SECTION 3

SECTION 3
WATER SYSTEM ANALYSIS

This chapter presents an analysis of the City of Battle Ground's (City's) supply, pumping, storage, and distribution facilities based on industry standard criteria developed by the Washington State Department of Health (DOH). The water demand forecasts summarized in Section 2 are used in conjunction with these criteria to assess the adequacy of the water system to deliver sufficient quantities of water under peak or fire flow conditions at acceptable pipeline velocities and system pressures.

Water Supply Criteria and Analysis

The City's water supply capacity was evaluated, based on the criteria shown in Table 3-1, to assess the current system's ability to reliably supply existing and future demands.

Table 3-1
Water Supply Criteria

No.	Criteria Description	Reference	Necessity
1	Supply must be sufficient to provide, at a minimum, the maximum day demand (MDD)	WAC 246-290-222(4)	Required
2	Two (2) or more sources are capable of replenishing fire suppression storage within 72 hours while simultaneously supplying MDD	DOH *2009 Water System Design Manual*	Reliability Consideration
3	Total source capacity provides MDD with less than 18 hours of pumping	DOH *2009 Water System Design Manual*	Reliability Consideration
4	With largest source out of service, remaining sources can supply average day demand (ADD)	DOH *2009 Water System Design Manual*	Reliability Consideration
5	Backup power supply available (power receptacle for portable generator, two (2) public power sources or on-site auxiliary power)	DOH *2009 Water System Design Manual*	Reliability Consideration

Water Supply Analysis

Supply capacity is evaluated by comparing existing and projected MDD for the City's service area to the total available supply from all sources. Supply adequacy for individual pressure zones is evaluated later in this section through analysis of the booster pump stations serving each of the City's two (2) pressure zones. Table 3-2 summarizes the supply evaluation including a brief evaluation of the maximum instantaneous water rights to assess whether existing water rights are adequate to allow for expanded supply to meet future MDD. Further analysis of water rights is presented in Section 4.

Table 3-2
Supply Evaluation Summary

Year	MDD	Available Supply		Additional Supply Needed	
		Instantaneous Water Rights[1]	Operational Supply[2]	Water Rights	Operational Capacity
	(mgd)	(mgd)	(mgd)	(mgd)	(mgd)
2012	2.89	3.35	2.85	-	0.04
2018	3.16	3.35	2.85	-	0.31
2032	5.42	3.35	2.85	2.07	2.57

Notes:

1. Sum of the allowable instantaneous withdrawal rates (Q_i) for Wells 1, 2 and 4 thru 9. Well 3 has been abandoned and the Well 3 water rights have been transferred to Clark Public Utilities.
2. Sum of the current maximum operating capacities for Wells 1, 2, 4, 5, 7, 8 and 9 as shown in Table 1-1, plus the 500 gpm maximum contractually allowable flow of the existing CPU intertie at Maple Grove School. Well 6 is excluded from total operational supply as it is currently offline due to customer complaints associated with iron bacteria.

Existing water rights are sufficient to support projected water system MDDs through 2018. If the City is able to drill additional wells and transfer the location of existing water rights there will still be a need for wholesale supply over the 20-year planning period. The City is currently coordinating with Clark Public Utilities (CPU) to participate in the development of regional water supply and transmission facilities to serve the north Clark County area. The City is currently negotiating water supply partnership and wholesale water purchase agreements with CPU. The City's capital investment in these facilities, and associated water supply capacity, is described further in Section 8.

The current maximum operational supply will be insufficient within the 6-year planning horizon due to the decline of existing well yields. To address this known operational deficiency, the City is moving forward with plans to construct a larger intertie with CPU that would initially provide a supply of 1,000 gallons per minute (gpm) or 1.44 million gallons per day (mgd). This new intertie would include provisions for an ultimate capacity of 3,000 gpm (4.32 mgd) as CPU develops new water sources. This intertie project is included in the capital improvement program (CIP) found in Section 8 of this plan.

