City of The Dalles

Water System Master Plan Update

November 2024

PREPARED BY:

Consor

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IN ASSOCIATION WITH:

Jacobs

GSI Water Solutions, Inc.

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Public Health Division
Center for Health Protection, Drinking Water Services
Tina Kotek, Governor

February 7, 2025

Emily Flock, PE
Consor
Via email: Emily.Flock@consoreng.com

Re: **Master Plan Approval (PR#3-2025)**
City of The Dalles (PWS ID#00869)

Dear Emily:

Thank you for your submittal to the Oregon Health Authority's Drinking Water Services (DWS) of plan review information for the 2024 Water System Master Plan Update for the City of The Dalles. On January 7, 2025, our office received a copy of the plan. A plan review fee of $4,125 was received on January 8, 2025.

The Master Plan represents a 20-year planning horizon out to the year 2044. The plan includes system goals and description, future demand estimates, engineering evaluation, evaluations of options to meet future demand, financing, and list of recommended projects and cost estimates. A seismic risk assessment and mitigation plan was required and was included. Upon review of the plan, it appears the elements required in Oregon Administrative Rules (OAR) 333-061-0060(5) have been addressed.

Please note that OAR 333-061-0060 contains plan submission and review requirements for all major water system additions or modifications. Construction plans and specifications must be submitted to and approved by DWS before construction begins.

If you have any questions, please feel free to call me at (971) 201-9794.

Sincerely,

Carrie Gentry, PE
Regional Engineer
OHA-Drinking Water Services
Carrie.L.Gentry@oha.oregon.gov

cc: Josh Seerup, REHS, OHA/DWS
Brian Ginter, PE, Consor
Dave Anderson, Public Works Director, City of The Dalles

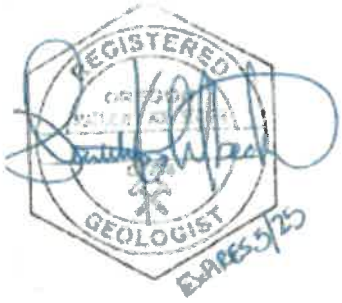
Water System Master Plan Update

City of The Dalles

November 2024

Chapters 1-3 and 5-7

Chapter 4 developed with,



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Appendix B Hydraulic Model Data

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Appendix D Wicks WTP Expansion Alternatives Analysis

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CHAPTER 1

Introduction and Existing Water System

1.1 Purpose

The purpose of this Water System Master Plan Update (WSMP) is to perform an analysis of the City of The Dalles' (City's) water system and:

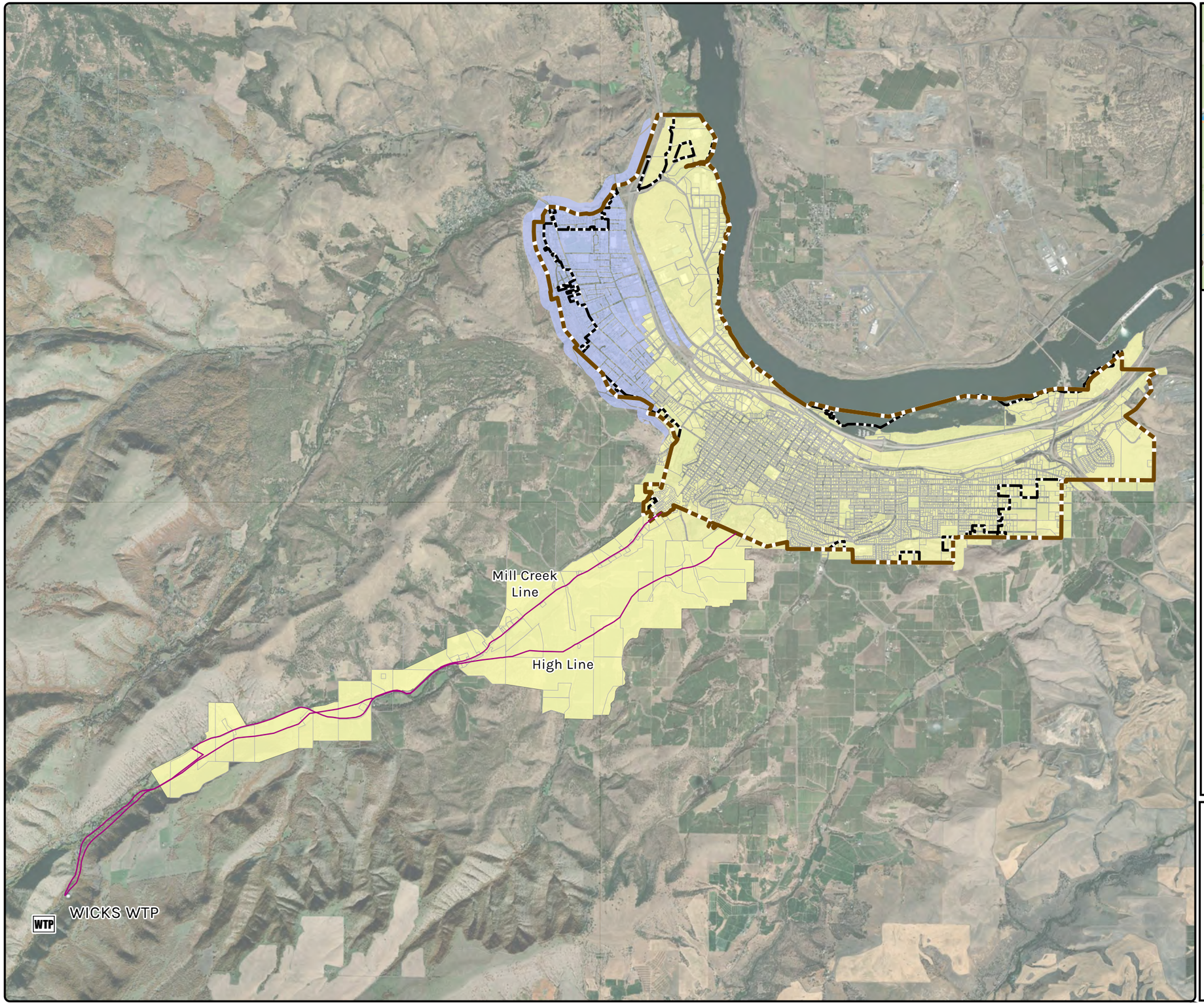
- Document water system upgrades, changes, and growth since the 2006 Water Master Plan
- Estimate future water requirements including infill development within the City's existing Urban Growth Area (excluding the Chenowith Water PUD service area)
- Identify deficiencies and recommend water facility improvements that correct deficiencies and provide for growth
- Document a high-level system seismic resilience evaluation
- Provide a recommended, prioritized Capital Improvement Program (CIP) for the water system
- Comply with water system master planning requirements for Public Water Systems established under Oregon Administrative Rules (OAR)

