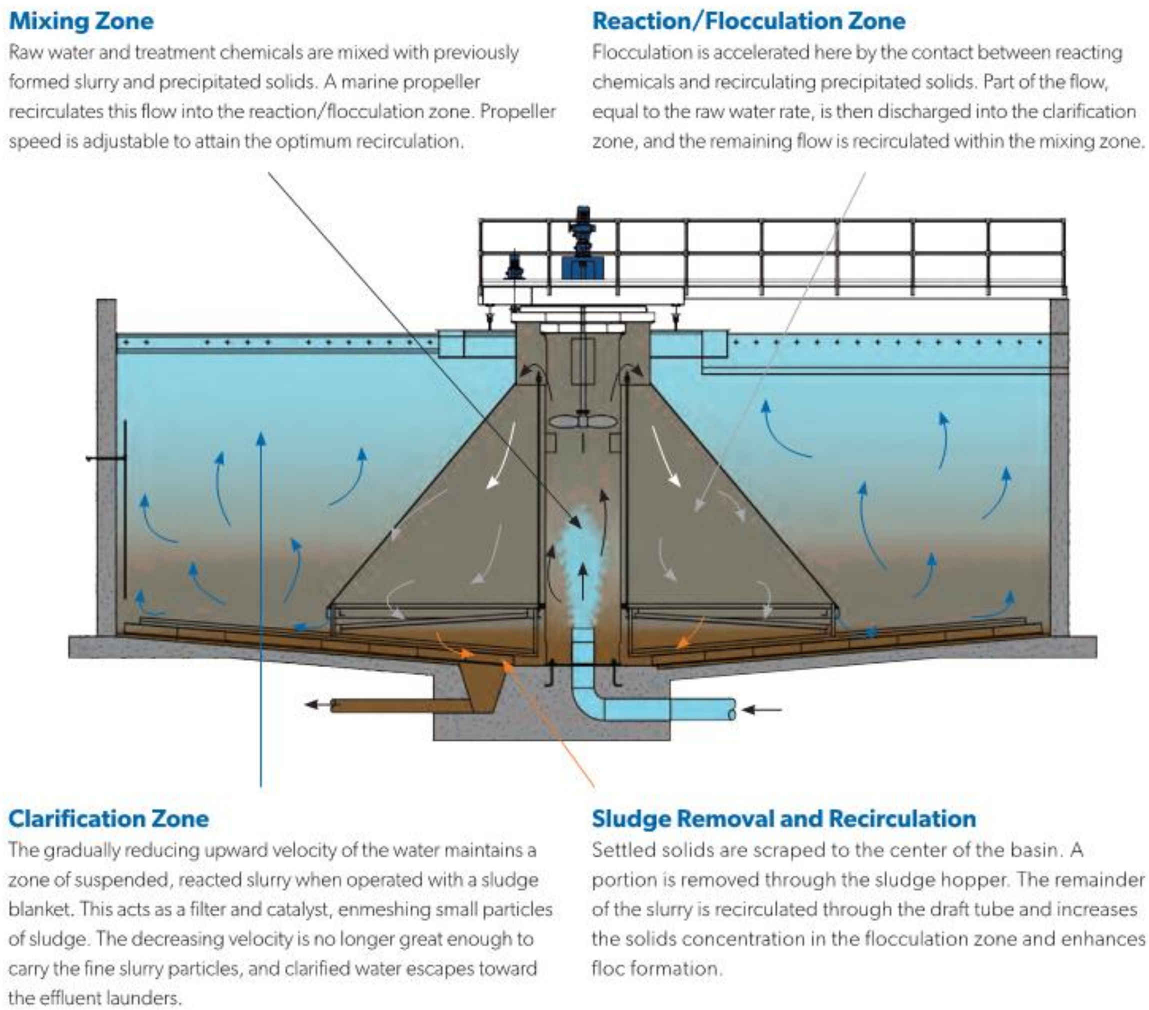
From the aerator, the water flows by gravity, through a 10" pipe, into a solids contact unit (concrete basin). The solids contact unit/clarifier combines mixing, residual recirculation, and sedimentation functions in one basin. Lime slurry along with a polymer is applied directly to the mixing zone of the solids contact basin; thus, promoting flocculation of contaminants into larger, heavy particles. The heavy particles (sludge) continually drop to the floor where they are slowly moved inward toward the center column and conveyed by gravity to a sludge pit through a pipe buried beneath the basin. The clarified water flows up and over the radial launders located at the water surface. The water level inside the clarifier is maintained by the submerged orifices in the effluent launders. A schematic detail is provided in **Figure 2-12**.

The existing solids contact unit was furnished by General Filter, Ames, IA (a company which is now owned by WesTech, Salt Lake City, UT) under the trade name Contraflo®. The solids contact clarifier can be bypassed through existing valves and pipes directly to the recarbonation basin.

Figure 2-11: Existing Solids Contact Unit presents a photo of the existing solids contact unit within the WTP. The diameter of the existing concrete tank is approximately 40' with a side water depth of 18.25'. The unit is rated for a flow of 1,800 gpm with a surface overflow rate of 1.75 gpm/ft^2.

Figure 2-11 Existing Solids Contact Unit

Figure 2-12: Solids Contact Unit Schematic



Courtesy: Westech, Inc.

Given that the basin is a single unit, no redundancy is provided. This has caused issues for the city in the past when maintenance or failures of the unit has occurred. Other noted concerns are corrosion to the steel structure and overall age of the unit. Operation in a high pH environment when lime is added to water is very hard on steel. Operational staff note that the existing unit has failures of the painting system and is need of major rehabilitation. It is recommended that complete replacement of the unit is performed if this is to be kept in service. Replacement units can be stainless steel or painted steel. The existing area roof will have to be removed in order to accomplish the replacement. Further discussion of improvement alternatives is found in later sections of this report.

2.5.3 SCU Sludge Removal System

Settled solids or sludge is removed from the basin via a 6” pipe which discharges into an adjacent sludge collection pit. The design of the system includes a separate 3” actuated valve which is intended to allow sludge removal on a periodic basis from the basin. However, the 3” valve frequently become plugged and the actuator is not reliable and failures of valves in the past causes leaks and flooding of a normally dry area. It is recommended to reconfigure the existing valving to utilize a single, 6” actuated valve and provide a backflush system that flushes clean water backwards through the sludge line to limit any plugging and operational issues. The following figure illustrates the sludge valve pit.

Figure 2-13: SCU Sludge Valve Pit

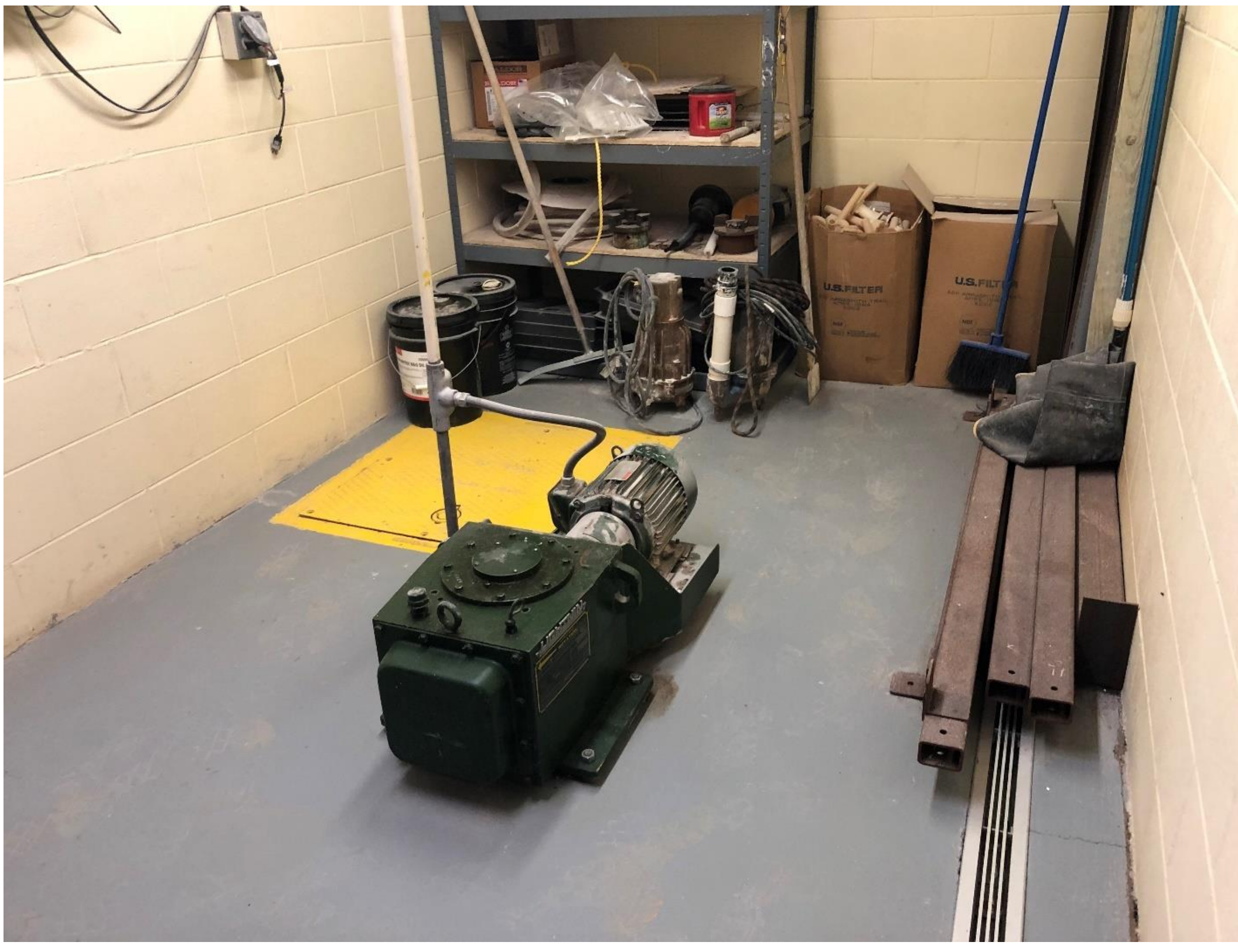
2.5.4 Recarbonation Basin

The existing concrete recarbonation basin separates the solid contact basin from the dual media gravity filters. Water collected within the effluent launders of the SCU flows by gravity into the rectangular recarbonation basin. Carbon dioxide is injected into the basin following the solids contact unit in order to stabilize and reduce the pH of the water down to between 8 and 8.5.

The recarbonation basin holds approximately 18,000 gallons and includes a low speed mechanical mixer. The basin provides a detention time of approximately 10 minutes at the design flow rate of 1,800 gpm.

The overall condition of the recarbonation basin is good. There are no known operational issues and the existing mixer is reported to be in excellent condition. The following figure shows a picture of the existing mixer drive unit.

Figure 2-14: Existing Recarbonation Basin Mixer Drive



2.5.5 Gravity Media Filters

After recarbonation, water overflows by gravity into dual-media gravity filters. The existing gravity filter unit serving the City consists of four-cells, with a total filter area of 700 ft^2 (14’ x 12.5’ each). At the design filtering rate of 2.60 gal/min-ft^2, the unit has a capacity of approximately 1,800 gpm. The original filters were manufactured by General Filter in Ames, IA (now owned by WesTech in Salt Lake City, UT). **Figure 2-15: Gravity Media Filter Cell** presents a photo of one of the filters.

Figure 2-15: Gravity Media Filter Cell

The filters consist of 18" of anthracite media (0.6 to 0.8 mm), 12" of sand (0.5 to 0.6 mm), and support gravel. According to available information, the filter media was last replaced in 2006 with filter sand (0.45 to 0.55 mm) and anthracite (0.9 to 1.0 mm). The underdrains are reported to have been replaced in 2006. The original fiberglass wash troughs are still in use.

Each filter is served by a number of valves and actuators that are original to the plant. Staff report that overall, the valves and actuators are in fair condition, but do leak. Given their age, it is recommended that any project replace these valves as it is very difficult to do so if not in conjunction to a major rehabilitation project.

Backwashing of the filters is a manual operation as the operator is responsible for initiation and the duration of the backwash cycle at their discretion. The existing system is designed for an air scour period followed by a water backwash. Backwash water is sourced from filtered water from three of the filter cells along with a supplemental backwash water pump. Typically, backwashes are needed between 3-4 times per week depending on the water demand in the system.

In order to meet Ten States Standards for backwash flow rate and achieve adequate cleaning of each filter, 15 gpm/ft^2 is required or 2,625 gpm. If less than this rate is provided, the filter media will not be cleaned well and can develop "mud balls" or areas where the filter media sticks together. Over time, inadequate backwashing can reduce filtering performance and cause short circuiting through the filters. The original plant was designed to backwash at 14 gpm/ft^2.

Based upon discussion with operations staff, the filter system has not been backwashed correctly for quite some time. Staff report that historically the water plant has only operated at 800 gpm or flow equal to one well operating at a time. During a backwash cycle, the nominal 800 gpm is passed through three filters to backwash the subject filter. This yields a backwash rate of only 4.5 gpm/ft^2

which is far below the necessary rate. A supplementary backwash pump is included in the plant and is rated for 540 gpm according to the Operations Manual. However, staff do not think the correct pump is installed and provides considerably less water that needed. Even if the 540 gpm rate is correct, normal operations would then only provide 1,340 gpm, well short of the 2,625 gpm required.

Any improvement project must improve the backwash capability of the system to provide for adequate cleaning of the media. Improved cleaning will likely extend filter run times and reduce the number of backwashes per week. Given the age of the filter media (14 years), the original backwash troughs, original valves, and the need to provide a better backwash system, it is recommended to perform a rehabilitation of the filter system.

2.5.6 Backwash Holding Pit (Backwash Water Recovery)

Water that exits the filters from backwashing and decant water from the SCU sludge pit both enter an existing backwash holding pit. The pit is designed to hold this water and slowly recycle all the water back to the solids contact unit via single, submersible pump. Excess water can be discharged to the sewer system but is not commonly done so and nearly all process water is recovered in the facility.

The existing tank dimensions are approximately 19.3' x 9.6' x 17' tall which holds about 23,000 gallons. If a filter is backwashed at the design rate of 15 gpm/ft^2 for 15 minutes, this amounts to about 26,250 gallons. Thus, the backwash tank can only handle backwash from a single filter at a time and is probably the reason operationally, that the backwash rate has never met design standards. If improvements are made to the filter backwash system, either discharge to the sewer is required or a combination air-water backwash will be required to reduce overall water used.

Backwash wastewater can discharge to the gravity sewer system which drains through a 10" diameter pipe to an effluent manhole, east of the treatment building. The manhole connects to a 10" diameter pipe that discharges to the sewer system. The capacity of the 10" pipe is approximately 600 gpm at a 0.40% slope. Thus, direct discharge of backwash water is not possible at the required backwash rate without attenuation of the flow.