Water Supply Reliability

The reliability of water supply to the City is enhanced through multiple supply facilities. There are four (4) wells that pump directly into the distribution system and three (3) wells that pump into the Horsethief Reservoir. The pump station that supplies the Main Zone with water from the Horsethief Reservoir has four (4) pumps, two (2) have a 500 gpm capacity and two (2) have a 1,000 gpm capacity.

Table 3-3 summarizes an analysis of the City's supply facilities ability to meet current and near-term reliability criteria both before and after addition of a new 1,000 gpm (1.44 mgd) intertie with CPU to replace the existing 500 gpm intertie at Maple Grove School which would be used only for emergencies.

Table 3-3
Supply Reliability Analysis

Criteria	Required Capacity (mgd)		Water System Capacity (mgd)	
	Current (2012)	2018	Existing	With New CPU Intertie
Two (2) or more sources are capable of replenishing fire suppression storage within 72 hours while simultaneously supplying MDD[1]	2.97	3.24	2.85	3.57
Total source capacity provides MDD with less than 18 hours of pumping	2.89	3.16	2.14	2.68
With largest source out of service, remaining sources can supply ADD	1.29	1.41	2.13	2.13
Backup power supply available[2]	-	-	partial	partial

Notes:

1. Reliability capacity based on current and 2018 MDDs of 2.89 mgd and 3.16 mgd respectively, and replenishment of the largest 2,000 gpm, 2-hour fire within a 72 hour period. System capacities based on maximum current source operating yields as summarized in Table 3-2.
2. No well source facilities currently have backup power provisions. However, the Horsethief Pump Station, which pumps Wells 7, 8, and 9 source water into the distribution system from the 2.0 million gallon (MG) Horsethief Reservoir, maintains on-site emergency power.

Under existing conditions, supply reliability is deficient. However, with the planned addition of the 1,000 gpm (1.44 mgd) CPU intertie and its eventual expansion to 3,000 gpm (4.32 mgd), all reliability criteria will be met within the 20-year planning period. Backup power does not exist at all supply facilities. This deficiency is offset by the large pumping capacity of the Horsethief Pump Station which has on-site backup power. Additional capital improvements to the new intertie, for reliability purposes, are not considered necessary at this time and should be re-evaluated with the next Water System Plan update.

Pump Station Criteria and Analysis

The capacity requirements for booster pumping facilities vary based on whether the pump station is supplying constant pressure to an area, referred to as a "closed pressure zone" or supplying a reservoir which then serves customers by gravity in an “open pressure zone”. In the City’s water system there are two (2) pump stations, the Horsethief and Tukes Mountain pump stations. The capacity evaluations of these facilities were based on two (2) different sets of requirements, due to the differing pressure zone configurations that they serve.

Horsethief Pump Station

The Horsethief Booster Pump Station supplies the Main Zone with water from the Horsethief Reservoir because the ground level reservoir cannot supply the system and maintain adequate system pressures with gravity flow. The Main Zone hydraulic grade line (HGL) is dictated by water levels in the Tukes Mountain Reservoirs, thus the Main Zone is an open pressure zone. Analysis of the Horsethief Pump Station is based on criteria for booster pumping to an open pressure zone as summarized in Table 3-4.

Table 3-4
Open Zone Pump Station Criteria

No.	Criteria Description	Reference	Necessity
1	Must be able to supply pressure zone MDD with all pumps in service.	WAC 246-290-222(4) and DOH *2009 Water System Design Manual*	Required
2	Must have capacity to supply zone ADD with largest pump out of service	DOH *2009 Water System Design Manual*	Required
3	Capacity to provide MDD with largest pump out of service	DOH *2009 Water System Design Manual*	Reliability Consideration
4	Minimum 30 psi at pump intake under peak hour demand (PHD) or fire flow plus MDD conditions	DOH *2009 Water System Design Manual*	Reliability Consideration
5	Automatic shut-off installed for pressures lower than 10 psi	DOH *2009 Water System Design Manual*	Reliability Consideration
6	Backup power supply available (power receptacle for portable generator, two (2) public power sources or on-site auxiliary power)	DOH *2009 Water System Design Manual*	Reliability Consideration

Required criteria 1, supply Main Zone MDD with all pumps in service, can be met through 2018 with the existing Horsethief Pump Station capacity. Required criteria 2, supply Main Zone ADD with the largest pump out of service, can be met through the 20-year planning horizon with the current station capacity as shown in Table 3-5.