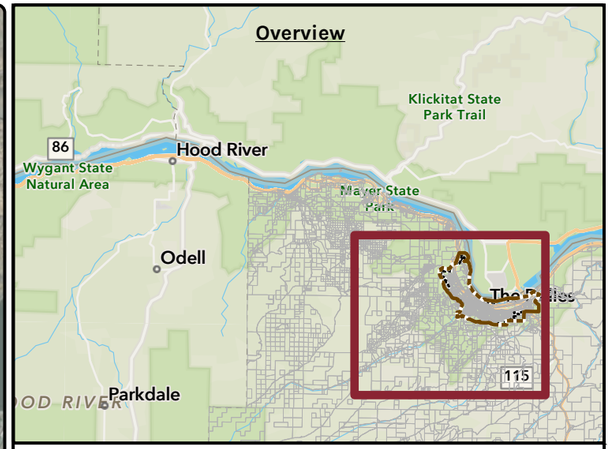
This report is divided into eight chapters to address the goals described above. Chapter 1, Chapter 2, and Chapter 3 summarize the existing system and water demands, estimate future water demands, and list the performance criteria used to analyze the system. Chapter 4, Chapter 5, and Chapter 6 build off the prior chapters to identify system deficiencies, vulnerabilities, and development improvements projects for the supply, distribution system, and water treatment plant respectively. Chapter 7 compiles the proposed projects into a CIP prioritized in 5-year increments. Chapter 8 presents the financial analysis completed as part of the WSMP. The planning and analysis efforts presented in this WSMP are intended to provide the City with the information needed to inform long-term water supply, treatment, and distribution infrastructure decisions.

This plan complies with water system master planning requirements established under Oregon Administrative Rules for Public Water Systems, Chapter 333, Division 61 (OAR 333-061-0060(5)).

1.2 Service Area and System Description

The City operates a community water system serving most residents of The Dalles, Oregon, and a small number of customers located outside the city limits. The City's water system has been assigned the state and federal Public Water System Identification No. 4100869. Figure 1-1 provides an overview map of the City service area. The estimated service population for 2023 is 13,417 out of a total City population of approximately 16,417. Most of the City's residents who are not served by the City water system obtain their drinking water from the Chenowith Water Public Utility District (Chenowith PUD).





Legend

- UGB
- City Limits
- Chenowith PUD
- Existing City Service Area
- Transmission Main

0 2,000 4,000 Feet

N
W
E
S

City of The Dalles
Water System Master Plan

consor

Figure 1-1
Existing Service Area

W196117OR

November 2024

Data Sources: City of The Dalles, 2023;Community: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS
World Imagery: Maxar
Coordinate System:
Disclaimer: Consor and CLIENT make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

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The City water system is generally comprised of raw water storage, water treatment plant (WTP), transmission mains, groundwater wells, and distribution system which includes piping, reservoirs, booster pump stations (BPS), and pressure relief valves (PRVs). A schematic of the system is shown in **Figure 1-2**. Existing water system components are described in the following sections.

1.3 Supply

The City supplies both surface water and groundwater to their customers. An overview of the City's water supply system is illustrated in **Figure 1-3**. The City treats surface water at the Wicks WTP from the South Fork Mill Creek which includes flows supplemented by water diverted from the Dog River watershed. The City currently operates three groundwater wells – Lone Pine, Marks, and Jordan Wells. All three wells are in the city limits and draw groundwater from the Dalles Groundwater Reservoir (DGWR, also known as the Dalles Pool Aquifer).

Historically, surface water has been the primary source water for the City. In recent years, the City has obtained approximately 78 percent of its water from surface water supplies located south of the City. The remaining 22 percent is provided by groundwater wells which are utilized in late spring through early fall to supplement supply during peak demand season. This split between surface water and groundwater supplies represents an increase in groundwater usage in comparison to the 2006 WSMP data.

1.3.1 Surface Water Supply

The City obtains its surface water supply from the South Fork Mill Creek which includes flow diverted from the Dog River watershed. The City installed Crow Creek Dam to store the higher winter and spring flows for release during the drier summer and fall months. The dam was installed downstream of the Dog River pipeline discharge to South Fork Mill Creek and creates the Crow Creek Reservoir. The City's surface water supply system, illustrated schematically in **Figure 1-3**, consists of the following major components (in order from upstream to downstream):

- Dog River Diversion Pipeline. The original 20-inch wood-stave pipeline constructed in 1913-1914 was replaced in 2022 and 2023 with a new 30-inch diameter Ductile Iron Pipe Size (DIPS) High Density Polyethylene (HDPE) pipeline which conveys up to 26.3 cubic feet per second (cfs) (17.9 million gallons per day [MGD]) three and one-half miles from the Dog River watershed to the South Fork Mill Creek watershed. The Dog River diversion includes a fish screen and rock ramp fish passage structure, constructed in 2023 and 2024.

- Crow Creek Dam and Reservoir. This dam is located at the confluence of the South Fork Mill Creek with Crow Creek. It impounds up to 800 acre-feet (260 million gallons [MG]) in the Crow Creek Reservoir.

    - The City holds two storage water right permits, one of which has been perfected (certificated). The storage rights exceed the physical capacity of the existing Crow Creek Dam at this time. **Table 1-1** summarizes the information pertaining to these rights.

- South Fork Mill Creek Intake. The intake facility, which was constructed in 2002 to comply with fish screening requirements, is located near the Wicks Water Treatment Plant (WTP). It has a capacity of 12 MGD. Water flows by gravity from the intake to the plant.

