2018 SEASONAL WATER SUPPLY AUGMENTATION AND CONTINGENCY PLAN

CITY OF PORTLAND **PORTLAND WATER BUREAU**

MAY 11, 2018

1. OVERVIEW

Each year, the Portland Water Bureau (bureau) prepares a seasonal water supply augmentation and contingency plan, commonly referred to as the Summer Supply Plan. The Summer Supply Plan provides a comprehensive strategy for augmenting the bureau's baseline water resources, if needed during the peak demand season. An interdisciplinary team of bureau staff prepares the plan based on current supply and demand information, and analysis of resource options.

The summer supply strategy is designed to make the best use of existing resources to meet multiple objectives. The main objectives include water supply reliability, high water quality, water use efficiency, fish recovery, and cost management. A glossary of key terms is included at the end of this document.

During the summer of 2018, the bureau expects that sufficient water will be available to meet the range of potential supply and demand conditions that could occur in the Portland water system. The bureau will continue to focus on water conservation and augmentation of the Bull Run supply with groundwater from the Columbia South Shore Well Field (CSSWF) to meet peak season water demands. The bureau will also continue flow releases into the lower Bull Run River to enhance fish habitat and meet river water temperature targets. As the summer progresses, the bureau will coordinate with key stakeholders to ensure that interested parties are apprised of supply and demand conditions as they unfold.

The following document outlines the bureau's plan for managing water supplies during the 2018 peak season.

2. SUPPLY PLANNING OBJECTIVES

The bureau wants to reliably meet the demands of all users with high quality water while effectively managing costs. To meet this overarching goal, the bureau is required to balance multiple objectives and coordinate staff efforts in several work groups.

Supply Reliability - Demand includes municipal and industrial users, both in the Portland service area and in the wholesaler service areas. It also includes water demand for fish, or in-stream demand. Supply reliability is ensured by carefully managing the use of primary water resources, employing conservation strategies, and preparing for the potential use of contingency resources.

Water Quality - Water quality for municipal and industrial users involves meeting all drinking water quality regulations as they apply from the source water to the distribution system. Meeting the regulations is a minimum standard for the bureau; the bureau strives to supply better water quality than that defined by regulations. This means managing the system in such a way that multiple water quality parameters are maintained within optimal ranges. Water quality is also important for fish. Therefore, water temperature and minimum stream flows are regulated downstream of Headworks at Larson's Bridge. Managing stream temperature and flow are part of the bureau's larger objective to contribute to fish recovery of federally-listed steelhead, coho salmon, and Chinook salmon (Endangered Species Act, ESA).

Cost Management - Managing potential public and private costs is important to the bureau. The primary water supply, the Bull Run Watershed, provides water through an efficient gravity-fed system. Operation of the CSSWF, the bureau's main augmentation resource, involves greater energy costs. The bureau strives to balance use of its groundwater resource and other augmentation resources to keep water provisions cost-effective while meeting all other objectives.

System Maintenance - The bureau has as goals maintaining the equipment and operational skills needed for using its main augmentation resource, the CSSWF. Exercising the wells and pump station help to keep equipment in repair and to identify needed maintenance. Doing so also keeps operators up to date with the process of operating groundwater and ensures that the groundwater system will work properly when it is needed. Between March 12, 2018 and March 21, 2018, the bureau operated the groundwater system from the CSSWF. During this operation, the bureau completed the annual maintenance of the groundwater system and produced approximately 160 million gallons (MG) of groundwater. In addition to preventive maintenance, this operation allowed PWB to use the supply of hypochlorite at the groundwater facility before degradation required significant disposal costs.

Summer supply planning is a complex process that involves continually weighing multiple factors as conditions change throughout the season. The Supply Planning Group meets regularly during the reservoir drawdown period of the year to decide what operations are necessary to meet all these objectives.

3. ASSESSMENT OF PEAK SEASON DEMAND AND SUPPLY RESOURCES

In late winter and early spring of each year, the bureau evaluates available information about the upcoming summer peak demand season. The bureau monitors precipitation, snowpack, and streamflow, and evaluates current and projected water demands. The population supplied by the city's water system during the 2018 peak season will be approximately 934,104 (including retail and wholesale customers and accounting for wholesale customer offloads). In an average weather year, the bureau estimates that peak season (122 days) daily average water demand would be about 113 million gallons per day (MGD). The actual average peak season demand in 2017 was 120 MGD.

Fish in the Bull Run River also require water for their habitat needs. The bureau continues to work collaboratively with numerous partner organizations to improve habitat for federal ESA-listed fish species in the Sandy River Basin and to reduce summer season water temperatures in the lower Bull Run River. Federal rules require protection of the listed steelhead, coho salmon, and Chinook salmon. State and federal rules also require meeting temperature objectives designed to protect aquatic habitat. The bureau will release flows into the lower Bull Run River consistent with the Bull Run Water Supply Habitat Conservation Plan (HCP) and final Temperature Management Plan that was approved in April 2009.