Although there is an apparent MDD deficiency at the Horsethief Pump Station in 2032, before recommending expanded station capacity, it is important to consider the contribution of supply sources simultaneously serving Main Zone customers. Wells 1, 2, 4 and 5 provide approximately 430 gpm to the Main Zone. 500 gpm can be supplied from the CPU intertie at Maple Grove School with an additional 500 gpm to be constructed within the 6-year planning horizon. All of these existing sources offset the 705 gpm pump station deficiency in 2032. No additional capacity is recommended at the Horsethief Pump Station as part of this plan.

Table 3-5
Horsethief Pump Station Required Capacity Evaluation

Description	Current (2012) (gpm)	2018 (gpm)	2032 (gpm)
Required Criteria 1 – Supply Main Zone MDD with all pumps in service			
Main Zone MDD	1,975	2,160	3,705
Total Pump Station Capacity[1]	3,000	3,000	3,000
Additional Capacity Needed	**-**	**-**	**705**
Required Criteria 2 – Supply Main Zone ADD with the largest pump out of service			
Main Zone Average Day Demand (ADD)	882	964	1,654
Pump Station Capacity with Largest Pump Out of Service[1]	2,000	2,000	2,000
Additional Capacity Needed	**-**	**-**	**-**

Note:
1. Based on existing individual pump capacities of 500, 500, 1000 and 1000 gpm.

Horesthief Pump Station Reliability

The current configuration of the Horsethief Pump Station has the ability to meet most reliability criteria in combination with other existing or planned facilities:

- **Criteria 3 -** The 2018 MDD can be met with the largest Horsethief pump out of service at which time the new 1,000 gpm CPU intertie is anticipated to be in service. This would allow the 2032 MDD to be met by a combination of the reduced pump station capacity, Wells 1, 2, 4 and 5 and the new CPU intertie without impacting service to the Main Zone.

- **Criteria 4 and 5 -** Although the height of the Horsethief Reservoir that supplies the pump station does not permit 20 psi at the inlet, the normal operating suction pressures have not caused operational issues with the pumps and there are no existing or anticipated services on the suction side.

- **Criteria 6 -** The Horsethief Pump Station has on-site emergency power.

No capital improvements are recommended to the Horsethief Pump Station due to reliability considerations.

Tukes Mountain Pump Station

The purpose of the Tukes Mountain Pump Station is to supply the Tukes Mountain Pressure Zone with constant pressure water service. The service elevations within this zone cannot be supplied at the pressures furnished to the Main Zone by gravity from the Tukes Mountain Reservoirs. The criteria for evaluating the capacity and reliability of a pump station serving a closed pressure zone are summarized in Table 3-6.

Table 3-6
Closed Zone Pump Station Criteria

No.	Criteria Description	Reference	Necessity
1	Must have capacity to supply zone PHD at 30 psi	WAC 246-290-230(5) and DOH *2009 Water System Design Manual*	Required
2	Must be able to supply zone MDD plus largest fire flow demand at 20 psi	WAC 246-290-230(6) and DOH *2009 Water System Design Manual*	Required
3	Capacity to provide fire flow plus MDD with largest "routinely used" pump out of service	WAC 246-293-660(1) and DOH *2009 Water System Design Manual*	Required
4	Capacity to provide PHD with largest pump out of service	DOH *2009 Water System Design Manual*	Reliability Consideration
5	At least 20 psi at intake under PHD or fire flow plus MDD conditions	DOH *2009 Water System Design Manual*	Reliability Consideration
6	Automatic shut-off installed for pressures lower than 10 psi	DOH *2009 Water System Design Manual*	Reliability Consideration
7	Backup power supply available (power receptacle for portable generator, two (2) public power sources or on-site auxiliary power)	DOH *2009 Water System Design Manual*	Reliability Consideration

As shown in Table 3-7, the existing Tukes Mountain Pump Station meets PHD and MDD plus fire demand criteria through 2032, with or without the largest pump in service.