Legend

- Reservoir
- Booster Station
- Well
- Sample Station
- Normally Open PRV
- Normally Closed PRV
- Normally Closed Valve

PRV Summary Table

1	W 10th & CHERRY HEIGHTS	26	E 12th ST & G ST
2	W 13th & JORDAN	27	1104 DRY HOLLOW
3	MT. HOOD & 23rd STREET	28	E 17th ST & MONTANA
4	2013 W SCENIC DRIVE	29	E 15th ST & NEVADA
5	2013 W SCENIC DRIVE	30	E 16th ST & OREGON
6	E 21st ST & RADIO WAY	31	E 16th ST & OREGON
7	E 21st ST & RADIO WAY	32	1825/1835 E 19th ST
8	W 16th ST & LINCOLN	33	1825/1835 E 19th ST
9	W 16th ST & LINCOLN	34	E 19th ST & OAKWOOD
10	SOROSIS PARK	35	E 19th ST & OAKWOOD
11	SOROSIS PARK	36	1801 GOLDEN WAY
12	W 8th ST & PENTLAND	37	E 11th ST & OREGON
13	W 15th ST & LIBERTY	38	E 10th ST & OREGON
14	W 15th ST & LIBERTY	39	E 9th ST & QUINTON
15	W 13th ST & LIBERTY	40	E 18th ST & MORTON "SUM MODE"
16	7th ST & UNION	41	E 18th ST & MORTON "SUM MODE"
17	814 COURT ST	42	E 12th ST & MORTON
18	6th PL & WASHINGTON	43	E 12th ST & MORTON
19	E 13th ST & WASHINGTON	44	WASCO DR. & ROYAL CREST DR. E
20	E 12th ST & LAUGHLIN	45	COL. VIEW DR. & SUMMITT RIDGE DR.
21	E 16th PL & H ST	46	COL. VIEW DR. & SUMMITT RIDGE DR.
22A	E 19th ST & DRY HOLLOW	47	SEUFERT'S DRIVEWAY
22B	E 19th ST & DRY HOLLOW	48	SEUFERT'S DRIVEWAY
23A	E 19th ST & DRY HOLLOW	49	LES SCHWABS DRIVEWAY
23B	E 19th ST & DRY HOLLOW	50	LES SCHWABS DRIVEWAY
24	E 18th ST & 20TH ST	51	AMERITIES
25	E 18th ST & 20TH ST	52	EAST SIDE INTER-TIE

Vista
NEW VISTA
786
18THMORTON
S-7
Columbia View
Winter Feed,
Summer normally closed
Summer Feed,
Winter Off
600
500
400
300
200
100
Intermediate
Intermediate Booster
I-1
C-5
513
660E
C-12
632
S-1
Sunridge
Brenner's
507
E-1
E-3
Sorosis Booster
NC
NC
Sorosis
S-4
High Line
Sorosis Overflow
660W
S-3
475
S-2
560
WTP
Wicks
880
W-1
Mill Creek Line
Garrison
Garrison Booster
NC
G-7
Marks Well
Jordan Well
M-5
460
J-6
395W
G-9
395
G-2
G-12
G-4
G-6
G-10
310
G-1
G-3
G-8
G-5
G-11
G-13
G-14
352
I-6
I-7
L-18
Lone Pine Well
Eastside Intertie
#40, 41
#34,35
#24,25
#23
#22
#10,11
#6,7
#42, 43
#44
#45,46
#32, 33
#30, 31
#29
#36
#28
#4,5
#8,9
#21
#13, 14
#3
#47,48
#49,50
#38
#37
#26
#20
#19
#15
#39
#27
#51
#52
#18
#17
#16
#12
#2
#1

City of The Dalles Distribution System Schematic

Figure 1-2 Existing Water System Schematic

- Wicks WTP. This plant, described in **Section 1.4**, has an estimated capacity of approximately 5.6 MGD based on recently replaced media in the filters. Additional discussion and analysis of the WTP capacity is included in **Chapter 6**.

The City holds five surface water right permits, three of which have been perfected (certificated). **Table 1-1** summarizes information pertaining to these rights.

