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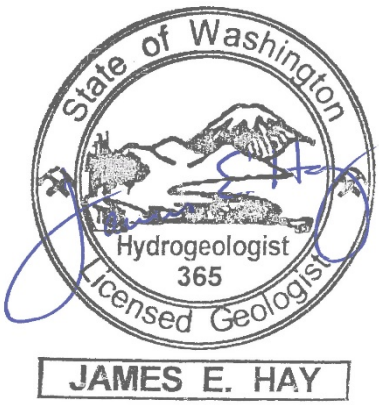
Technical Memorandum

To: Henry Chen, Engineering and Capital Projects Director
Cascade Water Alliance

From: James E. Hay, LHG, CPG

Date: July 1, 2022

Subject: Independent Water Supply Audit
City of Issaquah
(Robinson Noble project no.: 3400-001A)



1 – Audit Purpose

Cascade Water Alliance (Cascade) is a municipal corporation formed by its Member agencies under RWC 39.106, the Joint Municipal Utility Services Act. The seven Member agencies entered into the Cascade Joint Municipal Utilities Services Agreement, dated March 28, 2012 (the "Joint Agreement"). Cascade serves as a regional wholesale water supplier to its Members, some of which own independent water systems.

As a part of the water supply relationship under the Joint Agreement, Members with independent supply are responsible for maintaining that supply capacity and availability, with Cascade's supply obligation incremental to that independent supply. As a part of Cascade's original formation, each Member's water supplies were "audited" to determine both regulatory and physical capacity. These water supply audits formed part of the basis for, and terms of, membership and remain the basis for Members' independent supply obligations. Cascade is now conducting new and updated water supply audits of the four Members with independent supply, including the City of Issaquah.

The results of these audits are only for Cascade's purposes of implementation of the Joint Agreement. The focus of these audits is to quantify the Members' available water supply capacity, both in terms of regulatory and infrastructure capacity, and their ability to meet established production requirements. The results will be used to update the inventory of Members' independent supplies, establish Members' independent supply capacity, and determine our Member's individual and collective ability to meet their related production requirements. Like prior audits, this evaluation primarily considers system characteristics and production data for a three-year period, in this case the 2017 – 2019 calendar years.

2 – Introduction

The City of Issaquah (City) is a municipal corporation that owns and operates a Group A community water system. Table 1 summarizes data for the system as presented in the Washington State Department of Health (Health) Water Facilities Inventory form, accessed on June 17, 2021. The City's water service area is shown in Figure 1.

Table 1: City of Issaquah Water System

Water System Name:	Issaquah Water System
WSDOH System ID No.:	36350
Address:	PO Box 1307, Issaquah, WA 98027-1307
Water Operations Manager:	Greg Keith
Total Service Connections:	16,178 [a]
Source Wells in Service:	Risdon Wells 1 and 2, Gilman Wells 4 and 5

[a] The total service connections indicated by Health on the WFI form (16,178) is the number of residential units that receive water from the water system. In contrast, purveyors typically count the physical number of service connections (10,315). This value is lower because a single, physical connection to a multi-family building serves multiple residential units.

