WATER DISTRICT

19

SYSTEM RELIABILITY AND CAPACITY ANALYSIS APPROVED APRIL 2016

EXECUTIVE SUMMARY

Water District 19 is currently in a moratorium prohibiting new connections. The moratorium was imposed in 1996 based upon Department of Health (DOH) rules, projected water use, and the limited sources of water supplies available to the District. Subsequently, peak day usage has declined overall and the annual total usage has also declined, most likely due to conservation behavior by our ratepayers. This declination began in 2005 and the District predicts these trends (declining peak usage and overall usage) will continue due to changing customer behavior driven at least partially by the District's conservation programs. The District has current service obligations equal to 1791 active water service units which includes 155 zero use units (fiscal year 2015 data).

This report will enable the District to reevaluate the system capacity to determine if the current capacity is adequate to meet its commitments, if more connections could be added to the system and/or if resource development must be addressed. It has been peer reviewed by Gray & Osborne Engineering Consultants.

This evaluation of system capacity has been completed using the recommended, criteria set forth in the Washington State Department of Health's (WDOH) *Water System Design Manual* published in 2009. While not required by law, adherence to these design standards represents a high degree of system reliability and redundancy for public water systems by providing a conservative estimate of system capacity and the number of customers that could be served. Board adoption of these criteria has had the effect of providing a margin of safety in determining the system's capacity. As a result, the District has never had to declare a water emergency or restrict water usage during peak demand periods.

This capacity analysis does not specifically address future alternatives available to the District to reduce water consumption, such as specific conservation measures, more aggressive inclined block pricing, or water use restrictions. As part of the revised Municipal Water Law, the District has been required to implement a published conservation program which is filed with the DOH and is integrated into the most recent approved Comprehensive Water System Plan. The program must show substantiated reductions in per capita use over time. Program development has been completed and is included in the 2008 Comprehensive Water System Plan approved in 2010.

The overall conclusions of this 2016 Capacity Report are:

1. Peak day usage continues to decline overall. Taking into account the projected usage of 155 zero use units and required fire storage replenishment, Water District 19 must now be prepared to produce 898,560 gallons on a peak day.
2. Water District 19 is now capable of producing 1,058,400 gallons on a peak day (1,031,040 with Well #4 reduction). Therefore, there is a surplus (132,480 gallons) of peak capacity.
3. The system continues to operate safely and reliably.
4. The District can consider a temporary lifting of the 1996 moratorium on new water service connections to add connections.

DEMAND CONSIDERATIONS

Background

Water District 19 is currently in a moratorium on new connections, the second such moratorium imposed by the District. The moratorium was imposed in 1996. A major factor in the imposition of the moratorium was the District's concern about meeting the peak or maximum day demand, as required by the Department of Health. Data collected between 1990 and 1996 indicated that, the District was at or near the limits imposed by its water rights during peak use periods.

The District currently has 1791 outstanding water service units for 1463 accounts. The District uses the peak day demand over the past five years to plan for the number of customers that its infrastructure can safely serve. Referencing Table 1 below, at the conclusion of the summer of 2015, the District's rolling five-year peak day (which is the figure used for District capacity planning purposes) fell from 793,700 (measured peak day use in 2009) to 711,703 gallons per day (measured peak day use in 2015). The peaking factor increased accordingly from 2.22 to 2.39, and the overall peak usage for all rate classes continues to trend downward.

Table 1 – Five-Year Demand

YEAR	Average Day Demand	Maximum Day Demand	Peaking Factor
2011	290,747	538,959	1.85
2012	302,796	627,649	2.07
2013	288,931	640,175	2.22
2014	305,908	637,646	2.08
2015	313,793	711,703	2.39