Figure 1-3 | Water Supply System Overview

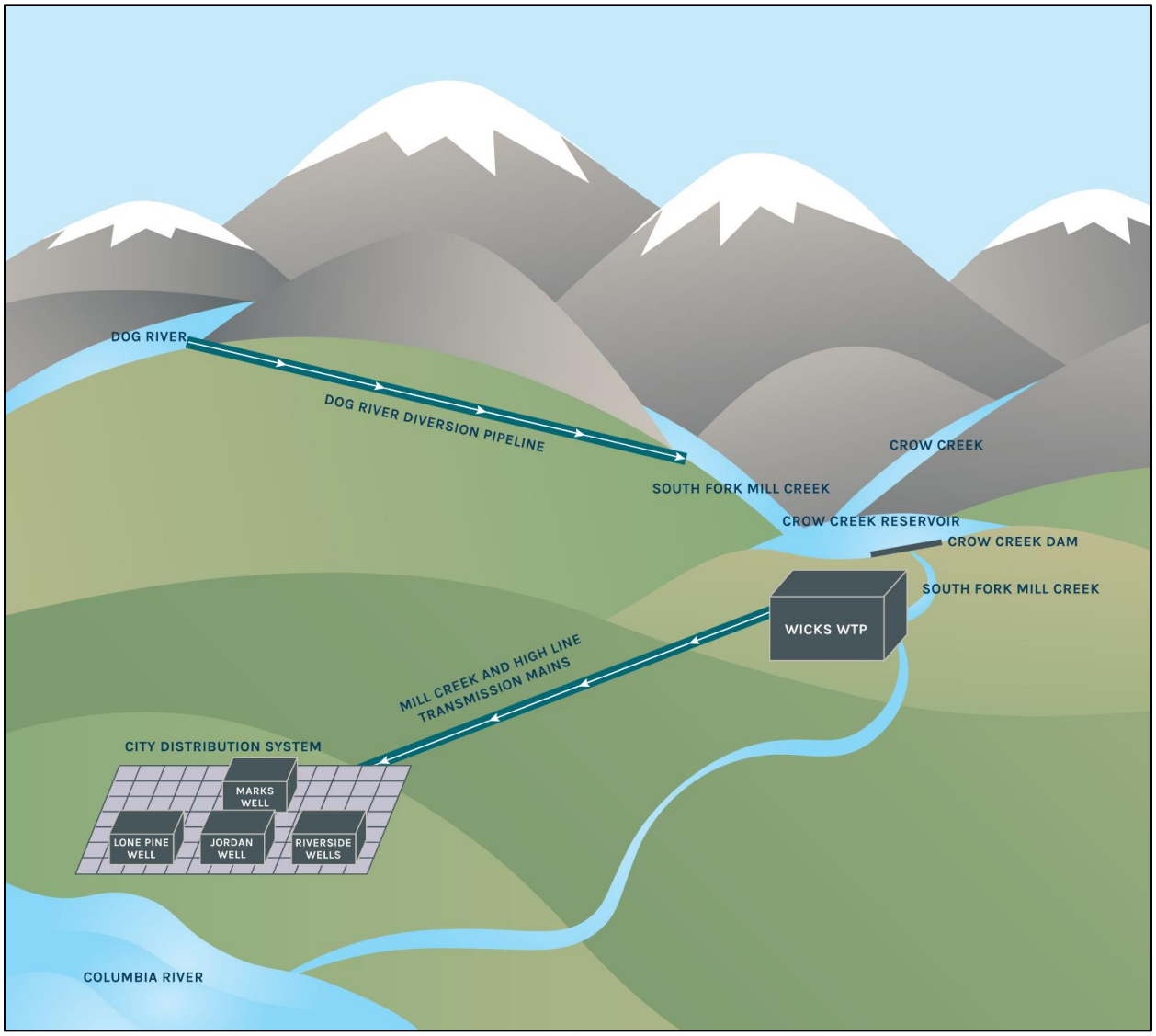

Table 1-1 | Surface Water Rights Summary

Source	Application	Permit	Claim, Decree, or Transfer	Certificate	Priority Date	Type of Beneficial Use	Authorized Rate (cfs)	Authorized Volume (AF)	Authorized Date for Completion
Surface Water									
South Fork Mill Creek, a tributary of Mill Creek	-	-	Mill Creek Decree	5691	12/31/1862	Municipal	2.0	-	N/A
Dog River, a tributary of East Fork Hood River	-	-	Hood River Decree	14954	8/1/1870	Municipal use for irrigation, domestic, power and stock	"All the water in stream at point of diversion"	-[1]	N/A
Crow Creek Reservoir, a tributary of South Fork Mill Creek	S-43668	S-32479	-	60410	5/29/1967	Municipal	-	955	N/A
Crow Creek Reservoir, a tributary of South Fork Mill Creek	S-84050	S-53930	-	-	1/21/1999	Municipal	-	2100	10/1/2041
Columbia River, a tributary of the Pacific Ocean	S-55346	S-49653	-	-	1/13/1986	Municipal	40	-	10/1/2073
Storage									
South Fork Mill Creek, Dog River	R-43667	R-4988	-	44917	5/29/1967	Storage for Municipal Use	-	955	N/A
South Fork Mill Creek, Dog River	R-84049	R-13105	-	-	1/21/1999	Storage for Municipal Use	-	2100	11/20/2031

Note:

1. Through Special Use Agreement with USDA Forest Service, the City has agreed to bypass to Dog Rover a minimum of 0.5 cfs at the Dog River diversion during August, September, and October annually.

1.3.2 Groundwater Supply

The Dalles currently uses three wells as part of its water supply: Lone Pine, Marks, and Jordan. Together, the three wells have supplied approximately 22 percent of the City's water supply on an annual basis over the past 5 years. All three wells are located within the city limits (shown in **Figure 1-4**). The Jordan and Marks Wells are located in the west-central area and have design capacities of 1,750 gallons per minute (gpm) and 1,500 gpm respectively. Lone Pine Well is located on the east edge of the City near the I-84 Freeway and has a design capacity of 2,100 gpm. As of May 2024, OWRD has approved a water right transfer (T-13904) authorizing the use of Riverside Wells 1 and 2 under multiple groundwater rights. It is anticipated that this transfer will be assigned to the City. Descriptions of well capacity and the authorized rates and volumes of water use anticipate that T-13904 will be assigned to the City. Riverside Wells 1 and 2 were under construction at the time of the WSMP. The wells are anticipated to be online in early 2025. Data for these wells is summarized in **Table 1-2**. In addition, the 660 gpm Wicks Well located near the Wicks WTP provides an emergency supply. Water from this well requires treatment at the Wicks WTP prior to distribution. The Stadelman Well is not currently in use for water quality issues. The Mill Creek Well water right was transferred to Mark's Well and the Mill Creek Well is not currently in use. The City's wells are completed in the DGWR (also known as the Dalles Pool Aquifer), which is comprised of several flows of the Columbia River Basalt Group, including the Sentinel Gap flow, Sand Hollow (I and II) flows, and Ginkgo flow.

Table 1-3 summarizes the City's groundwater rights. Use of the municipal water supply wells shown in **Table 1-2** is authorized by the 26.834 cfs (equivalent to 17.34 mgd) of groundwater rights, including 15.7 cfs (10.15 mgd) of certificate water rights and 11.50 cfs (7.43 mgd) evidenced by an inchoate transfer (T-13904) and groundwater claim registration (GR-4258). The available capacity for meeting the City's needs is significantly lower than the City's groundwater rights because of three factors:

- The production from the Jordan, Marks, and Lone Pine Wells is limited to the pumping capacities of individual wells and the capacity of the distribution system at the locations to which the wells are connected.
- The area in which the City's wells are located has been designated The Dalles Critical Groundwater Area (CGWA) by the Oregon Water Resources Department (OWRD) because of historically declining water levels in the aquifer. Groundwater levels stabilized in the mid-1990s when annual pumping was roughly between 5,000 and 5,500 ac-ft (1,629-1,792 MG) (Golder, 1999). Although the levels have remained stabilize in recent years, OWRD may restrict annual withdrawals by the City and other groundwater users if water levels begin again to decline.
- The groundwater quality from the Marks and Jordan Wells is less desirable than that of the surface water supply due to their higher mineral content, so the City limits their contribution to the system. Both wells produce water with higher manganese levels.

The City also holds a limited license for testing of aquifer storage and recover (ASR) in the DGWR (ASR LL#25). The limited license allows the City to use up to four proposed ASR wells to store up to 1,200 MG of treated surface water in the DGWR.