Table 3-7
Tukes Mountain Pump Station Required Capacity Evaluation

Description	Current (2012) (gpm)	2018 (gpm)	2032 (gpm)
Required Criteria 1 - Supply Tukes Mountain PHD at 30 psi			
Tukes Mountain PHD	53	58	98
Total Pump Station Capacity	2,330	2,330	2,330
Additional Capacity Needed	**-**	**-**	**-**
Required Criteria 2 - Supply Tukes Mountain MDD plus 1,000 gpm residential fire flow at 20 psi			
Tukes Mountain MDD	32	35	60
Tukes Mt Largest Fire Flow	1,000	1,000	1,000
Total Pump Station Capacity	2,330	2,330	2,330
Additional Capacity Needed	**-**	**-**	**-**
Required Criteria 3 - Supply Tukes Mountain MDD plus 1,000 gpm residential fire flow with largest "routinely used" pump out of service			
Tukes Mountain MDD	32	35	60
Tukes Mountain Largest Fire Flow	1,000	1,000	1,000
Pump Station Capacity with Largest Pump Out of Service	1,330	1,330	1,330
Additional Capacity Needed	**-**	**-**	**-**

Tukes Mountain Pump Station Reliability

The current configuration of the Tukes Mountain Pump Station meets all reliability criteria shown in Table 3-6:

- **Criteria 4 -** The pump station capacity with the largest pump out of service exceeds peak hour demands through the 20-year planning horizon.

- **Criteria** 5 **and 6 -** The water system hydraulic model was used to confirm adequate service pressures are provided from the Tukes Mountain Pump Station under PHD and MDD plus fire flow conditions. Pump station operation with Main Zone, suction side pressures below 20 psi does not occur and is not expected to occur in the future.

- **Criteria 7 -** The Tukes Mountain Pump Station is equipped with a receptacle for a portable emergency power generator.

No capital improvements are recommended for the Tukes Mountain Pump Station due to reliability considerations.

Storage Criteria and Analysis

Storage Criteria

Water system storage is provided for different purposes which are represented by the following storage components: operational, equalizing, standby, fire, and dead storage. A description of each storage component and the criteria used to evaluate the capacity of the City's six (6) existing reservoirs is provided below.

Operational Storage: Operational storage is used to supply the water system under normal demand conditions. Operational storage is the average amount of draw down in the reservoir during normal operating conditions, which represents the volume of storage that is not available for other purposes. Operational storage in the City's reservoirs is calculated as the volume of storage between the water level when pumps are signaled to beginning re-filling the reservoirs and the maximum water level (i.e. overflow elevation) of the reservoirs.

Equalizing Storage: When source pumping capacity cannot meet the periodic peak demands placed on the water system, equalizing storage must be provided to meet these demands. The required volume of equalizing storage is calculated according to the *December 2009* DOH *Water System Design Manual*. Equalizing storage is the amount of PHD in excess of all available, non-emergency supply sources for 2.5 hours.

Standby Storage: The purpose of standby, or emergency, storage is to provide a measure of reliability should supply sources fail or unusual conditions impose higher demands than anticipated. The volume of standby storage recommended for systems with one (1) supply source may be different than for systems, such as the City's, which are served by multiple sources. The required volume of standby storage for multiple source systems is calculated according to the *December 2009* DOH *Water System Design Manual*. Standby storage is two (2) times ADD minus all but the largest available, non-emergency supply sources pumping for 24 hours.

Fire Storage: The purpose of fire suppression storage is to provide adequate volume 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 volume of fire storage is calculated as the product of the maximum required fire flow rate and duration.

