2015 SEASONAL WATER SUPPLY AUGMENTATION AND CONTINGENCY PLAN

CITY OF PORTLAND **PORTLAND WATER BUREAU**

MAY 26, 2015

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, with input from wholesale customer representatives, 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. Key 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 the document.

During the summer of 2015, 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 reduce river water temperatures. As the summer progresses, the bureau will coordinate with key stakeholders and customers to ensure that interested parties are apprised of supply and demand conditions as they unfold.

The following report outlines the bureau's plan for managing water supplies during the 2015 peak season. The bureau has circulated this plan for review and comment to a set of stakeholders, including wholesale customers.

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 a number of objectives and coordinate the efforts of staff 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 water that has a better water quality than that defined by regulations. This means managing the system to keep a large suite of water quality parameters within optimal ranges. Water quality is also important for fish. Temperature and minimum flows are regulated for fish 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 federal Endangered Species Act (ESA)-listed steelhead, coho salmon, and Chinook salmon. The water quality component of managing summer supply is complex, with operational changes having varied effects on different water quality parameters.

Cost Management—Managing potential public and private costs is important to the bureau. The primary water supply, the Bull Run Watershed, provides water through a gravity-fed system that is efficient and cost-effective. 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 the bureau's 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. As in past years, the bureau plans to conduct a maintenance operation of the groundwater system in 2015 that would last approximately seven days and produce approximately 30 million gallons (MG) of groundwater.

Summer supply planning is a complex process that involves continually weighing a large number of factors as conditions change throughout the season. The Supply Planning Group meets regularly throughout the reservoir drawdown period each 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 information available about the upcoming summer peak demand season. The bureau monitors precipitation, snowpack, and streamflow. The bureau also assesses current and projected water demands. The population supplied by the city's water system during the 2015 peak season will be approximately 960,000 (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 122 million gallons per day (MGD). The actual average peak season demand in 2014 was 124 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 uses 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 2014. These projected drawdown curves are used to determine suggested groundwater use rates based on the remaining volume of Bull Run storage above baseline elevations, and the calendar date. These groundwater use rates keep the Bull Run reservoirs above their baseline storage levels while minimizing the volume of pumped groundwater and attempting to maintain a relatively constant pumping rate throughout the drawdown season.

These groundwater pumping curves and a hypothetical drawdown curve (based on 1987 weather) are shown in Figure 1.