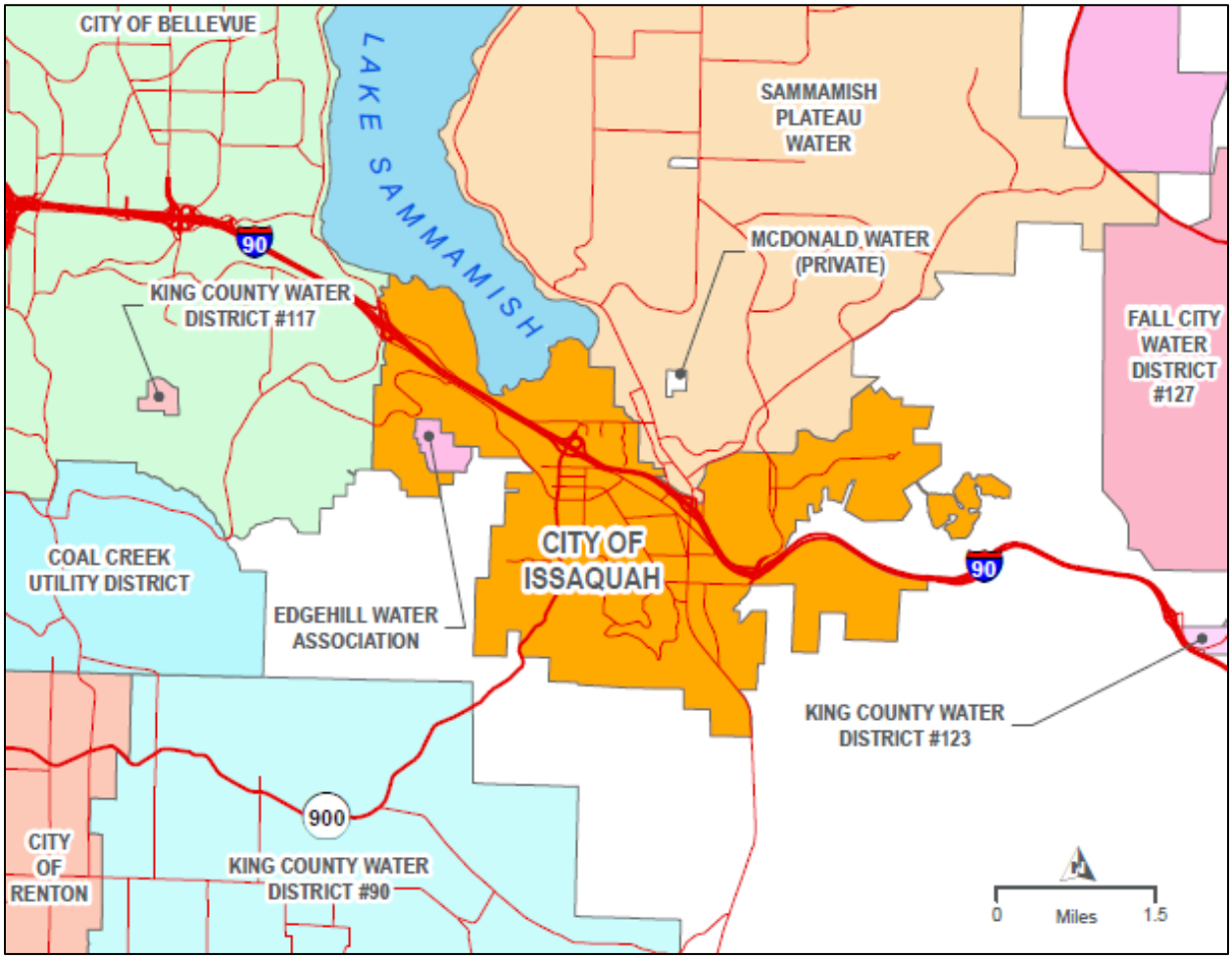


Figure 1: Issaquah Water System service area
(excerpted from the City's 2018 Water System Plan Update)

3 – Independent Sources of Supply

The City currently has four source wells in service, summarized in Table 2.[1] Two additional wells, Gun Club Wells 3 and 3a, have been decommissioned, though their respective water rights are presumed valid and protected from relinquishment by the Municipal Water Law.[2]

Table 2: Summary of Source Wells in Service

Well No.	Unique Well ID	Source No.	Year Drilled	Depth (ft bgs) [a]	Casing Diameter (in) [a]	Screen Diameter (in)	Screen Interval (ft bgs)	Test Rate (gpm) / year / SC (gpm/ft) [a,b]	Pump Capacity (gpm)
1	AFG-404	01	1967	107	12	12T [c]	90 – 106	1,000 / 1967 / 90.9	550
2	AFG-405	02	1969	97	12	12T	82 – 97	1,000 / 1969 / 86.2	1,050
4	AFG-406	04	1987	112	16	10P [c]	77 – 102	234 / 1987 / 4.5	250
5	AFG-407	05	1987	412	16	6P	323 – 405	1,000 / 1987 / 7.8	1,000

[a] ft bgs, feet below ground surface; in, inches; gpm, gallons per minute; SC, specific capacity; gpm/ft, gallons per minute per foot of drawdown

[b] Specific capacity, a measure of well efficiency calculated by dividing the production rate by the drawdown incurred, is technically only directly comparable for equivalent production rates and durations. Test durations for Wells 1, 4, and 5 were 24 hours; test duration for Well 2 was apparently only 15 minutes.