Supply Probability Analysis

The bureau employs the Groundwater Use Model to evaluate the need for and timing of groundwater pumping. This model does not rely on weather forecasts but uses historic weather and streamflow data to construct a set of groundwater pumping curves that are compared to actual drawdown as it progresses. The Groundwater Use Model uses current-year demand projections (generated by the bureau's Demand Model using historical weather data), historical reservoir inflows, and anticipated fish flow releases into the lower Bull Run River to develop a series of reservoir drawdown curves – one for each weather year from 1940 to 2017. These projected drawdown curves are used to determine suggested groundwater pump rates based on the remaining volume of Bull Run storage above baseline elevations and the calendar date. During drawdown, if the actual storage volume in the Bull Run reservoirs drops below a groundwater pumping curve, then the pumping rate corresponding to that curve is recommended to augment supply. The recommended groundwater pump rates should keep the Bull Run reservoirs above their baseline storage levels while minimizing the volume of pumped groundwater and maintaining a relatively constant pumping rate throughout the drawdown season.

An example of groundwater pumping curves and a hypothetical drawdown curve (based on 2015 weather, a drier than average year) are shown in Figure 1. In this example, the storage curve remains above the pumping curves until July 2, at which point the storage curve crosses the 36 MGD pumping line. In response, two of the main groundwater pumps (18 MGD each) are turned on and reservoir drawdown is slowed measurably.

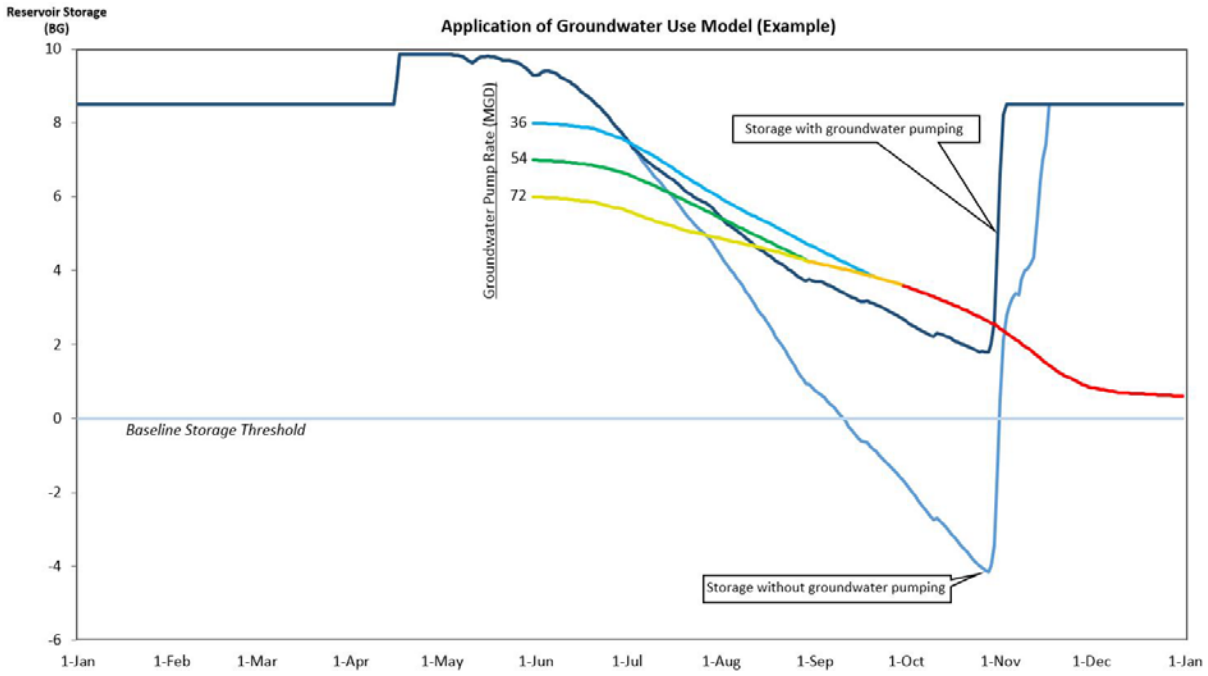

Figure 1. An example of groundwater pumping curves and a hypothetical drawdown curve. See text for an explanation. BG, billion gallons; MGD, million gallons a day.

The blue, green, and yellow curves represent constant groundwater pump rates. The orange and red curves represent a constant supply from Bull Run with variable groundwater flow to meet demands. The orange curve is in effect from September 1 to September 30 and uses a flow of 20 MGD in each of the three Conduits for a total Bull Run flow of 60 MGD. This maximizes the amount of groundwater that can be supplied while keeping all three Conduits in service, as 20 MGD is currently the minimum flowrate that each Conduit can supply. The red curve is in effect starting October 1 and uses two Conduits for a total Bull Run flow of 40 MGD. This conserves additional water in the Bull Run Reservoirs if drawdown extends further into fall. When Conduits flows are constant, the groundwater flow rate varies from 35-80 MGD depending on demand. The light blue storage line in Figure 1 shows what the progression of drawdown would have been if no groundwater had been used. Table 1 summarizes the subsequent changes in storage and groundwater pumping rates made in response.

Table 1. Example of applying the Groundwater (GW) Use Model to determine the timing and rate of groundwater pumping in millions of gallons a day (MGD).

