Water System Analysis

7

INTRODUCTION

This chapter presents the analysis of the City of Stanwood's (City) existing water system. Individual water system components were analyzed to determine their ability to meet policies and design criteria under existing and future water demand conditions. The policies and design criteria are presented in **Chapter 5**, and the water demands are presented in **Chapter 4**. A description of the water system facilities and current operation is presented in **Chapter 2**. The last section of this chapter presents the existing system capacity analysis that was performed to determine the maximum number of equivalent residential units (ERUs) that can be served by the City's existing water system.

PRESSURE ZONES

The ideal static pressure of water supplied to customers is between 40 and 80 pounds per square inch (psi). Pressures within a water distribution system are commonly as high as 120 psi, requiring pressure regulators on individual service lines to reduce the pressure to 80 psi or less. It is difficult for the City's water system (and most others) to maintain distribution pressures between 40 and 80 psi, primarily due to the topography of the water service area.

Table 7-1 lists each of the City's seven pressure zones, the highest and lowest elevation served in each zone, and the minimum and maximum distribution system pressures within each zone based on maximum static water conditions (full reservoirs with no demand). The upper portion of the table illustrates the minimum and maximum pressures of the existing system, and the lower portion of the table illustrates pressures after proposed pressure zone improvements are implemented. While this table presents the results of the pressure evaluations based on the adequacy of the pressure zones under static conditions, the hydraulic analysis section later in this chapter presents the results of the pressure evaluations based on the adequacy of the water mains under dynamic conditions.

The City is currently providing water at pressures of at least 40 psi to all services in each zone except for the 125, 255, and 297 Zones, as shown in **Table 7-1**. The lower pressures in the 125 Zone occur downstream of the State Route (SR) 532/530 pressure reducing valve (PRV). The lower pressures in the 297 Zone occur in the higher elevations near the Knittle Reservoirs. The lower pressures in the 125 Zone and 297 Zone are slightly below 40 psi and not low enough to require pressure zone improvements. The lower pressure area in the 255 Zone is near 278th Street NW and 84th Avenue NW; however, it will be eliminated in the future with the completion of the proposed pressure zone improvements described in **Chapter 9** that are scheduled to occur within the 20-year planning period. The pressures in all of the zones after the completion of the pressure zone improvements are shown in the lower portion of **Table 7-1**.

Table 7-1
Minimum and Maximum Distribution System Static Pressures

Pressure Zone	Highest Elevation Served		Lowest Elevation Served	
	Elevation (feet)	Static Pressure (psi)	Elevation (feet)	Static Pressure (psi)
Existing System				
125 Zone	36	39	0	54
245 Zone	113	57	8	103
252 Zone	140	49	88	71
255 Zone	172	36	25	100
265 Zone	158	46	56	91
297 Zone	206	39	31	115
365 Zone	252	49	173	83
Future System - After Proposed Zone Modifications				
125 Zone	36	39	0	54
245 Zone	126	52	8	103
297 Zone	201	42	31	115
365 Zone	255	48	120	106

The highest pressure in the system occurs along Pioneer Highway in the 297 Zone. Individual services that have pressures greater than 80 psi have pressure regulators to reduce the pressures to acceptable levels.

SOURCE CAPACITY EVALUATION

This section evaluates the combined capability of the City's existing sources to determine if they have sufficient capacity to meet the overall demands of the water service area based on existing and future water demands. The section that follows will address the evaluation of the individual facilities to determine if they have sufficient capacity to meet the existing and future demands of the individual zone, or zones, that they supply.

Analysis Criteria

Supply facilities must be capable of adequately and reliably supplying high quality water to the system. In addition, supply facilities must provide a sufficient quantity of water at pressures that meet the requirements of Washington Administrative Code (WAC) 246-290-230. The evaluation of the combined capacity of the sources in this section is based on the criteria that they provide supply to the system at a rate that is equal to or greater than the maximum day demand (MDD) of the system.

Source Capacity Analysis Results

The combined capability of the City's active sources to meet both existing and future demand requirements, based on existing pumping capacities of the individual supply facilities, is presented in **Table 7-2**. The demands used in the evaluation for 2021, 2025, and 2035 are future demand projections without reductions from water use efficiency efforts, as shown in **Table 4-12** of **Chapter 4**. Therefore, if additional reductions in water use are achieved through water use efficiency efforts, the total source capacity required in the future will be less than that shown in **Table 7-2**.

Table 7-2
Water Source Capacity Evaluation

Description	Existing	Future Projections		
	2013	2021 (+6 years)	2025 (+10 years)	2035 (+20 years)
Required Source Capacity (gpm)				
Maximum Day Demand	974	1,160	1,258	1,503
Available Source Capacity (gpm)				
Bryant Well No. 1	1,350	1,350	1,350	1,350
Bryant Well No. 3[1]	0	800	800	800
Cedarhome Well	600	600	600	600
Fure Well[2]	0	-	-	-
Hatt Slough Springs[3]	0	0	0	0
Totals	1,950	2,750	2,750	2,750
Surplus or Deficient Source Capacity (gpm)				
Surplus or Deficient Amt.	976	1,590	1,492	1,247

1 = Bryant Well No. 3 will have a pumping capacity of 1,000 gpm when operated alone. However, the combined source capacity of Bryant Well No. 1 and No. 3 is limited by the 2,000 gpm instantaneous water right and the water treatment plant capacity. It is anticipated that the 150 gpm Fure Well water right will be transfered to Bryant Well No. 3 and the water treatment plant will be upgraded by 2021, resulting in a 2,150 gpm instantaneous water right. When Bryant Well No. 1 and No. 3 operate together, Bryant Well No. 3's variable frequency drive will limit flow to approximately 800 gpm in accordance with the 2,150 gpm maximum. For normal operations, Bryant Well No. 1 and No. 3 will generally operate separately at their design flow rates of 1,350 gpm and 1,000 gpm, respectively.

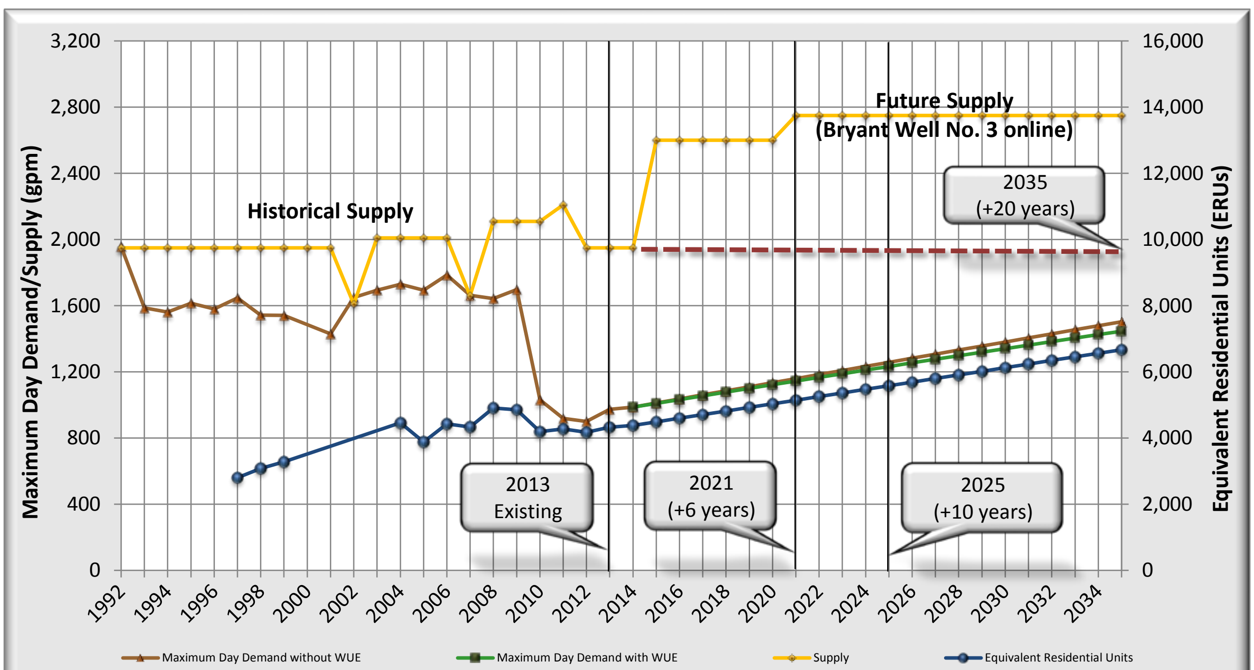
2 = The analyses assume that the Fure Well is an existing emergency source of supply. When the City successfully transfers the water right to the Bryant Well field and modifies the water treament plant as necessary (prior to 2021), the supply capacity for Bryant Well No. 3 will be 800 gpm and the Fure Well will be removed from service.