Dead Storage: This type of storage is water that cannot be used because it is stored at an elevation that is too low to provide sufficient pressure by gravity within the service area. This unusable storage occupies the lower portion of many ground-level standpipe type reservoirs.

In addition to the storage volume requirements discussed above, reliability criteria used for storage facility analysis is summarized in Table 3-8.

Table 3-8
Storage Analysis Criteria

No.	Criteria Description	Reference	Necessity
1	Adequate operational, equalizing, fire, and standby storage volumes at minimum required pressures (30 psi at equalizing levels and 20 psi under fire flow conditions)	WAC 246-290-235 and DOH *2009 Water System Design Manual*	Required
2	More than one gravity storage tank with the ability to isolate each tank	DOH *2009 Water System Design Manual*	Reliability Consideration
3	Sufficient storage to give standby capacity of at least 2 times ADD for all users with fire suppression available at minimum pressure requirements	DOH *2009 Water System Design Manual*	Reliability Consideration
4	A minimum standby storage of 200 gpd/ERU regardless of source capacity	DOH *2009 Water System Design Manual*	Recommendation
5	An alarm system is installed that alerts operators to high and low operating levels in abnormal operating conditions	DOH *2009 Water System Design Manual*	Reliability Consideration

Storage Analysis

As previously discussed, the City's system is composed of two (2) pressure zones, Main and the constant pressure, closed, Tukes Mountain Zone. Although the Tukes Mountain Pressure Zone can only be supplied through pumping and not by gravity from City reservoirs, adequate storage capacity is required to provide suction supply to the Tukes Mountain Pump Station. Thus, the storage analysis will consider total, system-wide demands including the Main and Tukes Mountain Pressure Zones rather than a zone by zone analysis approach.

The entire volume of the Horsethief Reservoir is considered dead storage because it is not capable of supplying the water system by gravity but only through the Horsethief Pump Station. For the purposes of this storage analysis, the Horsethief Pump Station is considered a supply source just like the City's Wells 1, 2, 4 and 5 and the CPU intertie. Storage analysis in 2018 and 2032 includes the replacement 1,000 gpm CPU intertie source capacity anticipated for construction prior to 2018. Well 6 is not included as a supply source as it is primarily operated for emergency purposes. Wells 7, 8 and 9 are not included as supply sources for the storage analysis because they pump directly to the Horsethief Reservoir which can only supply the system through the adjacent pump station.

Operational storage is calculated as the difference between the Horsethief Pump Station operational set points. Pumps at the Horsethief Station are signaled to turn on when the Tukes Mountain Reservoir No. 1 water level is at 88 percent and turn off when it is at 90 percent. This two (2) percent operational range equates to approximately 0.7 feet of water volume in each of the City's five (5) Tukes Mountain Reservoirs.

Due to the number of supply sources serving the City's Main Zone, standby storage calculated according to the *2009 Water System Design Manual* for systems with multiple sources, through 2018, is significantly less than the 200 gallons per day per equivalent residential unit (gpd/ERU) recommended for system reliability. Standby storage presented in Table 3-9 is calculated as 200 gpd/ERU through 2018 for reliability. Due to this conservatively high storage volume, fire storage is nested inside the required standby storage volume.

Table 3-9
Storage Capacity Evaluation

Year	Required Storage (MG)					Existing Storage (MG)			Additional Capacity Needed (MG)
	Operational	Equalizing	Standby	Fire[1]	Total Required[1]	Total Existing	Dead	Effective	
Current (2012)	0.03	0.00	1.32	0.24	1.36	3.84	2.06	1.78	-
2018	0.03	0.00	1.45	0.24	1.48				-
2032	0.03	0.27	2.78	0.24	3.08				1.30

Note:
1. Fire storage is nested inside the required standby storage volume, thus total required storage is the sum of operational, equalizing and standby storage.