Date	Position of Storage Line Relative to GW Pumping Curves	Response	GW Pumping Rate
July 2	Cross 36 MGD curve	Turn on two main GW pumps	36 MGD
August 2	Cross 54 MGD curve	Turn on one additional main GW pump	54 MGD
August 13	Cross 72 MGD curve	Turn on one additional main GW pump	72 MGD
September 1	Under 3 Conduit curve	Supply 60 MGD from Bull Run, GW makes up the remaining demand	Variable

Date	Position of Storage Line Relative to GW Pumping Curves	Response	GW Pumping Rate
October 1	Under 2 Conduit curve	Supply 40 MGD from Bull Run, GW makes up the remaining demand	Variable
October 30	Cross above 2 Conduit Min curve	Turn off all GW pumps	0 MGD

In actual practice, the groundwater pumping curves inform supply decisions but do not dictate them. Other factors, such as short-range weather forecasts coupled with knowledge of antecedent hydrologic conditions in the Bull Run Watershed, the state of distribution system storage, minimum conduit flows, and the timing of the electric power billing cycle at the groundwater pump station are also considered in determining the timing and rate of groundwater pumping. The groundwater pumping curves also take into consideration the continued flow releases from the Bull Run reservoirs into the lower Bull Run River for fish habitat needs.

Habitat Conservation Plan (HCP) Supply Provisions

The city has developed a package of actions to improve habitat conditions for fish in the Bull Run and Sandy rivers. The HCP was developed in coordination with more than a dozen public and private organizations working on salmon recovery in the Sandy River Basin and it includes flow and water temperature commitments for the lower Bull Run River. The fifty-year HCP was approved by the Portland City Council in September 2008. The National Marine Fisheries Service approved the plan in April 2009 and issued the city an Incidental Take Permit which ensures regulatory compliance with the federal ESA. The flow commitments described within the HCP are now part of a regulatory compliance program for the bureau and will determine fish flow releases by the bureau for the duration of the plan. More information regarding the HCP is available on the bureau's web site, www.portlandoregon.gov/water/46157.

Minimum flow releases from Headworks during this summer's drawdown period will range from 20 to 50 cubic feet per second (cfs) from July 1 through September 30, which is equivalent to 13 to 32 MGD. Release volumes may change each day in response to the temperature of the water being released and the expected (forecasted) maximum air temperature. In October and November, minimum release volumes are a percentage of the total inflow to the Bull Run reservoirs, with a minimum of 70 cfs (October) to 150 cfs (November) during normal water years. The total volume of the downstream flow releases that occur during drawdown varies from year to year.

The total volume of the Bull Run downstream flow releases during drawdown can also change depending on the amount of precipitation that the Bull Run Watershed receives during the year. With low amounts of precipitation, two types of critically dry seasonal conditions, or triggers, can result in lower downstream flow releases: 1) a dry spring that causes early reservoir drawdown; and/or 2) dry fall conditions. These triggers provide the bureau with the option to respond by altering the flow releases for fish in the lower Bull Run River. The altered flow regime would be an earlier ramp down from spring flows

after June 1st, and/or lower fall season releases (based on a percentage of inflow and both minimums and flow caps).

A critical spring can be declared anytime drawdown begins prior to June 15. If this trigger is met in 2018, the bureau may decrease the flow in the lower Bull Run River down to approximately 30-40 cfs while following a down-ramping rate of 2 inches per hour of water stage as measured at the United States Geological Survey (USGS) gauge site on the lower Bull Run River. Critical spring conditions have occurred three times since 2010 (in 2014, 2015, and 2016), the first year of HCP implementation. Modeling of current demand levels with historic weather conditions and streamflows shows that critical spring conditions can be expected about one year in five.

The trigger for a critical fall season is based on whether the August and September inflows to the Bull Run reservoirs are within the lower 10% of historical flows for that time period. Critical fall flows cannot be implemented more frequently than two years in a row and cannot be implemented four years after a year that has had critical fall flows implemented. For example, since critical fall flows were implemented in 2014 and 2015, the bureau could not apply critical fall flows in 2016 (two consecutive year rule), and cannot apply them in 2018 or 2019 (four years later rule). In all cases, critical fall flows can be implemented only if the August-September low flow criterion is met that year. By definition, the City can expect to experience critical fall conditions one year out of ten. The City will not have the option to implement critical fall flows in 2018. Counting for the consecutive-year requirements began in 2006 and they are summarized in Table 2.

Table 2. History of critical spring and fall conditions starting in 2006.

Year	Spring		Fall	
	Conditions	Flow Implemented	Conditions	Flow Implemented
2006	Normal	Normal	Critical	Normal
2007	Critical	Critical	Normal	Normal
2008	Normal	Normal	Normal	Normal
2009	Normal	Normal	Normal	Normal
2010	Normal	Normal	Normal	Normal
2011	Normal	Normal	Normal	Normal
2012	Normal	Normal	Normal	Normal
2013	Normal	Normal	Normal	Normal
2014	Critical	Critical	Critical	Critical
2015	Critical	Critical	Critical	Critical
2016	Critical	Critical	Normal	Normal
2017	Normal	Normal	Normal	Normal