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Table 1-2 | Well Summary

Well	Well ID	Target Aquifer	Year Drilled	Depth Drilled (ft)	Pump Depth (ft)	Instantaneous Capacity (cfs)/ (gpm)	Daily Capacity (MGD)	Horsepower	Last Maintenance/ Replacement	Treatment Systems
Jordan Street	WASC 2428	Sand Hollow Flows	1954	291	300	3.90/1,750	2.52	300	Pump & Motor Rehab 2013	Sodium hypochlorite; Corrosion control (polyphosphate)
Marks Well	WASC 2431	Sentinel Gap and Sand Hollow Flows	1931	570	300	3.34/1,500	2.16	200	Pump & Motor Rehab 2012	Sodium hypochlorite; Corrosion control (polyphosphate)
Lone Pine Well	WASC 2385	Ginkgo Flow	1979	385	292	4.67/2,100	3.02	300	Rewound Motor 2019	Fluoride; Sodium hypochlorite; Corrosion control (polyphosphate)
Riverside Well 1	Not Yet Assigned	Sentinel Gap and Sand Hollow Flows	2024	320	195	4.01/1,800	2.59	TBD	New 2024	Sodium hypochlorite; Corrosion control (polyphosphate)
Riverside Well 2	Not Yet Assigned	Sentinel Gap and Sand Hollow Flows	2024	320	TBD	4.01/1,800	2.59	TBD	New 2024	Sodium hypochlorite; Corrosion control (polyphosphate)

Table 1-3 | Groundwater Rights Summary

Source	Application	Permit	Claim, Decree, or Transfer	Certificate	Priority Date	Type of Beneficial Use	Authorized Rate (cfs)	Authorized Volume (AF)	Authorized Date for Completion
Groundwater: Municipal System Connection									
4 wells: Lone Pine, Jordan, Marks, and ASR 1 Wells	-		GR 4258, Modification T-12893		10/11/1923	Municipal, Domestic, Irrigation, Manufacturing, and Industrial	5.124	-	-
A well - Marks Well	U-135	U-127		15543	11/1/1940	Municipal	2.68	-	N/A
A well - Marks Well	U-181	U-189	T-7258	86380	10/4/1945	Municipal	0.69	-	N/A
A well - Jordan Street Well	G-23	G-7806	-	48991	10/16/1953	Municipal	5.5	-	N/A
A well - Lone Pine Well	G-1415	G-7807	-	60026	3/13/1959	Municipal	4.46	-	N/A
Wicks Well	G-2076	G-2132	-	44915	7/2/1962	Municipal	1.56	-	N/A
A well - Mill Creek Well	U-181	U-189	T-7258	85886	10/4/1945	Municipal	0.81	-	N/A
A well - Stadelman Well (not in use)	-	-	GR 4257	-	12/31/1910	Domestic / manufacturing	0.368	-	-
Riverside Wells 1 & 2	G-471	G-338	T-13904	46835	9/7/1956	Municipal	2.9	-	10/1/2044
Riverside Wells 1 & 2	G-734	G-645		46836	8/19/1957	Municipal	1.11	-	
Riverside Wells 1 & 2	G-737	G-648		46839	8/19/1957	Municipal	1.6	-	
Riverside Wells 1 & 2	G-735	G-646		82480	8/19/1957	Municipal	0.4	-	
Dog River, a tributary of Hood River (under Cert 14954); South Fork Mill Creek (under Cert 5691); and Crow Creek Reservoir (under Cert 60410)	ASR LL#25	LL#25	-	-	None - diversion of water for ASR testing retains priority date of source water rights (14954, 5691, 60410)	ASR testing	16.7 cfs diverted from surface water sources; max injection rate of 1,875 gpm per well (up to four wells); max recovery rate of 2,500 gpm per well	Up to 1,200 MG stored in aquifer	Limited License expires 3/21/2028

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1.4 Water Treatment Plant

The Wicks WTP was constructed in 1949 and is located about 7 miles south of the City. It treats water from South Fork Mill Creek, which is fed by the Crow Creek Reservoir and the Dog River diversion. The Wicks WTP includes flocculation/sedimentation basins with tube settlers followed by media filters. Chlorination is used for disinfection before the clearwells. The Wicks WTP consistently provides high-quality drinking water to the community at a relatively low cost. The finished water quality meets all current drinking water standards. A primary reason for the low cost is that water flows by gravity to and from the plant. Additional discussion of plant capacity and condition are included in Chapter 6.

1.4.1 Finished Water Transmission Pipelines

Finished water from the Wicks WTP is delivered to the City's customers by gravity flow, mostly without the need for pumps. The two finished water transmission pipelines connect to the outlet of the plant clearwell and transmit water approximately 7 miles north to the city limits. One is called the High Line and the other the Mill Creek Line. The High Line original pipe is 14-inch diameter welded steel; some sections have been replaced with 20-inch diameter ductile iron. The Mill Creek Line original pipe is 12-inch diameter welded steel; some sections have been replaced with 20-inch diameter ductile iron. Both were originally installed approximately 75 years ago. Their combined capacity as reported in the 2006 WSMP is approximately 7.5 MGD (5,200 gpm). There has been no additional testing to confirm capacities since the previous WSMP.

The pipelines parallel each other and are located along South Fork Mill Creek for approximately the first 4.5 miles from the plant. At this point, the High Line alignment turns northeast and runs across private and public lands on a mostly direct route to Sorosis Reservoir, which is located behind Sorosis Park. The Mill Creek Line continues along Mill Creek Road right-of-way to 16th Street, just west of Skyline Road, where its alignment turns east. This pipeline connects to Garrison Reservoir.

In addition to supplying water to the City's distribution system, each transmission line serves a limited number of customers on properties adjacent to the pipeline alignments. Most of these services were granted many years ago in exchange for having the customers provide pipeline easements while others have been authorized more recently.

1.5 Distribution System

Figure 1-4 illustrates the City's distribution system as described in the following sections.

1.5.1 Pressure Zones

The Dalles' distribution system is divided into 16 service zones. They are labeled numerically, the label generally being reflective of the hydraulic grade line (HGL) for service within the zone. The zones have been developed to provide acceptable pressures to customers. Two pressure zones, Brenner and Sunridge, are small areas created within the former 660 and 507 pressure zones. The distribution system pressure zones are illustrated in Figure 1-4 and Figure 1-5. Figure 1-5 illustrates the existing distribution piping by pressure zone. Table 1-4 summarizes the pressure zones with minimum and maximum elevations and approximate static pressures. Four of the pressure zones are governed by the HGL of storage tanks and the others are governed by the HGL set at pressure reducing valves (PRV) serving them.