[c] "P" and "T" denote pipe- and telescope-size screen, respectively.

4 – Regulatory Status of Sources

4.1 – Water System

The regulatory requirements for Group A water systems are specified in Chapter 246-290 WAC, governed by the Washington State Department of Health (Health). The fundamental planning and engineering document for water systems is their Water System Plan (WSP). The City's WSP, last updated in December 2018, contains detailed information about all aspects of the City's system, including infrastructure and service area, source approval, demand projections, production capacity, water rights, and overall regulatory compliance. The City's wellhead protection plan (WHPP) for the Lower Issaquah Valley, a primary source water protection requirement (WAC 246-290-135), is included in the WSP appendices. The wellhead protection areas (WHPAs),[3] which are also shown on Health's

[1] These four wells were in service throughout the 2017 – 2019 audit timeline. Gilman Well 5 has since been taken out of service and is now designated for emergency use only; the City supplements its remaining well production with additional water from Cascade.

[2] The Municipal Water Law refers to Second Engrossed Second Substitute House Bill 1338, passed by the legislature in 2003.

[3] A WHPA reflects a portion of the zone of contribution of water to a well, including both horizontal and vertical flow; however, WHPAs present a "flat" birds-eye view of the area contributing water to a well without respect to depth. Historically, WHPAs have consisted of three time-of-travel (TOT) boundaries: 1-year (Zone 1), 5-years

Source Water Assessment Program GIS Mapping Tool,[4] were delineated with numerical modeling techniques, widely considered to be the most sophisticated method of delineating the areas contributing water to source wells. It does not appear that the City has updated its WHPAs to include 6-month TOT boundaries in Zone 1 for each well. The WHPP included in the WSP was accomplished in November 1993 and pre-dates this subsequent requirement under WAC 246-290-135(3)(c)(ii).

Health also summarizes the status of key aspects of the water system via reports accessible from Sentry Internet.[5] The Water Facilities Inventory Report, last updated on June 1, 2020, shows that Wells 1, 2, 4, and 5 have the approved source numbers and pump capacities[6] shown in Table 2. As of June 17, 2021, Health's Pre-Adequacy Data Summary Report indicates the City has a current and valid operating permit, a permit category color of green,[7] no current water quality violations or compliance actions, and the total approved connections are unspecified (not limited).

4.1.1 – Water Treatment

Source approval also indicates that water provided by the City's wells meets potable water standards after any necessary treatment and blending. As discussed in the WSP and observed during site visits, the only treatment required for water from Wells 1 and 2 is chlorination.[8] Water from Well 4 passes through a temporary, granular activated carbon filtration system to remove perflourochemicals (PFCs) and water from Well 5 is treated with sequestrate to prevent manganese deposits throughout the distribution system. Water from Wells 4 and 5 is then blended prior to chlorination.

The City's 20-year Capital Improvement Program, presented in the WSP, includes a multiple-year project to construct a new water treatment plant to address water quality (specifically PFCs, manganese, iron, arsenic, pH), fluoridation, and chlorination of blended supplies (scheduled through 2021).

4.2 – Water Rights

Water rights consist of an instantaneous quantity (gallons per minute, gpm) referred to as "Qi," and an annual quantity (acre-feet per year, afy), referred to as "Qa." These quantities may be additive or non-additive. Additive quantities define the full allocation of water that may be produced, whereas non-additive quantities provide flexibility in which sources produce the water. For the purposes of the current audit, it is the additive quantities that are most relevant.

As reflected in the Washington State Department of Ecology's (Ecology's) Water Right Tracking System (WRTS), the City maintains six water rights, four associated with the wells in service and two

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(Zone 2), and 10-years (Zone 3). As of April 9, 1999, WAC 246-290-135(3)(c)(ii) requires that a six-month TOT boundary also be delineated as part of Zone 1.