The results of this storage evaluation indicate that the system is meeting storage requirements through the 6-year planning period, but will become deficient before 2032. Interpolating the 6-year and 20-year projections, a new storage reservoir constructed within the Main Zone should be planned in approximately 2023, when existing storage is estimated to become deficient. For the purposes of this plan, a 1.4 MG reservoir is included in the CIP to meet storage requirements in 2032. Storage facility design should consider the reservoir's expected life, thus it is recommended that the proposed 1.4 MG design capacity for this reservoir be revisited with the next Water System Plan update or as part of a preliminary design report. Current storage volume and operational features satisfy all reliability criteria presented in Table 3-8.

Distribution and Transmission System Criteria and Analysis

The City's existing distribution and transmission mains were evaluated using a hydraulic network analysis model to determine if the system is sized and looped adequately to provide the necessary flow rates and service pressures to meet existing and future demands. A hydraulic model of the system was developed using H2OMap, a GIS based modeling program developed by Innovyze. The model was used in a steady state mode to analyze existing and future system deficiencies. The process of creating and calibrating the model against field measurements is summarized in the following paragraphs.

Hydraulic Model Development

Facilities modeled for the City's distribution system analysis are illustrated on Plate 1 in Appendix A. Existing CAD mapping and record drawings obtained from the City were digitized to develop the initial model links (pipes) and nodes. This process included verification of pipeline physical parameters and modifications that were necessary to increase accuracy and create full system connectivity. Other sources of input used to establish the model base included:

- Clark County contour mapping was imported and interpolated to establish assigned node elevations.

- Source water pumping facilities were input based on available existing pump model information. When manufacturer's data was unavailable or dated, operational data was used to model the facility. Individual pumps within the City's two (2) pump stations were input to the model based on manufacturer's pump curves provided. For well pumping facilities, a constant supply was modeled based on current operational capacities.

- Storage facilities were modeled based on actual physical dimensions and volumes, as well as known operating parameters. The Horsethief Reservoir was input separately, whereas the five (5) individual tanks existing at the Tukes Mountain site were combined and modeled as one (1) facility, based on the composite storage volume per foot of height of the individual tanks. This adjustment was made to alleviate convergence issues that can develop when running model scenarios.

- The active CPU intertie at Maple Grove School was modeled as a fixed demand input, based on the flow control established by the intertie facilities and the HGL dictated by reservoir levels and operating supply facilities within the Main Pressure Zone.

- Wells 7, 8, and 9, which feed the Horsethief Reservoir, were not included in the model, since the booster pump flows are affected only by the water level of the reservoir, not by the flows into the reservoir.

- For future modeling scenarios, the planned CPU intertie at 219th Street, including a new pump station and transmission main in the vicinity of NE 219th Street between NW 92nd Avenue and 29th Avenue, was modeled. The pump station is required because CPUs system is at a lower HGL than the City's system. Proposed pumps, based on design documentation and an available project report, include an initial firm capacity of 1,000 gpm and an ultimate capacity of 3,000 gpm. This will be achieved with two (2) 1,000 gpm pumps in phase 1 and two (2) additional 1,000 gpm pumps in phase 2. These pumps and their associated curves were added to the model, with a fixed hydraulic grade anticipated from CPU set on the suction side.

Model Scenarios and Demand Input

Model scenarios were defined to analyze the performance of the system under multiple demand and fire flow conditions. Specifically, scenarios were created for ADD, MDD + FF, and PHD conditions for existing and projected 2018 and 2032 populations developed in Section 2.

Information for 2011 water service connections and consumption by customer class, which was discussed in Section 2, was used to estimate percentages of the total system demand associated with residential and commercial land uses. County zoning information was used to associate each model node with either a "Residential" or "Commercial" land use category. When assigning demands to the model, the total demand associated with each land use type was distributed evenly throughout all model nodes that belonged to each land use category.

Facility settings within the model differed for the various scenarios. Reservoir levels were set at the bottom of operational, standby, and fire volumes for the ADD, MDD+FF, and PHD scenarios, respectively. Source of supply facilities operating during each of the scenarios was determined by existing system operational protocol and set points, in many cases dictated by reservoir levels.