Finished water from the Wicks WTP enters the system by gravity through the two transmission lines: one feeds Garrison Reservoir, and one feeds Sorosis Reservoir. The Sorosis Booster Pump Station moves water from the Sorosis Reservoir up to the Vista Reservoir. The higher elevation zones are fed from the Sorosis

and Vista Reservoirs or directly from one of the transmission pipelines. The lower zones are fed from the Garrison Reservoir and through a number of PRVs.

A smaller portion of water is supplied from the City's three existing wells. As shown in the system schematic, **Figure 1-2**, the Marks and Jordan Wells pump directly into the distribution system (460 Zone), and the Lone Pine Well has a dedicated pump line to the Intermediate Reservoir.

Table 3-1 lists the existing pressure zones with associated elevation range for customer connections, approximate minimum and maximum static pressure, and the facility governing HGL. Pressure zones are illustrated on the hydraulic schematic in **Figure 1-2** and in **Figure 1-4**.

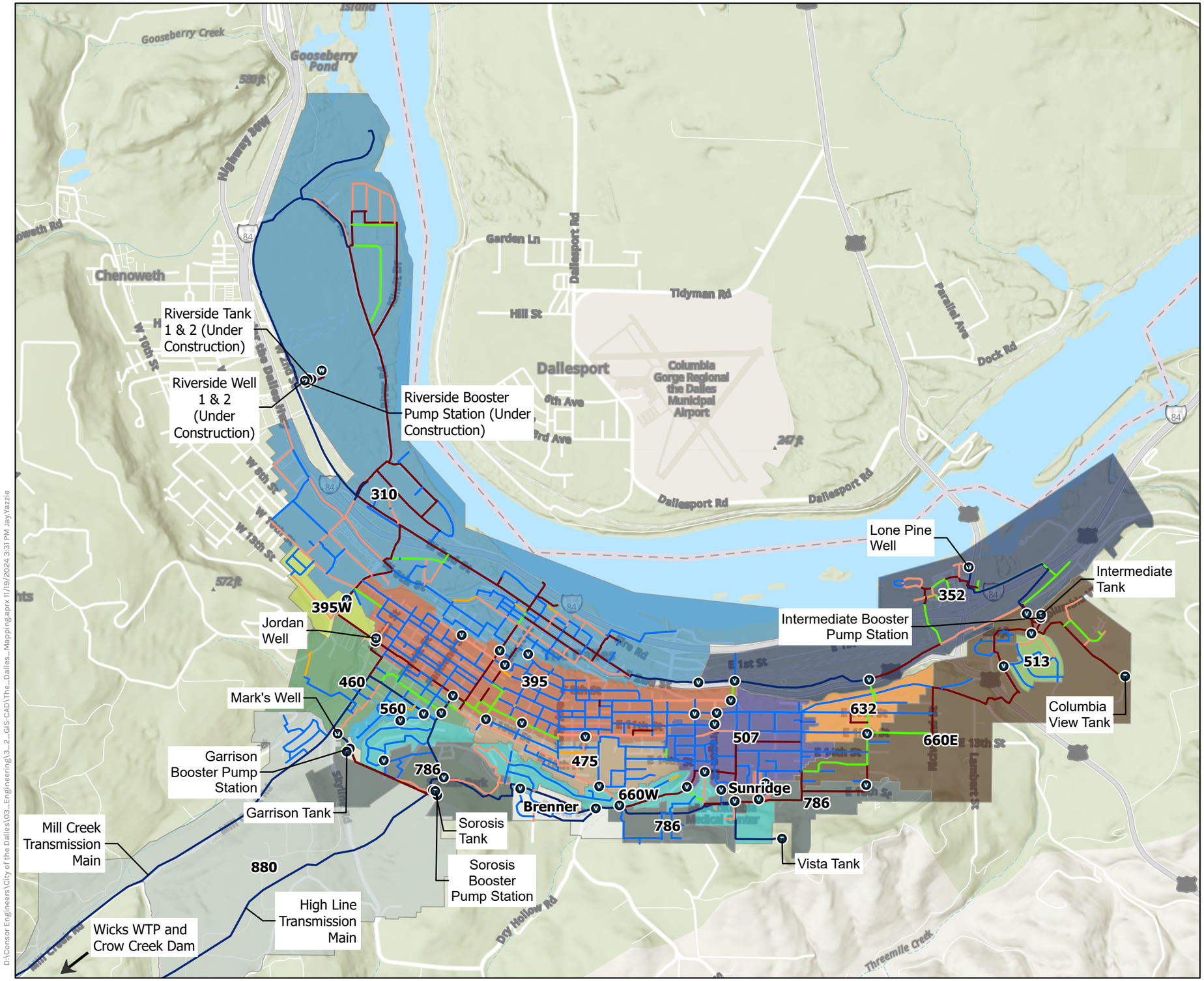
The largest demand area is the 310 Zone. This area encompasses the downtown as well as the port. It includes the majority of commercial and industrial customers. During peak summertime demand periods, this zone accounts for approximately 45% of the total system demand.

The gorge on the east side of the City, through which Highway 197 is located, restricts water movement in the east and west directions. This physical barrier does not completely eliminate movement of water into or out of the eastern zones (660E, 632, 513, and 352 zones), but it does limit the transfer of water. This results in two system conditions. One is that the City is unable to make full use of the Lone Pine Well because the demand in 660E, 632, 513, and 352 zones is insufficient to fully use the 2 MGD pumping capacity of this well. The second, related condition is that there is insufficient turnover in the Columbia View Reservoir when all water is being supplied from the Wicks WTP and the Lone Pine Well is offline because of a single combined inlet/outlet configuration. The City currently removes this reservoir from service during the winters because of water quality concerns due to stagnation.