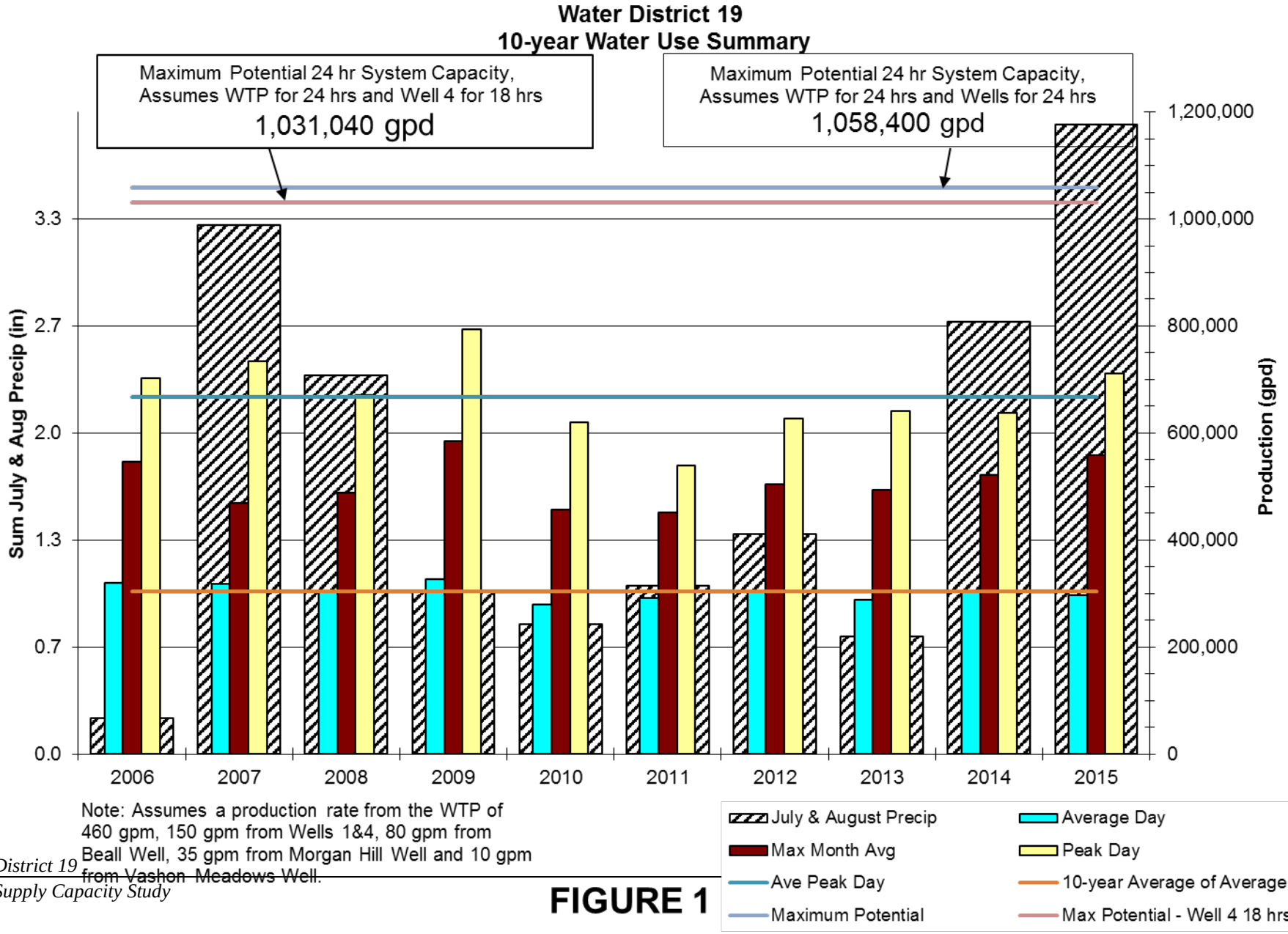
The Department of Health urges systems to be prepared to provide water for a major fire on the peak day, requiring a fire storage replenishment amount of 120,000 gallons. The District is also committed to serve 155 zero-use connections, resulting in a total required production of 898,560 gallons per day (GPD).

Zero Use

As part of the total estimated demand, the District will factor in the average use for all "zero use" accounts. Currently there are 155 zero use accounts across all classes of customers. A zero use account is defined as an account that has had no measured use for the period of time germane to this analysis – 2011 through 2015. Reference Table 2 below to observe the distribution of zero use accounts.

Table 2 – Zero Use Accounts

Zero Use Accounts –2011 through 2015				
Unit Valuation GPD	**Apartment**	**Commercial**	**Public Entity**	**Residential**
600	0	12		24
800	0	36	1	82
TOTALS	0	48	1	106



Note: Assumes a production rate from the WTP of 460 gpm, 150 gpm from Wells 1&4, 80 gpm from Beall Well, 35 gpm from Morgan Hill Well and 10 gpm from Vashon Meadows Well.

FIGURE 1

SYSTEM RELIABILITY

There are four major components to the District's water system: sources, treatment, storage and distribution. An analysis of overall system capacity and reliability must include an analysis of all four.

RELIABILITY CONSIDERATIONS AND REQUIREMENTS

The Washington Department of Health (WDOH) 2009 Water System Design Manual discusses reliability as excerpted below.

Reliability

""Reliability" applies to expectations consumers may have in obtaining sufficient water, at an acceptable pressure. Therefore, reliability often differs based on customer viewpoints about an appropriate level of service.