3 = The analyses assume that Hatt Slough Springs will remain offline until further notice. The City will reevaluate the need and cost of service for the source on a regular basis.

The results of the analysis indicate that the City has approximately 976 gallons per minute (gpm) of surplus source capacity to meet existing demands. With Bryant Well No. 3 online as shown in **Table 7-2**, the City's sources are sufficient to meet the projected demands of the system until at least 2035. **Chart 7-1** shows the relationship between historic and projected supply and demands. The historic supply reflects the removal and addition of sources as described in the footnotes of the chart. The projected supply assumes that Bryant Well No. 3 is online at a rate of 650 gpm in 2015 and it will increase to 800 gpm by 2021 with the transfer of the Fure Well water right. The Hatt Slough Springs source, currently offline, is expected to remain offline until further notice. The City plans to reevaluate the use of the source on a regular basis and will bring the source online when it is necessary to meet demands and it is cost effective. These improvements are described further in **Chapter 9**.

Additional source capacity should continue to be pursued to provide sufficient backup supply in the event that one of the existing sources is out of service for maintenance or an emergency event. Currently, if Bryant Well No. 1 was out of service, the City could not supply maximum day demands to water system customers. When Bryant Well No. 3 is online, the City will be able to supply maximum day demands with one of the Bryant Wells out of service, but will not be able to supply maximum day demands if both Bryant wells are offline. The City plans to continuing evaluating improvements to improve the utilization of Hatt Slough Springs or to use the water right elsewhere to provide more source of supply redundancy.

Chart 7-1
Future Water Supply and Demand Projections



NOTES:
-Historical supply assumes that the City used the Fure Well until 2002.
-Historical supply assumes that the Hatt Slough Springs had a maximum capacity of 260 gpm from 1992 through 2011, although it may have been higher historically.
-Historical supply assumes that Bryant Well No. 1 was capable of 1,000 gpm until its upgrade to 1,400 gpm in 2003 and then a reduction to 1,350 gpm with the addition of the water treatment plant in 2008.
-Historical supply assumes that Bryant Well No. 2 was capable of approximately 600 gpm from 1992 to 2001 and declined to approximately 350 gpm in 2002. By 2007, the well was no longer capable of supplying the water system.
-Historical supply assumes that the Cedarhome Well had a capacity of 500 gpm starting in 2008 and capacity increased to 600 gpm with the completion of the Sill water right.

WATER SUPPLY FACILITIES EVALUATION

This section evaluates the existing supply facilities to determine if they have sufficient capacity to provide water supply at a rate that meets the existing and future demands of each of the zones that they supply. **Figures 2-1** and **2-2** in **Chapter 2** display the pressure zones described within this section. This section also identifies facility deficiencies that are not related to the capacity of the supply facilities.

Analysis Criteria

The evaluation to determine if supply facilities have adequate capacity is based on one of two criteria, as follows: 1) if the pressure zone that the facility provides supply into has water storage, then the amount of supply required is equal to the MDD of the zone; or 2) if the pressure zone that the facility provides supply into does not have water storage, then the amount of supply required is equal to the peak hour demand (PHD) of the zone. The higher supply requirement of the latter criteria is compensating for the lack of equalizing storage that is typically utilized to provide short-term supply during times of peak system demands.

Supply Analysis Results

297 Zone Facilities

The Bryant Wells and Cedarhome Well provide water supply directly to the 297 Zone and the Fure Well would supply the 297 Zone if it were in service. Transfer of the Fure Well water right to the Bryant Wells is in progress and the transfer is expected to be complete by 2021. These supply facilities also indirectly serve the 365 Zone through the Knittle and Cedarhome Booster Pump Stations, and the 245, 252, 255, and 265 Zones through pressure reducing stations. Since Hatt Slough Springs is currently offline, all supply to the 125 Zone is provided through an altitude valve and pressure reducing stations from the 297 Zone. **Table 7-3** summarizes the current and future supply requirements of the 297 Zone based on existing and projected water demands for the system. **Table 7-3** also summarizes the amount of water supply available to the 297 Zone. The results of the analyses indicate that the existing and proposed configurations and capacities of the 297 Zone facilities are sufficient to meet both existing and future demands.

Table 7-3
297 Zone Supply Evaluation

Description	Existing 2013	Future Projections 2021 (+ 6 years)	2025 (+ 10 years)	2035 (+ 20 years)
Required Supply (gpm)				
297/Other Zone Maximum Day Demand	579	711	772	954
Transfer to 125 Zone[1]	324	325	325	340
Transfer to 365 Zone	71	124	162	208
Total Required Supply	974	1,160	1,258	1,503
Available Supply (gpm)				
Bryant Well No. 1	1,350	1,350	1,350	1,350
Bryant Well No. 3[2]	0	800	800	800
Cedarhome Well	600	600	600	600
Fure Well[3]	0	-	-	-
Total Available Supply	1,950	2,750	2,750	2,750
Surplus or Deficient Supply (gpm)				
Surplus or Deficient Amount	976	1,590	1,492	1,247

1 = Due to the uncertainty associated with the future of Hatt Slough Springs, the analysis assumes that the entire demand of the 125 Zone will be supplied via transfer from the 297 Zone until 2035 to ensure adequate supply to the 125 Zone in the event that bringing Hatt Slough Springs back is further delayed.
2 = Bryant Well No. 3 is expected to be online in 2015. The maximum capacity of Bryant Well No. 1 and No. 3 together will initially be 2,000 gpm and this is expected to increase to 2,150 gpm by 2021 when the Fure Well water right is transferred to the Bryant well field.
3 = Fure Well is currently an emergency supply source and it is expected that its 150 gpm water right will be transferred to the Bryant well field prior to 2021.

125 Zone Facilities

Water supply to the 125 Zone is currently provided by the Bailey Altitude Valve and two PRV stations, the Cedarhome Drive & BNRR PRV and the SR 532/530 PRV, which transfer water from the 297 Zone. Transfer is primarily via the altitude valve, and only via the PRV stations during larger demand events, such as fire flow. Hatt Slough Springs, the only direct source to the 125 Zone, is currently offline, and is assumed to be offline for the entire planning period. **Table 7-4** summarizes the current and future supply requirements of the 125 Zone based on existing and projected water demands for the 125 Zone. **Table 7-4** also summarizes the current and future amount of water supply available to the 125 Zone based on the capacity of the altitude valve. The capacity of the altitude valve is based on the Cla-Val engineering data sheet for the installed valve. The capacities of the PRV stations, as noted in the table, are limited by the inlet piping at a velocity of 8 feet per second (fps). The results of the analysis indicate that the existing configurations is sufficient to meet both the existing and future demands of the 125 Zone.

Table 7-4
125 Zone Supply Evaluation

Description	Existing 2013	Future Projections 2021 (+ 6 years)	2025 (+ 10 years)	2035 (+ 20 years)
Required Supply (gpm)				
125 Zone Maximum Day Demand	324	325	325	340
Total Required Supply	324	325	325	340
Available Supply (gpm)[1]				
Hatt Slough Springs	0	0	0	0
Transfer from Bailey Altitude Valve	460	460	460	460
Total Available Supply	460	460	460	460
Surplus or Deficient Supply (gpm)				
Surplus or Deficient Amt.	136	135	135	120

1 = The Cedarhome Drive and BNRR PRV and the SR 532/530 PRV can provide 2,820 gpm and 1,958 gpm, respectively, of supply to the 125 Zone for emergency or high demand purposes as necessary.

365 Zone Facilities

Water supply to the 365 Zone is currently provided by the Cedarhome and Knittle Booster Pump Stations. **Table 7-5** summarizes the current and future supply requirements of the 365 Zone based on existing and projected water demands for the 365 Zone. **Table 7-5** also summarizes the current and future amount of water supply available to the 365 Zone based on the capacity of the booster pump stations. The results of the analyses indicate that the existing and proposed configurations are of sufficient capacity to meet both existing and future demands.