[4] https://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/SourceWater/GISMappingTool, accessed June 17, 2021.

[5] https://fortress.wa.gov/doh/eh/portal/odw/si/Intro.aspx, accessed June 17, 2021.

[6] Two pumps have been replaced and have slightly different capacities than shown on the WFI Report: Well 1 (450 gpm per the WFI Report) and Well 5 (1,150 gpm per the WFI Report). The values in Table 2 are correct.

[7] Per Health, "Systems in this category are considered adequate for existing uses and new service connections up to the number of approved service connections."

[8] As of 2022, water from Wells 1 and 2 also receives pH adjustment prior to distribution.

associated with the Gun Club wells (decommissioned in 1987 and 1988). The City's full water rights portfolio authorize an additive Qi of 3,880 gpm and an additive Qa of 2,400 afy. Excluding the two offline wells, the four remaining source wells are limited to an additive Qi of 3,080 gpm, as summarized in Table 3. This data is consistent with that presented in the City's WSP.

Table 3 Issaquah Water System Groundwater Rights

		Instantaneous Quantity (Qi)		Annual Quantity (Qa)	
	Document No.	Additive	Non-additive	Additive	Non-additive
Wells in Service					
Risdon Well 1	G1-*08632CWRIS	630 gpm [a]		1,000 afy [a]	
Risdon Well 2	G1-*10071CWRIS	1,200 gpm [b]		1,600 afy [b]	
Gilman Well 4	G1-24809CWRIS	250 gpm		200 afy	
Gilman Well 5	G1-24633CWRIS	1,000 gpm [c]			1,600 afy [c,d]
		3,080 gpm		2,800 afy [d]	
Offline Wells					
Gun Club Well 3a	G1-22733C	300 gpm			119 afy
Gun Club Well 3	G1-22734C	500 gpm			645 afy
		800 gpm		0 afy	

[a] The WRTS entry indicates both Qi and Qa quantities are supplemental (non-additive); however, the certificate does not contain this provision and the Proof of Appropriation (PA) form bears a handwritten note that indicates the certificate should issue without this "s.s." provision.

[b] The WRTS entry lists the Qi as supplemental (non-additive). Also, the WRTS entry, the Report of Examination (ROE), and the permit split the Qa into 385 afy primary (additive) and 1,215 afy supplemental (non-additive). The certificate, however, was issued without any supplemental (non-additive) language. Further, the subsequent ROE for G1-24633CWRIS states that the entire 1,600 afy quantity is primary (additive). Values above are consistent with the District's WSP.

[c] The WRTS entry indicates both Qi and Qa quantities are supplemental (non-additive); however, the ROE, permit, and certificate each only annotate the Qa quantity as supplemental.

[d] There is some ambiguity as to whether the District's additive total is 2,600 afy or 2,800 afy. The ROE, permit, and certificate for G1-24633CWRIS carry the following provision: "This is a supplemental right to primary ground water certificates 6343 and 7031. Total annual withdrawals from all sources shall not exceed 2600 acre-feet per year previously approved on primary rights." This provision, which only refers to the G1-*08632CWRIS and G1-*10071CWRIS rights, originates with the ROE, dated February 13, 1986, almost one full year prior to the ROE for G1-24809CWRIS, dated February 2, 1987, authorizing 200 afy without any supplemental (non-additive) language. Adding 200 afy to the District's additive total, previously capped at 2,600 afy, totals 2,800 afy and is consistent with the District's WSP. However, the certificates issued in the reverse order of the ROEs, with the G1-24809CWRIS certificate dated September 15, 1989, and the G1-24633CWRIS certificate dated February 15, 1990. While both PAs are annotated "issue cert as per permit," suggesting the provisions are merely carried forward, it could be interpreted by Ecology that the above-stated provision in the later certificate (G1-24633CWRIS) capped production "from all sources" at 2,600 afy.