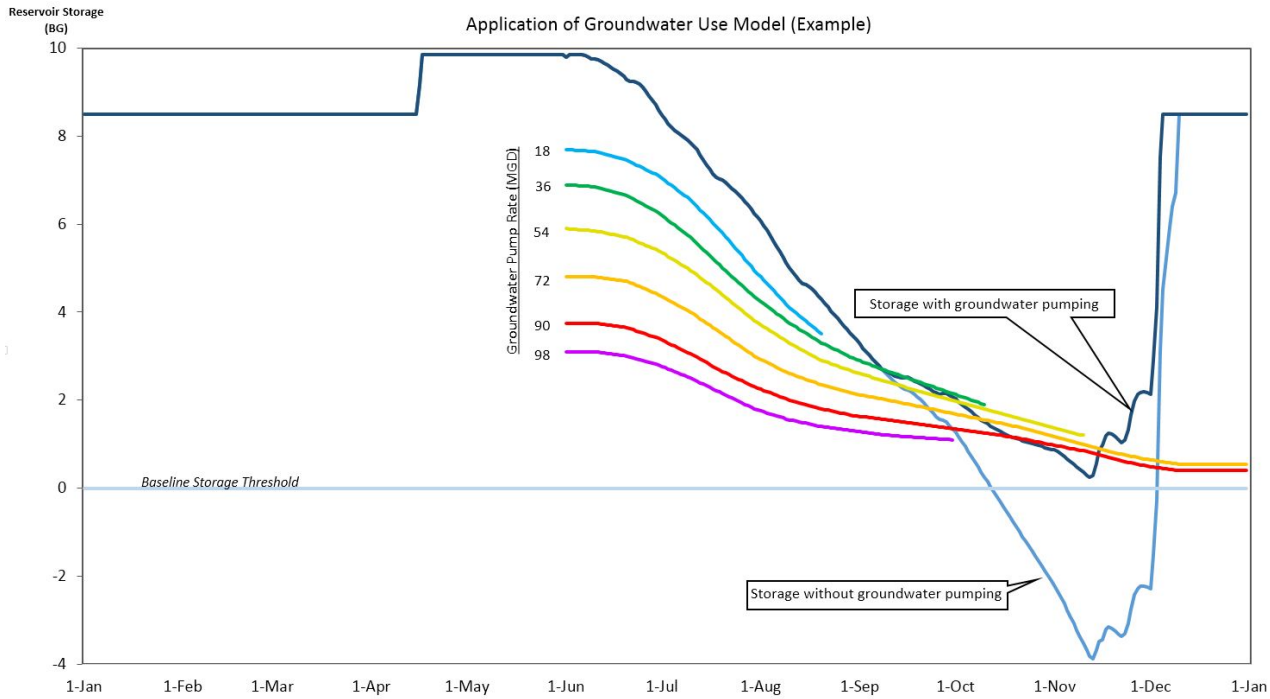

Figure 1

In this example, the storage curve remains above the pumping curves until September 8, 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. Table 1 summarizes the subsequent changes in storage and the changes in groundwater pumping made in response. The light blue storage line in Figure 1 shows what the progression of drawdown would have been had no groundwater been used.

Table 1. Example of applying the Groundwater Use Model to determine the timing and rate of groundwater pumping.

Date	Position of Storage Line Relative to GW Pumping Curves	Response	GW Pumping Rate
September 8	Cross 36 MGD curve	Turn on two main GW pumps	36 MGD
October 2	Cross 54 MGD curve	Turn on one additional main GW pump	54 MGD
October 9	Cross 72 MGD curve	Turn on one additional main GW pump	72 MGD
October 18	Cross 90 MGD curve	Turn on one additional main GW pump	90 MGD
November 15	Cross 72 MGD 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, and the timing of the electric power billing cycle at the groundwater pump station are also taken into account in determining the timing and rate of groundwater pumping.

The groundwater pumping curves take into consideration continued flow releases from the Bull Run reservoirs into the lower Bull Run River for fish habitat needs. Released water helps reduce water temperatures in the lower river and maintain wetted habitat for spawning and rearing of steelhead, coho salmon, and Chinook salmon. These fish species are listed as threatened under the federal ESA, and federal rules prohibit harming them or their habitat.

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 dictate 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.

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. Based on historical weather patterns and demand patterns the total annual volume of fish flows during drawdown can range from 1.0 to 6.7 billion gallons (BG) and averages about 2.6 BG.

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. If either or both of these triggers occur in 2015, the bureau has 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 2015, 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 actually occurred six times since 1963 (in 1978, 1986, 1992, 2003, 2007, and 2014). 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, because critical fall flows were implemented in 2014, the bureau could apply critical fall flows in 2015, 2016, or 2017, but could not apply them in 2018 (four years later rule). If critical fall flows are implemented in 2015, they could also not be implemented again in 2016 (two consecutive year rule) or 2019 (four years later rule), but could be implemented in 2017. In all cases, critical fall flows can be implemented in a given year 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 have the option to implement critical fall flows in 2015 if the August-September low flow criterion is met. Counting for the consecutive-year requirements began in 2006. Table 2 shows conditions starting in 2006.

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

4. 2015 BASELINE AND SEASONAL CONTINGENCY RESOURCES

The following section of this report outlines the baseline and contingency resources available to help the bureau meet peak season demand in 2015. 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 twice since 1963, when Bull Run Reservoir 2 came on-line. In 2014, drawdown began on July 3 (after an initial drawdown start of May 31 followed by rains which refilled the reservoirs) and ended on October 22, lasting 112 days. Subsequent increased downstream flow releases resulted in a second smaller drawdown with reservoirs refilled again by November 25, 146 days after the beginning of drawdown. 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, the maintenance operation of the Columbia South Shore wells, and ongoing water conservation. In 2015, Bull Run Lake Increment #1 is being designated as a Baseline Primary Resource. The Columbia South Shore wells constitute the “Baseline Augmentation Resources.” 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 2015 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. The resource options are described in this section. 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 2015

