CHAPTER 7
WATER TREATMENT EVALUATION

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WATER TREATMENT EVALUATION CHAPTER 7

7.1 INTRODUCTION

This chapter builds on the regulatory requirements presented in Chapter 3 and presents a drinking water treatment program designed to achieve regulatory compliance. The chapter begins with the identification of treatment objectives and a review of historical water quality parameters. This forms the basis for the selection of specific treatment plant components and processes in the subsequent section.

The second half of the chapter addresses plant capacity with regard to future water demands as developed in Chapter 5, discusses the role of the City's two existing wells that will not be integrated into the treatment plant, and concludes with recommended improvements. Capital costs for the recommendations presented in this chapter appear in Chapter 10.

7.2 TREATMENT OBJECTIVES

Oregon Administrative Rule (OAR) 333-061-0032 defines statewide treatment requirements for drinking water. This section presents the water treatment objectives developed to satisfy these requirements.

7.2.1 Inactivation/Removal of Microbial Contaminants

Junction City currently owns six operable wells. Four of these wells are currently utilized for water production and are classified as groundwater sources. As previously presented in Chapter 6, the City's two off-line wells have been identified as potential GWUDI sources. Future municipal growth will require the use of these two developed sources—in large part due to their strong yield and their close proximity to the proposed water treatment plant. As such, efforts should be undertaken to confirm the classification of each. Microbial contaminant treatment requirements for the two categories of source water are presented below to underscore the importance of this determination and to recognize the ramifications if groundwater sources are subsequently reclassified within the design life of the treatment plant.

Groundwater Sources

As presented in Chapter 3, the Ground Water Rule (GWR) goes into effect December 31, 2009. Assuming that the City's wells can be confirmed as groundwater sources without direct influence from surface water, compliance with the GWR will require the provision of 4-log (99.99%) removal and/or inactivation of viruses. The City is currently unable to provide this level of treatment at any of their well facilities. Failure to provide treatment by the regulatory deadline will require the operation of the water system in its current condition with the requirement to perform triggered monitoring in the event of any positive routine total coliform testing. Triggered monitoring is viewed as a necessary transitional phase prior to the construction new treatment facilities however the provision of a permanent facility that can reliably and efficiently achieve 4-log virus removal/inactivation is critical.

GWUDI Sources

Additional levels of treatment will be required should any of the City sources be reclassified as GWUDI. In addition to the 4-log treatment for viruses, public water systems utilizing GWUDI are required to install and properly operate a water treatment process that reliably achieves 3-log (99.9%) removal and/or inactivation of *Giardia lamblia*, and a minimum of 2-log (99%) removal and/or inactivation of *Cryptosporidium*.

7.2.2 Nitrate Removal

Over the last 20 years, numerous studies and sampling programs have documented the rise of nitrates in the groundwater of the Southern Willamette Valley. Within the City, nitrate levels in the 11th & Elm Street well have risen from roughly three quarters of the maximum contaminant level (MCL) in 1986 to well over the MCL in 2002. Due to the lack of treatment facilities, this well was taken out of service. A similar trend has been observed with nitrate levels in the 8th & Front Street well although current levels of in this well remain below the MCL.

Given the regional history of nitrate in groundwater and the likely increase of contaminant levels in future years the removal of this primary drinking water contaminant is viewed as an important treatment objective.

7.2.3 Corrosion Control

The decay of distribution system infrastructure due to corrosion is a challenge facing water systems nationwide. A 1997 survey of large municipal water systems found that the most common distribution system problem is the corrosion of cast iron pipe[18].

The primary goal of a corrosion control program is to slow or control the corrosion process thereby preserving infrastructure and maintaining water aesthetic. Iron-based pipe and asbestos cement pipe comprise roughly 40 percent of the City's distribution system by total length and are materials particularly sensitive to the corrosion process.

Common problems resulting from the corrosion process are the loss of pipe and joint integrity, the accumulation of scale in distribution pipes, the release of this scale and corrosion particulates into the water, the leaching of lead and copper from domestic plumbing systems and the depletion of chlorine residuals.

A treatment objective for the new plant is to re-evaluate the City's existing corrosion control practice in light of the treatment process proposed for the new treatment plant.