State public drinking water system rules largely focus on safety and reliability. A reliable water system is designed and then operated to meet the needs and expectations of consumers at all times. The two elements affecting the adequacy of a water system's reliability are:

- Source reliability
- Facility reliability"

SOURCE

"Source reliability depends on the availability of water to meet consumer demands in a given period. Under drought conditions, line breaks, unscheduled power outages, or other unusual circumstances, water systems may need to limit consumer water use. Consumer acceptance of the extent of the limitation during such periods can be expected to vary.

Surface water reliability is dependent on rainfall, snow pack, and runoff rates, especially during extended drought. Reliability depends on how frequently a water system expects water availability to be limited. This is expressed as the one-in-10, -20, -50, or even -100 year recurrence intervals for water limitations.

It is important for water systems that depend on surface water to let consumers know of the potential limitations. For example, consumers should know that water may not always be present in unrestricted quantities. If a water system adopts a standard of 98 percent reliability, consumers should expect restrictions on water use at least once every 50 years. A lower standard would suggest a more frequent curtailment. In this context, reliability becomes a balance between consumer expectations and the cost of achieving such expectations.

Climatic changes also affect groundwater source reliability. However, the effect may not be as rapid or as great. Groundwater source reliability relates more to the estimated sustainable yield of an aquifer. Engineers use pumping tests and hydrogeological analyses to determine the sustainable yield of an aquifer. The extent

of the analysis usually relates to the size of the utility and its willingness to expend resources to gain the necessary data. Chapter 7 outlines pumping test procedures for wells."

The following presents a brief summary of DOH recommendations that are intended to promote high levels of source reliability for service to customers:

1. Development of two or more sources with a supply capacity able to replenish depleted fire suppression storage within a 72-hour period while concurrently supplying the maximum day demand.
2. Sources capable of providing the maximum day demand for the system with 18 hours of pumping. (This recommendation generally applies to ground water sources.)
3. With the largest source out of service, remaining sources(s) able to provide a minimum of the average day demand for the system.
4. Pump stations with power connections to two independent primary public power sources, or either portable or in-place auxiliary power available.
5. The firm yield of surface water sources is that associated with the lowest flow and/or longest period of extended low precipitation on record.

> "The source or sources for a water system **must** be able to meet the water system's maximum day demand (MDD) (WAC 246-290-222(4)). In rare cases, DOH may grant an exception to this requirement if a water system has multiple days of storage to provide peak-day service when the supply sources cannot meet the MDD on their own. For reliability purposes, supply sources should be able to replenish depleted fire suppression storage within 72 hours while concurrently supplying the MDD of the water system. (Sec. 7.1)"

The Washington Administrative Code (WAC 246-290-220) requires that a water purveyor's source production be able to meet maximum demand. DOH recommends the additional guidelines of fire suppression storage replenishment and the 18 hours per day pumping.

The District passed Resolution 1054 in November 2003, declaring the treatment plant and its two surface sources as the District's largest single source.

Facility Reliability

"Facility reliability depends on the ability of water system facilities, such as pumps, storage tanks, and pipelines, to deliver adequate quantities of water over specified timeframes. The frequency and duration of service interruptions, and the cost required to minimize them, affect consumer expectations. Consumer expectations often drive decisions on improvements that provide higher levels of reliability for a water system.

Consumers may accept service interruptions for one, maybe two, days per year because of water system flushing, cleaning, maintenance or repair. However, they may not accept water outages for three or four hours each month, or at any time for more than two consecutive days. The water system should consider events limiting water availability, and weigh the

higher cost (engineering and construction) of gaining added reliability against the costs associated with interruptions of service."

DEFINITIONS OF TERMS AND THE ASSOCIATED DISTRICT VALUES

Equivalent Residential Units

An equivalent residential unit (ERU) is a unit of measure used to equate consumption associated with non-residential and multi-family residential customer water usage to the consumption of an equivalent number of single-family residences. For example, if a system has sufficient capacity to serve 100 ERUs, then that system would have sufficient capability to meet the projected needs of 100 single family residences, or any combination of single family residences, multi-family residential, commercial or industrial users that would use the same amount of water. Water consumption expressed in ERUs is system specific and changes through time as usage patterns change and active connections are added. Based on the analysis performed by PACE Engineers for the 2008 Comprehensive Water System Plan revision, the District determined that a water service unit equaled a peak usage of 600 gallons per day (codified in Resolution 1127, 12/19/2008). For the purposes of this report, an ERU is equivalent to a **water service unit**.