Table 7-5
365 Zone Supply Evaluation

Description	Existing 2013	Future Projections 2021 (+ 6 years)	2025 (+ 10 years)	2035 (+ 20 years)
Required Supply (gpm)				
365 Zone Maximum Day Demand	71	124	162	208
Total Required Supply	71	124	162	208
Available Supply (gpm)[1]				
Transfer from Cedarhome BPS	1,000	1,000	1,000	1,000
Transfer from Knittle BPS	1,360	1,360	1,360	1,360
Total Available Supply	2,360	2,360	2,360	2,360
Surplus or Deficient Supply (gpm)				
Surplus or Deficient Amt.	2,289	2,236	2,198	2,152

1 = The Cedarhome BPS is the primary supply facility for the 365 Zone. The Knittle BPS is only used in emergencies or when the Cedarhome BPS is offline.

Facility Deficiencies

Bryant Well No. 1 is the older well at the Bryant Well site, but has not had a decrease in production like Bryant Well No. 2. The capacity of Bryant Well No. 2 was approximately 1,000 gpm until 1998, and then it had a steady decline until it was taken out of service in approximately 2008. The City is in the process of replacing Bryant Well No. 2 with Bryant Well No. 3 to fully utilize the 2,000 gpm water right that is shared by both wells. Bryant Well No. 3 is expected to be online in 2015. Bryant Well No. 2 will be utilized as a monitoring well. Bryant Well No. 2 monitoring improvements and structural demolition are included in **Chapter 9**.

The City is also in the process of transferring the 150 gpm Fure Well water right to the Bryant Well field. When the transfer is complete and the Bryant Well No. 3 facility is in use, a pilot study will be necessary to determine if improvements are necessary at the Bryant Well Treatment Facility to accommodate the larger water right and the water quality from Bryant Well No. 3. The original Bryant Well Treatment Facility has a design capacity and DOH rating of 2,000 gpm and was designed based on water quality testing from Bryant Well No. 1. The pilot study and potential treatment improvement are discussed further in **Chapter 9**. Pump improvements at Bryant Well No. 1 and No. 3 will not be necessary. Abandonment of the existing Fure Well source is also an improvement discussed in **Chapter 9**.

The City has an additional well, the Sill Well, which has not been used in over 20 years and is located outside of the City's existing retail service area. The well is not equipped with a pump, but the well has not been properly decommissioned. Decommissioning of the Sill Well is included as an improvement in **Chapter 9**.

Hatt Slough Springs is approximately 80 years old. The facility is currently offline due to access road issues and is in need of building and pump improvements. The spring collection system was modified in 1984 but does not currently produce the full supply amount that is available under the source's water right. The Washington State Department of Health (DOH) directed the City to seal the spring's collector boxes due to contamination concerns and the sealing was completed in 2010. Beginning in January 2013, the City performed initial geologic and geotechnical analyses for evaluating the feasibility of the City's continued operation of the Hatt Slough Springs source and potential enhancement of the water supply rate from the source **(Appendix O)**. The project included an evaluation of repairing the existing access road, an evaluation of the options for improving the spring collection system, and the options for developing a well or well field source to fully utilize the existing water right and increase water production. The analyses results concluded that an interim solution to repair the road and improve drainage was warranted to improve access, but further degradation to the access road since the analysis has determined that repairing the road is a potentially dangerous solution and the City prefers to hold off using the source until further notice. The spring rehabilitation analyses determined that there was limited potential for improving spring production beyond 350 gpm. With the current spring collection boxes, the City could continue to withdraw the previous flow rate of approximately 260 gpm. The City also evaluated the potential existence of groundwater sources capable of producing a sustainable supply of potable groundwater at rates between 350 and 500 gpm from single or multiple wells with the intent to transfer water rights from Hatt Slough Springs to the new point or points of withdrawal. The evaluation is included in **Appendix O**. The City's cost-benefit analysis determined that improvements are not warranted at this time and Hatt Slough Springs will remain offline until improvements are justified. A reevaluation of Hatt Slough Springs are identified in **Chapter 9**.

The Cedarhome Well is currently being upgraded to move equipment to an above-grade building extension for easier operations and maintenance. The project, scheduled for completion in 2014, also relocates the chlorine injection and water quality sampling points to locations closer to the monitoring equipment. The Cedarhome Well has historically had some issues with producing sand that could potentially clog water treatment equipment, increase maintenance time, and create excessive wear on pumping equipment over time. The sand production has decreased in recent years and the City installed a filter before the control valve, but improvements may be necessary if the sand production becomes problematic in the future as use of this well increases. Proposed improvements to resolve potential deficiencies are identified in **Chapter 9**.

The City's Cedarhome Booster Pump Stations is relatively new and in excellent condition. The station is not equipped with an emergency generator and the installation of a generator would allow the Cedarhome Reservoir to fill during power outages. Proposed emergency power improvements are identified in **Chapter 9**.

The Knittle Booster Pump Station is approximately 16 years old and has not been improved since its initial construction. Improvements to the rusting steel floor and piping are necessary to improve the reliability and usability of this facility. The City is also interested in verifying the efficiency of the existing pumps and installing an emergency generator at this site. If a development in the Traditional Neighborhood land use has a fire flow requirement greater than 1,500 gpm, an engine generator at the Knittle Booster Pump Station shall be installed at that time for the purposes of the fire flow pump. Proposed booster pump station improvements and emergency power improvements are identified in **Chapter 9**.

STORAGE FACILITIES

This section evaluates the City's existing water storage tanks to determine if they have sufficient capacity to meet the existing and future storage requirements of the system. This section also identifies facility deficiencies that are not related to the capacity of the water tanks.

Analysis Criteria

Water storage is typically made up of the following components: operational storage, equalizing storage, standby storage, fire flow storage, and dead storage. Each storage component serves a different purpose and will vary from system to system. A definition of each storage component and the criteria used to evaluate the capacity of the City's storage tanks is provided below.

Operational Storage - Volume of the reservoir used to supply the water system under normal conditions when the source or sources of supply are not delivering water to the system (i.e., sources are in the off mode). Operational storage is essentially the average amount of drawdown in the reservoir during normal operating conditions, which represents a volume of storage that will most likely not be available for equalizing storage, fire flow storage, or standby storage. The operational storage in the Bailey Reservoirs, Knittle Reservoirs, and Cedarhome Reservoir is the amount of storage between the fill, or pump starting setpoint level, and the overflow elevation of the tank.

Equalizing Storage - Volume of the reservoir used to supply the water system under peak demand conditions when the system demand exceeds the total rate of supply of the sources. DOH requires that equalizing storage be stored above an elevation that will provide a minimum pressure of 30 psi at all service connections throughout the system under PHD conditions. Because the City's supply sources primarily operate on a "call on demand" basis to fill the reservoirs, the equalizing storage requirements are determined using the standard DOH formula that considers the difference between the system PHD and the combined capacity of the supply sources.

$$\mathbf{ES = (PHD - Q_S)(150\ minutes)}\text{, but in no case less than zero}$$

Where:

ES = Equalizing Storage, in gallons.

PHD = Peak Hour Demand, in gpm.

Q_S = Sum of all installed and active sources, except emergency supply, in gpm.

For the equalizing storage analysis, the altitude valve serving the 125 Zone, the well sources serving the 297 Zone, and the booster pump stations serving the 365 Zone were utilized for the supply capacity for their respective zones. The capacities of the sources that supply each zone are sufficient to meet the peak hour demands of their zones. Therefore, the equalizing storage requirement for each supply area is zero. The equalizing storage analyses also considered the supply capacity available to the system as a whole to ensure that the zones that transfer storage through PRVs or booster pump stations have sufficient supply capacity to do so. Since the available capacity from the City's wells is greater than the system-wide PHD, there is sufficient supply capacity for storage transfer.