2.5.7 Finished Water Storage/Clearwell

After exiting the gravity filters, the treated water flows into a clearwell (holding tank) adjacent to the WTP. This clearwell has a capacity of approximately 500,000 gallons. The condition of the existing clearwell was noted in an inspection conducted in 2017. With few exceptions both the exterior and interior of the clearwell was found to be in good condition. The primary issue noted was spalling of concrete and exposed rebar on the roof of the tank. The referenced report also noted a few additional recommendations to replace the tank appurtenances and install isolation valves.

2.5.8 High Service Pumps

The high service pumping station at the WTP consists of three (3) high service pumps. These pumps were replaced in 2010 and have Variable Frequency Drives (VFDs) installed on each pump. All three pumps have a capacity of 875 gpm. The pumps are reported to be in good condition. However, minor valve replacements, painting of existing piping, and potential relocation of the VFD's to a better location are recommended.

Figure 2-16: Water Treatment Plant High Service Pumps shows that each pump discharge consists of an air release valve, check valve, and gate valve and ties into a common 12" discharge pipe that flows to the city's distribution system.

Figure 2-16: Water Treatment Plant High Service Pumps

2.5.9 Sludge Dewatering

The settled sludge is drained out of the bottom of the SCU via a 6" or 3" pipe to the sludge valve and collection pit. Decanted water from the pit is directed to the backwash holding tank as previously indicated. The settled sludge is then pumped via a diaphragm pump to a sludge plate press and conveyor, then hauled off site. **Figure 2-17: Sludge Belt Filter and Conveyor** presents a photo of the plate press and conveyor used for the lime sludge from the SCU.

Figure 2-17: Sludge Belt Filter and Conveyor

Overall, this piece of equipment is the primary operational headache in the existing water plant. The plate press is not an automatic system. Plant personnel are required to start the sludge pump manually and provide full time in person operation of the press. The pumped solids pass through a series of filters in the press unit. Plant personnel then have to manually separate the press plates, scrape off the collected solids on to the conveyor and push the press plates back together. Given the current operation; 3-4 days a week plant personnel have to operate this equipment for most of a workday. In addition, the conveyor simply caries the lime solids to a waiting dump truck that must be unloaded regularly offsite. Currently, staff are storing lime solids at the wastewater treatment plant site on the other side of town.

It should be noted, given the design of the facility, the only means to remove accumulated solids from lime/iron/manganese is through the manually operated press. All other water which contains solids (backwash, sludge pit decant, & water from the press operation) is directed to the backwash tank and pumped back to the solids contact unit. It is the opinion of this report, that this operation causes quite a few issues in facility. The plate press does not provide 100% removal of solids and will allow fine particles to return through the system. This reduces the effectiveness of settling in the SCU and likely is why polymer must be used in this plant. Many lime softening plants do not need to use polymer and not using polymer would reduce O&M costs and maintenance costs in the plant.

For any improvement project, it is recommended to provide an improved means to handle lime sludge and to discontinue recovery of all backwash/lime sludge decant water.

2.5.10 Chemical Feed Systems

The treatment facility currently utilizes hydrated lime, polymer, carbon dioxide gas, and chlorine gas chemical feed systems to facilitate the treatment process. Based on visual inspection, available information, and discussion with the water treatment plant operator; the systems appear to range from average working condition to poor condition.

2.5.10.1 Hydrated Lime

The city utilizes hydrated lime to facilitate the removal of iron, manganese, arsenic, and other similar constituents, as well as to partially soften the water. The system in place consists of a lime silo for bulk storage, a lime slaker, slurry tank, feed pumps, and appurtenances.

The existing lime silo is 12’ in diameter and 18’ tall with a truncated bottom cone. With the bottom cone, the total volume is approximately 3,475 cubic feet. A dust collector/bag shaker is installed on the top of the silo for vent filtering. The bag filter shakes the collected particles loose automatically. The system experiences excessive “dusting” during filling operations, which is wasted product and can lead to upset neighbors around the WTP. The “dusting” that has been occurring during the filling process is the result of hydrated lime escaping through a pressure relief hatch on the top of the unit, which is an indication that the silo is being pressurized during filling operations. The silo is likely pressuring due to a non-functioning bin vent/dust collector. It is recommended that the city inspect the equipment and verify that all equipment is functioning properly. It may be necessary to replace the bin vent/dust collector.

The truncated bottom cone had an attached vibrator; however, it was not operational and replaced with a compressed air system which is intended to stop “bridging” in the lime silo. However, staff report the system does not work and bridging is currently being resolved by simply hitting the cone with a mallet. The overall structural condition of the silo appears sound, however, much of the ancillary items (compressed air system, dust filters, process controls) are in poor condition.

Figure 2-18: Hydrated Lime Silo presents a photo of the existing lime silo and exterior appurtenances.

Figure 2-18: Hydrated Lime Silo

Normal operation is for the bulk hydrated lime to be fed into a slaker through the truncated cone and a volumetric feeder. Water is added and the lime is mixed to create a lime slurry. This slurry is pumped into the mixing zone of the solids contact unit. **Figure 2-19: Hydrated Lime Interior** presents a photo of the existing lime interior apparatuses.

Figure 2-19: Hydrated Lime Interior

The overall condition of the lime slaker, mixing tank, and pumping system is poor. The system has issues with plugging of the volumetric feeder, frequent failures of the mixing system, slurry pump failures, and overall unreliability of the unit. In addition, actual feed rates of the lime are difficult to control and true product measurement into the SCU is not able to be determined. Operations staff typically have to learn what works by trial and error and true process control is not possible. Given the age and condition of this system, complete replacement is required.

2.5.10.2 Carbon Dioxide Gas

The carbon dioxide gas feed system is sourced from a rented bulk storage tank, then injected via diffuser in the recarbonation basin. Per the WTP O&M Manual, an estimated 34 lbs/hour feed rate was used. A 1 HP Lightnin mixer is used to mix the basin. This mixer was last replaced in 2010 and is good condition.

Figure 2-20: Bulk Carbon Dioxide Storage Tank presents a photo of the existing 6-ton carbon dioxide storage tank serving the WTP. The overall feed system has been changed from the original design but needs to be updated. Lack of accurate metering control, redundancy of feeding equipment, and operational issues are common.

Figure 2-20: Bulk Carbon Dioxide Storage Tank

2.5.10.3 Gas Chlorine

Chlorine gas feed system was partially replaced in 2017. The chlorine feed concentrations are regulated by a Hydro® feed system. The system regulates gas chlorine use of 150-pound cylinders, with an automatic use and switchover system. The chlorine cylinder scales were last replaced in 2002. Storage for an additional five 150-pound cylinders is provided in the chlorine feed room.

The chlorine feed can be injected into the process at several locations but is currently only injected as the water enters the clearwell. Other potential feed locations are located before the aerators and after the high service pumps.

Figure 2-21: Gas Chlorine Feed System presents a photo which includes the Hydro® feeder, gas chlorinators, and the 150-lb gas cylinders sitting on scales. Based on conversations with the water treatment plant operator, the gas chlorine feed system is believed to be in average working condition. However, the necessary solenoid valves, injectors, and overall layout of the chlorine system is in poor condition. Given the mismatched nature of the system, age of some equipment, and lack of true control of dosing rates, it is recommended to upgrade and replace much of the chlorine feed system.

Figure 2-21: Gas Chlorine Feed System

As noted, the chlorine is injected after the filters, prior to the water entering the clearwell. Though the benefit of chlorine being inject here is increased chlorine contact time, there is no regulation or general requirement to do this. However, as noted in a recent clearwell inspection report, the concrete clearwell roof has areas with exposed rebar and spalling concrete. It is the opinion of this report that the presence of chlorine in the clearwell is contributing to this deterioration. Chlorine naturally dissipates from water over time and the open air headspace above the waterline in the clearwell is likely to have varying levels of chlorine gas present. This chlorine gas can recombine with moisture present on the interior roof surface and create hypochlorous acid which can react with calcium in the concrete causing spalling.

An alternate injection point which should be considered is after the high service pumps when the water is pumped into the distribution system. This would remove chlorine from the clearwell and remove the potential from further spalling due to hypochlorous acid. In addition, the chlorine dose could then be more easily controlled to match the flow rate from the pumps. To successfully accomplish this change in chemical injection, a small booster pump will be necessary to increase the injection pressure to overcome the pump discharge pressure and update the controls to flow paced injection based on the high service pump flowrate conditions.

2.5.10.4 Polymer

The city uses the addition of polymer to aid in the formation of flocs from precipitates. The polymer is injected into the center well of the solids contact clarifier. The original and replacement systems have been an automatic dry/liquid polymer feeder system. The current system is a Neptune Polymaster blending system, which was replaced in 2010, and again in 2019. The city has had issues with this system and using this system, there is not a way to measure how much polymer is used per day. **Figure 2-22: Polymer Feed System** presents a photo of the current polymer feed system.

Figure 2-22: Polymer Feed System

If the polymer system is to be continued, a replacement system is recommended. Installing a neat polymer mixing and dosing system would allow the city to use neat polymer and eliminate the need to mix and/or dilute dry or bulk liquid polymer.

However, it is the opinion of this report that a typical lime softening plant should not normally use a polymer system. It is surmised that the polymer is necessary because the backwash water recovery system. The nearly 100% recycle of water in the plant never allows fine, small particles to be removed from the treatment system and they tend to get reprocessed over and over. The polymer is required to help capture and coagulate these small particles in the solids contact unit so they may be removed via the sludge press. If the backwash recovery system and the sludge press water are completely removed from the process and not recycled, the polymer feed system is likely to not be needed.

2.5.10.5 Sequestrant

Blended polyphosphate is added to the finished water supply after the gravity filters in order to sequester any remaining iron and manganese in the water supply and limit the aggressiveness of the water in the distribution system. Operations staff report that much of the old distribution system is unlined cast iron and has a tendency to cause dirty water by releasing iron and manganese scale into the water. Any alternatives should include the continued use of the sequestrant to limit dirty water complaints and control lead and copper which is also caused by aggressive waters leaching the contaminants from pipes in users' buildings.

2.5.11 Automatic Control System

The current SCADA system is outdated and in need of repairs as described in prior reports. In addition, the existing filter backwash system is the original, manually controlled system. **Figure 2-23: Current Filter Control Panel** presents a photo of the filter control panel.

Figure 2-23: Current Filter Control Panel

Overall, a complete rehabilitation of the control system is warranted to provide necessary operator control, remote management, and to reduce the burden on operational staff.

2.5.12 Water Treatment System Water Quality

Table 2-3: Water Quality Results shows the water quality at different points in the water treatment process.

Table 2-3: Water Quality Results

Analysis	Unit	WTP Influent	WTP @ CO_2	Dist. System Water	EPA Limits/Guidelines[1]	
Alkalinity	Mg $CaCO_3$/L	328	111	106	-	
Calcium	Mg Ca/L	88.8	25.3	15.7	-	
Chloride	mg/L	3	4	5	250	SMCL
Fluoride	mg/L	0.2	0.2	0.2	4	MCL
TDS	mg/L	482	244	240	500	SMCL
Hardness	Mg $CaCO_3$/L	319.8	145.4	112.9	-	
Total Iron	mg/L	0.77	0.05	n.d.	0.3	SMCL
Manganese	mg/L	**0.464**	0.028	0.008	0.05	SMCL
pH	pH Units	7.37	8.28	7.33	6.5-8.5	SMCL
Conductivity	mmhos/cm	741	376	370	-	
Sulfate	mg/L	72	72	66	250	SMCL
TOC	mg/L	n.d.	n.d.	n.d.	-	
Arsenic	mg/L	**0.0142**	0.0046	0.0029	0.01	MCL
Nitrate	mg/L	n.d.	n.d.	0.116	10	MCL
Sodium	mg/L	25.2	25.4	24.3	-	

[1]:MCL – Maximum Contaminant Level; SMCL – Secondary Maximum Contaminant Level
[2]: Highlighted values indicate contaminants over the associated MCL/SMCL

2.5.13 Water Treatment Plant Building

The existing water plant building was constructed in 1981. Overall, the building is in adequate condition. However, some general improvements are necessary. Replacement of doors, windows, and general exterior repairs are needed. The existing roof system appears to be in good condition.

On the interior, lab spaces are dated and in poor condition. It is recommended that improvements to the labs and operation rooms are completed.

2.5.14 Water Treatment Plant Conclusion

The WTP currently functions and provides acceptable water to the city. However, based on the previous items reviewed, there are many areas in the facility that should be considered for improvements (the priority level of identified improvement areas is discussed later in the report).

As will be outlined in the alternatives section, there are three primary paths for the David City water treatment system. Depending on the path taken, not all of these recommended improvements are necessary. This report recommends the following improvements be completed:

- Rehabilitation of the existing aerator units.
- Replacement of the existing solids contact unit mechanism.
- Upgrade of the solids contact unit sludge removal system.
- Gravity filter improvements and modification of the backwash system.
- Modification or removal of the backwash water recovery system.
- Chemical feed system improvements (lime, CO_2, chlorine, polymer).
- Improvements to the lime sludge removal system.
- Controls and electrical improvements.
- General building improvements and modernization.
- Alternate method of softening and abandon the lime system.

2.6 Financial Status

2.6.1 Existing Operations and Maintenance Costs

The city's water system operating revenues and expenses for four (4) fiscal years are presented below in **Table 2-4: O&M Costs (Previous 4 Years)**.

The water system averaged gross revenues of approximately $1.1 M per year over the fiscal years 2017-2020 with average expenses totaling approximately $879,315 per year (excluding depreciation expenses).

The city also has three current water debts which include approximately $1,796,500 of outstanding balances.