Seasonal Water Supply Resources	Potential Rate of Use (MGD)	Potential Peak Season Volume (BG)	Potential Use Period (Duration = 151 days, 6/ 1– 10/29)
Baseline Primary Resources			
▪ Bull Run			
– Streamflow	Variable	11.1 – 68.3 BG	Duration
– Reservoirs 1 and 2	Variable	9.9 BG (usable storage)	Duration
▪ Columbia South Shore Wells[1] maintenance operation	4.5 MGD	30 MG	7 days
▪ Water Efficiency	Incorporated into demand forecast	Incorporated into demand forecast	Duration
▪ Bull Run Lake Increment #1[2] (above elevation 3,165 ft)	Up to 43 MGD	Up to 0.7 BG depending on starting lake surface elevation	Up to 28 days (release not permitted prior to July 15)[3]
Baseline Augmentation Resources			
▪ Columbia South Shore Wells SGA, BLA and TSA Wells (less 15% off-line for maintenance)	88 / 80 / 71 MGD (30 / 90 / 151 days)	2.7 / 7.4 / 11.7 BG (30 / 90 / 151 days)	Duration
Contingency – Tier 1[4]			
▪ Interruptible Water Elimination	0.18-2.64 MGD; Incorporated into demand forecast	0.19 BG; Incorporated into demand forecast	122 days max
▪ Bull Run Lake Increment #2 (elevation 3,165 to 3,152 feet)	Up to 43 MGD	Up to 1.8 BG depending on starting lake surface elevation	72 days[3]
▪ Emergency well startup (repair of off-line CSSWF wells and use of BLA well 17)	19 / 17 / 15 MGD (30 / 90 / 151 days)	0.6 / 1.6 / 2.5 BG (30 / 90 / 151 days)	Duration
▪ Voluntary Curtailment	8 MGD	0.25 BG	30 days (before Sept 1)
Contingency – Tier 2[4]			
▪ Bull Run Lake Increment #3 (elevation 3,152 to 3,143 feet)	Up to 43 MGD	Up to 1.1 BG depending on starting lake surface elevation	37 days
▪ Powell Valley Wells[5]	6.3 / 5.8 / 5.0 MGD (30 / 90 / 151 days)	0.2 / 0.5 / 0.8 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] The planned rate of use should not significantly impact the capacity of the well field if needed for supply augmentation.
[2] Bull Run Lake Increment #1 will be used as a Baseline Primary Resource in 2015. In subsequent years this resource may be moved back to Baseline Augmentation Resources.
[3] Potentially longer period, if the gravity flow rate or temperature considerations require a more prolonged discharge.
[4] Contingency resources within a given tier are not listed in priority order.
[5] The currently available capacity of the Powell Valley wells is approximately 6 MGD, based on the need to perform electrical and/or mechanical upgrades to two of the six wells before they can be put into service.

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 1940-2014.

Month	Minimum Inflow Volume (BG)	Maximum Inflow Volume (BG)	Mean Inflow Volume (BG)
June	2.0	29.6	10.5
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	10.0

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 January 2002 memorandum titled "Definition of Water Quality Based Threshold Elevations in the Bull Run Reservoirs and Resulting Conclusions about Volume Available for Water Supply."

Columbia South Shore Wells Maintenance Operation

As mentioned in Section 2, the Operations Group plans to conduct a maintenance operation of the CSSWF. This would involve producing 4.5-5 MGD of groundwater for approximately 7 days for an estimated total of 30 MG groundwater. Timing of this operation will be coordinated with electrical meter read dates at the groundwater pump station in order to minimize electrical costs. In 2015, the maintenance operation is anticipated to start during the last week of July.

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. Portland is currently operating under this plan and will report on the conservation elements set as benchmarks in May of 2015. Bureau water efficiency programs, including activities associated with the Regional Water Provides 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 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/.

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 3,165 feet. This elevation provides an 85% 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 3,170 feet in a given year, the amount of water available for use would be the increment between 3,170 feet and 3,165 feet, or approximately 0.7 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. New requirements require 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.

Bull Run Lake was not used in 2014. In the fall of 2014, repairs were made to a broken pipe from the deep-water intake to the lake's outlet, which will allow the bureau to release cold water from the deeper parts of the lake, if needed. In 2015, Bull Run Lake Increment #1 will be used as a Baseline Primary Resource. In subsequent years, this resource may be moved back to Baseline Augmentation Resources. As of April 27, 2015, the lake level was 3175.4 feet elevation, 1.4 feet above full pool elevation. The precise amount available for 2015 will depend on spring season snowmelt and precipitation.

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 2015, this consists of the Columbia South Shore Well Field.