Table 1-4 | Existing Pressure Zone

Pressure Zone	Minimum Elevation (ft)	Maximum Elevation (ft)	Minimum Static Pressure[1] (psi)	Maximum Static Pressure[2] (psi)	Facility Governing Hydraulic Grade Line (HGL)
310	86	195	52	99	PRV 1B HG: 314 ft
352	94	246	36	112	Intermediate Tank HG: 352 ft
395	103	329	30	128	PRV 15 HG: 399 ft
395W	174	215	68	86	PRV 2 HG: 373 ft
460	193	393	11	116	Garrison Tank HG: 460 ft
475	286	389	47	91	PRV 13 HG: 497 ft
507	242	472	26	125	PRV 32 HG: 531 ft
513	323	421	42	84	PRV 45 HG: 517 ft
560	339	418	58	92	PRV 4 HG: 552 ft
632	125	442	40	178	PRV 42 HG: 535 ft
660E	249	578	13	166	Columbia View Tank HG: 632 ft
660W	352	631	9	133	Sorosis Tank HG: 659 ft
786	429	635	50	156	Vista Tank HG: 790 ft
880	223	667	79	272	Wicks Water Treatment Plant HG: 850 ft
Brenner	463	576	52	101	PRV 23A HG: 696 ft
Sunridge	376	460	71	107	PRV 34 HG: 623 ft

Note:
1. Tanks that govern the hydraulic grade of a pressure zone, the minimum water level was used to calculate minimum static pressure.
2. Tanks that govern the hydraulic grade of a pressure zone, the maximum water level was used to calculate maximum static pressure.



Legend

- Well
- Tank
- Pump
- PRV

Diameter (inch)

- Less then 6
- 6
- 8
- 10
- 12
- Greater than 12

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

City of the Dalles
Water System Master Plan

Figure 1-4. Existing Water Distribution System

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W196117OR

November 2024

Data Sources: City of The Dalles, 2023;Community: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS
World Imagery: Maxar
Coordinate System:
Disclaimer: Consor and CLIENT make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

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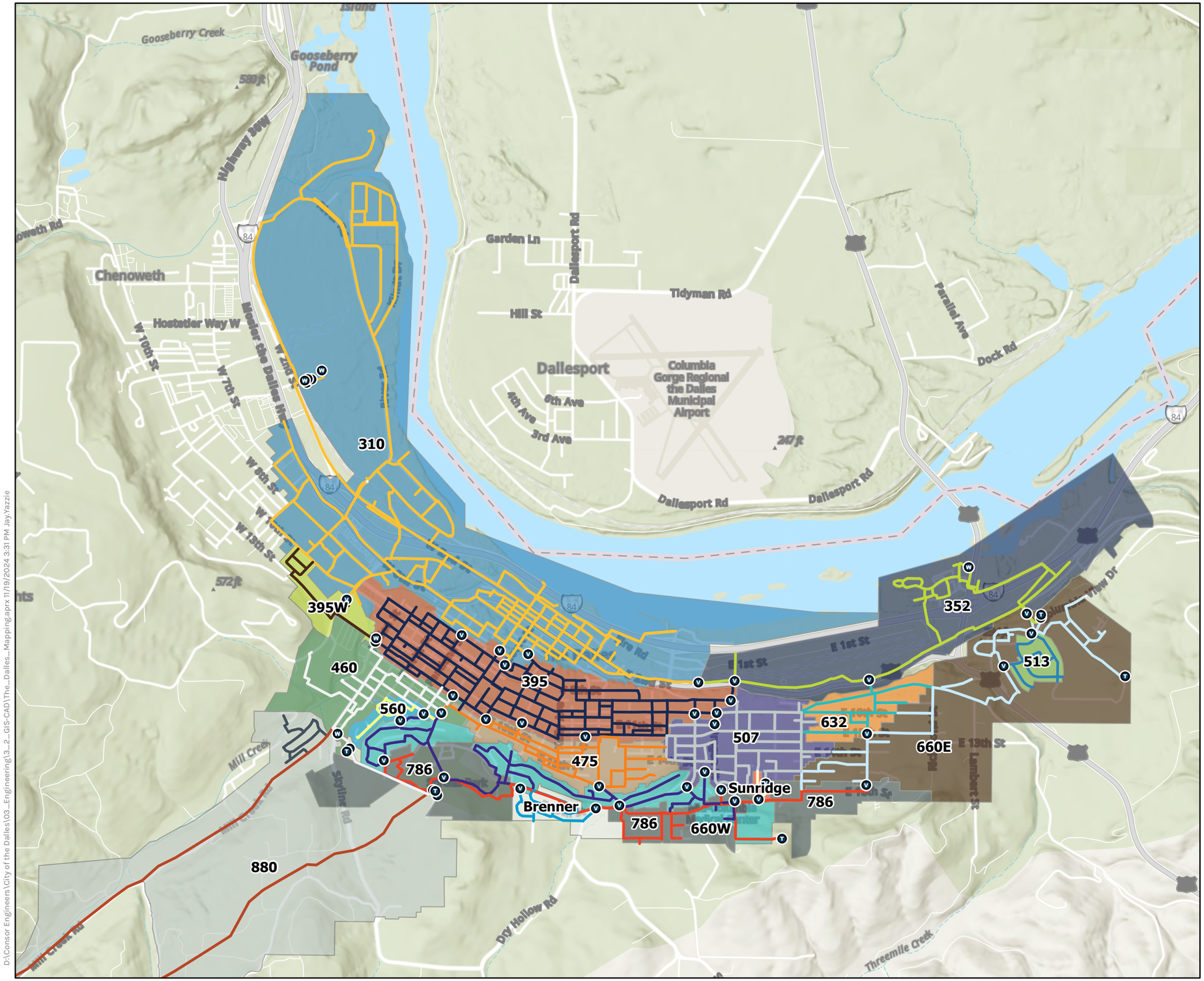

Legend

- Well
- Tank
- Pump
- PRV

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Piping per Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- 880-HighLine
- 880-MillCreek
- Brenner
- Sunridge

City of the Dalles
Water System Master Plan

Figure 1-5. Existing Water Distribution System Piping by Pressure Zone

consor

W196117OR

November 2024

Data Sources: City of The Dalles, 2023;Community: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS
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1.5.2 Pressure Reducing Valves

There are 37 PRV stations in the City's water distribution system. Ten PRV stations maintain the hydraulic grades for 10 pressure zones. **Table 1-4** in the previous subsection lists those PRV and their hydraulic grade. The other 27 PRV stations are set to a lower hydraulic grade and are on standby. These PRVs provide additional flow to the zone if demands are large or during fire flow conditions. **Figure 1-4** shows all the PRVs in the system between zone boundaries.