Table 2-4: O&M Costs (Previous 4 Years)

Fiscal Year	2016-2017	2017-2018	2018-2019	2019-2020	*4-Year Averages*
Revenue[1,3]					
Sales Tax	$66,606	$55,000	$72,398	$79,784	**$68,447**
Tap Permit Fees	$775	$7,500	$775	$3,100	**$3,038**
Rental Fees	$0	$0	$462	$944	**$352**
Refunds	$644	$0	$52	$150	**$211**
Interest on Investments	$961	$0	$1,551	$1,129	**$910**
Sales & Service (Exempt)	$136,703	$11,000	$152,156	$155,520	**$113,845**
Sales & Service (Taxable)	$893,249	$725,000	$977,735	$1,060,768	**$914,188**
Miscellaneous	$754	$200	$10,730	$785	**$3,117**
Supplies Sold (Exempt)	$3,255	$500	$722	$3,406	**$1,971**
Supplies Sold (Taxable)	$970	$500	$1,442	$4,759	**$1,918**
Revenue Total	**$1,103,917**	**$799,700**	**$1,218,023**	**$1,310,346**	**$1,107,996**
Expenses[1]					
Salaries & Wages: Full-Time	$96,382	$103,425	$100,713	$145,846	**$111,592**
Salaries: Overtime	$4,907	$9,850	$15,340	$22,166	**$13,066**
Salaries: Administrative	$0	$15,000	$0	$4,250	**$4,813**
Salaries: Clerical	$36,000	$36,445	$40,981	$51,473	**$41,225**
Salaries: Mayor, City Council	$3,285	$4,000	$5,130	$5,558	**$4,493**
Salaries: Part-Time	$2,903	$3,000	$10,788	$8,005	**$6,174**
Retirement Plan	$3,225	$5,000	$1,836	$0	**$2,515**
Group Insurance	$22,368	$30,000	$16,044	$21,344	**$22,439**
Insurance: Workmen's Comp.	$4,704	$5,500	$5,191	$4,481	**$4,969**
Disability Insurance	$217	$200	$288	$365	**$268**
Social Security Remittance	$10,680	$11,500	$13,047	$17,693	**$13,230**
Audit	$2,935	$4,500	$2,938	$3,268	**$3,410**
Attorneys Fess & Legal Expense	$350	$3,000	$4,098	$12,146	**$4,899**
Dues, Meetings, Mileage	$5,641	$6,000	$1,331	$4,482	**$4,364**
Elster - Maint. Contract	$13,136	$14,500	$17,586	$0	**$11,306**
Contract Labor	$4,987	$0	$1,513	$7,629	**$3,532**
Fuel, Oil, Gas	$3,136	$4,000	$4,424	$2,914	**$3,619**
Vehicles: Repair & Maintenance	$1,344	$3,000	$2,594	$3,668	**$2,652**
Printing & Publishing	$829	$1,000	$928	$736	**$873**
Insurance	$21,092	$31,000	$12,518	$14,685	**$19,824**
Utilities	$77,318	$85,000	$82,824	$92,088	**$84,308**
Safety Expenses	$937	$2,500	$2,798	$1,443	**$1,919**
Repair & Maint - Bldgs./Grounds	$1,755	$6,000	$5,037	$7,078	**$4,968**
Repair & Maint: Equipment	$13,471	$61,000	$1,650	$6,802	**$20,731**
Repair & Maintenance - System	$29,501	$40,000	$51,445	$40,996	**$40,485**
Rep & Maint: Wells & Reservoir	$9,347	$6,000	$7,069	$4,654	**$6,767**
Miscellaneous	$9,114	$14,000	$4,940	$19,715	**$11,942**

Fiscal Year	2016-2017	2017-2018	2018-2019	2019-2020	*4-Year Averages*
Sales Tax Remittance	$65,974	$55,000	$78,336	$78,889	**$69,550**
Laboratory Fees	$3,348	$3,800	$3,628	$4,011	**$3,697**
Occupation Fee to General	$30,127	$28,000	$32,571	$35,185	**$31,471**
Economic Development Director	$2,500	$4,000	$0	$0	**$1,625**
Office Supplies	$2,762	$6,000	$3,657	$3,601	**$4,005**
Lab Supplies	$117	$1,500	$765	$301	**$671**
Shop & Small Tools	$888	$2,500	$1,107	$4,452	**$2,237**
Pipes, Valves, Fittings, Etc.	$0	$250	$10,220	$12,769	**$5,810**
Chemicals	$52,370	$62,000	$55,410	$81,065	**$62,711**
Miscellaneous Supplies	$231	$500	$1,153	$1,784	**$917**
Depreciation[2]	$6,413	$5,000	$349,046	$0	**$90,115**
Rentals: Miscellaneous Equip	$0	$3,000	$8,312	$10,537	**$5,462**
Cap Improve: Land & Buildings	$0	$0	$0	$285	**$71**
Cap. Improve: Equip & Vehicles	$17,116	$40,000	$0	$10,384	**$16,875**
Cap. Improve - System	$238,298	$565,000	$0	$92,035	**$223,833**
Expenditures Total (Less Depreciation)	**$793,295**	**$1,276,970**	**$608,212**	**$838,784**	**$879,315**
Net Revenue (Loss)	**$310,622**	**($477,270)**	**$609,812**	**$471,562**	**$228,681**

[1]: Categories that have no values listed for the 4 year period were deleted from the table.
[2]: Depreciation expense excluded from total expenditures for clarity.
[3]: Fund transfers were noted in the last two fiscal years but omitted for the purposes of examining actual water utility financials.

2.6.2 Financial Status Conclusion

The information presented in **Table 2-4** shows that the city's historical income and expenses has been mostly positive with an average net revenue of $228,681. However, periodic large capital projects along with large annual repair items have caused a negative cash balance in some years. Overall, the position of the water utility fund appears to be healthy.

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SECTION 3

3 Need for a Project

3.1 Health, Sanitation & Security

The city is in compliance with all agencies' standards and has not had significant violations in the past.

3.2 Aging Infrastructure

The existing water treatment facility is the primary concern of the city at this time. The existing plant is nearly 40 years old and only has had minor rehabilitation work in the past. Operational staff are concerned that major treatment equipment may fail and cause a long term issue providing water treatment to the users as lead time and construction of major equipment items take months to complete even in an emergency scenario. Simply looking at the age of the facility and condition of its components, improvements are warranted.

3.3 Operational Difficulties

The primary issue with the current water treatment facility is the operational issues and amount of time necessary to operate the facility. The lime feed system is the primary issue at the facility along with other chemical feed systems, solids contact unit issues, and general system optimization. The lime feed system is in very poor condition and hard to keep operational. The hydrated lime silo and slaker systems do not work well. The silo does not have a means to measure how much lime is used per day or per volume of water treated. Additionally, bridging occurs due to the cone vibrator often being inoperative. The existing lime pump is frequently replaced due to the seals going bad. Furthermore, the lime sludge wasting process ("sludging") is very labor intensive and must happen several times a week. Operating the lime press is very demanding on staff time and there is difficulty in constantly finding a disposal site for the collected lime sludge. The current polymer injection system requires many man-hours to remain operational due to the binding of the polymer to the back side of the pump. The existing electrical and control systems are obsolete.

Due to all these issues, a major rehabilitation project or replacement project is necessary for the city.

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SECTION 4

4 Improvement Alternatives Considered

The referenced Olsson 2020 Water Treatment Facility Evaluation lists several recommendations and improvement alternatives. This report amendment considers those alternatives valid options for the City of David City. A summary of those alternative are as follows:

I. New water treatment plant with pressure filters for iron/manganese removal and no softening.
II. Improve the existing treatment process with various replacement and upgrade projects to maintain softened water.
III. Combination of changing to an iron/manganese removal only process and reuse the current water treatment facility. No water softening would be provided

However, after discussion of the alternatives in Olsson's report, local industries in the community have requested that the city continue the production of high quality (i.e. softened) water instead of providing normal water treatment of only iron and manganese removal. The industries have indicated that the current water supply is desirous for their individual businesses. Thus, to provide the City of David City additional options, this report primarily focuses on two additional alternatives.

1. Keep the existing water plant and make targeted improvements to improve the functionality of the lime system, replace the SCU, upgrade the filter system, change the lime solids handling approach, and make overall improvements to the water plant to provide a reliable, long term solution. This alternative would continue to provide softened water to the city's users.
2. Keep the existing water plant but modify it to perform iron/manganese removal followed by Reverse Osmosis (RO) to provide water softening.

4.1 Design Criteria Summary

Table 4-1: Design Criteria Summary summarizes the design flows of the facility. These values match the values determined in the referenced study.

Table 4-1: Design Criteria Summary

Design Year	2040	
Design Population	3,274	
Average Daily Demand	0.583 MGD	405 gpm
Peak Day Demand	1.67 MGD	1,157 gpm
Peak Hour Demand	3.333 MGD	2,315 gpm

4.2 Summary of Alternatives

Our previous review identified many areas where capital improvements to the water treatment system are recommended for the community. Major improvement alternatives are outlined in the following section as means to address the current system deficiencies and meet the future needs of the city's water system:

Alternative No. 1: Existing Water Treatment Plant Rehabilitation
This alternative involves the major rehabilitation of the WTP and the addition of lime sludge storage lagoons. The recommended improvements include a cleaning and rehabilitation of the aerator units, the replacement of the SCU unit, upgraded CO_2 and chlorine feed systems, new electrical and controls, gravity filter backwash system upgrades, replacement of filter media, and the removal of the lime press. In addition, no further backwash water recovery would be performed. New lime sludge storage lagoons would be constructed north of the existing WTP.

Alternative No. 2: Reverse Osmosis Plant
This alternative involves use of a reverse osmosis system to aid in the softening of the water along with removal of iron and manganese. The recommended improvements include a cleaning and rehabilitation of the aerator units, adding sodium permanganate to the recarbonation basin, gravity filter backwash system upgrades, replacement of filter media, new chlorine feed system, new sodium permanganate feed system, new electrical and control systems, and the demolition of the existing lime system. In addition, a reverse osmosis system will be installed in an expanded garage area and a new intermediate clearwell would be constructed. The new intermediate clearwell would collect water after the filters and include new pumps to send water to the reverse osmosis system.

Alternative No. 3: No Action
This alternative would be to not perform any improvements to the WTP as it currently meets all regulatory requirements and produces acceptable water quality. However, the operational issues of the facility, aging infrastructure, and frequent failures of equipment indicate that the facility may not last as is for very long as documented in this report and the Olsson Study. Thus, it is the opinion of this report that no action is not an option and as such will not be considered further in this report.

The following sections of the report will define the alternatives presented above and provide opinions of probable costs for construction and installation. In general, the preliminary opinion of probable construction costs presented below include the cost for materials, installation, plus contractor's labor, overhead, and profit. Cost information is developed from equipment suppliers' quotes, past experience on similar projects, Means Estimating Guide, and equipment catalogs. A 10% allowance has been included for contingencies at this conceptual stage of the project.

4.3 Alternative No. 1 – Existing Water Treatment Plant Rehabilitation (Lime Softening)

As indicated in this report and the referenced Olsson report, the existing water treatment facility is in need of some major upgrades. After operation for nearly 40 years, much of the equipment and processes are in need of improvements. The goal of this alternative is to continue with the process of lime softening and construct enhancements to the existing process to make the overall system more operator friendly, require less maintenance, improve treatment performance, and reduce long term O&M costs. The following sections outline each recommended improvement within this alternative.

4.3.1 Rehabilitation of the Existing Filters

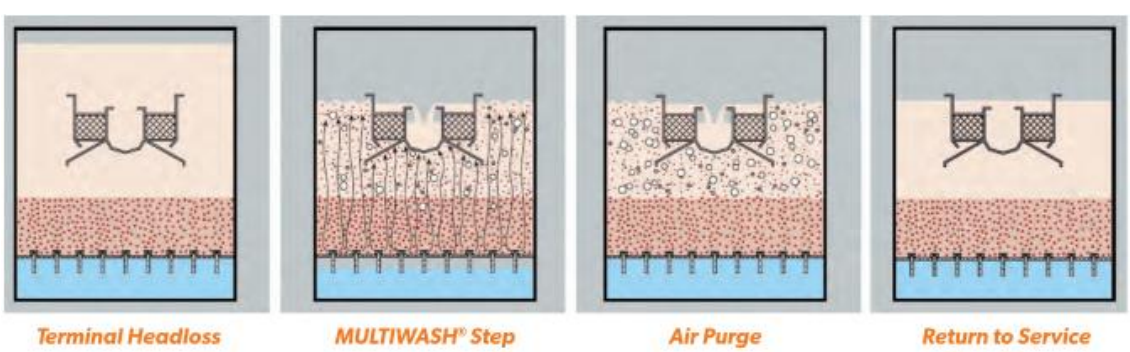
The existing four gravity filters are adequately sized to serve the city over the design period. In order to continue to use the filters and ensure their high performance, a number of improvements are recommended.

Based on available records, it is believed that the existing media within the filter cells was replaced in 2006. Typically, it is recommended to replace the filter media every 10-15 years to retain the same removal efficiencies within the filters. This alternative will plan to replace the media with similar anthracite media as originally designed for the system. However, to further improve the removal of manganese, the filter media itself needs to be conditioned with chemicals. The combination of permanganate and manganese oxide is applied to the filter media to create a coated media that reacts with any free manganese and captures it to the media particle. This will be of primary importance during bypass periods when lime softening is not being performed and permanganate addition is required. The media is then continuously regenerated via the addition of the permanganate. The captured manganese is removed via normal backwashing of the filters.

The existing four gravity filters are approximately 12.5' x 14' or 175 ft^2. The current general backwash process is for an air scour period followed by a water wash. Based upon normal design standards, each filter should be backwashed with treated water at a rate of 15 gpm/ft^2, and based upon the filter size, this would equate to a backwash rate of 2,625 gpm for a duration of around 5-10 minutes. As previously noted, plant operation historically has provided an insufficient backwash rate. An alternative to traditional backwashing is to upgrade the filter equipment to a Multi-Wash® system. This system allows for simultaneous backwash with air and water. When combined, the simultaneous wash is proven to clean a filter better and with less water. The cleaner filters allow for longer runtimes between backwashes and improved longevity of the media itself. The backwash water rate for a simultaneous backwash is half of a water wash alone, or 7.5 gpm/ft^2. The reduced amount of backwash water improves the efficiency of the WTP by creating less waste.

In order to accomplish this scope of work, new backwash troughs are required for each filter, a new blower is needed, and control improvement are required. The new backwash troughs are specifically designed to prevent the loss of filter media during the washing of each filter. The following figures illustrate the general backwash process and type of wash troughs required.

Figure 4-1: MultiWash® Backwash Process Schematic



Courtesy: Westech, Inc.

Figure 4-2: Multi-Wash® Backwash Troughs Installation Example

In order to improve the backwash system, a means to provide adequate backwash volume is needed. As previously shown, the current method of backwashing provides inadequate volumes of water needed to thoroughly clean the filters. This alternative includes the installation of either a new backwash pump or piping and valving required to use distribution system water for backwashes. The exact method used would be determined in design.

Additional items anticipated to be needed include replacement of underdrain nozzles (as needed), replacement of all existing butterfly valves and actuators, and improved controls for the automation of filter operation.

4.3.2 Solids Contact Unit Replacement

The existing solids contact unit is original to the construction of the treatment plant. It has noted issues and has operated beyond its design life. Since there is only single unit, if a problem were to occur in the future, there would be a long period of bypassing and poor water quality. Thus, it is recommended to completely replace the existing SCU with a new, updated solids contact unit.

In order to replace the SCU, it is anticipated that the existing aerators will be used and the water then be bypassed to the recarbonation basin. Since lime will not be utilized during the rehab process, additional chemical feed (potassium permanganate) will be used to effectively treat and allow the filters to remove the iron and manganese in the raw water along with any arsenic to below regulatory standards. It should be noted that during this process hard water will be produced for a period of 6-8 weeks.