Standby Storage - Volume of the reservoir used to supply the water system under emergency conditions when supply facilities are out of service due to equipment failures, power outages, loss of supply, transmission main breaks and any other situation that disrupts the supply source. DOH requires that standby storage be stored above an elevation that will provide a minimum pressure of 20 psi at all service connections throughout the system. The criteria for determining the standby storage requirements for the City's system, which has multiple supply sources, is based on the standard DOH formula that requires average day demand and supply source capacity data. The amount required is sufficient to supply the system for a 48-hour period when the primary supply facility is out of service and the system is experiencing average day demands.

$$\mathbf{SB = (2\ days)[(ADD)(N) - t_m\ (Q_S - Q_L)]}$$

Where:

SB = Standby Storage, in gallons.

ADD = Average Day Demand per ERU, in gallons per day (gpd) per ERU.

N = Number of ERUs.

Q_S = Sum of all installed and continuously available sources, except emergency supply, in gpm.

Q_L = The capacity of the largest source available to the system, in gpm.

t_m = Time the remaining sources are pumped on the day when the largest source is not available, in minutes. Unless otherwise restricted, this value is 1,440 minutes.

The standby storage analysis was completed for each reservoir operating area. For the 297 Zone, the largest capacity source that was assumed to be out of service was Bryant Well No. 1. For the 365 Zone analysis, the Knittle Booster Pump Station was assumed to be out of service and the PRVs supplying the 125 Zone were assumed to be out of service for the 125 Zone standby storage analysis. The standby storage analyses also considered the supply capacity available to the system as a whole with the largest source, Bryant Well No. 1, out of service to ensure that the zones that transfer storage through PRVs or booster pump stations have sufficient supply capacity to do so. Since the available capacity of the Cedarhome Well is greater than the system-wide ADD, there is sufficient supply capacity for storage transfer.

DOH recommends that the minimum standby storage volume be no less than 200 gallons per ERU. In all cases, this calculation determined the standby storage volume required for the City's reservoir operating areas.

Fire Flow Storage - Volume of the reservoir used to supply water to the system at the maximum rate and duration required to extinguish a fire at the building with the highest fire flow requirement. The magnitude of the fire flow storage is the product of the fire flow rate and duration of the system's maximum fire flow requirement established by the local fire authority, the City of Stanwood Fire Department. DOH requires that fire flow storage be stored above an elevation that will provide a minimum pressure of 20 psi at all points throughout the distribution system under MDD conditions.

The fire flow storage requirements shown in the analyses that follow are based on a maximum planning-level fire flow requirement in the 297 Zone of 3,500 gpm for a 3-hour duration, which is equivalent to 630,000 gallons. The Cedarhome Reservoir can currently provide fire flow storage of 2,500 gpm for a 2-hour duration, which is the 365 Zone's largest future planning-level fire flow requirement, and the remaining portion of the maximum fire flow requirement is stored in the 297 Zone reservoirs. Fire flow storage in the 365 Zone will be used to supplement fire flow storage in the 297 Zone through PRVs; similarly, fire flow storage in the Knittle Reservoirs will provide fire flow to the 125 Zone and all other lower pressure zones through PRVs.

The Cedarhome Reservoir was originally sized for a maximum 365 Zone fire flow requirement of 1,000 gpm for 2 hours, or 0.12 MG, based on the residential zoning at the time of design. City zoning changes have increased the potential fire flow requirement in the 365 Zone to 2,500 gpm for 2 hours, or 0.30 MG, due to the potential for commercial development in the traditional neighborhood zones. In 2025 and beyond, the Cedarhome Reservoir will be capable of providing fire flow storage of 1,500 gpm for a 2-hour duration, or 0.18 MG, for the 365 Zone, and the fire flow pump at the Knittle Booster Pump Station will provide an additional 1,000 gpm from the 297 Zone. An emergency generator and automatic transfer switch at the Knittle Booster Pump Station will be necessary at that time. Emergency power improvement projects are addressed in **Chapter 9**.

Dead Storage - Volume of the reservoir that cannot be used because it is stored at an elevation that does not provide system pressures that meet the minimum pressure requirements established by DOH without pumping. This unusable storage occupies the lower portion of most ground level reservoirs. Water that is stored below an elevation that cannot provide a minimum pressure of 20 psi is considered dead storage for the analyses that follow.

Storage Analysis Results

The storage analyses are based on an evaluation of the existing storage facilities providing water to three supply areas; the 125 Zone, the 365 Zone, and the combined areas of the 297 Zone and all other zones.

Existing Storage Analysis

As shown in **Table 7-6**, the maximum combined storage capacity of the City's reservoirs is 2.12 million gallons (MG). The total amount of usable storage for operational, equalizing, standby, and fire flow purposes is slightly reduced due to the dead storage (i.e., non-usable storage) in the lower portion of the reservoirs in the 297 Zone. The dead storage is due to a few water services in the 297 Zone that are located at the higher elevations in that pressure zone. The City completed a major pressure zone conversion project in 2012 (i.e., CIP PZ1 from the 2010 Comprehensive Water System Plan (WSP)) that reduced the dead storage in the 297 Zone from 0.86 MG to 0.06 MG. The remaining high elevation services were not transferred to the higher pressure zone due to concerns with increasing pressures in old service lines on Stauffer Road and near 80^{th} Avenue NW and 278^{th} Street NW. The remaining dead storage is not likely to be eliminated until water main improvements replacing the small service lines are completed and both improvements are lower priorities for the City.

Table 7-6
Existing Storage Evaluation

Description	Supply Area 125 Zone	297 & All Other Zones	365 Zone	Totals
Available/Usable Storage (MG)				
Maximum Storage Capacity	0.38	1.19	0.55	2.12
Dead (Non-usable Storage)	0.00	-0.06	0.00	-0.06
Total Available Storage	0.38	1.13	0.55	2.06
Required Storage (MG)				
Operational Storage	0.14	0.21	0.14	0.49
Equalizing Storage	0.00	0.00	0.00	0.00
Standby Storage	0.29	0.51	0.06	0.87
Fire Flow Storage	0.00	0.33	0.30	0.63
Totals	0.43	1.05	0.51	1.99
Surplus or Deficient Storage (MG)				
Surplus or Deficient Amt.	-0.05	0.08	0.04	0.07

The results of the existing storage evaluation, as shown in **Table 7-6**, indicate that the system has deficient storage in the 125 Zone, but surplus storage in the 297 and 365 Zones, combining for a net surplus of approximately 0.07 MG.

Future Storage Analysis

The system's future storage requirements were computed for the 6-, 10-, and 20-year planning periods, based on year 2021, 2025, and 2035 demand projections as shown in **Table 7-7**. The analyses were performed to determine the adequacy of the City's storage facilities to meet future storage requirements for each storage supply area. The future analyses are based on the available storage remaining constant until 2035. The standby storage requirements slowly increase through 2035 as the number of ERUs served increases. The calculations also assume that Bryant Well No. 3 is online for the future storage calculations. For the purposes of storage calculations, the Hatt Slough Springs source is offline for the future hydraulic analyses.

Table 7-7
Future Storage Projections, Without Proposed 0.4 MG Tank

Description	2021 Supply Area[1]				2025 Supply Area[1]				2035 Supply Area[1]			
	125 Zone	297 & All Other Zones	365 Zone	Totals	125 Zone	297 & All Other Zones	365 Zone	Totals	125 Zones	297 & All Other Zones	365 Zone	Totals
Available/Usable Storage (MG)												
Maximum Storage Capacity	0.38	1.19	0.55	2.12	0.38	1.19	0.55	2.12	0.38	1.19	0.55	2.12
Dead (Non-usable Storage)	0.00	-0.06	0.00	-0.06	0.00	-0.06	0.00	-0.06	0.00	-0.06	0.00	-0.06
Total Available Storage	0.38	1.13	0.55	2.06	0.38	1.13	0.55	2.06	0.38	1.13	0.55	2.06
Required Storage (MG)												
Operational Storage	0.14	0.21	0.14	0.49	0.14	0.21	0.14	0.49	0.14	0.21	0.14	0.49
Equalizing Storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standby Storage	0.29	0.63	0.11	1.03	0.29	0.69	0.14	1.12	0.30	0.85	0.18	1.33
Fire Flow Storage	0.00	0.33	0.30	0.63	0.00	0.45	0.18	0.63	0.00	0.45	0.18	0.63
Totals	0.43	1.17	0.55	2.15	0.43	1.34	0.47	2.24	0.44	1.50	0.51	2.46
Surplus or Deficient Storage (MG)												
Surplus or Deficient Amt.	-0.05	-0.04	0.00	-0.09	-0.05	-0.21	0.08	-0.18	-0.06	-0.37	0.04	-0.39

1 = Assumes available storage remains constant.