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 13.8 BG during the 2015 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. Approximately 11.7 BG of groundwater is expected to be available for baseline augmentation during the 2015 peak season, assuming an 85 percent reliability for the wells, as determined based on industry standards and prior bureau experience with routine well maintenance, and incidents of unexpected equipment failures.

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

The four Blue Lake Aquifer (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), because the BLA wells are the bureau's shallowest, highest yielding wells, with the highest specific capacities and the smallest hydraulic lifts. With the exception of well Production Well 18 (PW-18), which produces water containing high levels of naturally occurring manganese, the BLA would be the bureau's first choice of aquifers.

The SGA is the bureau's deepest confined aquifer with the best natural protection from surface contamination, and, with 15 available wells, is the aquifer with the greatest over-all 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 well field capacity.

The TSA is an intermediate level confined aquifer with moderate to 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 now 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, primarily to make up shortfalls in overall capacity and for matching well field output with the booster pump station output.

Since 1985, the bureau has used groundwater for seasonal surface water supply augmentation 13 times. The cumulative volume of groundwater pumped for seasonal supply augmentation since 1985 is 24 BG and the maximum single seasonal groundwater augmentation volume to date was 5.3 BG in 1987. 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 2004 to better approximate reductions in the production rates of the wells during prolonged well field use resulting from groundwater pumping level declines and well interference effects. This time-dependent reduction in CSSWF capacity is now calculated in the following way:

- From well field start-up to 30 days of pumping, it is assumed that 100 percent of the initial individual well capacities are available;
- Between 30 and 90 days of pumping, it is assumed that 90 percent of the initial well capacities are available; and
- Between 90 and 151 days of pumping, it is assumed that 80 percent of the initial well capacities are available.

Actual pumping data from extended groundwater operations in 2003 and 2006 provide evidence in support of 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.

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 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 2015, 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.

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 wholesale customer. Under all other circumstances, the City may cease providing interruptible water at any time on 21 days written or verbal notice to the wholesale customer. Section 6 of the wholesale water sales agreement, entitled "Interruptible Water," provides the terms and conditions for interruptible water sales.

Bull Run Lake Increment #2 (elevation 3,165 down to 3,152 feet)
The bureau can obtain about 1.8 BG by releasing water from Bull Run Lake Increment #2, bringing the lake down to a surface elevation of 3,152 feet. Limiting the drawdown to 3,152 feet provides 90-95 percent chance that the lake will refill to 3,165 feet the following spring. 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 played out (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 additional CSSWF capacity on-line by completing repairs and restarting any wells which have been removed from service for pump and motor maintenance, and by bringing BLA Production Well 17 (PW-17) on-line. Well PW-17 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 this manner, up to 19 MGD of additional CSSWF capacity can be tapped as a Tier 1 resource.

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 near 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 emergency situation.

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).

Powell Valley Wells
The former Powell Valley Road Water District (PVRWD) wells, now referred to as the Powell Valley wells, include three Troutdale Gravel Aquifer (TGA) wells and three Upper Gravel Aquifer (UGA) wells, with a total combined production capacity of about 8 to 9 MGD. The currently available capacity of the Powell Valley wells is about 6 MGD, based on the need to perform significant upgrades to two of these wells before they can be put back into service. These wells are classified as a Tier 2 Contingency Resource because of long-term maintenance issues associated with their use and the fact that they are not currently piped into the supply system in such a way that water from these wells can easily be blended at the Powell Butte reservoir with water from other sources.

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 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 2015, 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 twice a month 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 2015, this consists of the Columbia South Shore wells.

2. Baseline Primary Resources – The basic supply and demand management resources that are used each year. In 2015, these include Bull Run streamflow, Bull Run reservoirs, groundwater produced in a maintenance run of equipment, Bull Run Lake Increment #1, 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. Water Efficiency – The reduction of water use through more water efficient technologies, practices, and behavior changes.

6. 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.

7. 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 10th 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.

8. 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.

9. Curtailment – Restriction of water use due to emergencies or drought. Voluntary and mandatory curtailment include the same actions and methods, but mandatory curtailment has an enforcement component associated with it.

10. 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.

11. 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.

12. Groundwater Maintenance Operation – Production from the CSSWF to maintain equipment and make repairs. This is typically groundwater production of 4.5-5 MGD for seven days for a total of approximately 30 MG.

13. 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.

14. 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.

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

16. 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 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.

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