5 – Physical Status of Sources

Site visits to all four wells were conducted on June 28, 2021. Based on the information reviewed, all four wells appear compliant with Chapter 18.104 RCW (Water Well Construction) and the subsequent

WAC 173-160 (Minimum Standards for Construction and Maintenance of Wells).[9] The physical capacity of the City's wells to produce water is summarized below. For Gilman Wells 4 and 5, this capacity is indicated by both historical pump test data and the capacity of the installed pump. In the case of Risdon Wells 1 and 2, this data also includes the results of a pump test conducted by City personnel as part of the audit process. Note that actual production capacities may be constrained by a variety of factors that are not evaluated here, including: short- and long-term variations in water level, groundwater recharge, and water quality; and both operations and resource management decisions.

5.1 – Risdon Site

The City's 20-year Capital Improvement Program, presented in the WSP, includes plans to refurbish the Risdon Well facilities, including evaluating the need for rehabilitation or replacement of both wells (planned for 2024 in the program).

5.1.1 – Risdon Well 1

According to this well's Water Well Report, at construction Risdon Well 1 was tested at a constant rate of 1,000 gpm for 24 hours. At the end of the test, the drawdown was 11 feet, indicating a 24-hour specific capacity of 90.9 gpm/ft. The installed well pump is capable of 550 gpm, and the discharge pipe, valves, and flow meter are 8-inch diameter.

On September 2nd, 2020, City personnel conducted an 8-hour constant-rate test of Risdon Well 1. Due to system demand, it was not possible to rest both Risdon wells for the test. As such, for 8 hours prior to the test of Well 1, Well 2 was pumped at a typical rate, averaging 1,015.1 gpm and causing a stable 5.9 feet of interference drawdown in Well 1. Well 1 was then brought online at an average rate of 542.6 gpm for 8 hours, during which time production from Well 2 declined to an average rate of 990.0 gpm (combined production of 1,532.7 gpm). At the end of the test, the additional drawdown in Well 1 (beyond that caused by the Well 2 production) was roughly 4.2 feet, indicating an 8-hour specific capacity of 128.5 gpm/ft. The observed drawdown slope was shallow, and the projected 24-hour specific capacity is estimated to be 123.3 gpm/ft (roughly 35% more efficient than at construction). Well 1 is physically capable of producing more than 550 gpm, at least in the short term; however, the well is operated at less than maximum capacity due to the interference drawdown with Well 2, which is completed in the same aquifer. At the pump's maximum capacity of 550 gpm, Well 1 requires roughly 4.5 feet of drawdown (10% of the available drawdown) after 24 hours of continuous production.

5.1.2 – Risdon Well 2

According to this well's Water Well Report, at construction Risdon Well 2 was tested at a constant rate of 1,000 gpm for 15 minutes.[10] At the end of the test, the drawdown was 11.6 feet, indicating a

[9] Wells 1 and 2 were constructed prior to the July 1, 1971, effective date of Chapter 18.104 RCW. The well log for Well 2 indicates a concrete surface seal to a depth of 7 feet. WAC 173-160-231(1)(c) specifies a minimum seal depth of 18 feet, but the well is considered compliant unless and until the well is reconstructed under WAC 173-160-231(6).

[10] This would be a very short test and the drawdown intervals shown on the Water Well Report are atypical: "1/12 hrs" (6 minutes), "1/6 hrs" (12 minutes), and "1/4 hrs" (15 minutes). It is unknown whether Well 1 was also pumping at the time.

15-minute specific capacity of 86.2 gpm/ft. The installed well pump is capable of 1,050 gpm, and the discharge pipe, valves, and flow meter are 8-inch diameter.

The September 2nd pump test of Well 1 also served to provide a specific capacity for Well 2. The 8 hours of production at 1,015.1 gpm prior to starting Well 1 caused a total drawdown of 8.7 feet in Well 2, indicating an 8-hour specific capacity of 117.4 gpm/ft. The observed drawdown slope was shallow, and the projected 24-hour specific capacity is estimated to be 114.7 gpm/ft. Well 2 is physically capable of producing more than 1,050 gpm, at least in the short term. At the pump's maximum capacity of 1,050 gpm, Well 2 requires roughly 9.2 feet of drawdown (17.7% of the available drawdown) after 24 hours of production.