Table 7-7 shows the future storage projections if no additional tank is constructed. Without additional storage, a deficiency of approximately 0.4 MG can be expected in 2035. As shown in **Table 7-8**, the construction of a 0.4 MG 297 Zone reservoir prior to 2035 will meet the needs of the system through the 20-year planning period. Site acquisition and the design and construction of a new reservoir have been identified in **Chapter 9** to provide the additional storage needs of the system.

Table 7-8
Future Storage Projections, With Proposed 0.4 MG Tank

Description	2021 Supply Area[1]				2025 Supply Area[1]				2035 Supply Area[2]			
	125 Zone	297 & All Other Zones	365 Zone	Totals	125 Zone	297 & All Other Zones	365 Zone	Totals	125 Zones	297 & All Other Zones	365 Zone	Totals
Available/Usable Storage (MG)												
Maximum Storage Capacity	0.38	1.19	0.55	2.12	0.38	1.19	0.55	2.12	0.38	1.62	0.55	2.55
Dead (Non-usable Storage)	0.00	-0.06	0.00	-0.06	0.00	-0.06	0.00	-0.06	0.00	-0.08	0.00	-0.08
Total Available Storage	0.38	1.13	0.55	2.06	0.38	1.13	0.55	2.06	0.38	1.54	0.55	2.48
Required Storage (MG)												
Operational Storage	0.14	0.21	0.14	0.49	0.14	0.21	0.14	0.49	0.14	0.21	0.14	0.50
Equalizing Storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standby Storage	0.29	0.63	0.11	1.03	0.29	0.69	0.14	1.12	0.30	0.85	0.18	1.33
Fire Flow Storage	0.00	0.33	0.30	0.63	0.00	0.45	0.18	0.63	0.00	0.45	0.18	0.63
Totals	0.43	1.17	0.55	2.15	0.43	1.34	0.47	2.24	0.44	1.51	0.51	2.46
Surplus or Deficient Storage (MG)												
Surplus or Deficient Amt.	-0.05	-0.04	0.00	-0.09	-0.05	-0.21	0.08	-0.18	-0.06	0.04	0.04	0.02

1 = Assumes available storage remains constant.
2 = Includes proposed 0.4 MG tank.

Facility Deficiencies

The City's existing reservoirs are relatively new and do not have any noticeable deficiencies. The City's Bailey Reservoirs, which were built in 1989, are the oldest tanks in the system. All tanks were designed to withstand seismic events.

The City's steel tanks include Knittle Reservoir No. 2, which was as built in 1997, and the Cedarhome Reservoir, which was built in 2009. Although the paint coatings are currently in good condition, a qualified coating inspector will be retained to inspect the integrity of the coating on a

5-year time schedule, or more frequently, if visible signs of coating deterioration appear. Recoating is generally necessary every 15 to 20 years based on the typical life of steel tank coatings. Knittle Reservoir No. 2 will likely be in need of recoating in the near future based on the tank's age. The inspection and recoating improvements are identified in **Chapter 9**.

DISTRIBUTION AND TRANSMISSION SYSTEM

This section evaluates the City's existing distribution and transmission system (i.e., water mains) to determine if they are adequately sized and looped to provide the necessary flow rates and pressures to meet the existing and future requirements of the system. This section also identifies deficiencies that are not related to the capacity of the water mains.

Analysis Criteria

Distribution and transmission mains must be capable of adequately and reliably conveying water throughout the system at acceptable flow rates and pressures. The criteria used to evaluate the City's distribution and transmission system is the state mandated requirements for Group A water systems contained in WAC 246-290-230, Distribution Systems. The pressure analysis criteria states that the distribution system "…shall be designed with the capacity to deliver the design PHD quantity of water at 30 psi under PHD flow conditions measured at all existing and proposed service water meters." It also states that if fire flow is to be provided, "… the distribution system shall also provide MDD plus the required fire flow at a pressure of at least 20 psi at all points throughout the distribution system."

Hydraulic analyses of the existing system were performed under existing PHD conditions to evaluate its current pressure capabilities and identify existing system deficiencies. The existing system was also analyzed under existing MDD conditions to evaluate the current fire flow capabilities and identify additional existing system deficiencies. Additional hydraulic analyses were then performed with the same hydraulic model under future PHD and MDD conditions and with the proposed improvements to demonstrate that the identified improvements will eliminate the deficiencies and meet the requirements far into the future. The following is a description of the hydraulic model, the operational conditions and facility settings used in the analyses.

Hydraulic Model

Description

A computer-based hydraulic model of the existing water system was updated using version 8i of the WaterGEMS® program, developed by Bentley Systems, Inc. All water mains in the City's water system, including dead-end mains, were included in the model and based on AutoCAD® water system maps and as-built records provided by the City. The junction node elevation data was extracted from a digital elevation model file that was obtained from the United States Geological Survey (USGS), and modified in some locations when as-built or pressure information was available. A hydraulic model node diagram, providing a graphical representation of the model of the water system, is contained in **Appendix M**.

Demand Data

The hydraulic model of the existing system contains 2013 ADD data. Supply data from the 2007 ADD was distributed throughout the junction nodes of the model based on allocation levels that reflect the proportionate share of total supply to each of the City's meter routes and the meter route allocations were updated with 2013 ADD data. Demands for the City's largest water users were entered separately into the model at their appropriate service locations. The peaking factors shown in **Chapter 4** were used to analyze the system under PHD and MDD conditions.

The hydraulic model of the proposed system contains 6-year demand levels that are projected for the year 2021, 10-year demand levels that are projected for the year 2025, and 20-year demand levels that are projected for the year 2035. The future demand distribution is based a City land capacity analysis that evaluated vacant and redevelopable parcels identified by the City and input from the City regarding when and where development is likely to occur during the various planning periods.

Facilities

The hydraulic model of the existing system contained all active existing system facilities. For the proposed system analyses in the years 2021, 2025, and 2035, the hydraulic model contained all active existing system facilities and proposed system improvements identified in **Chapter 9** for the 6-year, 10-year, and 20-year planning periods, respectively.

The facility settings for the pressure analyses corresponded to a PHD event in the water system. All sources of supply that are currently available to the system, or will be available in the future for the years 2021, 2025, and 2035 analyses, during a peak period were operating at their normal summertime pumping rates. The reservoir levels were modeled to reflect full utilization of operational and equalizing storage. The operational conditions for the pressure analyses are summarized in **Table 7-9**.

Table 7-9
Hydraulic Analyses Operational Conditions

Description	PHD Pressure Analysis				Fire Flow Analysis[1]			
	2013	2021	2025	2035	2013	2021	2025	2035
Demand	2013 PHD	2021 PHD	2025 PHD	2035 PHD	2013 MDD	2021 MDD	2025 MDD	2035 MDD
Bailey Reservoirs HGL (ft)	118.9	118.9	118.9	118.8	118.9	118.9	118.9	118.8
Knittle Reservoirs HGL (ft)	289.0	289.0	289.0	289.0	276.2	276.2	271.6	271.6
Cedarhome Reservoir HGL (ft)	356.5	0.0	0.0	0.0	338.5	0.0	0.0	0.0
Bailey Altitude Valve	ON	ON	ON	ON	ON	ON	ON	ON
Knittle BPS	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON
Cedarhome BPS	ON	ON	ON	ON	ON	ON	ON	ON
Bryant Well No. 1	ON	ON	ON	ON	ON	ON	ON	ON
Bryant Well No. 2	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Bryant Well No. 3	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Cedarhome Well	ON	ON	ON	ON	ON	ON	ON	ON
Fure Well	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Hatt Slough Springs	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

Separate fire flow analyses were performed on the system to size distribution system improvements and calculate fire flow availability. The hydraulic model for the fire flow analyses contained settings that correspond to MDD events. All sources of supply that are currently available to the system during a peak period were operating at their normal pumping rates, and the reservoir levels were modeled to reflect full utilization of operational, equalizing, and fire flow storage based on the maximum planning level fire flow requirement. **Table 7-9** summarizes the operational conditions for the fire flow analyses for the existing, year 2013 and year 2021, 2025, and 2035 systems.