Calibration

Hydraulic model calibration is the process of using field pressure and flow data to modify model input parameters, resulting in simulations that more accurately replicate actual system operation. Hydrant flow testing was conducted at various locations within the City's distribution system on May 31, 2012. During testing, pressure gauges at a hydrant nearby to the opened hydrant measured both static and hydrant flow residual pressures. A flow gauge was used to measure flow out of the opened hydrant. Additionally, boundary conditions, such as, reservoir levels and pumps operating (booster and well) were recorded. Results from the 10 individual flow tests were entered into the model as different scenarios under ADD conditions, with the following observations and modifications made before completion of calibration:

- Simulated pressures within the model under the same system boundary conditions were generally calculated to be higher than field measurements.

- Alteration of pipe friction factors, which were initially set at a Hazen-Williams "C" factor of 130 to reflect a large portion of newer ductile iron pipe within the system, did not result in significant reduction in the measured and modeled pressure discrepancies unless drastically decreased "C" factors were used. Implementing such changes to the model would not result in increased "real world" accuracy, and very limited changes were made to the friction factors during the calibration process.

- Much of the hydrant testing was performed during morning hours when higher diurnal demands are common. When increasing static demand conditions within the model by 25 percent over ADD levels, calculated and measured pressures calibrated within accuracy tolerances, given the relative accuracy of all measuring equipment employed during testing.

- Measured pressures within the Tukes Mountain Pressure Zone during field testing resulted in increased understanding of the operating set points for the Tukes Mountain Pump Station, and the discharge pressure band under which pumping to the closed zone is signaled "on" or "off".

Distribution and Transmission Criteria

Criteria for evaluating the capacity and reliability of the distribution system piping network are summarized in Table 3-10.

Table 3-10
Distribution and Transmission System Criteria

No.	Criteria Description	Reference	Necessity
1	Capacity to deliver PHD at 30 psi measured at any existing water service meters	WAC-246-290-230(5)	Required
2	Provide MDD plus required fire flow while retaining a minimum 20 psi residual pressure at any point in the distribution system	WAC-246-290-230(6)	Required
3	Distribution system mains should be looped whenever feasible	DOH *2009 Water System Design Manual*	Reliability Consideration
4	Pipeline velocities should not be greater than 8 feet per second (fps) under PHD conditions	DOH *2009 Water System Design Manual*	Reliability Consideration
5	All pipelines can be flushed at a flow velocity of at least 2.5 fps	DOH *2009 Water System Design Manual*	Reliability Consideration
6	All mains should have appropriate internal and external corrosion protection	DOH *2009 Water System Design Manual*	Reliability Consideration
7	Fire fighting demands should not create pressures below 30 psi in the distribution system to prevent cross-connection contamination	DOH *2009 Water System Design Manual*	Reliability Consideration

Distribution and Transmission Analysis

The distribution and transmission analysis used the hydraulic model to test the existing system's ability to provide PHD or MDD plus fire flow while maintaining minimum required system pressures. For the fire flow analysis, system adequacy was assessed using a 2,000 gpm fire flow to all non-single family residential areas within the Main Zone and a 1,000 gpm fire flow to the single family residential areas within both the Main and Tukes Zones. Model scenarios were developed to test the existing system with current 2012 and future 2018 and 2032 projected demands.

The results of the modeling analysis indicate that the existing and future system effectively maintains a minimum pressure of 30 psi to all customers under the PHD condition. However, for the MDD plus fire flow condition, three (3) existing piping deficiencies were identified:

- An estimated 550 linear foot (LF) section of existing 2-inch main along SW 2nd Court, north of SW 4th Street. This portion should be upgraded to an 8-inch waterline that can deliver fire flows under the MDD condition at the minimum required 20 psi residual pressure, as well as reduce pipeline velocities to acceptable levels.

- A portion of the existing 2-inch main along SW 3rd Street extending from S Parkway Avenue. It is recommended that approximately 50 LF of this main between the 8-inch existing main on S Parkway Avenue and an existing fire hydrant on SW 3rd Street be upsized to meet fire flow, pressure and recommended pipeline velocity requirements. The remainder of the existing 2-inch main is located within private property and could continue to provide nominal residential demands.