7.2.4 Minimizing Waste Streams

Conventional treatment methods for the removal of nitrate and iron can generate a combined waste streams between 1 and 5 percent of total plant flow. The waste is typically generated from the regeneration of ion exchange media and the backwashing of filtration systems. Aside from the direct loss of water, there are costs associated with the management of this waste stream. The minimization of this waste stream is accordingly identified as a treatment objective.

[18] AWWA, 1997

7.2.5 Taste & Odor

Taste and odor, at objectionable levels occur in approximately 16 percent of water utilities nationwide[19] and although the safety of the water in these systems is not at risk, consumers may perceive that the water is unsafe to drink because it has an unpleasant smell or taste. Although the City has not experienced significant problems due to this issue, improvements to taste and odor have been identified as desirable and this aesthetic is accordingly listed as a treatment objective.

7.2.6 Plant Reliability and Redundancy

With the exception of elevated storage, Junction City's existing water system currently benefits from multiple levels of redundancy. For example, the failure of a given well or well pump can be managed by bringing one or more of the underutilized wells on-line. The looped nature of the distribution grid allows flows to be routed around the failure of a distribution pipe. The decision to centralize water treatment for any municipality requires a careful evaluation of redundancy. At the broadest level the loss of the entire plant, taken as a whole, could certainly be perceived as a risk due to a lack of redundancy. However, like any complex mechanical process, failure is rarely catastrophic or comprehensive and more frequently occurs on an elemental level with the localized loss or interruption of a given component or sub-process.

A key treatment objective is to be able to provide treatment for average day demand in the event of a disruption or failure of any process component. This is based on the reasonable assumption that the difference between average day demand and either peak hour, or maximum day demand can be satisfied by storage reserves or by water use curtailment on an emergency basis. In such cases, timely notification of consumers is critical and an emergency notification and curtailment plan is essential to quickly reduce water demand.

7.3 SOURCE WATER CHARACTERISTICS

Oregon Administrative Rule 333-061-0036 defines statewide sampling and analytical requirements for public water systems. Test results of City water sources reported to the state in compliance with this regulation in addition to test results for other parameters recorded by the City have been summarized in Appendix X.

The well water is generally characterized by moderate to high concentrations of nitrate in two of the six wells and levels that are generally non-detectable in the remaining four. Nitrite levels are low to non-detectable in all wells. Alkalinity is generally 100 mg/L and pH in the distribution system ranges from 7.0 to 8.25. Water hardness is moderate with a range of 95-110 mg/L. Sodium levels are slightly elevated and range from 13 mg/L to 64 mg/L across the wells. Ninety percent of the observed sulfate concentrations are below 20 mg/L. The well at 5th & Maple has a history of hydrogen sulfide and related consumer complaints. Test results for radionuclides have consistently been non-detect.

The City has consistently observed high iron levels from the 8th & Deal and 3rd & Cedar wells. Fifteen percent of the observed iron levels from these two wells were above 0.50 mg/L with seasonal peaks as high as 3.0 mg/L. Iron levels from the 5th & Maple and 8th & Deal wells were

[19] Suffet, et al, 1996

lower and consistent with levels observed in the wider distribution system with a peak of 1.0 mg/L. No iron data were available for the wells at 8th & Front or 11th & Elm.

The City has not historically monitored for turbidity in the raw or finished water, in part because this parameter is not regulated due to the City's status as a groundwater system. Recent sampling indicates that the four active wells have raw water turbidity levels ranging from 3.0 to 4.5 NTU. Due to elevated levels of iron in the City's sources, it is anticipated that this turbidity source is largely due to iron in the source water that is readily oxidizing into its insoluble form. Further investigations are needed to determine confirm this. A turbidity baseline is also needed to begin framing the treatment process. It is recommended that the City begin monitoring this parameter several times per week to establish a baseline. The City has also begun additional testing to determine levels of TDS, chloride, manganese, silica and radon.