The District tracks customer information in a number of ways. Based upon actual commodity sales, the recent historical average usage per water service unit by year is:

TABLE 3

5 - Year Historical Usage Summary

YEAR	BOOKED WATER SERVICE UNITS	ACTIVE[1] WATER SERVICE UNITS	GPD / WATER SERVICE UNIT	GPM / ACTIVE WATER SERVICE UNIT	PEAK DAY DEMAND GPM / ACTIVE WSU
2011	1727	1582	176	0.128	0.237
2012	1741	1582	168	0.133	0.276
2013	1753	1579	166	0.127	0.282
2014	1765	1582	165	0.134	0.280
2015	1791	1636	162	0.123	0.302

[1] Active is defined as an account with documented usage within a five year window ending in this year.

For planning purposes, the District will assume a repeat of year 2015 peak day demand.

If the District considers authorizing more connections, that action should be based on the number of water service units in the system. Each water service unit has the potential for adding demand to the system. It remains prudent to periodically review the rating of a water service unit that is District specific based on actual usage patterns to determine the number of water service units that can be served. It is also prudent to add water service

units cautiously, only a few at a time, to assure system demand and capacity remain in balance.

Authorized Consumption versus Distribution System Leakage

The recent implementation of the Water Use Efficiency Rule (WUE) mandated a change in terminology when analyzing and quantifying the difference between metered sales of water and water produced. The new terms are "Authorized Consumption" and "Distribution System Leakage". Distribution system leakage represents water that is not consumed by the system's metered and billed customers or accounted for as other uses. It is calculated as the difference between water, production leaving the treatment plant and wells, and sales. Distribution system leakage includes losses through leaks, fires (when not reported), meter inaccuracies and illicit use. It must be monitored to determine the impact on available service levels. Distribution system leakage has ranged from 5.2% to 6.9% during the period analyzed (2011 - 2015). Production reports have reflected the following in Table 4 for the period:

TABLE 4

Distribution System Leakage

YEAR	TOTAL VOLUME PRODUCED & PURCHASED[1]	SALES[2] + OTHER[3]	% LEAKED
2011	97,670,933	90,959,105	6.9%
2012	110,947,696	103,247,494	6.9%
2013	105,634,696	98,317,312	6.9%
2014	111,990,601	106,174,770	5.2%
2015	114,869,494	108,481,657	5.9%

[1] Data from in-house reports.
[2] Data from Continental Utility Solutions AR Posting Summary report
[3] Other includes reported/known "consumption" including fire suppression, flushing, leak estimates.

Average Day Demand

Average day demand is the total amount of water produced over the entire year divided by the number of days. For the five year period 2011 - 2015, the average day production was 300,435 gallons per day (gpd) or 209 gallons per minute (gpm) which equates to 0.128 gpm/active water service unit.

Maximum Day (Peak Day) Demand

Maximum day demand is the total amount of water produced on the highest production day of the year (usually in late July or early August) plus water utilized from storage but not replenished. Currently, the District generally maintains its reservoirs near full, so

reservoir storage depletion is not a significant factor in maximum day demand calculations.
As a matter of policy, the District uses a five-year rolling time period for planning purposes. For the period 2011 - 2015, the average annual maximum day demand was 631,226 gallons. For that same time period the peak maximum day occurred in 2015 and was 711,703 gallons. In this report, 711,703 gallons per day will be used (0.302 gpm/water unit) as the potential maximum day demand.

Peaking Factor

The peaking factor is utilized by industry professionals to project peak flows from average flows. Peaking factors have been used as a planning tool to calculate peak hour demand, maximum day demand or maximum month demand. The average peaking factor for the District for the last 10 years is 2.19 and has ranged as high as 2.43. For the purposes of this report, the District considers the five-year period 2011 - 2015, over which the peaking factor ranged from 2.39 to 1.85 with an average of 2.12.

The peaking factor will typically be used to predict near term system demand. Ongoing tracking of the ratio can also be used for long range infrastructure investment planning potentially accelerating or curtailing the need to schedule capital upgrades or additions.

The table below summarizes the data of record and an interpolation for meeting the potential demand for serving all committed water units based on actual 2015 maximum data.

TABLE 5

Demand Summary

	Maximum Day			Average Day		
	GPM [1]	**MGD**	**GPM/ ERU**	**GPM**	**MGD**	**GPM/ ERU**
2015 – recent peak- 1636 active water service units	494	0.712	0.302	n/a	n/a	n/a
2011 - 2015 average	438	0.631	0.268	209	0.300	0.128
Committed No. of water service units 1791	541	0.779	0.302	229	0.330	0.128
Committed No. of water service units plus fire[2]	624	0.899	0.348	n/a	n/a	n/a

[1] Assumes a 24-hour average pumping rate.