Calibration

Hydraulic model calibration was completed for the City's 2010 WSP and was not recalibrated for this WSP since significant changes have not occurred in the distribution network. Hydraulic model calibration is achieved by adjusting the roughness coefficients of the water mains in the model so the resulting pressures and flows from the hydraulic analyses closely match the pressures and flows from actual field tests under similar demand and operating conditions. Initial Darcy-Weisbach roughness coefficients were entered in the model based on computed estimates of the coefficients from available pipe age and material data. For example, older water mains were assigned higher roughness coefficients than new water mains; thereby assuming that the internal surface of water pipe becomes rougher as it gets older. Additional calibration of the model was achieved using field flow and pressure data that were collected throughout the system for this purpose. The average accuracy of the calibrated model for the 2010 WSP was approximately 97 percent of the actual field data collected, with 90 percent of the individual analysis locations predicting the field results to an accuracy of 95 percent. Hydraulic model calibration is recommended for the next WSP update, as identified in **Chapter 9**.

Hydraulic Analysis Results

Several hydraulic analyses were performed to determine the capability of the system to meet the pressure and flow requirements identified in **Chapter 5** and contained in WAC 246-290-230. The first analysis was performed to determine the pressures throughout the system under existing (i.e., 2013) PHD conditions. The results of this analysis were used to identify locations of low and high pressures. To satisfy the minimum pressure requirements, the pressure at all water service locations must be at least 30 psi during PHD conditions. In addition, the system should not have widespread areas with high pressures, generally considered to be more than 100 psi. A summary of the pressure deficiencies identified from the results of this analysis is contained in **Table 7-10**.

Table 7-10
Pressure Analysis Summary

Description	Approx. Location	Existing Pressure Zone	Proposed Pressure Zone	Node Number	Pressure (psi)			
					Existing System	2021 (+6 years)	2025 (+10 years)	2035 (+20 years)
Low Pressure Areas								
Single Family Area	278th St NW and 84th Ave NW	255	297	J-215	30	30	30	51
High Pressure Areas								
Industrial Area	Intersection of SR 532 and SR 530	297	297	J-443	109	112	112	112
Industrial Area	Cedarhome Dr and BNRR	245	245	J-752	103	103	103	103
Single Family Area	Near Intersection of Pioneer Hwy and Lindstrom Rd	297	297	J-50	100	103	103	103
Industrial Area	South of Cedarhome Dr near Carlson Trucking	245	245	J-754	100	100	100	100

The second set of analyses was performed to determine the capability of the existing water system to provide fire flow throughout the existing water system under MDD conditions. A separate fire flow analysis was performed for each node in the model to determine the available fire flow at a minimum residual pressure of 20 psi in the main adjacent to the hydrant and a maximum allowable water main velocity of 8 fps. More than 1,000 fire flow analyses were performed to comprehensively evaluate the water system. For each node analyzed, the resulting fire flow was compared to its general planning-level fire flow requirement, which was assigned according to its land use classification. As is typical of most water systems, the City's distribution system was constructed to meet fire flow requirements that were in place at the time of construction. Land use classification changes and/or increases in fire flow requirements over time may create deficiencies. A summary of the results of the analyses for representative system nodes is presented in **Table 7-11**.

Table 4-11 in **Chapter 4** lists the general planning-level fire flow requirements for each land use classification. Since the fire flow requirement varies for buildings within each land use classification, the land use based fire flow requirements are only used as a general target for the primary purpose of the system-wide analyses that were performed for this WSP. Additional improvements may be needed in areas where actual fire flow requirements exceed the planning level targets and shall be the responsibility of the developer. The results of the fire flow analyses were used to identify undersized water mains and proposed water main improvements. A summary of the fire flow deficiencies is contained near the end of this section.

Table 7-11
Fire Flow Analysis Summary

Description	Approx. Location	Existing Pressure Zone	Node Number	Available Fire Flow (gpm) Existing System	Future 2021	Future 2025	Future 2035	Target Fire Flow (gpm)
Stanwood Primary School	10227 273rd Pl. NW	125	J-125	2,486	2,486	2,486	6,164	3,500
Main Street Business	Main Street	125	J-133	704	704	704	4,831	3,000
Stanwood Medical Center	9631 269th St. NW	125	J-1250	3,225	3,225	3,225	5,573	3,000
Twin City Foods	10120 269th Pl. NW	125	J-623	3,377	3,377	3,377	5,549	3,500
Viking Village	8820 Viking Way	125	J-641	1,288	1,287	1,288	5,174	3,000
Thrifty Foods	271st St. NW & 88th Ave. NW	125	J-643	1,099	1,099	1,099	4,798	3,500
Stanwood Middle School	9405 271st St. NW	125	J-800	3,294	3,294	3,294	3,880	3,500
Josephine Sunset Home	9901 272nd Pl. NW	125	J-989	1,896	1,896	1,896	5,085	2,500
Northstar Cold Storage	27110 Pioneer Hwy	245	J-436	2,785	2,778	2,775	3,550	3,500
Multi-Family Area	Pioneer Hwy & 85th Dr. NW	255	J-222	776	791	770	4,634	2,500
Single-Family Area	Hennings Estates	265	J-238	914	951	918	1,330	1,000
Single-Family Area	Copper Station	297	J-1016	2,224	2,875	2,252	4,340	1,000
Cedarhome Elem. School	27911 68th Ave. NW	297	J-1092	1,845	1,843	1,842	4,133	3,500
Stanwood High School	7400 272nd St. NW	297	J-287	2,154	2,171	2,156	5,514	3,500
Schenk Packing	8204 288th St. NW	297	J-370	900	931	866	3,981	3,500
Single-Family Area	Candle Ridge	297	J-458	2,977	2,968	2,976	3,118	1,000
Single-Family Area	Church Creek Estates	297	J-477	1,068	1,068	1,067	1,884	1,750
Single-Family Area	Fox Hill Estates	297	J-497	1,252	1,251	1,251	1,250	1,000
Port Susan Middle School	7506 267th St. NW	297	J-676	2,242	2,238	2,237	5,743	3,500
Maple Court Apartments	26031 72nd Ave. NW	297	J-62	2,947	2,926	2,896	4,395	2,500
Twin City Elementary	26211 72nd Ave. NW	297	J-73	2,782	2,760	2,748	4,071	3,500
Stanwood Camano Village	26603 72nd Ave. NW	297	J-93	2,001	2,001	2,001	4,562	3,000
Single-Family Area	Eagle Heights	365	J-1055	1,063	1,360	1,117	2,074	1,000
Single-Family Area	Bay View Lane	365	J-440	1,880	2,066	1,842	2,135	1,000
Single-Family Area	Cedarhome Farms	365	J-850	1,229	1,546	1,302	6,562	1,000

Once all deficiencies were identified, proposed water main improvements were included in the model, and pressure and fire flow analyses were performed throughout the system to demonstrate that the improvements will eliminate the deficiencies and meet the flow and pressure requirements. These analyses were modeled under projected year 2021, 2025, and 2035 MDD conditions to ensure that the improvements are sized sufficiently to meet the future systems' needs. A summary of the results of these analyses is shown in **Tables 7-10** and **7-11** for the same areas that were summarized from the existing water system analyses. The results of the fire flow analyses indicate that all fire flow deficiencies are resolved by 2035 with proposed improvements. A description of these improvements and a figure showing their locations are presented in **Chapter 9**. A description of the deficiencies identified from the hydraulic analyses is presented in the following section.

Deficiencies

This section presents a summary of the distribution and transmission system deficiencies that were identified from the hydraulic analyses results of the existing water system and also includes deficiencies not related to the capacity of the mains. These deficiencies will be eliminated upon completion of the proposed improvements that are presented in **Chapter 9**.

Pressure Deficiencies

The following areas have pressures that are either lower or higher than the acceptable pressure levels.

- Slightly high pressures in the industrial area north of the intersection of SR 532 and SR 530; however, all services in this area have individual PRVs that reduce pressure to 80 psi or lower and improvements are not necessary.

Fire Flow Deficiencies

The following areas have low fire flows that do not meet the actual or target fire flow levels.