7.4 TREATMENT PROCESS

As overall municipal demand increases, and treatment needs become more complex, the case can increasingly be made for a centralized water treatment plant. Figure 6-1 presented at the end of Chapter 6, depicts the locations of the six functional municipal wells. As the figure shows, four of the wells are loosely centralized in an area with a 1,000 foot radius. This grouping of relatively high yield wells—13th & Elm, 8th & Deal, 8th & Front and 11th & Elm—comprising roughly 70 percent of the City's pumping capacity presents an opportunity to centralize water treatment.

The chlorination/disinfection requirements of the GWR and the nitrate removal process are two examples of treatment processes that benefit from a centralized approach. The operational flexibility of being able to bypass a portion of the treatment plant with high quality source water and blend the streams at the end of the treatment process is another strong reason for a centralized facility. Additionally, the economies of scale present in a centralized plant can often deliver a lower cost per unit of treated water. For these reasons and because of an expressed interest on the part of City Staff, a centralized plant is proposed.

Water treatment in the context of a centralized plant is performed by the aggregate of several discrete process units. Each process unit provides a specific treatment role and contributes its 'product' to the flow stream as water passes through the plant. The combination of these incremental treatment steps creates a treatment 'train' whose finished water product is intended to meet the overall treatment objectives as well as regulatory standards.

The WTP should be provided with treatment processes capable of providing current benefit with an operating margin that will allow the City to successfully treat water to meet anticipated near term regulatory requirements. The following paragraphs of this section discuss the generalized process units of the proposed plant.

7.4.1 Nitrate Removal

Several approaches were considered to achieve regulatory compliance with regard to nitrate. These approaches are summarized as follows:

- *Abandon existing wells with elevated nitrate levels and develop new wells that are free from the contaminant.*

The history of nitrate-free well development in the municipal area does not support this approach. Records show that generally only one in four new wells are low nitrate. The long term prospects of such a well remaining nitrate free given is unclear. As an alternative, deepening the City's only shallow well at 11th & Elm is attractive for several reasons. Sourcing the well out of the deeper aquifer may reduce the nitrate levels and would reduce it's susceptibility to contamination from the surface. Additionally, City ownership of the property, it's close proximity to the proposed treatment plant and the ability to structure the re-developed well for a higher yield could result in significant savings for the City.

- *Blend the nitrate sources with uncontaminated sources to meet the regulatory standards.*

Under this approach flows from the two nitrate rich sources would simply be combined with those that do not have nitrate to produce a blended product with nitrate levels below the MCL. Although this approach allows the City to meet regulatory contaminant levels, and recover the use of the two currently off-line wells, it is viewed as a stopgap measure that defers the problem and leaves the City operating on a narrow margin since relatively small increases in nitrate levels in future years would put the plant out of compliance.

- *Removal of nitrate with an approved treatment process.*

Of the above options the removal of nitrate from the 8th & Front and 11th & Elm Street raw water is viewed as the most sustainable long-term solution. A nitrate removal process installed to treat flows from the nitrate bearing wells will minimize the near-term cost of this process. This approach will require the construction of a dedicated raw water pipe to connect the two nitrate wells to the treatment plant. Raw water flow from the non-nitrate wells at 13th & Elm and 8th & Front would be connected to the plant with a separate raw water pipe. Should nitrate levels in the aquifer continue to rise, the nitrate removal process could be expanded to include the remaining sources.

7.4.1.1 Nitrate Removal Technologies

The EPA has approved three methods for the removal of nitrate from drinking water; ion exchange, electrodialysis reversal and reverse osmosis. Alternative methods of nitrate removal include biological denitrification, distillation and chemical reduction, however this report will present comparisons only between approved technologies with a proven record of municipal performance in the United States.

Ion Exchange

The ion exchange (IX) process as the name implies uses a charged anion resin to exchange acceptable ions from the resin for undesirable nitrate ions in the water. The removal process begins by passing nitrate-laden water through a bed of resin. As the water moves through the media bed, chloride or hydroxide anions are desorbed from the resin, and the nitrate ions are absorbed onto the resin. After the resin exchange sites are filled with nitrate ions the resin is regenerated with a strong brine solution. During this process the nitrate on the resin is replaced with chloride ions and the nitrate rich spent brine is discharged to waste. Following regeneration the resin bed is rinsed and placed back into service.