[2] Assumes a fire storage replenishment flow rate of 83 gpm.

As stated previously, the District's infrastructure currently is able to produce 735 gpm (1,058,400 gallons per day). It is capable of producing more as stream flows increase, but peak day normally occurs during the summer low stream flows.

In addition to the maximum day peaking factor there is a peak hour peaking factor. The peaking factor for peak hour demand varies with the number of connections. For the District, peak hour is approximately 1,018 gpm (Source: Water System Design Manual WDOH, December 2009, Equation 5-1) which indicates a peak hour factor estimation of 2.05 (1018/496). The peak hour demand is used in the evaluation of the distribution system and storage only.

Maximum Month Demand

Maximum month demand is the amount of water produced during the month of highest demand (usually July or August). This is recorded by calendar month and not the highest 30-consecutive-days of demand.

SYSTEM CAPACITY

Table 2 summarizes both the District's peak ability to produce water and the District's maximum permitted capacity. The District's measured peak (summer) capacity is 735 gallons per minute (GPM) or 1,058,400 GPD. Given this capacity, and a required peak production of 898,560 GPD which includes fire suppression storage replenishment, the District has a resource surplus.

In addition, a review of the District's capacity to serve its current commitments shows that the District is able to meet average day demand with the largest source, the treatment plant, out of service, which is a Department of Health recommendation.

With the District now in a surplus, it would be prudent to consider a plan to issue some new connections to those on the current waiting list. Because both usage trends and production capacity are highly problematic and unpredictable in the short-run, it is recommended that the Commission cautiously add a relatively small number of new customers at a time to assure both demand and capacity continue to result in resource surplus.

The District should continue to leverage available conservation program resources to further reduce demand where feasible. Additionally, the District should continue to pursue the development of additional raw water resources, including additional points of withdrawal for current water rights, consistent with restraining the increase in the cost of water, which is already among the most expensive water in the state. The District is constrained by a lack of access to new water rights and large portions of the District being closed by the Department of Ecology to further drilling.

Table 6 - Peak Demand Water Resources

Water Right	Permitted Instantaneous (gpm)	Current Limitation (gpm)	Gallons Per Day (with limitation)
Beall Creek	404	460 combined	662,400
Ellis Creek	225		
Wells No. 1, 2, 4 & Morgan Hill Well	250	185	266,400
Beall Well	180	80	115,200
Vashon Meadows Well	20	10	14,400
Total	**1079**	**735**	**1,058,400**

Water Rights

The District has the following water rights.

TABLE 7

Water District 19 Water Rights

Water Right	Instantaneous (gpm)	Annual Water Right (acre-ft)
Beall Creek[1]	404	651
Ellis Creek[1]	225	361
Wells No. 1, 2, 4 & Morgan Hill Well	250	300
Beall Well[2]	80	55
Vashon Meadows Well	10	1.16
Total	**969**	**1,368**

[1]Annual water right is instantaneous right multiplied out for the entire year. There is no statutory limit.

[2] Not currently perfected.

As seen earlier in Table 6, "Peak Demand Water Resources", there are shortfalls between certificated water right amounts and what is currently accessible. In order to bridge these gaps and avoid the risk of permanently losing the right to access the water, it will be necessary to invest in source development within the stated limits of the individual water rights. For example, regarding the wellfield water right, a 65 gpm shortfall remains year round suggesting additional points of withdrawal will be needed (well(s)). To address the creek water rights, water could be impounded by constructing lakes or the District could embark on a regulatory process through DOE to transfer some of the surface water rights to groundwater rights.

Regardless of the path taken, proactive action must be taken to complete projects prior to expiration dates related to water right perfection. In some cases an extension of time can be granted by DOE. The Table below summarizes the rights and quantities to be perfected.

TABLE 8

Water Rights and Quantities to be Perfected

Certificate No.	Description	Quantity Q_a To Perfect	Next Deadline
G1-23519BP	Wellfield, 250 gpm, 300 ac-ft	78 ac-ft	Sept. 30, 2019
8145A	Beall Well	55 ac-ft	n/a[1]

[1] Project completion only. No deadline for putting to beneficial use.

Minimum Stream Flow

The District has been monitoring stream flows on a periodic basis since 1997 on both Beall and Ellis Creeks. The data indicate that Ellis Creek has a minimum flow of approximately 160 gpm, 65 gpm below the 225 gpm water right. The data from Beall Creek indicates that it has a minimum flow of approximately 360 gpm, 44 gpm below the existing 404 gpm water right. In addition, as part of the agreement executed with Protect Our Water and the Department of Ecology regarding the Beall Water Right, an instantaneous minimum residual flow of 48 gpm must remain in the stream. Consequently, at low flows the usable flow in Beall Creek is approximately 310 gpm.