Once bypass systems are established, the existing hollow core roof will be removed and the existing SCU demolished. The existing concrete basin will also need to be thoroughly inspected and cleaned prior to the installation of the new solids contact unit mechanism. Given the condition of the exterior of the basin, it is anticipated that a new, waterproofing coating system will be applied to the tank interior. In addition, it is planned that the existing piping system will be cleaned to remove any buildup of solids to ensure full operation when the system is restored.

The new SCU will include a new scraper drive, mixer, support system, access bridge, baffle cone, and effluent launders. It is proposed to utilize stainless steel for the unit to avoid the need for painting and extend its lifespan since it is a single unit with no redundancy.

4.3.3 Aerator Rehabilitation

The existing aerators are reported to be original to the facility and have never been cleaned or rehabilitated to the knowledge of operations staff. As part of a major improvement, the aerators should be upgraded with new distributors, slats, and verification that the existing blower is working properly.

4.3.4 Lime Feed System Improvements

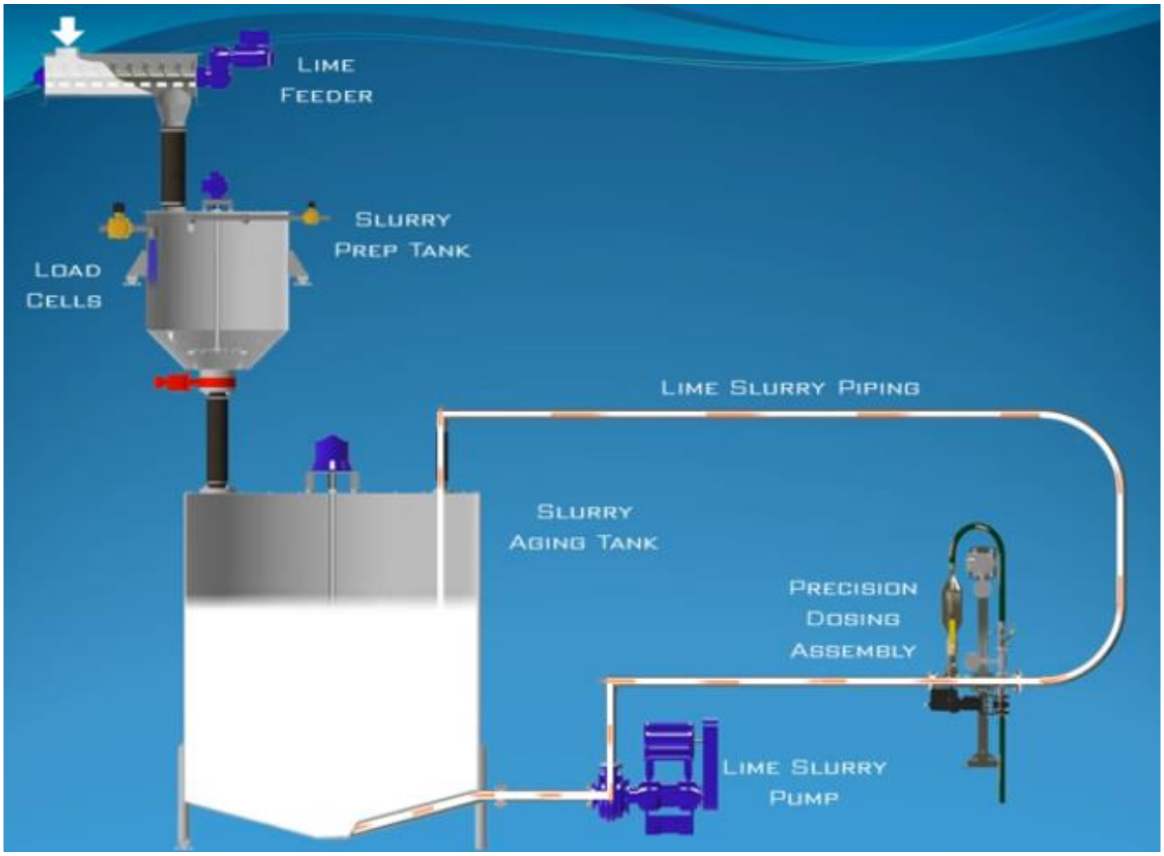
As noted previously, the primary complaint of the existing water treatment plant is the lime feed system. The overall unreliability of the existing feed system along with limited ability to control the actual lime dose to the SCU has made the system unsustainable. If lime softening is to continue, a new system is required.

For the purposes of this alternative, the existing silo will remain and continue to utilize hydrated lime. The existing silo dust collector system will be replaced to limit future dust emissions during the filling of the silo. A new bin activator system will be installed to eliminate the issues with bridging of the lime product in the silo.

The lime feed/slaker system is proposed to be completely revamped. The proposed system operates by taking a predetermined amount of hydrated lime which is added to a predetermined amount of water in a new slaker. The two are mixed for a selected period of time to a selected final slurry concentration before being discharged into a Slurry Aging Tank. The lime is then delivered to SCU through a continuous loop and precision dosing meter and valve. The velocity in the loop is maintained above the critical velocity required to minimize scaling in the pipes which plagues typical lime systems.

The new system is completely enclosed and will nearly eliminate lime dust in the water plant which is known to degrade equipment and electronics over time. The following figure illustrates the proposed lime feed system.

Figure 4-3: Proposed Lime Feed System



Courtesy: RDP Technologies, Inc.

4.3.1 Backwash and Lime Storage Improvements

The disposal of the lime sludge and the recycling of most of the backwash water in the WTP is a noted issue. If lime is continued to be used, the current handling method of the lime sludge needs to be modified. For the purposes of this alternative, it is recommended to utilize lime storage lagoons instead of a mechanical press.

Lime storage lagoons function by simply holding lime sludge and backwash water and allowing all the solids to settle and collect in the basin. Periodically, (typically every 2 years) the lagoons are cleaned and the collected lime sludge is hauled to area agricultural fields.

Ten States Standards recommends the lagoons be sized to provide 0.7 acres of surface area per 1 million gallons of water treated per day per 100 mg/L of hardness removed for a groundwater treatment plant. Based upon historical treatment data, it is estimated that approximately 220 mg/L of hardness is removed by the WTP. Thus, the proposed lagoons are to be sized as follows:

$$\frac{0.7 \text{ Acre} \times 0.583 \text{ MGD} \times 220 \text{ mg/L Hardness Removed}}{1 \text{ MGD} \times 100 \text{ mg/L}} = 0.90 \text{ Acres}$$

In addition to storage of lime, the lagoons need to be sized to store backwash water. As previously noted, it is the opinion of this report that the current practice of recycling all backwash water is negatively impacting the treatment process and requires the addition of polymer to the SCU. If all backwash is sent to a storage lagoon and not recycled, it is anticipated that polymer addition will be no longer necessary. For the purposes of this report, it will be assumed that filter backwashes will occur twice per week per filter at a rate of 7.5 gpm/ft^2 for a period of 10 minutes.

Backwash Volume per day:

4 filters x 7.5 gpm/ft^2 x 175 ft^2 x 10 min x 2 per week / 7 days = 15,000 gpd

The lagoons will be sized for approximately 6 months of backwash storage. Excess backwash water will be able to be directed to the sanitary sewer system on an as needed basis by the operational staff. Assuming the above backwash volume and planning for six months of storage, the lagoon sizing for backwash water holding is as follows:

Table 4-2: Backwash Storage Lagoon Calculation Summary

Water Balance Formula for Lagoons: QT=(LT+D)A

where:

Q=	annual average daily volume of influent flow, cubic feet per day
T=	retention time or filling time in days
L=	average weather and seepage losses per day (net evap. plus seepage), ft/day
D=	depth to fill, ft.
A=	required water surface area at average operating depth, sq. ft.

Q:

Average Annual	15,000	gallons per day
	2,005	cubic feet per day

T:

180	days

L: Water Losses = Net Evaporation + Seepage

	Annual Amount (in.)
Precipitation	26
Evaporation	43

	Lake Evaporation (inches)	Precipitation (inches)	Net Evap. (inches)	Day in Period	Net Evap. (in/day)
Jan to Dec	43	26	17	365	0.04658

Seepage		0	inches/day (assumed)		
Water Losses = L					
	Jan to Dec	0.04658	in/day	0.00388	ft/day

D:

Operating depth of cells:

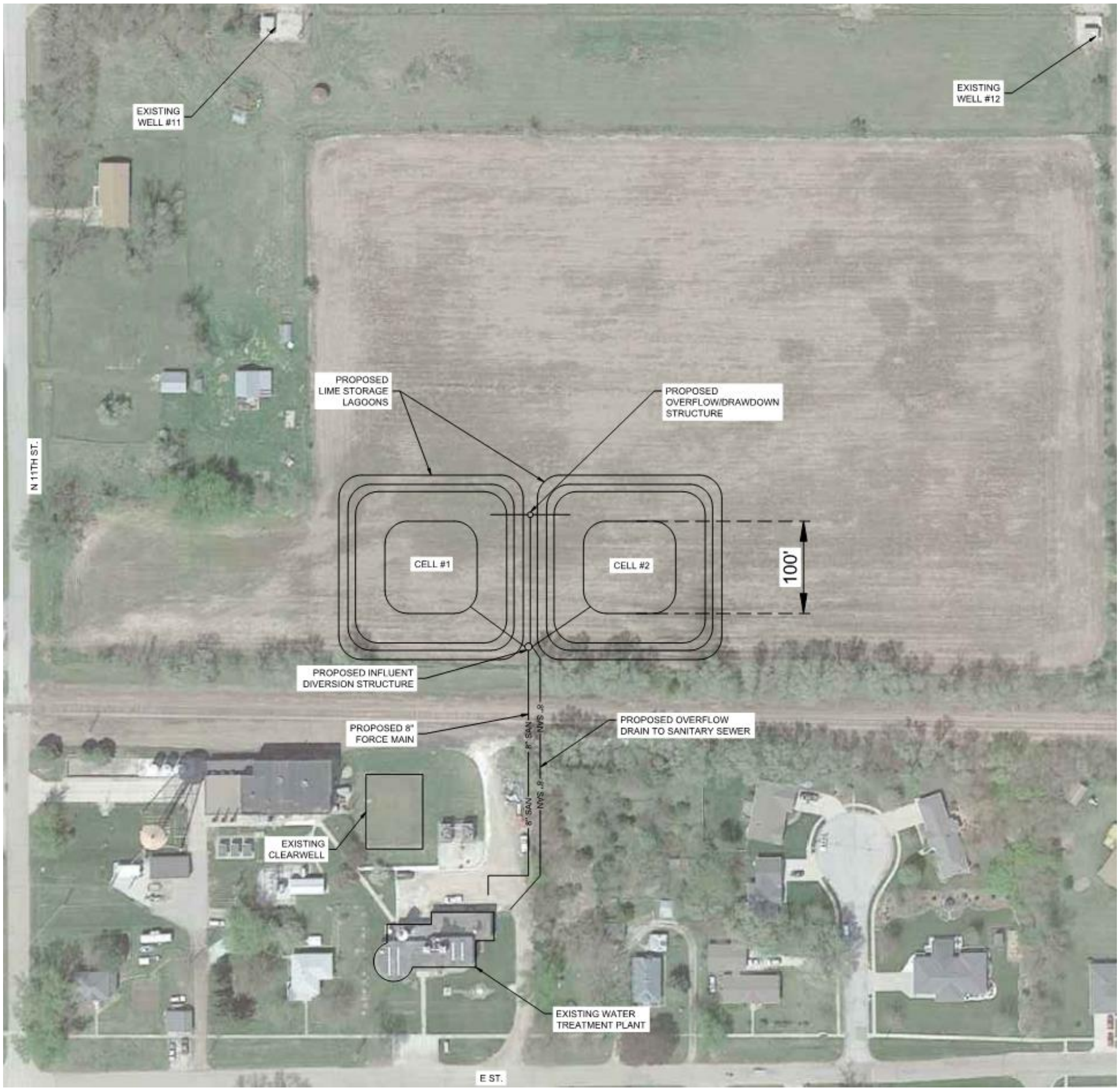
	Primary Cells	8	feet
	Final Cells	8	feet
Operating depth above 2-ft level			
	Primary Cells	8	feet
	Final Cell	8	feet
	Primary Cells	50%	total area
	Final Cell	50%	total area
	Average Depth for calculation	8	feet

Total required water surface area at average operating depth:

Jan to Dec	**41,496**	square feet	**1.00**	acres

Based upon the preceding calculations, it is proposed that two lagoon cells, each at 0.5 acres be constructed to hold the lime sludge and backwash water. Given the lack of room on the existing site owned by the city, it is anticipated that the lagoons will have to be constructed north of the existing WTP as shown in the following figure:

Figure 4-4: Proposed Lime Storage Lagoon Schematic



The land is not currently owned by the city and will have to be purchased for use. Additional appurtenances include an overflow system to the sanitary sewer and provisions to allow for lagoon cleaning every two years.

4.3.2 Chemical Feed System Improvements

The evaluation of the WTP indicated that there is a need for improvements in the chemical feed systems, specifically chlorine and carbon dioxide. This alternative includes the replacement of the existing carbon dioxide feed system with a new set of ejectors, flow based SCADA controller, and a new diffuser in the recarbonation tank.

The chlorine system is also proposed to be upgraded. It is recommended to relocate the existing chlorine injection points to a common injection point on the high service pump discharge piping to limit continued degradation of the existing concrete clearwell. With relocation of the chlorine injection points and the fact that the existing high service pumps are controlled via variable frequency drives (VFD's), it will also be necessary to update the controls to facilitate flow-paced injection based on the speed of the high service pump in-use. A booster pump will also be needed to increase the pressure of the chlorine chemical. The following figure illustrates what the upgraded chemical feed room may look like.

Figure 4-5: Example Chlorine and Carbon Dioxide Feed Room

4.3.3 Miscellaneous Building and Electrical Improvements

The final items included in this alternative is the general replacement of old building components and an upgrade of the electrical system. The existing 40 year old building has a need of replacement doors and windows along with upgrades to the laboratory facilities. It is proposed to replace all the existing doors and windows with new, energy efficient units. The existing HVAC system and exhaust fans are also in need to rehabilitation.

The existing electrical system is old and many of the components are obsolete. Thus, it is recommended to provide replacement motor control centers (MCC's) and replace conduit and wiring as appropriate.

The inspection report provided for the existing clearwell indicated that some concrete deterioration and spalling of the roof of the structure was occurring. This report recommends minor patching and epoxy coating of structure during an improvement project.

The referenced Olsson report indicated that the current WTP utilizes the city's neighboring power plant for backup power. Should that facility not be in operation, a new backup generator will be necessary. For the purposes of this report, this alternative will include a new generator and automatic transfer switch, however this could be deleted should the city determine the power plant will stay in operation for the foreseeable future.