Electrodialysis Reversal

Electrodialysis Reversal (EDR) uses a semipermeable membrane and an induced voltage potential in which ions migrate through the membrane from a less concentrated to a more concentrated solution as a result of a given ion's representative attraction to the electric current imposed by the process. After a period of operation, the process uses polarity reversal to clean the membrane surfaces. This cleaning process increases membrane life and does not typically require chemical cleaning.

Reverse Osmosis

Like EDR, reverse osmosis (RO) uses a semipermeable membrane to filter out dissolved ions from the source water. However unlike EDR and the use of a voltage potential, RO uses the application of hydraulic pressure to overtake osmotic pressure and force water through the membranes. Of the three processes presented, RO removes the largest amount of dissolved minerals from the water and as such has the highest fouling potential with correspondingly high costs for suitable pretreatment. Applications in situations with low to moderate source water dissolved solids (such as Junction City) can require chemical feed processes to re-establish lost alkalinity.

Summary

A generalized comparison of nitrate removal technologies is presented in Table 7-1. Note that each of the three approved processes will require pretreatment filtration to reduce the iron content present in Junction City's source water to prevent fouling. Each technology also produces a waste stream. While the nature and chemical composition of the waste streams varies from process to process, waste from the IX process is significantly less than that from EDR and RO. It is anticipated that securing a surface water discharge permit for a nitrate-laden stream is unlikely particularly in a setting with no perennial streams. Accordingly, this waste will be discharged to the sanitary sewer system. In such cases the smallest waste rate minimizes downstream pumping and treatment costs.

Table 7-1 | Comparison of Nitrate Removal Technologies

Method	Cost per 1,000 gallons treated	Removal Rate	Operating Energy	Waste Stream	Pretreatment Requirements	Demineralization of Finished Water	Media Replacement Cost
IX	$ 0.30	80-95%	Moderate	½ to 1%	Moderate	Low	Moderate
EDR	$ 0.85	60-90%	High	10-15%	High	High	High
RO	$1 to $4	60-90%	High	15-20%	High	High	High

A review of the City's water quality data and project conditions indicates that the ion exchange process offers the highest benefit for the following reasons:

- Lowest cost and highest nitrate removal rate per unit of treated water
- Lowest waste stream
- The removal method is targeted for nitrate and avoids demineralization
- Lowest operational staffing and monitoring burden
- Well suited to the City's source water quality and temperature

Table 7-2 presented at the end of this chapter provides additional comparative information on the three technologies.

7.4.2 Filtration

Filtration as a water treatment process is, in a majority of cases, required of water systems with surface water sources or those classified as GWUDI. In either case the filter is used as a treatment technique to remove turbidity prior to disinfection. Filtration is less commonly required for the treatment of groundwater, but when required, it is most often used to remove iron and manganese. Oregon has several large public water systems (classified as groundwater systems) that utilize filtration to remove these contaminants.

Filtration is therefore presented as a required treatment process for groundwater and GWUDI.

7.4.2.1 Groundwater Sources

Due to the elevated iron levels in the City's groundwater the ion exchange process for nitrate removal will require pre-treatment to reduce iron and manganese levels. Reduction levels required for the nitrate process will be coordinated with the equipment suppliers during the design phase, however residual levels of 0.05 and 0.01 mg/L for iron and manganese[20] respectively are anticipated. Failure to remove these constituents will result in premature fouling of the media and raise the bacterial growth potential. Therefore the use of an ion exchange process in a groundwater system with elevated iron levels commits the City to filtration.

The effective filtration of iron requires an oxidation process upstream of the filter to convert the iron from a dissolved ionic state to an oxidized particulate that can be removed by the filter. This conversion will require the careful control of pH and oxidant dosing and a suitable contact time ahead of the filtration process. Depending on the type of filter, the use of a coagulant and/or a filter-aid polymer is often applied to assist with the removal of oxidized elements and other particulates.

The complete evaluation and selection of a specific filtration technology is outside the scope of this report, however it is likely that the process will consist of either a direct filtration approach or a membrane system utilizing either microfiltration or ultrafiltration. These filter types are well suited to low turbidity water and the removal of iron precipitates.