4. 2018 BASELINE AND SEASONAL CONTINGENCY RESOURCES

The following section of this plan outlines the baseline and contingency resources available to help the bureau meet peak season demand in 2018. Available resources are shown in Table 3. This table reflects conservative assumptions to ensure that the bureau can manage even extreme supply shortage situations. For example, the estimated duration of the drawdown period shown in Table 3 is 151 days. Based on historic information, this is a conservative estimate because the drawdown period should be shorter than 151 days in about 95 percent of the years. In addition, the hypothetical drawdown date shown in the table is June 1, which is approximately one month earlier than the usual drawdown date. Drawdown has occurred as early as June 1 only four times since 1963, when Bull Run Reservoir 2 came on-line. In 2017, continuous drawdown began on June 22 and ended on September 17, lasting 87 days. For planning purposes, the summer supply plan uses June 1 – October 29 (151 days) for the potential duration of drawdown. Actual drawdown and refill vary each year.

"Baseline Primary Resources" include Bull Run streamflow, Bull Run reservoirs, CSSWF maintenance operation, and ongoing water conservation. "Baseline Augmentation Resources" include the Columbia South Shore wells, Interruptible Water Elimination, and Bull Run Lake Increment #1. The bureau manages these resources to meet water demand and to provide the multiple benefits described in Section 2.

Based on current demand and supply projections, baseline primary and augmentation resources available for 2018 should be sufficient to meet peak season demand even in a hot, dry summer. In the case that conditions were even warmer and drier than anticipated, the augmentation resources could easily make up the volume of water below the Baseline Storage Threshold. In a more extreme supply shortfall situation, contingency resources shown in Table 3 provide an added cushion of reliability for Portland water customers.

Table 3. Baseline, Augmentation, and Seasonal Contingency Resource Availability for Peak Season 2018.

Seasonal Water Supply Resources	Potential Rate of Use (Million Gallons a Day)	Potential Peak Season Volume (Billion Gallons)	Potential Use Period (Duration = 151 days, 6/1– 10/29)
Baseline Primary Resources			
▪ Bull Run			
– Streamflow	Variable	9.5 – 68.3 BG	Duration
– Reservoirs 1 and 2	Variable	9.9 BG (usable storage)	Duration
▪ Columbia South Shore Wells[1] maintenance operation	0 MGD	0.0 BG	N/A
▪ Water Efficiency	Incorporated into demand forecast	Incorporated into demand forecast	Duration
Baseline Augmentation Resources			
▪ Columbia South Shore Wells SGA, BLA and TSA Wells (excludes wells w/ lowest operational confidence & wells off-line for repairs)	79 / 71 / 63 MGD (30 / 90 / 151 days)	2.4 / 6.6 / 10.5 BG (30 / 90 / 151 days)	Duration
▪ Interruptible Water Elimination	0.21-2.82 MGD; Incorporated into demand forecast	0.21 BG; Incorporated into demand forecast	122 days max
▪ Bull Run Lake Increment #1 (above elevation 3,164 ft)	Up to 27 MGD	Approximately 0.8 BG	Up to 28 days (release not permitted prior to July 15)[2]
Contingency – Tier 1[3]			
▪ Bull Run Lake Increment #2 (elevation 3,164 to 3,152 feet)	Up to 43 MGD	Approximately 1.6 BG	72 days
▪ Emergency well startup (repair of off-line CSSWF wells and use of BLA well 18)	26 / 24 / 21 MGD (30 / 90 / 151 days)	0.8 / 2.2 / 3.5 BG (30 / 90 / 151 days)	Duration
▪ Voluntary Curtailment	8 MGD	0.25 BG	30 days (before Sept 1)
Contingency – Tier 2[3]			
▪ Bull Run Lake Increment #3 (elevation 3,152 to 3,143 feet)	Up to 43 MGD	Approximately 1.1 BG	37 days
▪ CSSWF BLA well PW-17	3.6 / 3.2 / 2.9 MGD (30 / 90 / 151 days)	0.1 / 0.3 / 0.5 BG (30 / 90 / 151 days)	Duration
▪ Milwaukie Intertie (with portable pump)	2.0 MGD	0.3 BG	Duration (less the 20 hottest days)
▪ Emergency Wholesale Demand Offloads	6.0 MGD	0.9 BG	Duration
▪ Mandatory Curtailment	25 MGD 12.5 MGD	0.8 BG 0.4 BG	30 days (before Sept 1) 30 days (after Sept 1)
▪ Additional draft of Bull Run Reservoirs 1 & 2 below 9.9 BG usable storage	Unspecified	Unspecified	Unspecified

[1] This operation was completed between 3/12/18 and 3/21/18. The planned rate of use should not significantly impact the capacity of the well field if needed for supply augmentation.
[2] Potentially longer period, if the gravity flow rate or temperature considerations require a more prolonged discharge.
[3] Contingency resources within a given tier are not listed in priority order.

A. Baseline Primary Resources

Bull Run Water Supply

Bull Run Streamflow
Historical averages for total reservoir inflow, by month, are shown below in Table 4.

Table 4: Monthly statistics for inflow volumes to Bull Run reservoirs in billions of gallons (BG) based on flows from 1940-2017.