4.3.4 Alternative No. 1 Opinion of Probable Cost

ESTIMATE OF QUANTITIES					
Item #	**Description**	**Unit**	**Qty**	**Unit Price**	**Total**
GROUP A - General Water Plant Improvements					
1.	Mobilization	LS	1	$275,000	$275,000
2.	Bonding and Insurance	LS	1	$120,000	$120,000
3.	Aerator Rehabilitation and Cleaning	EA	2	$35,000	$70,000
4.	Existing Pipe Cleaning/Pigging	LS	1	$20,000	$20,000
5.	Automatic Control System	LS	1	$230,000	$230,000
6.	Electrical Improvements	LS	1	$450,000	$450,000
7.	New Backup Generator and ATS	LS	1	$100,000	$100,000
8.	Building Improvements (Doors/Windows)	LS	1	$20,000	$20,000
9.	Building Improvements (Interior Painting)	LS	1	$40,000	$40,000
10.	Existing Clearwell Roof Patching and Epoxy Coating	LS	1	$320,000	$320,000
11.	HVAC Improvements	LS	1	$35,000	$35,000
12.	Temporary WTP Bypass Operations & Chemical Feed	LS	1	$25,000	$25,000
13.	Lab Improvements	LS	1	$15,000	$15,000
14.	Seeding, Fertilizer and Mulch	ACRE	2	$4,500	$9,000
15.	Erosion Control	LS	1	$5,000	$5,000
			Construction Subtotal	Group A	$1,734,000
			Contingency	10%	$173,400
			Total Opinion of Construction Cost - Group A		**$1,907,400**
GROUP B - Solids Contact Unit Replacement					
1.	Solids Contact Unit Equipment (Stainless Steel)	EA	1	$425,000	$425,000
2.	Solids Contact Unit Installation	LS	1	$85,000	$85,000
3.	Contact Basin Cleaning/ Concrete Sealing	LS	1	$50,000	$50,000
4.	Aluminum Handrails/Access Ladder	LS	1	$7,500	$7,500
5.	Existing Hollow Core Roof Removal	SF	1,800	$25	$45,000
6.	Hollow Core Roof Re-Installation w/ New Concrete Topping	SF	1,800	$50	$90,000
7.	New Facia, Insulation, & Roof Membrane	SF	1,800	$25	$45,000
8.	Sludge Blowdown New Actuator/Valve	LS	1	$12,500	$12,500
9.	Sludge Blowdown Automatic Backflush System	LS	1	$65,000	$65,000
10.	Sludge Pit Submersible Pump	LS	1	$20,000	$20,000
			Construction Subtotal	Group B	$845,000
			Contingency	10%	$84,500
			Total Opinion of Construction Cost - Group B		**$929,500**
GROUP C - Gravity Filter System Improvements					
1.	Removal and Disposal of Existing Media	LS	1	$15,000	$15,000
2.	New Gravity Filter Equipment (Media/Wash Troughs/Valves)	LS	1	$200,000	$200,000
3.	Gravity Filter Equipment Installation	LS	1	$150,000	$150,000
4.	Underdrain Nozzle Replacement (As Needed)	LS	1	$5,000	$5,000
5.	New Backwash Blower	LS	1	$15,000	$15,000
6.	Update Filter Control System and Instrumentation	LS	1	$35,000	$35,000
7.	Distribution Water Source Backwash System	LS	1	$30,000	$30,000

			Construction Subtotal	Group C	$450,000
			Contingency	10%	$45,000
			Total Opinion of Construction Cost - Group C		**$495,000**
GROUP D - Chemical Feed System Improvements					
1.	Carbon Dioxide Feed System Improvements	LS	1	$15,000	$15,000
2.	Gas Chlorine System Improvements	LS	1	$20,000	$20,000
3.	Lime Silo Dust Collector Rehabilitation	LS	1	$15,000	$15,000
4.	Lime Feed System Equipment	LS	1	$550,000	$550,000
5.	Lime Feed System Installation	LS	1	$150,000	$150,000
6.	Lime Feed Piping Loop to Solids Contact Basin	LS	1	$20,000	$20,000
			Construction Subtotal	Group D	$770,000
			Contingency	10%	$77,000
			Total Opinion of Construction Cost - Group D		**$847,000**
GROUP E - Backwash and Lime Lagoon Improvements					
1.	Earthwork Measured in Embankment (Established Quantity)	CY	7,000	$15	$105,000
2.	Stripping and Topsoiling	CY	1,200	$10	$12,000
3.	Clearing and Grubbing	LS	1	$5,000	$5,000
4.	Influent Diversion Structure	LS	1	$5,000	$5,000
5.	Drawdown Structure	EA	1	$7,500	$7,500
6.	16" Steel Casing, 0.3125" Thickness, Jack and Bore	LF	100	$350	$35,000
7.	8" PVC Force Main, DR 18	LF	450	$35	$15,750
8.	8" Fittings	LS	1	$5,000	$5,000
9.	Submersible Backwash Pump	EA	2	$20,000	$40,000
10.	6' Chain Link Fence	LF	2,000	$20	$40,000
11.	12" PVC Sanitary Sewer Main, SDR 35	LF	1,000	$65	$65,000
12.	48" Dia. Concrete Manhole	VF	30	$800	$24,000
13.	Crushed Rock Surface Course	TONS	40	$50	$2,000
			Construction Subtotal	Group E	$361,250
			Contingency	10%	$36,130
			Total Opinion of Construction Cost - Group E		**$397,380**
			Construction Subtotal - All Groups		$4,160,250
			Contingency		$416,030
			Total Opinion of Construction Cost - All Groups		**$4,576,280**
PROFESSIONAL SERVICES					
1.			Design Services (Engineering, Survey, Architecture)	18%	$823,800
2.			Overhead (Legal, Fiscal, Etc.)	2%	$83,200
3.			Land Acquisition	5 Acres	$50,000
			Subtotal Professional Services & Land		$957,000
			Total Opinion of Project Cost		**$5,533,280**

4.3.1 Alternative No. 1 Opinion of Probable O&M Costs

Given this alternative is a rehabilitation of the existing treatment plant, future Operation and Maintenance costs (O&M) are not expected to change significantly from current conditions. The following table summarizes the expected O&M costs. It should be noted that labor costs are not included in this analysis. It is expected that labor necessary for the water plant will be much less than currently needed, however, the additional time allowed existing staff will be better directed elsewhere in the water system and the overall labor costs will be equivalent.

Table 4-3: Alternative No. 1 Opinion of Probable O&M Costs

ELECTRICAL POWER	Hp				
Well Motor (1)	100	12	Hrs/Day/Ea =	1200	Hp Hrs/Day
Aerator Fans (2)	0.5	12	Hrs/Day/Ea =	12	Hp Hrs/Day
SCU Scraper Drive	0.5	24	Hrs/Day/Ea =	12	Hp Hrs/Day
SCU Mixer	5	24	Hrs/Day/Ea =	120	Hp Hrs/Day
Lime Slurry Pump	10	24	Hrs/Day/Ea =	240	Hp Hrs/Day
Lime Slaker Mixer	3	24	Hrs/Day/Ea =	72	Hp Hrs/Day
Recarbonation Basin Mixer	2	24	Hrs/Day/Ea =	48	Hp Hrs/Day
HSP's (3)	75	4	Hrs/Day/Ea =	900	Hp Hrs/Day
Backwash Tank Discharge Pump	20	2	Hrs/Day/Ea =	40	Hp Hrs/Day
Lime Sludge Pump	5	2	Hrs/Day/Ea =	10	Hp Hrs/Day
Chlorine Booster Pump	3	12	Hrs/Day/Ea =	36	Hp Hrs/Day
Air Wash Blower	25	0.25	Hrs/Day/Ea =	6.25	Hp Hrs/Day
Miscellaneous Electrical				30	Hp Hrs/Day
TOTAL				2726.25	Hp Hrs/Day
Hp Hrs/Day x 0.7457 KW-Hr/Hp-Hr =				2033	KW-Hr/Day
TOTAL ESTIMATED KW/HRS/DAY				2033	Kw Hrs/Day
Kw Hrs/Day x $0.12 / Kw-Hr =				$243.96	/Day
				$7,318.67	/Month
				$89,043.85	/Year
Total Estimate of Annual Electrical Power				**$90,000.00**	**/Year**
CHEMICALS:					
Hydrated Lime				$45,000.00	/Year
Carbon Dioxide				$17,000.00	/Year
Chlorine				$2,100.00	/Year
Sequestrant (Polyphosphate)				$1,500.00	/Year
Total Chemical Expense				**$65,600.00**	**/Year**
Total Alternative Estimated Annual O&M Cost:				$155,600.00	/Year
Existing Water System Annual O&M[1]				$503,000.54	/Year
TOTAL ESTIMATED ANNUAL O&M COST:				**$658,600.54**	**/Year**
Average Daily Water Production				0.538	MGD
Yearly Water Production				196.37	MGD
O&M per 1,000 gallons				**$3.35**	**per 1,000 gal**

[1]: Existing Water System O&M Average for the last 3 years less Utilities, Chemicals, Rentals, and Capital Improvements

4.4 Alternative No. 2 – Reverse Osmosis Plant

The second alternative examined in this amendment is to provide softened water without use of lime. This alternative involves use of a reverse osmosis system to aid in the softening of the water along with removal of iron and manganese. The existing treatment plant will be utilized as much as possible to limit overall costs. The proposed process uses the existing aerators, recarbonation basin, and gravity filters. The solids contact basin will be bypassed and not used in this alternative.

4.4.1 Aerator Rehabilitation

Similar to Alternative 1, the existing aerators will need to be rehabilitated. The units will be cleaned, inspected, and have new internals installed to ensure they are operating at peak efficiency.

4.4.2 Recarbonation Basin

The existing recarbonation basin is proposed to be repurposed into a chemical contact and mixing basin. The recarbonation basin holds approximately 18,000 gallons which will provide a detention time of approximately 10 minutes at the design flow rate of 1,800 gpm.

Ten States Standards recommends a minimum of 30 minutes of detention time following aeration to allow for complete oxidation of contaminants unless a pilot plant study indicates no need for detention. It is the opinion of this report that the existing recarbonation basin will be sufficient since the addition of permanganate is planned to oxidize any remaining iron and manganese after aeration. The iron levels in the raw water are comparatively low (highest level of 0.56 mg/L in Well #10) and aeration typically is not suitable for oxidation of manganese due to the very long reaction time (measured in hours) needed. Thus, it is recommended to proceed with this plan with the option of utilizing the solids contact basin as a contact tank should additional detention is needed. However, given the near instantaneous reaction of permanganate with iron and manganese, the large basin will not be needed in the opinion of this report.

4.4.3 Rehabilitation of the Existing Filters

As shown in Alternative 1, the existing filters will need to be rehabilitated. Instead of filtering water from the solids contact unit, the treatment process will be aeration, detention, and filtration. The iron and manganese will need to be removed prior to water flowing to the proposed reverse osmosis units.

The filter media will need to be changed and chemically conditioned to assist in manganese removal when dosed from a new permanganate feed system. Modification of the backwash system to provide supplemental water, new wash troughs, new blower, replacement valves, and control improvements is proposed identical to Alternative 1.

4.4.4 Addition of Reverse Osmosis

Reverse Osmosis (RO) technology uses semi-permeable membranes for removal of dissolved contaminates such as nitrates, hardness, and dissolved solids. The basic principle of the process is that under high pressure, water is driven to flow from a more concentrated, feed solution to a pure water location which is the opposite of the natural osmosis process. Thus, water is purified (known as permeate) leaving a concentrated waste stream (known as brine) that includes the majority of the contaminants that was originally present in the raw water.

Conventional RO technology utilizes cross-flow filtration (i.e. continuous flow parallel to the surface of the membranes) to allow water to cross into the inside of the membranes (permeate) while the rejected contaminants are swept away from the membrane surface as to not "plug" the membranes. Raw water is normally treated conventionally to remove any iron and manganese prior to be being pumped through the RO system.

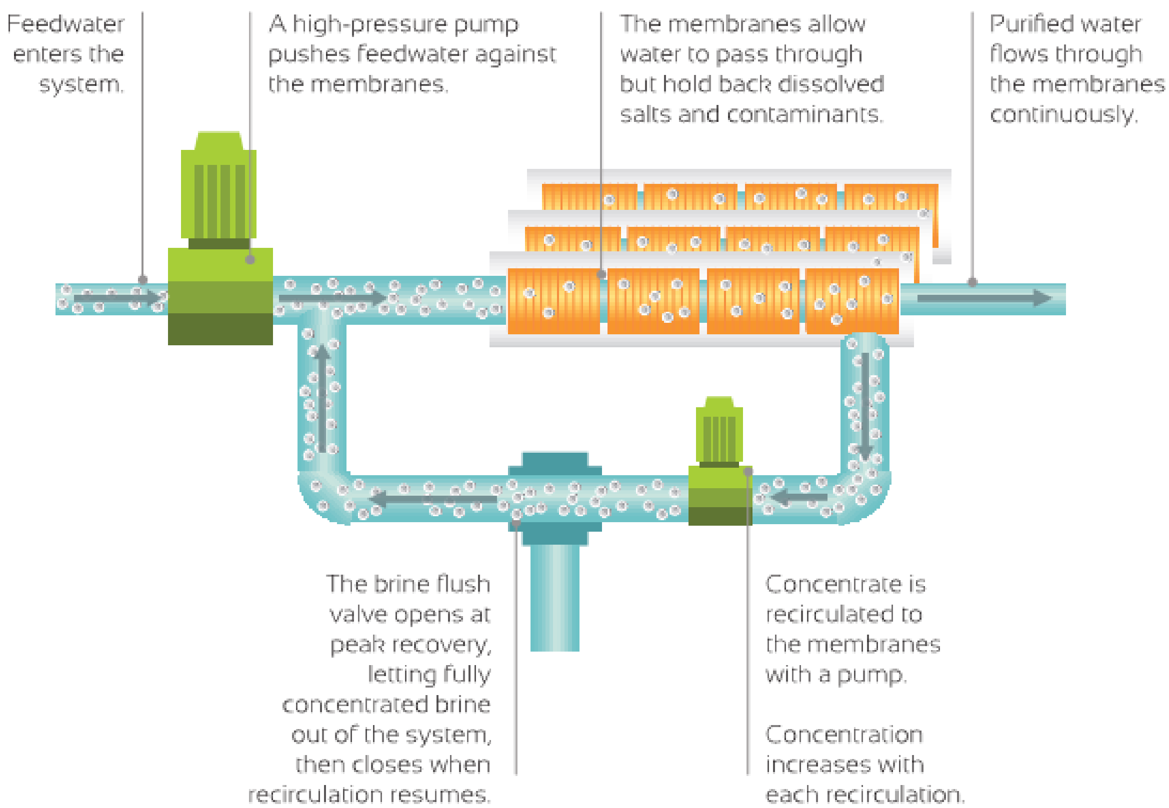
The RO system requires the use of anti-scalants to be injected in the process to keep the membranes clean. The typical lifespan of RO membranes is 5-10 years, depending on flowrates and the quality of the raw water.