7.4.2.2 GWUDI Sources

Filtration will be a required treatment technique should any of the City wells be reclassified as GWUDI. In light of the nitrate and iron levels present in the City's source water, the treatment required of a GWUDI source is additive to the treatment measures already outlined. The filtration technologies proposed for the removal of iron (direct filtration and membrane filtration) are applicable to the reduction of microbial contaminants with varying degrees of efficacy. Public water systems utilizing GWUDI are required to provide 3-log inactivation and/or removal of *Giardia lamblia*, and a minimum 2-log removal and/or inactivation of *Cryptosporidium*.

As an aside, 4-log virus inactivation and/or removal is also required however this is almost universally achieved as inactivation with the use of a disinfectant. Table 7-3 outlines the

[20] AWWA and ASCE, 1998

regulatory removal credits (contrasted with inactivation credits) granted to the two filter technologies.

Table 7-3 | Conventional Regulatory Removal Credits for Filtration Technologies

Pathogen	Direct Filtration	Membrane Filtration [1]
Giardia lamblia	2-log	Up to 4-log [2]
Viruses	1-log	Up to 0.5-log [2]
Cryptosporidium	2- log	Up to 4-log [2]

[1] Defined as the rejection of particulate matter larger than 1 micrometer
[2] As verified by challenge testing

As previously presented in Chapter 3, compliance with the LT2 rule may require additional *Cryptosporidium* inactivation/removal requirements above the current 2-log level based on the demonstrated level of *Cryptosporidium* in the source water. This is potentially a limiting factor for the direct filtration approach, one that may require additional treatment methods (other than chlorination) to meet the regulatory requirements. Accordingly, the selection of a specific filter technology becomes more important in a GWUDI setting.

It is anticipated that the decision to utilize direct filtration or membrane filtration will be made in the preliminary design phase following the adoption of this plan and will undoubtedly be made on the basis of performance, lifecycle cost, and ease of expansion.

7.4.3 Disinfection

Inactivation of microbial pathogens with a disinfectant complements removal rates achieved through the filtration process. The City currently disinfects with chlorine and recently switched from chlorine gas to sodium hypochlorite. With the possible exception of ultraviolet (UV) disinfection, the scale of the proposed plant does not warrant the complexity associated with chloramination, ozone or chlorine dioxide. Accordingly, the use of alternate disinfectants will not be evaluated. On-site generation of sodium hypochlorite has been successfully utilized at several Oregon treatment plants of this size and it is recommended that this technology be evaluated in the design phase.

The EPA developed the CT disinfection concept in order to determine the level of microbial inactivation achieved during disinfection. This approach uses the product of the disinfectant residual concentration (in mg/L) and the effective disinfectant contact time (in minutes)—with consideration given to pH and temperature—to quantify the capability of a chemical disinfection system to provide effective pathogen inactivation. Sufficient CT time will be provided for inactivation of the following pathogens. It is anticipated that the existing ground storage reservoir will be integrated into the design of the new treatment plant and will serve as the primary chlorine contact chamber.

7.4.3.1 Inactivation of Viruses

As of December 31, 2009 4-log inactivation of viruses will be required by the GWR. The proposed plant will utilize chorine disinfection to fully comply with this requirement. Any additional virus removal afforded by a filtration technology will be considered redundant.

7.4.3.2 Inactivation of *Giardia lamblia*

The proposed plant will utilize chorine disinfection to fully comply with the 3-log inactivation requirement for *Giardia lamblia.* Any additional removal credit afforded by a filtration technology will be considered redundant.

7.4.3.3 Inactivation of *Cryptosporidium*

It is widely understood that *Cryptosporidium* is resistant to inactivation with chlorine. Inactivation of *Cryptosporidium* is not recommended as a primary means for regulatory compliance. Removal of this pathogen through filtration is proposed in lieu of inactivation. Inactivation with UV disinfection may be considered in the design phase as an augmentation to direct filtration should inactivation/removal above 2-log be required and the selection of a membrane filtration system is unfeasible.