Well Capacity

The District has six wells. Three are located adjacent to the reservoirs (storage tanks), one is adjacent to the treatment plant (Beall Well), another is located at Morgan Hill Tank and Booster Station, and the sixth is at Vashon Meadows subdivision. Well 1 has a consistent production limit of 100 gpm. Well 2 has essentially failed and is used strictly as a drawdown monitoring well. Well 4 was predicted to produce 250 gpm exclusively. However, as has occurred to Wells 1 & 2 in the past, the specific capacity dropped off shortly after being commissioned, prompting an extraordinary and expensive redevelopment in its first year of operation. At this time, the District hydrogeologist has recommended maintaining a 100 gpm production rate (and no more than 150 gpm collectively from Well 1 and Well 4). Drawdown observations over the last eight years suggests it is prudent to maintain current levels and utilize a well coordination plan to enable the District to safeguard the sustainable wellfield capacity. The Beall Well has a maximum capacity of 80 gpm. The Morgan Hill Well has a maximum capacity of 35 gpm. The Vashon Meadows Well produces 10 gpm with a predicted maximum of 18 gpm with improvements.
For this report we have considered the total well production rate to be 256 gpm. The methodology used to arrive at this value is as follows:

Well 1	75 gpm
Well 4	75 X 75% = 56 gpm
Beall Well	80 gpm
Morgan Hill	35 gpm
Vashon Meadows Well	10 gpm

While the WDOH Criteria No. 2 has been adopted, the 18-hour per day pumping rate would be applied on peak day by using some combination of the remaining three functional wells, leaving the 256 gpm capacity intact.

TREATMENT CAPACITY

In addition to source limitations, there are other potential constraints in the system related to surface water pumping and treatment. These are discussed below.

Treatment Plant

The District's water treatment plant treats and filters surface water diverted from Beall and Ellis Creeks and pumped to the plant. The plant has two parallel clarifier-filtration treatment trains, each with a maximum instantaneous design rate of 350 gpm per filter. The plant is capable of operating 24 hours per day during peak demand periods assuming staff availability. Average combined summer flows in the creeks is 460 gpm.

The clarification-filtration process removes particulate matter from the water. Over time this particulate matter reduces the flow rate of water through the clarifiers and filters. As a result the clarifiers must be rinsed and the filters backwashed on a periodic basis to remove the accumulated particulate matter. The clarifier rinse operation utilizes raw water. The filter backwash process requires the use of previously treated and filtered water. All of the water that is used for rinsing and backwashing is conveyed to the backwash basin (recycle ponds) for later reuse.

The backwash basins provide temporary storage for approximately 290,000 gallons of water used to store the waste stream from clarifier rinses, filter backwashes and filter-to-waste operations. Settled "recycle" water is pumped from temporary storage into the treatment plant raw water piping to augment the flow from the creeks and to increase the instantaneous production rate. However it is assumed that there is no increase in 24-hour plant capacity since the backwash basin stored volume does not typically change over a 24-hour period. In addition, by regulatory decree (the DOH operating permit), no more than 15% of the influent stream into the treatment plant can be recycled water. A magnetic flow meter and manual valve are utilized in regulating the recycle flow. The instantaneous flow is displayed on the SCADA terminal in the operating room as well as a wall mounted remote display.

Surface Water Pump Stations

Currently the District is maximizing the available water in the two stream sources when needed. Minimum summer flows at Beall Creek Pump Station are approximately 360 gpm while Ellis Creek flows have been observed as low as 160 gpm. The Ellis Creek has exhibited a significant sensitivity to evapotransporation in the summer causing a documented reduction in nominal flow of 40 – 50 gpm. The dense foliage and forest are the prime mechanism for this uptake of creek flow.

SOURCE AND TREATMENT RELIABILITY EVALUATION

The WDOH recommends utilization of the reliability criteria in system planning. Table 9 compares the District's current system capacities against the DOH criteria. For criteria No. 1 we assume a peak day production of 460 gpm from the treatment plant and 256 gpm from the wells, for a total of 716 gpm, (1,031,040 gpd) on a 24-hour basis.