The traditional disadvantages of RO systems are increased energy usage needed to develop the pumping pressure to drive water through the RO membranes and the amount of reject water or brine that is discharged. Traditional RO systems have a reject rate of 20-25% of the raw water. Or in other words, 200 gallons of water must be discharged to the sewer system for every 800 gallons of clean water produced.

RO systems require periodic cleaning which are normally automated to recover membrane permeability. The automatic process generally uses sodium hydroxide or hydrochloric acid to dissolve and remove any collected contaminants on the membrane surface. Following chemical cleaning, the membranes are flushed to remove any residuals prior to resuming normal operation. Flushed chemicals must be neutralized prior to disposal to the sanitary sewer.

For the purposes of this alternative, reverse osmosis will be utilized to remove hardness and provide an equivalent softened water like a traditional lime softening process. The advantage of the RO process for the City of David City is that no future lime handling would be needed. In addition, this alternative proposes the use of a recent technology improvement in RO systems. The proposed process is what is called Closed Circuit Reverse Osmosis™ or CCRO™. CCRO™ uses the same basic processes as traditional RO except that the concentrate or brine is continuously recycled in the system to allow for recovery rates to exceed 94% vs. the typical 70-75% for traditional systems. The figure following illustrates the proposed RO system process.

Figure 4-6: Example CCRO™ Process Schematic



Courtesy: Desalitech®

The proposed RO system would utilize two banks of membranes rated for 485 gpm of permeate each. The proposed blend rate is based upon the desired hardness level in the water which is assumed to be around 5-7 grains per gallon (100 mg/L as calcium carbonate). Each unit will yield 485 gpm with a bypass flow of approximately 420 gpm depending on the exact combination of wells used. The total flow of 905 gpm (1.3 MGD) for each bank will equal the design rating of the water plant 1,800 gpm (2.6 MGD) with both RO units in service. Given that the RO system is not treating for a primary contaminant and only hardness, having 100% redundancy is not required. In addition, the projected average day flow of 0.583 MGD (405 gpm) is easily handled with one unit in service. The RO system reject water flow is approximately 25 gpm per bank or 50 gpm when both units are in operation. For average day demands of 0.583 MGD, the average amount of reject water will be 16,000 gpd.

4.4.5 Building Expansion & Intermediate Clearwell

In order to reconfigure the water plant to utilize RO, more infrastructure is needed beyond the RO units themselves. The proposed RO units will not fit in the existing building. This alternative removes the need for lime softening, thus the existing lime press and associated dump truck to haul lime sludge is not needed. This frees up space in the existing maintenance garage to fit one of the RO units. The second unit will need to be installed in a building expansion next to the existing garage.

Another requirement of RO is that the water fed to the system be a suitable pressure (usually greater than 30 psi) which is not available with the current water plant. A new system must also be able to direct a portion of the treated water from the gravity filters and allow a bypass blending scenario to occur. The proposed arrangement to accomplish this is to install an intermediate clearwell between the water plant and the existing clearwell. The following figure illustrates the proposed alternative.

Figure 4-7: Alternative 2 RO and Clearwell Schematic

A new 25,000 gallon intermediate clearwell will need to be constructed as shown in the figure. The concrete basin will consist of two chambers separated by a permanent wall with a weir. Normal operation would have all treated water from the filters flow into the influent side of the clearwell. One of two vertical turbine pumps would then pump the required flow to the RO systems while allowing the remaining unsoftened water to pass over the weir wall into the effluent side of the clearwell. Treated water from the RO units will flow back to the effluent side of the clearwell to provide the blended final product. The high service pumps will draw the final product from the existing clearwell and pump into the distribution system. Continuous monitoring equipment will measure and adjust the RO system and blend rate to maintain the desired hardness level in the water sent to the city. The clearwell will have a small block building directly over it to house the pumps, valves, piping, and monitoring equipment.

4.4.6 Backwash Improvements

As described previously, the current water plant recycles all the backwash water from the filters. This alternative will also eliminate this practice, but no storage lagoons are proposed. The existing backwash water tank will be reconfigured to pump all backwash water to the sanitary sewer. With the improvement of the filter backwash system, the overall flow to the sanitary sewer system will be approximately 15,000 gpd plus the projected reject water from the RO system of 16,000 gpd for a total additional flow to the sewer system of 31,000 gpd. It is preliminarily assumed that the city's existing wastewater plant will be able to handle this additional flow.

4.4.7 Chemical Feed System Improvements

Taking into consideration that the existing lime system will not be used, a modification of the existing chemical feeds systems will have to be made. The lime system will be demolished except that the lime silo is proposed to be left in place. The carbon dioxide system will no longer be needed as well.

As with Alternative No. 1, the chlorine system is also proposed to be upgraded. It is recommended to relocate the existing chlorine injection points to a common injection point on the high service pump discharge piping to limit continued degradation of the existing concrete clearwell. A new feed system, scales, ejectors, and piping will be installed.

The RO system will have need of anti-scalant and a cleaning system of either hydrochloric acid or sodium hydroxide. These new chemical feed systems are proposed to be installed in a new room constructed with the expansion of the existing building.

4.4.8 Miscellaneous Building and Electrical Improvements

The final items included in this alternative are identical to Alternative 1. The general replacement of old building components and an upgrade of the electrical system is required. It is proposed to replace all the existing doors and windows with new, energy efficient units. The existing HVAC system and exhaust fans are also in need to rehabilitation.

It is recommended to provide replacement motor control centers (MCC's) and replace conduit and wiring as appropriate.
The inspection report provided for the existing clearwell indicated that some concrete deterioration and spalling of the roof of the structure was occurring. This report recommends minor patching

and epoxy coating of structure during an improvement project which will be easier after construction of the proposed intermediate clearwell.

The referenced Olsson report indicated that the current WTP utilizes the City's neighboring power plant for backup power. Should that facility not be in operation, a new backup generator will be necessary. For the purposes of this report, this alternative will include a new generator and automatic transfer switch, however this could be deleted should the City determine the power plant will stay in operation for the foreseeable future.

4.4.9 Alternative No. 2 Opinion of Probable Cost

ESTIMATE OF QUANTITIES					
Item #	**Description**	**Unit**	**Qty**	**Unit Price**	**Total**
GROUP A - General Water Plant Improvements					
1.	Mobilization	LS	1	$275,000	$275,000
2.	Bonding and Insurance	LS	1	$120,000	$120,000
3.	Aerator Rehabilitation and Cleaning	EA	2	$35,000	$70,000
4.	Existing Pipe Cleaning/Pigging	LS	1	$10,000	$10,000
5.	Automatic Control System	LS	1	$240,000	$240,000
6.	Electrical Improvements	LS	1	$600,000	$600,000
7.	New Backup Generator and ATS	LS	1	$110,000	$110,000
8.	Building Improvements (Doors/Windows)	LS	1	$20,000	$20,000
9.	Building Improvements (Interior Painting)	LS	1	$35,000	$35,000
10.	Existing Clearwell Roof Patching and Epoxy Coating	LS	1	$320,000	$320,000
11.	HVAC Improvements	LS	1	$30,000	$30,000
12.	Temporary WTP Bypass Operations & Chemical Feed	LS	1	$10,000	$10,000
13.	Lab Improvements	LS	1	$15,000	$15,000
14.	Seeding, Fertilizer and Mulch	ACRE	1	$4,500	$4,500
15.	Erosion Control	LS	1	$2,500	$2,500
			Construction Subtotal	Group A	$1,862,000
			Contingency	10%	$186,200
				Total Opinion of Construction Cost - Group A	**$2,048,200**
GROUP B - Gravity Filter System Improvements					
1.	Removal and Disposal of Existing Media	LS	1	$15,000	$15,000
2.	New Gravity Filter Equipment (Media/Wash Troughs/Valves)	LS	1	$200,000	$200,000
3.	Gravity Filter Equipment Installation	LS	1	$150,000	$150,000
4.	Underdrain Nozzle Replacement (As Needed)	LS	1	$5,000	$5,000
5.	New Backwash Blower	LS	1	$15,000	$15,000
6.	Update Filter Control System and Instrumentation	LS	1	$35,000	$35,000
7.	Distribution Water Source Backwash System	LS	1	$30,000	$30,000
			Construction Subtotal	Group B	$450,000
			Contingency	10%	$45,000
				Total Opinion of Construction Cost - Group B	**$495,000**
GROUP C - Reverse Osmosis and Intermediate Clearwell					

1.	Reverse Osmosis Equipment (485 gpm)	EA	2	$450,000	$900,000
2.	Reverse Osmosis Equipment Installation	LS	1	$225,000	$225,000
3.	Garage Bay Expansion, Block Construction	SF	600	$350	$210,000
4.	Overhead Doors	EA	2	$7,500	$15,000
5.	HVAC	LS	1	$7,500	$7,500
6.	Intermediate Clearwell Structural Concrete	SY	100	$950	$95,000
7.	Clearwell Hatches	EA	2	$5,000	$10,000
8.	Vertical Turbine Pumps	EA	2	$20,000	$40,000
9.	Pump Building, Block Construction	SF	240	$300	$72,000
10.	Stairs and Miscellaneous Metals	LS	1	$6,000	$6,000
11.	16" Ductile Iron Pipe	LF	150	$120	$18,000
12.	10" Ductile Iron Pipe	LS	100	$100	$10,000
13.	Pump Discharge Fittings, Valves, Meter, Etc.	LS	1	$20,000	$20,000
14.	Miscellaneous Fittings	LS	1	$15,000	$15,000
15.	Hardness Monitoring Equipment and Meters	LS	1	$10,000	$10,000
			Construction Subtotal	Group C	$1,653,500
			Contingency	10%	$165,350
				Total Opinion of Construction Cost - Group C	**$1,818,850**
GROUP D - Chemical Feed System Improvements					
1.	Potassium Permanganate Feed System Improvements	LS	1	$15,000	$15,000
2.	Gas Chlorine System Improvements	LS	1	$20,000	$20,000
3.	Demolition of Obsolete Systems	LS	1	$5,000	$5,000
			Construction Subtotal	Group D	$40,000
			Contingency	10%	$4,000
				Total Opinion of Construction Cost - Group D	**$44,000**
GROUP E - Backwash Improvements					
1.	8" PVC Force Main, DR 18	LF	100	$35	$3,500
2.	8" Fittings	LS	1	$3,500	$3,500
3.	Submersible Backwash Pump	EA	2	$20,000	$40,000
4.	Piping Modifications	LS	1	$7,500	$7,500
5.	Crushed Rock Surface Course	TONS	40	$50	$2,000
			Construction Subtotal	Group E	$56,500
			Contingency	10%	$5,650
				Total Opinion of Construction Cost - Group E	**$62,150**
				Construction Subtotal - All Groups	$4,062,000
				Contingency	$406,200
				Total Opinion of Construction Cost - All Groups	**$4,468,200**
PROFESSIONAL SERVICES					
1.			Design Services (Engineering, Survey, Architecture)	18%	$804,300
2.			Overhead (Legal, Fiscal, Etc.)	2%	$81,200
				Subtotal Professional Services	$885,500
				Total Opinion of Project Cost	**$5,353,700**

4.4.10 Alternative 2 Opinion of Probable O&M Costs

Similar to Alternative 1, labor costs are not included in this analysis. It is expected that labor necessary for the water plant will be much less than currently needed, however, the additional time allowed existing staff will be better directed elsewhere in the water system and the overall labor costs will be equivalent.

The following table summarizes the expected O&M costs. The O&M costs for this alternative includes the elimination of the use of lime which has been a large expense for the city. However, the use of RO does add significant costs in terms of electricity. As seen in the table below, the overall increase in electrical costs vs. the savings in chemical use (lime) nearly offsets each other when compared to Alternative 1 O&M costs.

Table 4-4: Alternative 2 Opinion of Probable O&M Costs

ELECTRICAL POWER	Hp				
Well Motor (1)	100	12	Hrs/Day/Ea =	1200	Hp Hrs/Day
Aerator Fans (2)	0.5	12	Hrs/Day/Ea =	12	Hp Hrs/Day
Recarbonation Basin Mixer	2	24	Hrs/Day/Ea =	48	Hp Hrs/Day
HSP's (3)	75	4	Hrs/Day/Ea =	900	Hp Hrs/Day
Backwash Tank Discharge Pump	20	2	Hrs/Day/Ea =	40	Hp Hrs/Day
Intermediate Clearwell RO Feed Pump	25	12	Hrs/Day/Ea =	300	Hp Hrs/Day
RO Feed Pumps (2)	60	12	Hrs/Day/Ea =	1440	Hp Hrs/Day
Chlorine Booster Pump	3	12	Hrs/Day/Ea =	36	Hp Hrs/Day
Air Wash Blower	25	0.25	Hrs/Day/Ea =	6	Hp Hrs/Day
Miscellaneous Electrical				30	Hp Hrs/Day
TOTAL				4012	Hp Hrs/Day
Hp Hrs/Day x 0.7457 KW-Hr/Hp-Hr =				2992	KW-Hr/Day
TOTAL ESTIMATED KW/HRS/DAY				2992	Kw Hrs/Day
Kw Hrs/Day x $0.12 / Kw-Hr =				$359.03	/Day
				$10,770.97	/Month
				$131,046.75	/Year
Total Estimate of Annual Electrical Power				$132,000.00	/Year
CHEMICALS:					
Sodium Permanganate				$22,500.00	/Year
Antiscalant				$6,500.00	/Year
Cleaning Chemicals				$10,000.00	/Year
Chlorine				$2,100.00	/Year
Sequestrant (Polyphosphate)				$1,500.00	/Year
Total Chemical Expense				$42,600.00	/Year
Total Alternative Estimated Annual O&M Cost:				$174,600.00	/Year
Existing Water System Annual O&M[1]				$503,000.54	/Year
TOTAL ESTIMATED ANNUAL O&M COST:				**$677,600.54**	**/Year**
Average Daily Water Production				0.538	MGD
Yearly Water Production				196.37	MGD
O&M per 1,000 gallons				**$3.45**	**per 1,000 gal**

[1]: Existing Water System O&M Average for the last 3 years less Utilities, Chemicals, Rentals, and Capital Improvements

4.5 Summary of Engineer's Opinion of Costs and O&M Costs for Alternatives

Table 4-5 below provides a side by side comparison of the estimated opinion of probable cost and opinion of O&M cost for each of the alternatives. Note, for comparison purposes the three alternatives prepared by Olsson are included in this table. The referenced Olsson report did not have specific O&M estimates for each alternative as it concluded that existing O&M costs are not anticipated to change from the existing water utility expenses.