Month	Minimum Inflow Volume (BG)	Maximum Inflow Volume (BG)	Mean Inflow Volume (BG)
June	2.0	29.6	10.3
July	1.7	11.1	4.2
August	1.3	9.0	2.8
September	1.5	16.4	3.9
October	1.3	29.5	10.3

Bull Run Reservoirs 1 and 2 - 9.9 BG Total Usable Storage
Routine usable storage is defined as the amount available above 970 feet elevation for Reservoir 1 and above 840 feet elevation for Reservoir 2. The analysis supporting these levels is documented in a memorandum titled "Definition of Water Quality Based Threshold Elevations in the Bull Run Reservoirs and Resulting Conclusions about Volume Available for Water Supply" (January 2002). In years 2016 and 2017, there has been a shift to maintain a minimum elevation in Reservoir 1 of 985 feet. It is also preferred that Reservoir 2 does not drop below 845 feet elevation. While this further limits available storage from the Bull Run system, the benefits of reduced risk of turbidity or other water quality events from these higher "target" elevations outweigh the costs of running groundwater.

Columbia South Shore Wells Maintenance Operation

As mentioned in Section 2, the Operations Group conducted the annual maintenance of the CSSWF between March 12, 2018 and March 21, 2018. This operation produced approximately 160 MG of groundwater and allowed the bureau to use up its hypochlorite supply at the groundwater facility before degradation, which would have resulted in significant disposal costs.

Water Efficiency

Water efficiency programs are a key component of the bureau's summer supply strategy. These programs help reduce water demand and stretch surface water supplies during the summer period. Water savings from water efficiency are embedded in demand forecasts.

In 2010, Portland received approval of its Water Management and Conservation Plan. This plan contains State-mandated conservation and water curtailment elements. Bureau water efficiency programs, including activities associated with the Regional Water Providers Consortium (RWPC) are detailed in the plan.

The bureau's Water Efficiency Program offers technical resources and information about efficient water use to all customer classes. Programs include school assembly presentations, youth and adult education, attendance at community events, toilet rebates, meter data logging, consumption evaluation, and onsite water efficiency surveys for commercial and multifamily customers. Water efficiency devices are also distributed to all customer classes. More information about the bureau water efficiency programs can be found at http://www.portlandoregon.gov/water/efficiency.

An important supplement to Portland's own water efficiency programs is the RWPC's regional water conservation program. The RWPC's program operates year-round, but targets most of its resources toward reducing summer peak season demands. The RWPC's program consists of five key elements: television and radio; a comprehensive website; educational materials and conservation devices; school assembly programs; and community events and workshops geared toward homeowners, commercial property managers, landscape professionals, gardeners, and kids. Information on the RWPC's conservation program can be found at http://www.conserveh2o.org/.

B. Baseline Augmentation Resources

Baseline Augmentation Resources are sources of supply that are readily available for use, but are not used on a routine, ongoing basis. In 2018, they consist of the CSSWF, elimination of wholesale requested interruptible water, and Bull Run Lake increment #1.

Columbia South Shore Well Field (CSSWF)

The bureau is prepared, if necessary, to augment the Bull Run surface water supply by pumping groundwater and blending it with the Bull Run supply. Groundwater augmentation contributes to supply reliability, including meeting seasonal peak daily demands and/or making up seasonal supply deficits. If seasonal forecasting indicates a potential supply deficit, groundwater augmentation early in the summer helps the bureau maintain a desirable groundwater to surface water blend ratio. Maintaining a lower blend ratio can help minimize impacts on water quality-sensitive customers, aesthetic effects, and other potential customer inconveniences associated with water chemistry fluctuations in the system.

If groundwater is needed for supply augmentation, the bureau's working target for the groundwater blend ratio is approximately 30 percent groundwater or less. However, the projected or actual supply deficit, water demand, and the timing, magnitude, and duration of groundwater use all can affect the actual blend ratio.

The baseline augmentation CSSWF wells can provide up to 12.6 BG during the 2018 peak season, assuming 100 percent reliability of the well field. When wells are out of service for routine maintenance (which is normally performed during the summer months) or unavailable due to unexpected equipment failures, the total volume of groundwater available for augmentation is incrementally reduced by the capacity of the unavailable wells. During the 2018 peak season, two wells are out of service for pump repairs (PW-13 and PW-26) and two wells are considered less reliable due to declining

performance and/or recent operational issues (PW-3 and PW-5). Approximately 10.5 BG of groundwater is expected to be available for baseline augmentation during the 2018 peak season after the capacity of these four wells has been subtracted from baseline capacity.

Operation of the CSSWF involves balancing multiple factors including water demand, water quality, infrastructure capacity, and the cost of electricity required to run the well pumps and the pump station.

The Blue Lake Aquifer (BLA) wells are the bureau's shallowest and highest yielding wells, with the highest specific capacities and the smallest hydraulic lifts. As a result, the BLA wells produce water more efficiently (i.e., at lower electrical costs) than wells in the deeper Troutdale Sandstone Aquifer (TSA) and Sand and Gravel Aquifer (SGA). The BLA would be the bureau's first choice of aquifers because of this higher efficiency.

The SGA is the bureau's deepest confined aquifer with the best natural protection from surface contamination. With 15 available wells, the SGA is also the aquifer with the greatest total production capacity. Although SGA pumping costs are higher, the bureau's wells in this aquifer have good yields and specific capacities, and are therefore a mainstay of the bureau's groundwater usage.