5.2 - Gilman Site

The City's 20-year Capital Improvement Program, presented in the WSP, includes plans to refurbish Gilman Well facilities, including evaluating the need for rehabilitation or replacement of both wells (planned for 2024).

5.2.1 – Gilman Well 4

According to the well's construction and testing report, Gilman Well 4 was tested at an average rate of 234 gpm for 24 hours.[11] At the end of the test, the drawdown was 51.5 feet (72% of available drawdown), indicating a 24-hour specific capacity of 4.5 gpm/ft. The installed well pump is capable of 250 gpm against normal system pressure and 230 gpm against the additional backpressure of the temporary GAC treatment system. The well's discharge pipe, valves, and flow meters are 4-inch diameter.

5.2.2 – Gilman Well 5

According to the well's construction and testing report, Gilman Well 5 was tested at a constant rate of 1,000 gpm for 24 hours. At the end of the test, the drawdown was 128 feet (40% of the available drawdown), indicating a 24-hour specific capacity of 7.8 gpm/ft. The installed well pump is capable of 1,150 gpm; and discharge pipe, valves, and flow meters are 8-inch diameter.

5.3 – Interties

The City previously had four interties with the City of Bellevue called the Montreux Intertie, Lakemont Triangle Intertie, South Cove Intertie, and South Cove Emergency Intertie. These interties were recently transferred to Cascade.

The City has two, bi-directional emergency interties with Sammamish Plateau Water & Sewer District called the 1st Avenue NE Emergency Intertie and the SE 56th Street Emergency Intertie. The 1st Avenue NE Emergency Intertie is located at the intersection of 1st Avenue NE and Juniper Street through a 6-inch diameter pipe. The SE 56th Street Emergency Intertie is located at the intersection of SE 56th Street and 221st Avenue SE through an 8-inch diameter pipe. The agreement is for an emergency standby source of water, with an emergency defined as any event that requires the District's or City's water supply to be augmented on a temporary, emergent basis. The water provided by both parties is treated.

[11] The well log indicates a 250-gpm rate for the test and 56 feet of drawdown. However, the construction report indicates the rate of 250 gpm was reduced to 225 gpm after 9 hours, for a time-weighted average rate of 234 gpm.

6 – Cascade Production Requirements

Combined production, in millions of gallons, from these four wells for 2017 through 2019 calendar years is presented in Table 4 (peak month and year **underlined and in bold**; peak season shaded).[12]

Table 4: 2017 - 2019 Production (millions of gallons)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
2017	35.66	32.28	35.45	32.85	42.87	46.68	62.25	**68.39**	50.03	37.39	32.44	33.78	510.06
2018	33.40	30.98	39.89	45.99	57.18	71.86	83.29	**85.27**	70.87	56.74	50.19	41.62	**667.27**
2019	39.84	35.53	42.19	41.93	55.08	62.85	**68.91**	68.30	51.61	41.58	39.78	42.44	590.04
Average	36.30	32.93	39.18	40.26	51.71	60.46	71.48	**73.99**	57.50	45.24	40.80	39.28	589.12

As a Member of Cascade, the City agreed to maximum production requirements from their independent supply sources, based on three-year production averages (2001 – 2003).[13] In 2011, the Cascade Board established a minimum Demand Share for the City of 0.75 MGD and waived the City's production requirements as of 2012 (Resolution No. 2011-17).[14] Though there is a general waiver of production requirements currently in effect, Table 5 summarizes the City's recent average and peak-season day production, based on the data from Table 4, and peak-day capacity values based on both well pump capacity[15] (Table 2) and additive instantaneous (Qi) water rights (Table 3).[16,17]

[12] This audit only considers production data from 2017 – 2019; it was not finalized until 2022 due to delays caused by the COVID-19 pandemic.

[13] As defined in the Member Water Audit prepared for Cascade, dated May 23, 2008.

[14] In 2021, the Board reduced the City's minimum Demand Share to 0.25 MGD and re-established production requirements as of 2025 (Resolution No. 2021-01).

[15] Note that this simple sum of pump capacities may be an overestimate of actual production capacity as it makes no allowance for drawdown interference between wells.