Table 4-5: Summary of Engineer's Opinion of Cost and O&M Costs for Alternatives

Alternative No.	Description	Capital Cost	Estimated Water System O&M
I*	New Treatment Process and Building	$8,563,000	N/A
II*	Improve Existing Treatment Process	$4,775,000	N/A
III*	Modified Treatment Process	$5,040,000	N/A
1	Existing Water Treatment Plant Rehabilitation	$5,533,280	$658,601
2	Reverse Osmosis Plant	$5,353,700	$677,601

**As presented in* _2020 Water Treatment Facility Evaluation_ *by Olsson*

4.6 Pricing Index

Preliminary Opinions of Cost have been prepared for the purpose of making a monetary comparison between the proposed alternatives. Material and equipment costs were determined by review of local construction projects of similar nature and consultation with various material and equipment manufacturers and suppliers. Material and labor costs have increased over the recent years resulting in increasing construction, operation, and maintenance costs. Market conditions indicate that this trend will likely continue in the future at varying rates. The cost opinions have been prepared based on present value construction costs for comparison purposes.

Construction costs can be adjusted to different time periods by utilizing the Engineering News Record (ENR) construction cost index. The costs presented in this report are from January 2020 which correlates to the ENR index of 11,392. Construction cost can be adjusted from one time to another by multiplying the cost by the ratio of the two ENR indices (future/present). For example if the cost of a project is $100,000 when the ENR index is 10,000 the cost of same project when the ENR index is 11,000 can be estimate by multiplying 100,000 times 11,000 divided by 10,000 or 1.1. The resulting costs would be $110,000.00

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SECTION 5

5 Alternative Selection

5.1 Elimination of Alternatives

5.1.1 Technically Not Feasible

Alternative No. 3: No Action

This alternative is not feasible because the existing water treatment plant is a vital part of the water system for the City of David City. As shown in this report, the existing plant is in need of either rehabilitation or replacement to continue to operate reliably and remove a primary regulated contaminant (arsenic) from the treated water supply. Taking no action will cause the water plant to fall further into disrepair until a major equipment failure occurs which will not allow the City to deliver water to the community.

5.1.2 Financially Not Feasible

All alternatives are considered financially feasible.

5.2 Feasible Alternatives

5.2.1 Life Cycle Costs

The purpose of the cost effective evaluation is to determine the average annual equivalent cost of the alternatives identified over the design life of the project. This evaluation considers the initial cost, estimated annual operation and maintenance costs, and salvage value, if any.

5.2.1.1 Alternative Calculations

Table 5-1: Alternatives Lift Cycle Costs Summary

Alternative	1 Existing Water Treatment Plant Rehabilitation	2 Reverse Osmosis Plant
Total Capital Cost	$5,533,280	$5,353,700
Annual O&M Cost	$658,601	$677,601
20-yr Present Worth (O&M)	$12,766,065	$13,134,354
20-yr Salvage Value	$0	$0
20-yr Life Cycle Cost[1]	$18,299,345	$18,488,054

[1] : 20 Year Life Cycle Costs are calculated as Net Present Value = Capital Cost + Pres. Worth of O&M Costs – Pres. Worth of Salvage

A few observations from the analysis indicate that the overall capital cost for each alternative is very close with Alternative 2 being estimate to have a lower cost. Yearly O&M costs for each alternative are also very comparable. The 20 year life cycle cost for Alternative 1: Existing Water Treatment Plant Rehabilitation provides a slightly better value than Alternative 1.

5.2.2 Non-Monetary Factors & Environmental Impacts

For the previously presented alternatives, a preliminary look at the potential impacts upon social and environmental factors that are important when determining which alternative(s) should be pursued for the City. This evaluation will examine impacts to air, land, surface water and groundwater, as well as social and economic impacts. Beneficial water reuse or conservation are also important to consider when they are available.

The following is a preliminary list of likely known impacts from the potential improvement alternatives. A more comprehensive environmental analysis will be prepared for the selected alternative in a separate report at the conclusion of this review. As a part of that analysis, state and federal agencies will be consulted to review any potential concerns they may have.

5.2.2.1 Air

<u>All Alternatives:</u>
The construction may require the clearing and burning of trees and brush. All burning will be performed in accordance with the applicable permits and regulations. The excavation and placement of earth may cause fugitive dust emissions, but the process will be conducted with water application to reduce the amount of dust created.

5.2.2.2 Land Use

<u>Alternative No. 1: Existing Water Treatment Plant Rehabilitation</u>
This alternative will increase the amount of land occupied by the treatment plant with the construction of new lime storage lagoons. The proposed location of the lagoons is north of the existing water plant. This area is currently farmed and directly adjacent to an existing railroad.

The primary effect on the surrounding land occurs during the construction process where storm water runoff and erosion is the main concerns. To mitigate this process and comply with applicable regulations to reduce erosion, erosion control fencing and other erosion control methods will be employed. Site restoration will occur promptly following any proposed construction. Vegetation will be restored to the site via site seeding and mulching.

<u>Alternative No. 2: Reverse Osmosis Plant</u>
This alternative will be located entirely on existing property owned by the City at the water plant site.

5.2.2.3 Biological Resources

<u>All Alternatives:</u>
A thorough wildlife and endangered species review will be conducted in a separate report. While normal native wildlife is expected in any area, no known endangered species are present in the proposed site area.

5.2.2.4 Archeological Resources

<u>All Alternatives:</u>

A review of the National Register of Historic Places indicates that no historical buildings would be impacted by any of the alternatives. No known historical resources or archeological are present in the proposed site area at this time.

5.2.2.5 Surface Water & Wetlands

<u>All Alternatives</u>
The alternatives are not proposed to impact surface water and will not affect municipal, industrial or agricultural water users' availability of water. The potential impact to surface water from storm water runoff will be controlled via erosion control methods and best management construction practices.

From on-site inspections and review of the area topoquads, there does appear to be areas of wetlands or wetland type environments. All alternatives' proposed construction is not planned to be within any wetland areas. Prior to design of any of these alternatives, it is recommended that wetland delineation be accomplished to appropriately locate and define wetlands and to confirm that no proposed construction occurs within the defined areas. If any wetlands are encountered and disturbed for a proposed project, the wetland will be restored or mitigated to preconstruction condition in compliance with applicable regulations

5.2.2.6 Groundwater

<u>All Alternatives:</u>
The alternatives presented will not affect the amount of groundwater used by the facility. The existing wells in use are planned to remain (except formal abandonment of Well #8 and #9). Groundwater levels are not expected to be significantly impacted as a part of these alternatives.

5.2.2.7 Economic and Social Impacts

<u>All Alternatives:</u>
The primary economic impact for these alternatives is the cost to the water users in the City. The project costs are projected to be quite high. The City may be eligible for low-interest loans and/or grants that could reduce the financial burden of the rate payers. The largest economic impact could be to industrial users with the increased water rates.

There are expected to be few social impacts of this project. No relocations or disruptions of traffic are expected from this alternative.

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SECTION 6

6 Proposed Project

6.1 Selected Alternative(s) and Preliminary Design Information

A review of the City of David City water quality shows xxxxx. As a result, it is recommended that xxxx be selected.

6.2 Possible Project Schedule

The implementation of the recommended improvements can take a substantial length of time for the funding, design, review, and construction of the project(s). It is recommended that the City begin the project(s) process immediately so that the deficiencies can be corrected as soon as possible.

If the City decides to pursue the construction of these recommended alternatives, **Table 7-2: Potential Implementation Schedule** lists the typical steps and anticipated duration of each step to implement the alternative(s).

Table 6-1: Potential Implementation Schedule

Projected Steps	Elapsed Time
Completion and Acceptance of Facility Report	3 months
Start Environmental Assessment	3 months
Retain Services of Professional Engineer	3 months
WWAC Review	4 months
Complete Environmental Review Process	5 months
Secure Funding	6 months
Design of Improvements to the PWS	
Preliminary Design Review w/Owner	10 months
Final Design Review w/Owner	12 months
Advertise for Bids	14 months
Project Bid Letting and Contracts	16 months
Construction Period	16 to 26 months
Project Close-Out	28 months

If the City wishes to pursue an improvement project, the first step that should be taken is submittal of a pre-application to the Water & Wastewater Advisory Committee (WWAC) for review and consideration of financial assistance to the City. WWAC is made up of representatives for the funding agencies listed in Section 7 of this report. This committee reviews the proposed improvements and advises the City of which Agency's funding program may be most helpful.

6.3 Permitting Requirements

The recommended project will need to have multiple permits in order to complete. These permits include a construction permit from DHHS, state electrical inspection, local building permit, and potentially a railroad crossing permit. Other permitting requirement may apply as well and will be identified during design.

6.4 Engineer's Opinion of Total Project Cost

Table 6-2: Selected Alternatives Combined Opinion of Cost

6.5 Annual Operating Budget

Typically, a community will base their water rates on the amount of water used annually and the annual expenses incurred to maintain the department/division independently of other expenses in the City with a neutral or positive income (i.e. Water income/revenues = All water system expenses + reserves). Because water usage can vary drastically from year to year, a community can either lose money or gain money in any given year. Therefore, the water rates for a community are often established to cover all expenses over a given year as well as fund a 10 to 20% reserve for emergencies, capital improvements and periods of unexpected low revenue. Capital improvements in a water system are typically replacement of components and improvement projects like those recommended in this report.

The City of David City drinking water purchase rate structure for City users are at currently set per the following table as adopted in September of 2017.

Table 6-3: David City Water Rate Schedule & Users

Meter Size	No. of Users	Base Rate	Use Charge (First 10,000 gal)	Use Charge (Over 10,000 gal)
5/8”	1,091	$28.50	$3.41	$3.87
¾”	21	$35.75	$3.41	$3.87
1”	114	$35.75	$3.41	$3.87
1 ½”	13	$71.25	$3.41	$3.87
2”	17	$212.50	$3.41	$3.87
3”	9	$300.00	$3.41	$3.87
4”	3	$300.00	$3.41	$3.87
6”	1	$375.00	$3.41	$3.87

The average water use for each meter size class is presented in the referenced report.

A summary of the most recent water system expenses as listed in the City’s audit reports can be found in **Table 6-4: Water and Sewer System Expenses**.

Table 6-4: Water System Revenue and Expenses

Fiscal Year	2016-2017	2017-2018	2018-2019	2019-2020	*4-Year Averages*
Revenue[1,3]					
Sales Tax	$66,606	$55,000	$72,398	$79,784	**$68,447**
Tap Permit Fees	$775	$7,500	$775	$3,100	**$3,038**
Rental Fees	$0	$0	$462	$944	**$352**
Refunds	$644	$0	$52	$150	**$211**
Interest on Investments	$961	$0	$1,551	$1,129	**$910**
Sales & Service (Exempt)	$136,703	$11,000	$152,156	$155,520	**$113,845**
Sales & Service (Taxable)	$893,249	$725,000	$977,735	$1,060,768	**$914,188**
Miscellaneous	$754	$200	$10,730	$785	**$3,117**
Supplies Sold (Exempt)	$3,255	$500	$722	$3,406	**$1,971**
Supplies Sold (Taxable)	$970	$500	$1,442	$4,759	**$1,918**
Revenue Total	**$1,103,917**	**$799,700**	**$1,218,023**	**$1,310,346**	**$1,107,996**
Expenses[1]					
Salaries & Wages: Full-Time	$96,382	$103,425	$100,713	$145,846	**$111,592**
Salaries: Overtime	$4,907	$9,850	$15,340	$22,166	**$13,066**
Salaries: Administrative	$0	$15,000	$0	$4,250	**$4,813**
Salaries: Clerical	$36,000	$36,445	$40,981	$51,473	**$41,225**
Salaries: Mayor, City Council	$3,285	$4,000	$5,130	$5,558	**$4,493**
Salaries: Part-Time	$2,903	$3,000	$10,788	$8,005	**$6,174**
Retirement Plan	$3,225	$5,000	$1,836	$0	**$2,515**
Group Insurance	$22,368	$30,000	$16,044	$21,344	**$22,439**
Insurance: Workmen's Comp.	$4,704	$5,500	$5,191	$4,481	**$4,969**
Disability Insurance	$217	$200	$288	$365	**$268**
Social Security Remittance	$10,680	$11,500	$13,047	$17,693	**$13,230**
Audit	$2,935	$4,500	$2,938	$3,268	**$3,410**
Attorneys Fess & Legal Expense	$350	$3,000	$4,098	$12,146	**$4,899**
Dues, Meetings, Mileage	$5,641	$6,000	$1,331	$4,482	**$4,364**
Elster - Maint. Contract	$13,136	$14,500	$17,586	$0	**$11,306**
Contract Labor	$4,987	$0	$1,513	$7,629	**$3,532**
Fuel, Oil, Gas	$3,136	$4,000	$4,424	$2,914	**$3,619**
Vehicles: Repair & Maintenance	$1,344	$3,000	$2,594	$3,668	**$2,652**
Printing & Publishing	$829	$1,000	$928	$736	**$873**
Insurance	$21,092	$31,000	$12,518	$14,685	**$19,824**
Utilities	$77,318	$85,000	$82,824	$92,088	**$84,308**
Safety Expenses	$937	$2,500	$2,798	$1,443	**$1,919**
Repair & Maint - Bldgs./Grounds	$1,755	$6,000	$5,037	$7,078	**$4,968**
Repair & Maint: Equipment	$13,471	$61,000	$1,650	$6,802	**$20,731**
Repair & Maintenance - System	$29,501	$40,000	$51,445	$40,996	**$40,485**
Rep & Maint: Wells & Reservoir	$9,347	$6,000	$7,069	$4,654	**$6,767**
Miscellaneous	$9,114	$14,000	$4,940	$19,715	**$11,942**

Fiscal Year	2016-2017	2017-2018	2018-2019	2019-2020	*4-Year Averages*
Sales Tax Remittance	$65,974	$55,000	$78,336	$78,889	**$69,550**
Laboratory Fees	$3,348	$3,800	$3,628	$4,011	**$3,697**
Occupation Fee to General	$30,127	$28,000	$32,571	$35,185	**$31,471**
Economic Development Director	$2,500	$4,000	$0	$0	**$1,625**
Office Supplies	$2,762	$6,000	$3,657	$3,601	**$4,005**
Lab Supplies	$117	$1,500	$765	$301	**$671**
Shop & Small Tools	$888	$2,500	$1,107	$4,452	**$2,237**
Pipes, Valves, Fittings, Etc.	$0	$250	$10,220	$12,769	**$5,810**
Chemicals	$52,370	$62,000	$55,410	$81,065	**$62,711**
Miscellaneous Supplies	$231	$500	$1,153	$1,784	**$917**
Depreciation[2]	$6,413	$5,000	$349,046	$0	**$90,115**
Rentals: Miscellaneous Equip	$0	$3,000	$8,312	$10,537	**$5,462**
Cap Improve: Land & Buildings	$0	$0	$0	$285	**$71**
Cap. Improve: Equip & Vehicles	$17,116	$40,000	$0	$10,384	**$16,875**
Cap. Improve - System	$238,298	$565,000	$0	$92,035	**$223,833**
Expenditures Total (Less Depreciation)	**$793,295**	**$1,276,970**	**$608,212**	**$838,784**	**$879,315**
Net Revenue (Loss)	**$310,622**	**($477,270)**	**$609,812**	**$471,562**	**$228,681**

[1]: Categories that have no values listed for the 4 year period were deleted from the table.
[2]: Depreciation expense excluded from total expenditures for clarity.
[3]: Fund transfers were noted in the last two fiscal years but omitted for the purposes of examining actual water utility financials.