The District passed Resolution 1054 on November 18, 2003 in response to continued operational problems with the treatment plant. That resolution declared that for planning

purposes the treatment plant is to be considered a “single source” (Beall Creek and Ellis Creek are independent surface water sources that discharge to the water treatment plant). With the passage of this resolution the treatment plant became the District’s largest source. With the treatment plant out of service the District relies completely upon the wells. The estimated future average day demand for the District is 229 gpm to serve 1791 water service units. The current maximum instantaneous rate from the wells is 256 gpm with a Well #4 reduction. Although Beall Well must be operated in conjunction with the treatment plant (at up to 80 gpm), the District vulnerability analysis has shown that the risk of the treatment plant being disabled for an extended period of time will be limited to a natural disaster which will drive the decision to implement water restrictions. Therefore, the District will be able to meet average demand with its largest source out of service serving all committed water service units under normal operating conditions.

TABLE 9

Comparison of Water District 19 Production to DOH Criteria

		DOH Maximum Day Demand Plus Fire Storage Replenishment Criteria Vs. System Capacity				DOH Average Day Criteria Vs. System Capacity with Largest Source Out of Service	
	No. of Water Service Units	**Maximum Day Demand plus 3-Day Fire Storage Replenishment [2] (gpm)**	**Current Capacity Of Wells (gpm) [3]**	**Surface Water Treatment and Pumping Capacity (gpm) [4,5]**	**Total System Capacity (gpm)**	**Average Day Demand [6] (gpm)**	**System Capacity With Largest Source Out of Service [7, 8] (gpm)**
Actual - Existing System active water service units	1636[1]	**521**	256	460	**716**	**209**	**275**
Projected - Total # of Committed Water service units	1791	**577**	256	460	**716**	**229**	**275**
Projected - Total if waiting list water service units added to total committed water service units	1921[9]	604	256	460	**716**	**246**	**275**

[1]Current number of active units based upon year 2015 data.
[2]Max day use per water unit = (0.271 gpm* #units) +83 gpm to replenish fire storage.
[3]The current 24-hour capacity of all wells combined less 25% of Well 4 (19 gpm).
[4]Surface water capacity is Beall available creek flow + Ellis available creek flow.
[5]The current maximum capacity is 460 gpm.
[6]0.128 gpm * #units.
[7]Assumes that the treatment plant is the largest source. If the entire plant is down the emergency intertie with Heights will be activated and water use restrictions will be in place. Heights could supply 100 gpm in the winter months for scheduled plant shutdown maintenance, much less in the summer. This 100 gpm is not included in the above table. Booster station improvements at the tank site could increase storage capacity, as discussed below.
[8]Assumes that all the wells would be run 24-hours per day on peak day (= 275 gpm).
[9] Currently 120 units on the waiting list as of 12/31/2015.

STORAGE

In addition to source analysis, storage has to be examined to determine if sufficient storage exists. The District has three reservoirs – a 1 million gallon (MG) and 0.625 MG tank at the tank farm, and a 0.1 MG tank at Morgan Hill, for a total of 1,725,000 gallons. The 0.625 MG reservoir is filled by the wellfield. A booster station transfers water from the 0.625 MG reservoir to the 1.0 MG reservoir. A booster station on the discharge side of the 1.0 MG storage tank would enable the District to better utilize more of the stored water in this reservoir. Currently, when the level in this tank reaches approximately 60 feet, pressure in the distribution system drops below the DOH design guideline of 30 psi.

The 1.0 MG reservoir is 45 feet in diameter and provides 11,895 gallons/ft of storage. The elevation, height and pumps settings are given in Table 10.

TABLE 10

1.0 MG Reservoir Datums

	Elev. (ft)	Height (ft)	Storage (MG)
Highest Service	405	-9[1]	-
Reservoir Base	414	0	0
Reservoir Overflow	494	80	0.952
Fill Pumps off	493	79	0.940
31 psi min standard pressure. Booster pumps from 0.625 MG tank on at this level	486	72	0.856
30 psi, min req'd pressure	474	60	0.714
20 psi, min req'd pressure in fire flow situation	454	40[2]	0.476

[1] Per Gray & Osborne, "Source Capacity and Analysis" 2004.
[2]Three feet has been added to dead storage to allow for head losses, per Gray & Osborne, "Source Capacity Analysis" 2004.

There are five components which make up the storage requirement:
(Source: Water System Design Manual WDOH, December 2009)

1. **Operating Storage (OS):** This is determined by the normal operating levels of the storage tanks. The pumps from the clear well at the treatment plant are initiated on and off by set points in the 1.0 MG reservoir. The District has established the pump control settings so that the operational storage is 7 -foot, or 83,265 gallons. The 0.625 MG reservoir, which is filled by the wellfield, is set to pump into the 1.0 MG tank if the water level in the 1.0 MG tank drops below 72 feet (elevation 486 ft). Operational storage is independent of the number of water service units within the system.