7.4.4 Corrosion Control

The City currently utilizes orthophosphates for corrosion control. This program was implemented in response to a violation of the copper action level in 1994 and while it has satisfied regulatory requirements, no comprehensive evaluation of the efficacy of the program from a water chemistry or cost standpoint has been undertaken.

The proposed removal of iron and manganese at the new treatment plant will likely require a re-evaluation of the current corrosion control program. Oxidation rates for iron and manganese rise dramatically with higher pH values and it is likely that pH adjustments to enhance iron removal prior to filtration will require modifications to the current approach used for corrosion control. The goal is to provide a corrosion control program based at the new water treatment plant.

It should also be noted that distribution system pH data collected by the City demonstrates a somewhat atypical wide range of values. It is unclear whether this is a decay function of the water itself or a product of test procedures. Exposure of groundwater with excess carbon dioxide to the atmosphere can have a dramatic effect on pH after only a few minutes. Further evaluation of raw water pH values and a review of test procedures will be required before any conclusive observations can be made. It is therefore recommended that historical test data be validated with a review of the test procedures and the collection of additional data.

7.4.5 Minimizing Waste Streams

Regeneration of the ion exchange resin for nitrate removal will require the disposal of concentrated nitrate in a brine solution. The filtration process for iron removal will generate a waste stream that includes iron solids and other particulates removed from the source water. Due to the presence of nitrate, the brine stream is often disposed of at municipal wastewater treatment plants. The disposal of spent filter backwash is frequently accomplished with the construction of settling basins that discharge clarified water to nearby drainage or waterways. Naturally, the size of these basins can become quite large as the filtration capacity of a plant increases. The construction of settling basins for the proposed plant in Junction City is complicated by seasonally high groundwater levels and a relatively small site with much of the developable areas earmarked for treatment facilities and storage reservoirs.

For this reason it is currently proposed that a small membrane recovery process be installed to salvage water from the waste stream and return it to the head of the treatment plant. The use of a membrane recovery filter yields a small footprint and will likely reduce net waste from the filtration process from 10 to 15 percent of the total water processed to less than 1 percent.

It is anticipated that the combined waste stream for the plant will be on the order of 1.5 percent of total plant flow. The storage and off-peak discharge of these flows to the municipal sanitary system will avoid competition with municipal collection system flows generated during peak hours. Treatment equipment capable of producing minimal waste streams will be an important selection criterion during the procurement phase of this project. Minimizing this waste stream will reduce downstream pumping and treatment costs and is consistent with water conservation measures expected of the general public.

7.4.6 Taste and Odor

The control of taste and odor will largely be accomplished as auxiliary effects of the treatment processes already discussed. An important first step to reducing taste and odor complaints is the optimization of a corrosion control program. Effective corrosion control can reduce the leaching of metals such as copper, iron, and zinc from pipes or fixtures, as well as the objectionable color and taste associated with these contaminants. As previously stated proposed revisions to the City's existing corrosion control plan will provide contributing benefits to the control of taste and odor. The proposed filtration process will significantly reduce iron levels and other particulates, and the ion exchange process will collaterally reduce sulfate levels. The re-activation of the previously discussed off-line well sources will allow the 5th & Maple well (a current source of hydrogen sulfide) to be taken off-line and utilized as an emergency well.

Taste and odor problems can manifest in a water system's wells due to dissolved mineral content, corrosion byproducts or iron bacteria. Likewise drinking water in the distribution system is not sterile, regardless of the degree to which the water is treated. Biofilms or sediments commonly found in distribution systems can also be the source of taste and odor complaints. These problems can be mitigated by the proper design of the system and a regular flushing program.

The presence of taste and odor is highly subjective and can vary widely between individuals, however it is anticipated that the proposed treatment processes will measurably improve the aesthetics of the water.