The TSA is a moderately deep confined aquifer with fairly good protection from surface contamination and desirable water quality characteristics (e.g., high pH) for blending. However, specific capacities and yields of the TSA wells are generally lower than either the BLA or SGA wells, and the bureau has the capability to make pH and other water quality adjustments at the groundwater treatment facility. Furthermore, maintaining hydraulic pressure in the TSA serves to help protect the underlying SGA from possible downward migration of contaminants. Therefore, the TSA would be used by the bureau in a more limited manner than either the BLA or the SGA. The primary reasons for TSA use would be to make up shortfalls in overall production capacity and for matching well field output with the booster pump station output.

The cumulative volume of groundwater pumped for seasonal supply augmentation since 1985 has been 29.8 BG. The maximum single seasonal groundwater augmentation volume to date was in 2015 when 5.8 BG were used, which included an extended maintenance run in June and the subsequent augmentation run from July-November. A history of groundwater use is available on the bureau's website at: https://www.portlandoregon.gov/water/groundwateruse.

The method used to calculate the total 151-day yield of the well field was revised in 2018 to better match observed reductions in the production rates of the wells during extended well field use in 2015 and 2017. These temporary reductions result from groundwater pumping level declines and well interference effects. Wells return to their initial capacity after extended pumping operations stop and groundwater levels recover. The time-dependent reduction in CSSWF capacity has now been calculated in the following way:

- From well field start-up to 30 days of pumping, an average pumping rate was calculated for each well using the observed yields over the first 30 days of pumping

in 2015 and 2017;
- Between 30 and 90 days of pumping, it is assumed that 90 percent of the 30-day well capacities are available; and
- Between 90 and 151 days of pumping, it is assumed that 80 percent of the 30-day well capacities are available.

Actual pumping data from extended groundwater operations in 2003 and 2006 provided the basis for this approximation of declines in yield over time. The bureau prepares an annual CSSWF pumping plan that describes current agreements with the Oregon Department of Environmental Quality and provides additional details about well field operation.

Elimination of Wholesale Requested Interruptible Water

In the event of an emergency or other condition under which continued supply of interruptible water jeopardizes the reliability of the water system, the City may cease providing interruptible water at any time on one day's written or verbal notice to the Purchaser. Under all other circumstances, including any augmentation to supply, the City may cease providing interruptible water at any time on 21 days written or verbal notice to the Purchaser.

Bull Run Lake Increment #1 (projected fall elevation down to 3,165 feet)

The city considers water supply from Bull Run Lake as three distinct increments. Increment #1 is described here. The other two increments are described in subsequent sections. Bull Run Lake Increment #1 is defined as the amount of water available above a minimum fall lake surface elevation of 3,164 feet. This elevation provides a 75% probability of the lake refilling to the full pool elevation of 3,174 feet the following spring. As an example, if the minimum fall elevation is projected to be 3,168 feet in a given year, the amount of water available for use would be the increment between 3,168 feet and 3,164 feet, or approximately 0.6 BG. A portion of this increment is naturally contributed to the Bull Run reservoirs without releasing the water through the deep-water intake, as water seeps out of the lake and into the Bull Run River.

Under the terms of the city's easement from the U.S. Forest Service for use of Bull Run Lake, there are mitigation requirements that are triggered if water is released from the lake and it does not refill to full pool the following spring. In a letter dated April 17, 2013, the U.S. Forest Service agreed to updated mitigation and monitoring requirements for the remaining term of the easement through 2017 (subsequently extended through 2019). New requirements call for mitigation if, as a result of releasing water from the lake, the lake does not refill to full pool the following spring in more than one year of the remaining term of the easement.

In 2018, there is no planned release of water from Bull Run Lake Increment #1. As of May 10, 2018, the lake level was 3,178.7 feet elevation, 4.7 feet above full pool elevation. The precise amount available for 2018 will depend on spring season snowmelt and precipitation.

C. Seasonal Contingency Resources

Two categories of contingency resources are presented in Table 3 and described below. Tier 1 contingency resources are simpler and less costly to use than Tier 2 contingency resources, and are thus assigned a higher priority for use. In an actual situation in which the use of seasonal contingency resources is required, the bureau will consider operational issues, constraints, and opportunities existing at the time before selecting the appropriate combination of resources to meet identified needs. The resources listed within each tier are not shown in priority order. If the need for additional supply augmentation called for the use of resources within Tier 1 or Tier 2, the order of resource use would be decided at that time. The bureau does not expect to need contingency resources to meet water demands during 2018, but these resources will be available if necessary to manage unexpected circumstances.

Tier 1 Contingency Resources

Tier 1 resources include the simpler and/or less costly contingency resources available for use in summer supply augmentation.

Bull Run Lake Increment #2 (elevation 3,165 down to 3,152 feet)
The bureau can obtain about 1.6 BG by releasing water from Bull Run Lake Increment #2, bringing the lake down to a surface elevation of 3,152 feet. Drawing the lake down to 3,152 feet makes full refill of the lake the following spring very unlikely but provides a significant buffer over the lowest allowable lake elevation of 3,140 feet. The lake elevation is a key factor in the ability of cutthroat trout living in the lake to access tributary habitat for spawning. Until snowmelt and spring rains have declined (usually by early June), it is uncertain how much supply will be available from Bull Run Lake.