Overall, the water utility has experienced an average net revenue of $228,681 over the last four fiscal years when excluding depreciation.

The City of David City also currently has three outstanding water system bonds for prior project completed in the city.

Table 6-5: David City Existing Water System Debt

Item	Outstanding Debt	Payoff Year
Water Treatment Plant “D” Street Infrastructure	$265,535.00	FY 2022
GO Water Bonds Series 2017 Highway 15 / Downtown	$1,458,500.00	FY 2027
Water Treatment Plant Bond Payment #66	$72,533.98	FY 2021

6.6 Projected Impact to Users

The following **Table 6-6: Potential Impact to City Water Rates** provides the estimated impact on the average individual water use charge if various alternatives are installed. This table compares various potential funding possibilities and a typical average water rate. Any funding is not guaranteed, and the city will need to apply to the WWAC committee to determine what funding offers are available. It should be noted that the average user rate does not account for the range in water use in the city (i.e. industrial users vs. residential). A typical user will see higher and lower rates based upon individual water usage.

Table 6-6: Potential Impact to City Water Rates

Description	Alternative 1 Rehabilitation of the Existing Water Plant				Alternative 2 Reverse Osmosis Water Plant			
	SRF Only (20-YR)	SRF Only (30-YR)	USDA-RD (No Grant)	USDA-RD (Max Grant)	SRF Only (20-YR)	SRF Only (30-YR)	USDA-RD (No Grant)	USDA-RD (Max Grant)
Total Project Cost	$5,533,280	$5,533,280	$5,533,280	$5,533,280	$5,353,700	$5,353,700	$5,353,700	$5,353,700
- Loan Origination / Interim Financing Costs[1]	$27,666	$27,666	$165,998	$165,998	$26,769	$26,769	$160,611	$160,611
TOTAL	**$5,560,946**	**$5,560,946**	**$5,699,278**	**$5,699,278**	**$5,380,469**	**$5,380,469**	**$5,514,311**	**$5,514,311**
- USDA Grant[2]	$0	$0	$0	-$2,564,675	$0	$0	$0	-$2,481,440
- Other Cash / Grant	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL AMOUNT TO FINANCE	**$5,560,946**	**$5,560,946**	**$5,699,278**	**$3,134,603**	**$5,380,469**	**$5,380,469**	**$5,514,311**	**$3,032,871**
- Financing Interest Rate	2.50%	2.50%	1.250%	1.250%	2.50%	2.50%	1.250%	1.250%
- Financing Loan Term	20	30	40	40	20	30	40	40
SUBTOTAL ANNUAL DEBT SERVICE	**$356,800**	**$265,700**	**$182,000**	**$100,100**	**$345,200**	**$257,100**	**$176,100**	**$96,900**
- Other Annual Debt Service	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL DEBT SERVICE	**$356,800**	**$265,700**	**$182,000**	**$100,100**	**$345,200**	**$257,100**	**$176,100**	**$96,900**
- Debt Service Coverage Ratio	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
TOTAL ANNUAL DEBT SERVICE + RESERVE	**$392,480**	**$292,270**	**$200,200**	**$110,110**	**$379,720**	**$282,810**	**$193,710**	**$106,590**
- Utility Annual Expenses	$658,601	$658,601	$658,601	$658,601	$677,601	$677,601	$677,601	$677,601
TOTAL ANNUAL UTILITY REVENUE REQUIREMENT	**$1,051,081**	**$950,871**	**$858,801**	**$768,711**	**$1,057,321**	**$960,411**	**$871,311**	**$784,191**
- Number of Utility Users	1269	1269	1269	1269	1269	1269	1269	1269
FINAL AVERAGE MONTHLY UTILITY FEE	**$69.02**	**$62.44**	**$56.40**	**$50.48**	**$69.43**	**$63.07**	**$57.22**	**$51.50**

[1] - DWSRF loan origination fees are calculated as 0.50% of the loan value. Interim financing costs associated with USDA-RD construction loans are assumed to be 3.0% of the loan value.

[2] - Maximum USDA-RD grant award is 45% of project costs for communities in the poverty MHI category if not correcting a public health need.

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SECTION 7

7 Funding Sources

Depending upon the alternate selected, there are several methods of financing available; including:

- Revenue Bonds
- General Obligation Bonds
- The Nebraska Department of Health and Human Services Drinking Water State Revolving Loan Fund (DWSRF)
- The USDA Rural Development Water and Waste Disposal Loan and Grant Program
- The Nebraska Department of Economic Development CDBG Program

A combination of some or all of these funding sources is also possible. Considering the capital construction cost and ongoing O&M costs of the improvements, it may prove beneficial to the community to pursue funding assistance from one or more of the public programs listed above. A general description of each of these funding methods is provided below.

If the City of David City would like to proceed with this project, a representative from all these funding agencies will need to be contacted by submitting this report to the Water and Wastewater Advisory Committee (WWAC). This committee will review the report and make recommendations on funding that might be available. By submitting to the WWAC there is no obligation by the community to complete the project. The community will be given an opportunity to review the funding package offered by the WWAC and decide whether or not to move forward.

7.1 Revenue Bonds

Revenue bonds may be issued by utilities or jurisdictions that provide services for which revenues are collected. Debt service on the revenue bond issue is paid from the net revenues of the utility. One requirement of revenue bonds is that the net revenues of the utility must exceed the amount of the bond issue by an excess amount referred to as “coverage”. This coverage is typically as much as 1.10 to 1.25 times the annual debt service payments in order to make the bonds attractive to buyers. In projects such as this with large expenditures and debt service requirements, the revenue bond requirement for 1.10 to 1.25 coverage often is a hardship to the owner, which makes other forms of financing more attractive. Revenue bonds are currently at market rates up to 20 year terms, depending on market conditions and credit worthiness of the issuer. If the City is interested in pursuing revenue bonds, then it is recommended that the City contact its fiscal agent.

7.2 General Obligation Bonds

General obligation bonds may be issued for this type of improvement. General obligation bonds are a type of municipal government bond, which is government debt issued to raise money to finance public improvements. A general obligation bond is a municipal bond backed by the full faith and credit (taxing power) of the issuing jurisdiction, rather than the revenue from a given project. No assets are used as collateral for the bond and the bond is not dependent on revenue of any particular project for repayment. It is also common to retire general obligation bonds with utility revenues. General obligation bonds are currently sold at market rates up to 20 year terms, depending on market conditions and credit worthiness of the issuer. If the City is interested in pursuing general obligation bonds, then it is recommended that the City contact its fiscal agent.

7.3 Department of Health and Human Services – Drinking Water State Revolving Fund (DWSRF)

Based upon the 2014-2018 American Community Survey 5-Year Estimate, the median household income (MHI) of the community is $50,902 with a margin of error of ±$5,391. Given this value, the City is eligible for a 2.0% + 1.0% loan from the DWSRF Program and could possibly for 20% loan forgiveness.

Figure 7-1: DHHS Drinking Water SRF Program Requirements

Nebraska Department of Health & Human Services State Revolving Loan Fund State of Nebraska	
2014-2018 Median Household Income	Drinking Water State Revolving Fund
> $65,260	Interest Rate: 1.5% plus a 1% admin fee on the outstanding principal balance. Admin fee reduction may be available. Term: Up to 20 years Small Town Grant: None Loan Forgiveness: None
$43,507 - $65,260	Interest Rate: 1.5% plus a 1.0% admin fee on the outstanding principal balance. Admin fee reduction may be available. Term: Up to a 30-year term @ 1.5%+1.0% Small Town Grant: None Loan Forgiveness: Up to 20% of eligible project costs by MHI interpolation for towns having population < 10,000.
< $43,507	Interest Rate: 1.5% plus a 1.0% admin fee on the outstanding principal balance. Admin fee reduction may be available. Term: Up to a 30-year term @ 1.5%+1.0%. Interest rate reduction may be available for disadvantage communities. Small Town Grant: None^ Loan Forgiveness: 20% of eligible project costs for towns having population < 10,000. Projects that remedy or avoid an Administrative Order (A.O.) issued by the Nebraska Department of Health and Human Services – Division of Public Health (NDHHS-DPH) can receive up to 25% loan forgiveness.

Up to 35% loan forgiveness may be offered to Public Water Systems (PWS) whose projects will remedy an A.O. issued by DHHS-DPH.

A 50% loan forgiveness ceiling may be available to a PWS, at the discretion of the NDEQ and the Director of the DHHS-DPH up to a ceiling of $250,000, under all the following conditions:

- The PWS has closed a loan with the SRF within the past 5 years;
- That loan was for a project needed to resolve either an Enforcement Action or an Administrative Order (A.O.) issued to the PWS by the DHHS-DPH; and,
- That project did not resolve the specified Enforcement Action or A.O., or resulted in a separate Enforcement Action or A.O., through no fault by the PWS.

Note: 10 year loans set at 2.0% + 1.0% admin for private, non-profit water systems.

7.4 USDA Rural Development Program

USDA Rural Development uses the 2006-2010 American Community Survey 5-Year Estimate when considering funding eligibility for its program. The following diagram provides information about the type of assistance that may be offered to the community under the USDA Rural Development's Water and Waste Disposal Loan and Grant (WWDLG) Program, based upon the community's MHI value of $38,081 with a margin of error of ±$4,310. It shows that David City would be eligible for grant assistance. Rates shown are current as of the writing of this report.

Figure 7-2: USDA Rural Development WWDLG Program Requirements

USDA RURAL DEVELOPMENT
WATER AND WASTE DISPOSAL LOAN & GRANT PROGRAM
STATE OF NEBRASKA
2006-2010 MEDIAN HOUSEHOLD INCOME

Interest Rate	**Grant Eligibility**
Market Rate (2.125%) ↑	No grant assistance (*See Note below*).
MHI* $51,320	
↑ **Intermediate Rate (1.750%)** ↓	Up to 45% grant assistance (*See Note below*)
MHI* $41,056	
↓ **Poverty (1.250%)**	Up to 45% grant assistance, unless correcting a public health need. Then the maximum grant assistance is 75% (*See Note below*).

** MHI is the Median Household Income for the applicant according to the 2006-2010 American Community Survey 5-Year Estimates. At their sole discretion, an applicant may elect to conduct an MHI survey to challenge the Census figure. The MHI value established by this survey will be compared against the annually adjusted MHI value used by USDA for the applicant's service area. The results of the MHI survey will be valid for three (3) years, and then will revert to the 2006-2010 Census MHI figure.*

Note: USDA Rural Development Water and Waste Disposal Loan and Grant Program require a "Test of Credit." An applicant's projected user fee, including all grant funds, must meet USDA's Similar System User Rates before grant assistance can be applied to the project. Water meters are required.

7.5 Department of Economic Development CDBG Program

The most recent Census reports indicate that the community's low- and moderate-income (LMI) percentage is approximately 41.79%. In order to qualify for funding under the Nebraska Department of Economic Development's Community Development Block Grant – Water and Wastewater (CDBG – WW) Category, the communities must have an LMI percentage of 51% or higher. Therefore, it does not appear that the community may be eligible for CDBG funding.

However, the CDBG program does allow for a local challenge of this American Community Survey percentage figures if the community has reason to believe that the service area is actually above the 51% LMI threshold. To carry out this challenge, the community must conduct a statistically valid Income Survey of the entire service area, pursuant to CDBG Survey Methodology.

JEO recommends that the community seeks the assistance of an experienced individual/organization familiar with CDBG survey requirements to oversee the process. Failure to comply with CDBG survey methodology will invalidate the results of the survey.

This survey process will take additional time to complete and the outcome is not guaranteed. Therefore, the community must carefully weigh the potential inflationary cost of construction against the potential benefits of an added grant.

Figure 7-3: Department of Economic Development CDBG Program Requirements

<table>
<tr><th colspan="2">NEBRASKA DEPARTMENT OF ECONOMIC DEVELOPMENT
COMMUNITY DEVELOPMENT BLOCK GRANT (CDBG) PROGRAM
STATE OF NEBRASKA
2011-2015 LOW- TO MODERATE-INCOME</th></tr>
<tr><td>Low- and Moderate- Income (LMI) Percentage</td><td>CDBG Eligibility</td></tr>
<tr><td>51% - 100% LMI</td><td>If the applicant’s service area has a Low- and Moderate-Income (LMI) percentage greater than 51% (51%-100%) then the community/county may be eligible for up to $250,000 in Community Development Block Grant (CDBG) – Water and Wastewater (WW) funds.

The applicant’s LMI percentage can be obtained from the American Community Survey 5-Year Estimates (2006-2010), or by conducting an income survey in strict accordance with CDBG survey methodology. Such income surveys are valid for up to four years.

Other CDBG eligibility requirements include:

• the applicant has been invited to apply for CDBG – WW assistance by the Nebraska Department of Economic Development.

• the applicant has the financial capacity to provide the required 25% local match.

• the CDBG cost per beneficiary does not exceed $2,000.

• the applicant has a reasonably projected user fee, including all potential grant funds, exceeding $20 per household per month.

• the applicant has scored 85 points or more on the State’s most recent Intended Use Plan - Drinking Water Revolving Fund priority system (Drinking Water projects only).

• the applicant has scored 55 points or more on the State’s most recent Intended Use Plan - Clean Water Revolving Fund priority system (Clean Water projects only).</td></tr>
<tr><td>0% - 50.9% LMI</td><td>If the applicant’s LMI percentage is less than 51% (0%-50.9%), then the community/county is not eligible to apply for CDBG – WW funds, unless:

• the applicant elects to conduct an LMI income survey to challenge the LMI percentage established by the American Community Survey 5-Year Estimates (2006-2010). Income surveys that are conducted in accordance with CDBG methodology, are valid for up to four years.

• the applicant has, in its service area, 100 or more households with a high concentration of LMI residents (51%+). In this case, CDBG-assisted improvements must be design (in terms of sizing and capacity) to benefit only those beneficiaries within the targeted area.</td></tr>
</table>

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