7.5 PLANT CAPACITY

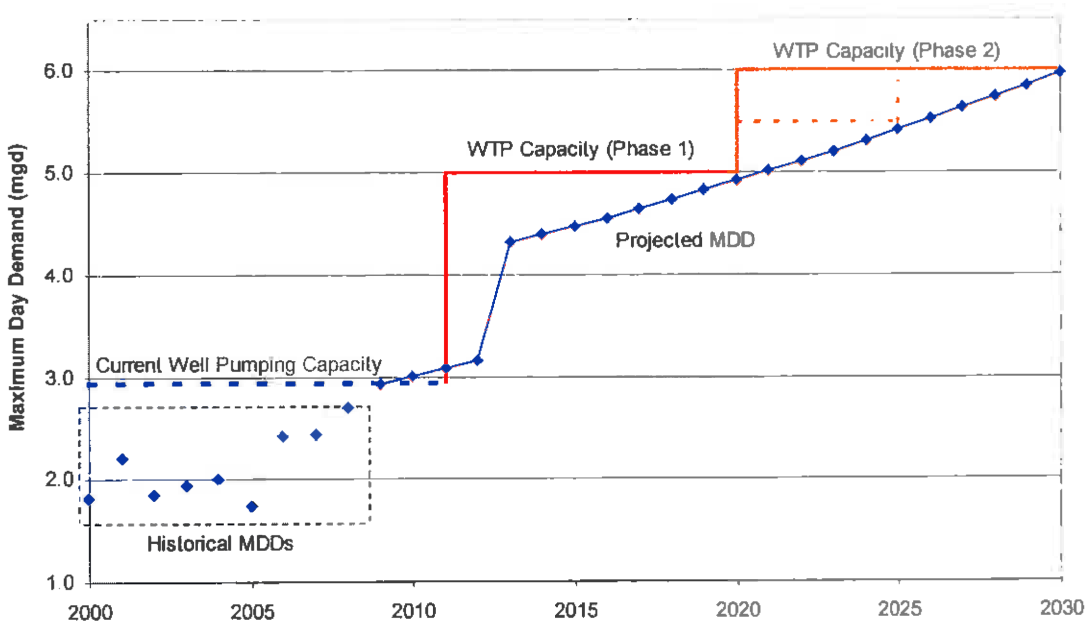
Maximum day demand (MDD) at the end of the planning period, in 2030 is 6.0 mgd. The water treatment facilities will be sized to deliver MDD over a 24-hour period plus anticipated water treatment plant process losses and uses. Distribution system losses have been factored into the MDD calculations and will be satisfied out of storage.

Optimal performance in a water treatment plant is often achieved when the plant operates at a constant production rate. For this reason production rates for a treatment facility are typically set at the maximum day demand to allow daily production and demands to equalize over the course of one day. The difference in instantaneous production and demand across the day is supplied by water storage. Failure to replenish storage reservoirs at the end of a daily cycle will cause storage levels to drop from one day to the next.

Figure 7-4 depicts MDD across the planning period with a staged approach to plant build-out. Due to anticipated funding constraints, plant expansion has been divided into two stages. Phase 1 of the treatment plant will be placed into service in 2011 and will include all major infrastructure components required for year 2030 with reduced capacities for filtration and nitrate removal. Under this interim phase, nitrate removal capacity is 1.5 mgd and filtration capacity is 5.0 mgd. These capacities have been selected to satisfy projected demand until the year 2020. Beginning no later than 2020, additional treatment units for both nitrate removal and filtration will be added on an incremental basis to satisfy evolving needs culminating in a total plant capacity of 6.0 mgd in the year 2030.

The selection of a filtration technology—direct filtration or membrane filtration—will determine to some extent the shape of the expansion curve forward of year 2020. Expansion of a direct filtration plant will likely require filtration increases no less than 1.0 mgd however a membrane filtration system could feasibly permit smaller expansions as capital permits.

Figure 7-4 | Water Demand Projection and Treatment Plant Capacity



7.6 PLANT RELIABILITY AND REDUNDANCY

In order to safeguard against an area-wide power failure and loss of water production, it is recommended that all four well facilities delivering water to the plant be provided with emergency power generators. It is also recommended that a power generator be provided for the water treatment plant to ensure the production of average day demand. The difference between 2020 and 2030 ADD is only 0.25 mgd therefore it is recommended that the generator be sized to provide service for the production of ADD in 2030, a production capacity of 2.25 mgd.

One of the early design period determinations will be the verification of flood plain elevations. The current site selected for the WTP is above the 100 year flood plain, however a thorough evaluation of flood records, soil types and access routes to the plant will ensure that plant operations are safeguarded during such an event.