Emergency Well Startup
If Tier 1 Contingency Resources are needed, the bureau expects to be able to bring an additional 13.6 MGD of CSSWF capacity on-line by completing repairs to the wells currently out of service and restoring any unexpectedly inoperable wells. Bringing BLA Production Well 18 (PW-18) on-line can add an additional 7.5 MGD. Well PW-18 is normally not operated due to high natural manganese levels, but it is equipped with a pump that can be started if there is a need for contingency resources. In total, up to 21 MGD of additional CSSWF capacity can be tapped as a Tier 1 resource. This capacity is conservatively estimated based on the projected 90-151 day well yields, which are 80% of the 30-day yields calculated from actual production in 2015 and 2017.

Voluntary Curtailment
In a very hot and dry summer, it may be necessary and appropriate to ask customers to voluntarily reduce their water use. Issuing voluntary reduction messages informs customers of a water shortage situation. The bureau can intensify its “wise water use” message to fit the circumstances. The bureau estimates that about 8.0 MGD of water savings could be obtained through voluntary reductions; however, the amount of savings would vary depending on the timing and intensity of the messages. Because media messages are not limited by utility service area boundaries, it is important to coordinate

the delivery of curtailment messages with other Portland area water providers and stakeholders. The bureau's Water Management and Conservation Plan, approved in 2010, outlines the triggers and implementation measures for voluntary curtailment. In addition, Section 14 of the wholesale contracts, entitled "Water Curtailment and Protection of the Water System," provides direction for implementing curtailment actions, as well as directs the preparation of curtailment plans in the future.

Tier 2 Contingency Resources

The group of Tier 2 Contingency Resources also includes a variety of options. Although Tier 2 resources are more complex and costly to use than Tier 1 resources, they provide critical flexibility to respond to an extreme supply shortage or an emergency.

Bull Run Lake Increment #3 (elevation 3,152 down to 3,143 feet)
Using Bull Run Lake Increment #3 would involve drawing the lake down to an elevation of 3,143 feet to provide about 1.1 BG of additional supply. Use of the lake to this level could have significant impacts on resident fish, which in turn would trigger federal permit conditions requiring expensive mitigation measures to restore and protect fish and wildlife habitat. The lake, if drawn to this level, would also likely take multiple years to refill; thus, limiting its availability as a water supply. (Bull Run reservoirs refill every winter because they are relatively small impoundments in a large basin. By contrast, Bull Run Lake is a large lake in a small basin).

CSSWF PW-17
If Tier 2 Contingency Resources are needed, the bureau expects to be able to bring BLA Production Well 17 (PW-17) on-line. Well PW-17 is not operated due to high natural manganese levels and would need to have the electrical supply to the pump restored if there is a need for contingency resources. Up to 2.9 MGD of additional CSSWF capacity can be tapped as a Tier 2 resource

Milwaukie Intertie (with portable pump)
An intertie exists between the City of Milwaukie's system and Portland's system. Utilizing a portable pump, this intertie could provide about 2.0 MGD.

Emergency Wholesale Demand Offloads
The bureau's water sales agreement states that each wholesale customer can purchase a guaranteed quantity of water each month. Some of the wholesale customers use other resources to supplement water purchased from Portland and may not use their entire monthly allocation. The largest alternative source is a groundwater system developed jointly by Rockwood Water Public Utility District (Rockwood) and the City of Gresham (Gresham), and Tualatin Valley Water District's (TVWD) partial ownership of the Joint Water Commission (JWC). The baseline forecast for the summer supply plan accounts for regular usage of these alternative sources. The alternative sources may also be able to provide additional offloads during an extreme water supply shortage or an emergency. Rockwood and Gresham could provide 6 MGD from their groundwater system on a regular basis, with the potential for greater volumes available intermittently.

Mandatory Curtailment
In an extreme water shortage, the City could require water use curtailment under authority of City Code Chapter 21.32, Water Conservation Measures. The code authorizes the bureau's Administrator to establish curtailment rules as appropriate to the situation. These rules would likely prohibit, curtail, or restrict certain water use practices such as lawn watering and residential car washing. The bureau's Water Management and Conservation Plan defines the triggers for mandatory curtailment as well as what measures would be implemented in the event of an extreme water shortage. The City imposed mandatory restrictions in the summer of 1992 when the CSSWF was not available for use. Mandatory curtailment can cause substantial inconvenience for a broad range of customers. For certain business sectors (e.g., landscape and nursery), mandatory curtailment can also cause significant economic hardship. For these reasons, mandatory curtailment would be implemented only if absolutely necessary.

Additional Draft of Bull Run Reservoirs 1 & 2 below 9.9 BG Usable Storage
The bureau could also draw the Bull Run reservoirs down below the Baseline Storage Threshold. However, because the Bull Run system is not filtered, extensive reservoir drawdown poses an increased risk of creating water quality related issues.