[16] Average Day production calculated by dividing the three-year average annual production by 365 days. Peak-season day production calculated by dividing the three-year average peak season production (June through September) by 122 days. Peak-day capacity calculated by multiplying instantaneous capacity (either pump capacity or additive Qi water rights) multiplied by 20 hours of production (83.3% of maximum production).

[17] Members must manage their resources to meet a wide variety of physical and regulatory constraints, so production history may not be indicative of the ability or intent to produce a maximum volume of water in any given year.

Table 5: Independent Source Production Summary

Production Metric	Production Requirement	2017 – 2019 Values	Peak Year (2018) Values	Peak Year Difference
Average Day	1.74 MGD	1.61 MGD	1.83 MGD	0.09 MGD
Peak-season Day	2.96 MGD	2.16 MGD	2.55 MGD	(0.41 MGD)
Production Metric	**Production Requirement**	**Peak-day Values**		**Peak-day Difference**
Peak-day Capacity	3.70 MGD	3.42 MGD (pump capacity) 3.70 MGD (additive water rights)		(0.28 MGD) [a,b] (0.00 MGD) [a,b,c]

[a] Pump capacity and additive rights exceed the Peak-day Capacity requirement without the 20-hour pumping limitation.

[b] Future replacement of the Gun Club wells is anticipated to eliminate this difference, provided the new wells have comparable capacities to the original wells.

[c] Without the Gun Club wells, additive water rights are slightly below (0.004 MGD) but round up to the production requirement value.

7 – Recommendations

7.1 – Wellhead Protection Plan

If six-month TOT boundaries have not been delineated for the City's wells per WAC 246-290-135(3)(c)(ii), that would technically be a minor regulatory deficiency. However, Health does not consistently enforce this requirement, as evidenced by ongoing approvals of the City's WSP, so this does not impact the City's ability to meet its Cascade production requirements.

Recommendation: The City should have six-month TOT boundaries delineated for all wells during its next wellhead protection plan update and submit the updated WHPAs to the Source Water Protection Program. Providing copies of the updated digital maps or shape files is encouraged.

7.2 – Water Rights

In aggregate, the reviewed water rights documents appear to support the City's additive Qa total at 2,800 afy, as indicated in the WSP; however, the fact that the G1-24633CWRIS certificate with the provision capping production "from all sources" at 2,600 afy post-dates the G1-24809CWRIS certificate for 200 afy creates some ambiguity.

Recommendation: If it hasn't already done so, the City should consult with its water rights attorney to verify that the City's additive Qa total is, in fact, 2,800 afy.

7.3 – Pump Capacity

The only identified physical deficiency in the City's water system is that the installed pump capacity, without the Gun Club Wells, is currently insufficient to meet the Peak-day Capacity (Table 5). The City's WSP indicates that applications to change the point of withdrawal for the water rights associated with the Gun Club Wells were submitted in 1997 and revised in 1998 following a test-drilling program; however, the applications were ultimately denied by Ecology. The WSP states that the City intends to conduct additional studies to identify options to again utilize these rights.

Recommendation: None beyond proceeding with the proposed studies, as planned.

8 – Conclusion

The purpose of this audit has been to summarize current production status and alert members to potential risks, now and in the future. It is intended to be used by Members to help ensure that they remain able to comply with their contractual obligations to Cascade.

All Cascade Members, including the City of Issaquah, have complied with their contractual production requirements to-date, particularly given the production waivers for all three metrics (Average Day, Peak-season Day, and Peak-day Capacity) discussed above. At some point, should such waivers expire and not be further extended, this audit and the production history indicate an ability to substantively meet the independent production requirements. Peak year production (2018) indicates that system capacity is consistent with the production requirements. The City maintains additive water rights equal to its Peak-day Capacity commitment; however, without the Gun Club Well replacements, the installed pump capacity is currently below that level.

Current water quality concerns have been addressed with a temporary block contract with Cascade, which enables the City to reduce production and waives production requirements for the term of that agreement (through 2034). Longer term, the City's WSP anticipates major projects to address capacity and water quality concerns.