2. **Fire Suppression Storage (FS):** This is the storage volume required to fight a fire within the District. The largest fire flow volume required in the District is 3000 gpm for 2 hours (120 minutes) or 360,000 gallons. This storage is independent of the number of water service units within the system.

3. **Dead Storage (DS):** This is the storage volume below the lowest level in the reservoir that provides the minimum system pressure of 30 psi at the highest point for peak hour conditions, and 20 psi for fire flow conditions. Dead storage is independent of the number of water service units within the system. For District No. 19 the volume is currently 475,800 gallons.

4. **Equalizing Storage (ES):** This is the storage required by the system to meet the peak hour demands. Equalizing storage is required if the pumping capacity of the District's sources are unable to keep up with the peak hour demand. This storage is dependent upon the number of water service units within the system, the associated system demands and available source and pumping capacities. The required equalization storage is 24,000 gallons for 1636 active water service units.

5. **Standby Storage (SB):** This is the storage required to provide a measure of reliability should sources fail or when unusual conditions impose higher demands than usual. Standby storage is dependent upon the number of water service units within the system, the associated system demands and available source and pumping capacities under emergency conditions, specifically, calculated with the largest source out of service. The required standby storage is 326,400 gallons for the current 1636 active water service units.

STORAGE RELIABILITY EVALUATION

Table 11 shows the storage components within the three reservoirs.

TABLE 11

Storage

Storage Component	1636 water service units (Gal) Source capacity= 256 gpm wells +460 gpm TP (Total 716 gpm)	1791 water service units (Gal) Source capacity= 256 gpm wells +460 gpm TP (Total 716 gpm)
OS[1]	83,265	83,265
ES[2]	10,800	21,000
FS *	360,000	360,000
SB [3]*	-135,232	-78,192
DS	475,800	475,800
Total Storage Required	929,965	940,065
Total Available Storage	1,725,000	1,725,000
Surplus (Deficit)	795,135	784,935

[1] The District has control over setting the "pump on" setting and thus can vary the amount of operational storage. The number listed here reflects the amount most often used.
[2] Peak Hour Demand estimated using DOH criteria in 2009 Design Manual – 788 gpm 2015, 856 gpm @ 1791 ERUs
[3] 184 gpd/ERU ADD used for calculation (0.128*1440)

*Only the larger of the two values for FS and SB storage is required to be included in the total available storage. The smaller of the two can be excluded from a water system's total storage requirement, provided that such practice is not prohibited by: (1) a locally developed and adopted Coordinated Water System Plan, (2) local ordinance, or (3) the local fire protection authority or County Fire Marshall [See WAC 246-290-235(4)]. None of these apply in the case of WD 19. Therefore, only standby storage will be included as a required storage in the calculation of the maximum number of ERUs.

DISTRIBUTION

The distribution system is not typically a determining factor on the overall number of authorized water service units. Localized constraints such as undersized old water mains in the system may create areas of low pressure or fire flow. Where those situations occur the District will endeavor to improve the pipe network to increase localized flow and pressure. Eleven thousand feet of water line was installed to improve fire flow and reduce leakage between the years 2000 and 2004. In 2009, the Board of Commissioners committed to investing $100,000 per year toward water main rehabilitation projects beginning with fiscal 2010. The SW 184th/ Ridge Road main replacement project

identified in the 2008 Comprehensive Water System Plan is the first of these projects to be implemented. To date (as of end of year 2015), over 4,136 feet of water main has been replaced.

CONCLUSION

The current capacity of the District is sufficient to meet the projected maximum day demand per DOH requirements. The current peak day capacity from all available sources is 1,058,400 GPD (with Well #4 reduction 1,031,040 GPD), while maximum planned peak day demand is 898,560 GPD. This theoretical surplus of 132,480 GPD allows the District to temporarily lift the moratorium on issuing new water service connections. Given the historical variance in peak day demand and the occasional failure of sources to be able to produce at maximum efficiency at all times, it is the recommendation that the Commission lift the moratorium incrementally, evaluating the ability of the District's sources to absorb the demand of these new water service units, before deciding in subsequent years to again temporarily lift the moratorium.

Efforts to fully utilize and perfect existing water rights should continue in order to maximize reliability and sustainability of the system. This would include increasing the points of withdrawal for ground water rights as well as consideration of impoundments on the creeks to store sufficient water to bridge the gap between summer creek flow and the permitted instantaneous withdrawal rate (Qi) of the individual water rights.