5. CONCLUSIONS

The Summer Supply Plan provides a comprehensive strategy for augmenting the bureau's baseline water resources, if needed during the peak demand season. Every year the Portland Water Bureau revisits the planning process and revises the Summer Supply Plan according to current situations and needs. During the summer of 2018, the bureau expects that sufficient water will be available to meet the range of potential supply and demand conditions that could occur in the Portland water system.

The bureau continues to refine its approach to supply planning by integrating new tools and utilizing the increasing wealth of experience gained each summer supply season. The Supply Planning Group meets monthly to review the current supply conditions and make decisions about how to utilize supply resources throughout the season.

GLOSSARY OF TERMS

1. Baseline Augmentation Resources – Sources of supply that are readily available for use but not used on a routine, ongoing basis. In 2018, this consists of the Columbia South Shore Well Field, elimination of wholesale requested interruptible water, and Bull Run Lake Increment #1.

2. Baseline Primary Resources – The basic supply and demand management resources that are used each year. In 2018, these include Bull Run streamflow, Bull Run reservoirs, groundwater produced in a maintenance run of equipment, and ongoing water conservation.

3. Baseline Storage Threshold – The point at which usable baseline storage in the two Bull Run reservoirs equals zero, even though there will be 6.9 BG left in the reservoirs. The distance of a plotted line above the Baseline Storage Threshold in Figure 1 indicates the amount of routine usable storage in the Bull Run reservoirs (9.9 BG when the reservoirs are full). The distance of a plotted line below the Baseline Storage Threshold represents the amount of water (or demand reduction) that would be needed to augment the Bull Run supply to meet peak season demand. The bureau could also draw the Bull Run reservoirs down below the Baseline Storage Threshold. However, because the Bull Run system is not filtered, extensive reservoir drawdown poses an increased risk of exceeding federal turbidity standards.

4. Bull Run Reservoirs Baseline Storage – The amount of water available above 970 feet elevation for Reservoir 1 and above 840 feet elevation for Reservoir 2 (9.9 BG when the reservoirs are full).

5. Contingency Resources – Sources of supply and demand management that require some advance planning to implement. Tier 1 contingency resources are simpler and less costly to use than Tier 2 contingency resources, and are thus assigned a higher priority for use.

6. Critical Fall – A management option for reduced fish flows that can be implemented in certain years when August and September cumulative inflow is in the lowest 10^{th} percentile of flows since 1940. If implemented, summer flow for temperature control continues from October 1-15. From October 16-31, 50% of reservoir inflow with a minimum of 30 cfs (20 MGD) and a maximum of 250 cfs (160 MGD) is implemented. From November 1-15, 40% of reservoir inflow with a minimum of 30 cfs and a maximum of 250 cfs is implemented. From November 16-30, 40% of reservoir inflow with a minimum of 70 cfs and a maximum of 350 cfs (225 MGD) is implemented. Critical fall flows may not be implemented in more than two consecutive years and also may not be implemented in the fourth year following a critical fall flow implementation.

7. Critical Spring – A management option for reduced fish flows that can be implemented whenever drawdown begins before June 15. If implemented, winter fish flows of 120 cfs are maintained until at least June 1; after June 1, flow can be decreased to 30 cfs until July 1, at which time summer flow for temperature control is implemented. There is no limit on recurrence of critical spring flows.

8. Curtailment – Restriction of water use due to emergencies or drought. Voluntary and

mandatory curtailment include similar actions and methods, but mandatory curtailment has an enforcement component associated with it.

9. Drawdown – The period of the year when the amount of water stored in the Bull Run reservoirs is decreasing because outflow from the reservoirs exceeds inflow to the reservoirs.

10. Flow Releases – Flows of water released from the reservoirs into the lower Bull Run River to meet flow and temperature targets developed to protect ESA listed fish. The Bull Run Water Supply Habitat Conservation Plan (HCP) has been finalized and approved and the flow release commitments are legally enforceable.

11. Groundwater Maintenance Operation – Production from the CSSWF to maintain equipment and make repairs. This is typically groundwater production of 17 MGD for nine days for a total of approximately 153 MG.

12. Interruptible Water - Water that a wholesale purchaser may purchase over and above its guaranteed purchase quantities under the terms and conditions in the water sales agreement section 6. According to the agreement, the City may cease to provide interruptible water at any time.

13. Peak Season – The period of highest water use due to warm weather and/or low incidence of rain. A 122-day period from June to September is considered for demand forecasting purposes.

14. Refill – The period when the streamflow into the reservoirs exceeds demand to town and downstream flows for fish. Refill begins when drawdown ends.

15. Regional Water Providers Consortium (RWPC) – A group of 21 water providers in the Portland Metropolitan Area and the regional government, Metro. The Consortium is operated under an intergovernmental agreement and is staffed by the bureau. The Consortium has been in operation since 1997, and since 2000 has implemented a cost-effective regional water conservation campaign designed to encourage the efficient use of the region's water supply. The Consortium also works together to prepare for, respond to and recover from emergency events. The Consortium provides a forum for study and discussion of water supply issues and coordinates the implementation of the Regional Water Supply Plan. www.regionalh2o.org.

16. Water Efficiency – The reduction of water use through more water efficient technologies, practices, and behavior changes.

17. Wholesale Demand Offloads – The reduction of demand on Portland's system when wholesaler providers utilize other sources of water.