- Low fire flows and high velocities in some commercial areas of downtown Stanwood west of Pioneer Highway, primarily due to the undersized 6- and 8-inch water mains in the area.
- Moderately low fire flows and high velocities in the Stanwood Primary School area, primarily due to the existing undersized 6- and 8-inch water mains in the area.
- Low fire flows and high velocities in the Josephine Sunset Home and adjacent multi-family areas of the 125 Zone, primarily due to the existing undersized 6- and 8-inch water mains in the area.
- Low fire flows and high velocities in the multi-family area near Island View Drive due to the undersized mains serving the area.
- Moderately low fire flows in the residential Hennings Estates area, primarily caused by the undersized 6-inch water mains serving the area.
- Moderately low fire flows and high velocities at Port Susan Middle School, primarily caused by undersized 8-inch mains in 267th Place NW.
- Moderately low fire flows and high velocities near Stanwood Camano Village, primarily due to the undersized water main serving the area.
- Moderately low fire flows and high velocities near Stanwood High School, primarily due to the undersized 8-inch asbestos cement (AC) water main in 272nd Street NW.
- Moderately low fire flows and high velocities near Twin City Elementary School, primarily caused by undersized water mains serving the area.
- Moderately low fire flows and high velocities near Cedarhome Elementary School, primarily caused by undersized water mains serving the area.
- Low fire flows and high velocities near Church Creek Estates caused by undersized water mains serving the area.
- Lack of fire flow in several locations without fire hydrants and with small water mains, including the following areas: the 252 Zone; the 255 Zone; the 265 Zone; south of SR 532 in the 125 Zone; Woodland Road; the 365 Zone in the northeast corner of the system; Old Pacific Highway north of 276th Street NW; and near the Stanwood Camano Fairgrounds.

Other Deficiencies

Several areas throughout the system have sufficient fire flow; however, high water velocities are experienced in the system because the water mains are undersized to carry the fire flows at acceptable water velocities. Operating the system with high water velocities can potentially damage the system due to the high pressure surges that commonly occur with high water velocities.

Some areas of the system have water mains that are more than 50 years old, which is beyond the average life expectancy of water mains. Most of the older water mains are located in the downtown area of the City in the 125 Zone. Approximately 19 percent of the City's water main is AC pipe. Most of the AC pipe is located in the older areas of the City. The City is planning to replace the aging water main in the future, as shown in the schedule of planned improvements in **Chapter 9**. All new water main installations are required to use ductile iron water main in accordance with the City's Water System Standards, a copy of which is included in **Appendix H**.

The City has historically had problems with corrosion within the water system. A 2012 Soil Corrosivity Testing and Data Analysis Study prepared for the City by Northwest Corrosion Engineering recommended the installation of anodes on ductile iron pipe when it is exposed for repair or replacement. Soil corrosivity tests are also recommenced prior to the installation of any new water main. The City plans to review their water system standards and update in accordance with the corrosion study recommendations. An update to the City's standards is included as an improvement in **Chapter 9**.

PRESSURE REDUCING STATIONS

This section evaluates the City's existing pressure reducing stations to identify deficiencies related to their current condition and operation capability.

Evaluation and Deficiencies

The City has a total of 11 pressure reducing stations, all of which are less than 25 years old. Five of the pressure reducing stations transfer water from the 297 Zone to the small pressure reduced zones above Pioneer Highway. The 252 Zone PRV station (288th Street and 89th Avenue PRV) is functioning properly, but is filled with water and has a tree root growing into the side of the vault. The 255 Zone has two PRV stations (282nd Street and Nordic Way PRV, and 280th Street and 83rd Drive PRV), and both are in good condition. The 282nd and Nordic Way PRV is in good condition. The 280th Street and 83rd Drive PRV is in need of cleaning due to standing water on the vault bottom. The 265 Zone PRV (276th Street and 80th Drive PRV) is operational, but is also filled with silt and water.

The PRV station at the intersection of SR 532 and 530, which is set to transfer water from the 297 Zone to the 125 Zone during a fire flow event in the lower zone, is in good condition. The Cedarhome Drive and BNRR PRV is set to transfer water from the 245 Zone to the 297 Zone and allows for emergency flow redundancy to the 125 Zone.

The City has four PRV stations that transfer water from the 365 Zone to the 297 Zone. The stations are all in excellent condition and less than 10 years old.

The 245 Zone PRV at 272nd Street and 81st Avenue is currently being constructed and will be the City's newest PRV station. The 2010 WSP recommended that this PRV station contain a pressure relief valve. A pressure relief valve will help protect the system in the event that one of the pressure reducing valves malfunctions in the wide-open position, thereby exposing the 245 Zone to higher pressures form the upper pressure zone. During the design of the 245 Zone, adequate property and drainage was not available to install a pressure relief station. A pressure relief station for the 245 Zone is identified as an improvement in **Chapter 9**. Proposed improvements for additional pressure reducing stations and general maintenance for the other pressure reducing stations are also addressed in **Chapter 9**.

TELEMETRY AND SUPERVISORY CONTROL SYSTEM

This section evaluates the City's existing telemetry and supervisory control system to identify deficiencies related to its condition and current operational capability.

Evaluation and Deficiencies

The City's existing telemetry and supervisory control system, which was installed in 2003, has not been significantly updated since its initial installation. The existing supervisory control and data acquisition (SCADA) computer, which was installed in 2007, is running on Windows XP and is in need of replacement. The City is currently updating the computer and improvements will be complete by the end of 2014.

A majority of the City's original Rugid 9 programmable logic controller (PLC) main boards, the board that all the other boards plug into, are due for updates within the next year. Main boards that were installed in the early 2000's have been found to be problematic due to capacitors made in China. The capacitors can cause voltage spikes that damage the other attached boards. The Bryant Well No. 1 board was redesigned and replaced, but updates are needed at the Master PLC, Knittle/Cedarhome Reservoir site, Cedarhome Booster Pump Station, Cedarhome Well, and the Bailey Reservoirs. In addition, the control panels at Bryant Well No. 1 and the Baily Reservoirs need to have uninterruptible power supplies (UPS) installed to prevent damage from power hits. The other water facilities already have the UPS feature.

The City's radio system also needs to be upgraded. The current radios are serial RS-232, which has been replaced with Ethernet transmission control protocol/internet protocol (TCP/IP) as a standard transport protocol in the control industry. Most modern PLC's do not support RS-232 unless it is through a protocol converter. The Bryant Treatment Plant is TCP/IP based, but it is equipped with a protocol converter to communicate over the original radio network.

Proposed telemetry improvements are identified in **Chapter 9**.

SYSTEM CAPACITY

This section evaluates the capacity of the City's existing water system components (supply, storage and transmission) to determine the maximum number of ERUs it can serve. Once determined, system capacity becomes useful in calculating how much capacity is available in the water system to support new customers that apply for water service through the building permit process. The system capacity information, together with the projected growth of the system expressed in ERUs, as shown in **Chart 4-11** of **Chapter 4**, also provides the City with a schedule of when additional system capacity is needed.

Analysis Criteria

The capacity of the City's system was determined from the limiting capacity of the water rights, supply, transmission, and storage facilities. The supply capacity analysis was based on the limiting capacity of the supply facilities and the system's MDD per ERU. The transmission capacity analysis was based on the total capacity of the transmission system for the supply sources and the system's MDD per ERU.

The storage capacity analysis was based on the storage capacity for equalizing and standby storage and the computed storage requirement per ERU. Operational and fire flow storage capacity were excluded from the storage analysis because these components are not directly determined by water demand or ERUs. For the analyses, a reserve amount equivalent to the existing operational and fire flow storage requirements were deducted from the total available storage capacity to determine the storage capacity available for equalizing and standby storage. This storage capacity available for equalizing and standby storage was divided by the existing number of ERUs presented in **Chapter 4** to determine the storage requirement per ERU.

The annual water rights capacity evaluation was based on the existing annual water rights, as summarized in **Chapter 6**, and the system's average day demand per ERU. The instantaneous water rights capacity evaluation was based on the existing instantaneous water rights, as summarized in **Chapter 6**, and the system's MDD per ERU.

The ERU-based demand data was derived from the average day demand of the system and demand peaking factors from **Chapter 4**.