- An estimated 1,190 LF of 6-inch main along NE Grace Avenue, between NE 6th Street and NE 10th Streets, should be upgraded to an 8-inch main to meet fire flow residual pressure requirements.

Distribution and Transmission Reliability

Within the last 15 years, the City has undertaken a rigorous CIP that has resulted in replacement of a large portion of the older distribution system. This has allowed the newly constructed pipelines to be brought up to current industry and City standards, resulting in a distribution system meeting almost all of the reliability considerations presented in Table 3-10. The recommended improvements discussed in the previous paragraph will result in the system meeting all reliability considerations almost system-wide. A continuing allowance is included in the CIP presented in Section 8 for yearly water main replacement of the remaining older system piping, further fortifying system reliability.

Valves, Telemetry and Intertie Evaluations

Valves

The City's distribution system includes valves installed at all intersections sufficient to allow isolation of all water main segments. Auxiliary valves are also installed on each hydrant branch. The number and placement of valves allows the City to isolate pipe sections in case of a main break or for maintenance and flushing. City design and construction standards for valves and hydrants are described in Section 7.

Telemetry

CPU currently operates the telemetry system for the City. Operators at CPU have the ability to turn booster pumps and wells on and off and monitor reservoir levels. This allows for continuous monitoring of the water system's pressure and flows.

Interties

As described in Section 1, the City has two (2) existing interties with CPU, one (1) of which is used for up to 500 gpm of supplemental supply during peak demand periods. The City does not have adequate supply capacity from other sources to meet MDDs without the use of this supplemental intertie. As discussed in the water supply analysis earlier in this section, the existing CPU intertie has insufficient capacity to supplement projected future MDD in the City's system. A new intertie with CPU is necessary to meet existing and future City demands, in lieu of any increases to the supply rate of the City's existing wells.

Physical Capacity Summary

The physical capacity of Battle Ground's water system is controlled by the City's source capacity. A new, larger capacity supply intertie currently being developed with CPU will expand source capacity within the 6-year planning horizon. The City has taken additional steps to begin regional supply planning with CPU to meet anticipated future demands in the long-term. Battle Ground's water system physical capacity is summarized in Table 3-11.

Table 3-11
Physical Capacity Summary

Water System Component	Operational Capacity	Required Performance Criteria	ERUs
Water Supply w/ 500 gpm CPU Intertie	2.85 mgd[1]	Sufficient to supply system-wide Max Day Demand (MDD)[3]	6,522
Water Supply w/ 1,000 gpm CPU Intertie in development[6]	3.57 mgd[1]		8,169
Water Supply w/ 3,000 gpm ultimate CPU Intertie capacity	6.45 mgd[1]		14,760
Capacity Related Storage	1.75 MG[4]	Adequate system-wide equalization and standby storage volume, see Table 3-9 and notes 4 and 5	8,522

Notes:

1. Sum of the current maximum operating capacities for Wells 1, 2, 4, 5, 7, 8 and 9 as shown in Table 1-1, plus the existing or future CPU intertie capacity as noted.
2. Average Day Demand (ADD) per ERU = 195 gallons per day (gpd)/ERU, see Table 2-5.
3. MDD per ERU = 195*2.24 = 437 gpd/ERU, see page 2-7.
4. Capacity related storage = equalization (ES) and standby (SB) storage only, See Table 3-9.
    a. Subtract operational (OS) and dead storage (DS) from total storage.
    b. Fire storage (FSS) is nested inside SB storage so it is not subtracted.
    c. 2.06 MG Horsethief Reservoir is all DS as this reservoir is too low in elevation to serve the Main Zone by gravity.
5. Number of ERUs calculated from capacity related storage using Equation 6-8 from the DOH *2009 Water System Design Manual.*
6. Initial capacity of new intertie is 500 gpm, supplemented by existing 500 gpm CPU intertie capacity of 500 gpm – providing a total intertie capacity of 1,000 gpm. New intertie on-line and operating June 2014.