In the event of a catastrophic failure at the treatment plant or an extended period power outage during periods of MDD, the emergency wells—5th & Maple and 3rd & Cedar—can be utilized to deliver 1.44 mgd directly into the distribution grid.

Since these wells do not have the ability to provide 4-log virus removal, they will be subject to triggered monitoring according to the Ground Water Rule as previously discussed in Chapter 3.

7.7 Finished Water Pump Station

It is anticipated that the existing ground storage reservoir will be integrated into the design of the new treatment plant and will likely serve as the primary chlorine contact chamber. The new 1.25 MG ground storage reservoir as discussed in Chapter 9, will be located at the WTP site and will serve as the City's largest storage reservoir. A finished water pump station will be required to deliver water from the new ground storage reservoir into the new elevated tank. This pump station will be sited near the reservoir and will be designed with a firm capacity of 6,000 gpm.

The proposed location of this pump station is close to the 13th & Elm Street well and it is likely that a new structure will be designed to house both facilities. It is anticipated that minor modifications and/or improvements to the well can be completed at this time. A single electrical service and backup power generator for the two facilities will allow the existing generator located at the 13th & Elm to be relocated to another well.

7.8 Recommended Improvements

- Confirm the water treatment objectives and begin preparations for the design and construction of a centralized water treatment plant with a 5.0 mgd interim capacity.
- Begin collecting additional water quality data. Additional water quality data is needed for the comprehensive evaluation of a nitrate removal process, the filtration process and the corrosion control process.
- Begin efforts to collect water quality data to confirm that the City's sources are in fact groundwater sources and not GWUDI.
- Begin investigative efforts and work with ODWP to resolve the potential issue of GWUDI in the City aquifer(s). Additionally the City should make a careful evaluation of previous and on-going studies that may point to a future reclassification of the City's groundwater sources. It appears unlikely that an investigation of this issue can be definitively resolved within the design and construction deadlines for the new treatment plant as defined in the intergovernmental agreement (IGA) between the City, DOC and DHS. There will accordingly be some ownership of risk on the part of the IGA members with regard to additional treatment levels that may be required should this classification change within the design life of the plant.
- Confirm the need for a finished water pump station and begin preparations for the design and construction of this facility.

- Make fiscal preparations for the hiring or development of a full time water treatment plant operator with Level 3 certification.
- Evaluate the efficacy of the City's corrosion control plan based on existing water quality, measured results, and operating costs.
- Begin fiscal preparations for a 1.0 mgd plant expansion in 2020.

Table 7-2 | Comparison of Nitrate Removal Technologies

Ion Exchange (IX)	Electrodialysis Reversal (EDR)	Reverse Osmosis (RO)
Advantages		
▪ Highest level of nitrate removal ▪ Low capital cost ▪ Low operating complexity and cost ▪ Low waste stream ▪ Single chemical (brine) for regeneration	▪ Low or no cleaning chemicals ▪ Mid-range ability to remove inorganic contaminants ▪ Moderate operating cost ▪ Moderate source water desalination (none required) ▪ Lowest rate of organic fouling	▪ Broadest range of inorganic contaminant removal ▪ Compact footprint ▪ High source water desalination (none required)
Disadvantages		
▪ Requires filtration pretreatment ▪ Requires salt storage ▪ Somewhat sensitive to the presence of competing ions ▪ Strongly basic anion resins are susceptible to organic fouling ▪ No TDS reduction (No TDS reduction required)	▪ Requires filtration pretreatment ▪ Moderate level of nitrate removal ▪ Moderate waste stream volume ▪ High capital cost ▪ Requires pH adjustment to feed water ▪ High operator skill required	▪ Requires filtration pretreatment ▪ Moderate level of nitrate removal ▪ High waste stream volume ▪ Highest capital cost ▪ Highest operating cost ▪ Frequent membrane integrity testing ▪ Undesirable acidic/caustic cleaning chemicals ▪ High sensitivity to oxidizing agents (chlorine) ▪ Highest fouling potential due to scaling. Requires pH adjustment and/or softening of feed water ▪ High operator skill required ▪ Multiple chemicals required for cleaning