Capacity Analysis Results

A summary of the results of the existing system capacity analysis is shown in **Table 7-12**. The results of the existing system capacity analysis indicate that the limiting capacity of the system is storage, which can support up to a maximum of approximately 4,702 ERUs. The existing water system has a surplus of approximately 372 ERUs based on this limiting component.

A summary of the results of the six-year projected system capacity analysis is shown in **Table 7-13**. The 6-year projected system capacity analysis includes improvements that are planned to be completed within the 6-year planning period, as described in **Chapter 9**. These improvements include changes in source capacity at the Bryant Well field. The results of the 6-year projected system capacity analysis indicate that the proposed improvements will increase the system capacity to approximately 4,703 ERUs based on the limiting component of storage. Thus, the system will have a deficient system capacity of approximately 443 ERUs in 2021 if the improvements are completed as planned.

A summary of the results of the 10-year projected system capacity analysis is shown in **Table 7-14**. The 10-year projected system capacity analysis does not include any additional improvements beyond those proposed for the 6-year projected system. The results of the 10-year projected system capacity analysis indicate that the system capacity will remain at approximately 4,703 ERUs based on the limiting component of storage. Thus, the system will have a deficient system capacity of approximately 879 ERUs in 2025.

A summary of the results of the 20-year projected system capacity analysis is shown in **Table 7-15**. The 20-year projected system capacity analysis includes improvements that are planned to be completed within the 20-year planning period, as described in **Chapter 9**. These improvements include the construction of a new 0.4 MG tank. The results of the 20-year projected system capacity analysis indicate that the proposed improvements will increase the system capacity to approximately 6,721 ERUs based on the limiting component of storage. Thus, the system will have a surplus system capacity of approximately 52 ERUs in 2035 if the improvements are completed as planned.

Table 7-12
Existing System Capacity Analysis

Demands Per ERU Basis	
Average Day Demand Per ERU (gal/day)	191
Maximum Day Demand Per ERU (gal/day)	324
Peak Hour Demand Per ERU (gal/day)	468
Source Capacity - Well and Spring Supply	
Well Supply Capacity (gal/day)	2,808,000
Maximum Day Demand Per ERU (gal/day)	324
Maximum Supply Capacity (ERUs)	8,673
Source Capacity - Annual Water Rights	
Annual Water Right Capacity (gal/day)	4,721,760
Average Day Demand Per ERU (gal/day)	191
Maximum Annual Water Right Capacity (ERUs)	24,677
Source Capacity - Instantaneous Water Rights	
Instantaneous Water Right Capacity (gal/day)	5,575,680
Maximum Day Demand Per ERU (gal/day)	324
Maximum Instantaneous Capacity (ERUs)	17,222
Storage Capacity	
Maximum Equalizing & Standby Storage Capacity (gal)	941,777
2013 Equalizing & Standby Storage Requirement (gal)	867,341
Equalizing & Standby Storage Requirement Per ERU (gal)	200
Maximum Storage Capacity (ERUs)	4,702
Transmission Capacity	
Transmission Capacity (gal/day)	3,666,100
Maximum Day Demand Per ERU (gal/day)	324
Maximum Transmission Capacity (ERUs)	11,324
Maximum System Capacity	
Based on Limiting Facility - Storage	4,702
Unused Available System Capacity	
Maximum System Capacity (ERUs)	4,702
Existing (2013) ERUs	4,331
Surplus Capacity (ERUs)	372

Table 7-13
Year 2021 System Capacity Analysis with Proposed Improvements

Demands Per ERU Basis

Average Day Demand Per ERU (gal/day)	192
Maximum Day Demand Per ERU (gal/day)	325
Peak Hour Demand Per ERU (gal/day)	469

Source Capacity - Well and Spring Supply

Well and Spring Supply Capacity (gal/day)	3,960,000
Maximum Day Demand Per ERU (gal/day)	325
Maximum Supply Capacity (ERUs)	12,202

Source Capacity - Annual Water Rights

Annual Water Right Capacity (gal/day)	4,721,760
Average Day Demand Per ERU (gal/day)	192
Maximum Annual Water Right Capacity (ERUs)	24,617

Source Capacity - Instantaneous Water Rights

Instantaneous Water Right Capacity (gal/day)	5,575,680
Maximum Day Demand Per ERU (gal/day)	325
Maximum Instantaneous Capacity (ERUs)	17,180

Storage Capacity

Maximum Equalizing & Standby Storage Capacity (gal)	941,777
2021 Equalizing & Standby Storage Requirement (gal)	1,030,465
Equalizing & Standby Storage Requirement Per ERU (gal)	200
Maximum Storage Capacity (ERUs)	4,703

Transmission Capacity

Transmission Capacity (gal/day)	4,794,100
Maximum Day Demand Per ERU (gal/day)	325
Maximum Transmission Capacity (ERUs)	14,772

Maximum System Capacity

Based on Limiting Facility - Storage	4,703

Unused Available System Capacity

Maximum System Capacity (ERUs)	4,703
Projected 2021 ERUs	5,145
Deficient Capacity (ERUs)	-443

Table 7-14
Year 2025 System Capacity Analysis with Proposed Improvements

Demands Per ERU Basis	
Average Day Demand Per ERU (gal/day)	192
Maximum Day Demand Per ERU (gal/day)	325
Peak Hour Demand Per ERU (gal/day)	469
Source Capacity - Well and Spring Supply	
Well and Spring Supply Capacity (gal/day)	3,960,000
Maximum Day Demand Per ERU (gal/day)	325
Maximum Supply Capacity (ERUs)	12,202
Source Capacity - Annual Water Rights	
Annual Water Right Capacity (gal/day)	4,721,760
Average Day Demand Per ERU (gal/day)	192
Maximum Annual Water Right Capacity (ERUs)	24,617
Source Capacity - Instantaneous Water Rights	
Instantaneous Water Right Capacity (gal/day)	5,575,680
Maximum Day Demand Per ERU (gal/day)	325
Maximum Instantaneous Capacity (ERUs)	17,180
Storage Capacity	
Maximum Equalizing & Standby Storage Capacity (gal)	941,777
2025 Equalizing & Standby Storage Requirement (gal)	1,117,823
Equalizing & Standby Storage Requirement Per ERU (gal)	200
Maximum Storage Capacity (ERUs)	4,703
Transmission Capacity	
Transmission Capacity (gal/day)	4,794,100
Maximum Day Demand Per ERU (gal/day)	325
Maximum Transmission Capacity (ERUs)	14,772
Maximum System Capacity	
Based on Limiting Facility - Storage	4,703
Unused Available System Capacity	
Maximum System Capacity (ERUs)	4,703
Projected 2025 ERUs	5,582
Deficient Capacity (ERUs)	-879

Table 7-15
Year 2035 System Capacity Analysis with Proposed Improvements

Demands Per ERU Basis

Average Day Demand Per ERU (gal/day)	192
Maximum Day Demand Per ERU (gal/day)	325
Peak Hour Demand Per ERU (gal/day)	469

Source Capacity - Well and Spring Supply

Well and Spring Supply Capacity (gal/day)	3,960,000
Maximum Day Demand Per ERU (gal/day)	325
Maximum Supply Capacity (ERUs)	12,202

Source Capacity - Annual Water Rights

Annual Water Right Capacity (gal/day)	4,721,760
Average Day Demand Per ERU (gal/day)	192
Maximum Annual Water Right Capacity (ERUs)	24,617

Source Capacity - Instantaneous Water Rights

Instantaneous Water Right Capacity (gal/day)	5,575,680
Maximum Day Demand Per ERU (gal/day)	325
Maximum Instantaneous Capacity (ERUs)	17,180

Storage Capacity

Maximum Equalizing & Standby Storage Capacity (gal)	1,349,150
2035 Equalizing & Standby Storage Requirement (gal)	1,338,718
Equalizing & Standby Storage Requirement Per ERU (gal)	201
Maximum Storage Capacity (ERUs)	6,721

Transmission Capacity

Transmission Capacity (gal/day)	4,794,100
Maximum Day Demand Per ERU (gal/day)	325
Maximum Transmission Capacity (ERUs)	14,772

Maximum System Capacity

Based on Limiting Facility - Storage	6,721

Unused Available System Capacity

Maximum System Capacity (ERUs)	6,721
Projected 2035 ERUs	6,670
Surplus Capacity (ERUs)	52

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