1.5.3 Reservoirs

The City's water distribution system has five (5) storage tanks with a combined storage volume of 16 million gallons (MG). The existing reservoirs are illustrated in **Figure 1-4**. **Table 1-5** lists the storage reservoirs and summarizes general information on each. In addition to the reservoirs listed in **Table 1-5**, two Riverside Reservoirs are currently under construction. They will have a combined storage of 2.5 MG when complete.

Table 1-5 | Existing Reservoirs

Reservoir	Material	Base Elevation (ft)	Low Water Setting (ft)	Maximum Water Level (ft)	Diameter (ft)	Volume (MG)	Pressure Zone Served
Columbia View	Steel	602	20	27.7	130	3.0	660E, 513, and 632
Garrison	Steel	408	28	52	140	6.0	460, 395, 395W, and 310
Intermediate	Steel	325	17	27	80	1.0	352 and 310
Sorosis	Steel	630.5	18	25.7	135	3.0	660W, 560, and 475
Vista	Steel	750.5	28	35	116	3.0	786, 660W, 507, Brenner, and Sunridge

1.5.4 Pump Stations

The City's water distribution system has three (3) booster pump stations (BPS) that lift water to three reservoirs: the Sorosis Pump Station, the Intermediate Pump Station, and the Garrison Pump Station.

The Sorosis Pump Station is located next to the Sorosis Reservoir. This pump station lifts water from the Sorosis Reservoir to the Vista Reservoir. The pump station is equipped with three constant-speed pumps and is designed to operate up to two pumps at a time yielding a firm capacity of about 1,500 gpm.

The Intermediate Pump Station is located next to the Intermediate Reservoir. This pump station lifts water from the 352 zone, which is fed by Lone Pine Well, to the 660E zone. It fills the Columbia View Reservoir. The Intermediate Pump Station has an approximate capacity of 3,000 gpm if both pumps are operating.

The Garrison Pump Station transfers water from the Garrison Reservoir (at an overflow elevation of 460 feet) into the Sorosis Reservoir (at an overflow elevation of 660 feet). The Garrison Pump Station is used only infrequently, during times when the Sorosis Reservoir is draining more quickly than it can be filled through the High Line.

A Riverside BPS is currently under construction in the 310 Pressure Zone. This BPS will pull water from the Riverside Reservoirs and supply it to the 310 Pressure Zone when completed. The BPS will have an initial capacity of 4,500 gpm with the ability to be expanded to 9,000 gpm.

Table 1-6 summarizes the existing pump stations and general operational information.

Table 1-6 | Existing Pump Stations

Pump Station	Base Elevation (ft)	Firm Capacity (gpm)	Pumps From	Pumps To	Controls
Garrison	406	500	Garrison Reservoir	Sorosis Reservoir	Controls are based on Sorosis water level. ON: 22 feet OFF: 26 feet
Intermediate	325	1,500	Intermediate Reservoir	Columbia View Reservoir	Controls are based on Columbia View water level. ON: 23.5 feet OFF: 28.5 feet
Sorosis	635	1,500	Sorosis Reservoir	Vista Reservoir	Controls are based on Vista water level. ON: 32 feet OFF: 34.5 feet

1.5.5 Distribution Pipe

The City's distribution system is composed of approximately 91 miles of various pipe types ranging in size up to 36 inches in diameter. Existing pipe diameter is shown in **Figure 1-4**. The majority of the pipe is 6 to 8 inches in diameter, which is the typical size used to convey domestic demands plus fire flow in local distribution. Over 90% of the pipes (by length) are cast iron or ductile iron – a significant portion is cast iron.

The oldest piping in the system likely dates back to 1875-1900. The approximate pipe ages range up to 125-150 years old with the majority being installed 50-75 years ago. Based on data from the City's geographic information system (GIS) pipeline database, approximately 60% of the pipe was installed 50-75 years or more ago. **Table 1-7** presents a summary of length of pipe (in miles) by diameter and approximate age within the distribution system.

Table 1-7 | Pipe Inventory by Diameter and Approximate Age

Diameter (in)	Approximate Age (years)							Length Install per Diameter (mi)	% of Total
	0-25	25-50	50-75	75-100	100-125	125-150	Unknown		
4 and smaller	1.1	0.7	1.1	0.3	0.6	0.3	0.7	4.9	5%
6	6.5	4.6	23.4	4.1	0.4	1.3	0.8	40.9	45%
8	3.2	2.1	5.4	1.8	0.6	0.2	<0.1	13.4	15%
10	0.4	2.9	2.3	0.9	0.1			6.4	7%
12	2.5	6.2	5.6	0.6	0.5			15.3	17%
14	<0.1	0.5	1.0	0.4				1.9	2%
16	2.1	1.0	0.7				<0.1	3.8	4%
18	4.0							4.0	4%
24		<0.1						<0.1	0%
30	0.1							0.1	0%
36	<0.1							<0.1	0%
Length Install per Age (mi)	19.8	18.0	39.5	8.1	2.2	1.8	1.5	90.8	100%
% of Total	22%	20%	43%	9%	2%	2%	2%	100%	

CHAPTER 2

Water Requirements

This chapter presents existing and projected future water demands for the City's water service area. Water demand forecasts presented in this section are used with performance criteria presented in Chapter 3 to evaluate the existing water system's capacity to serve current customers and future growth. Demand forecasts are developed from historical water consumption and production records, regional planning data, current land use designations, and previous City water planning efforts.

2.1 Water Service Area

2.1.1 Existing Service Area

The City's existing water service area encompasses most areas within the existing city limits and UGB and historical customers located outside the UGB as shown in Figure 1-1. The Chenowith Water Public Utility District (Chenowith PUD) provides water service to an area in the northwest of the City. The Chenowith PUD service area encompasses some area within the city limits and the UGB as shown in Figure 1-1.

2.1.2 Future Service Area

The future service area and the study area for this WSMP includes all areas within the city limits and the UGB. It is assumed that the Chenowith PUD service area will remain the same through the planning period.

2.2 Planning Period

The planning period for this WSMP is 20 years, through the year 2044, consistent with Oregon Administrative Rule (OAR) requirements for Water System Master Plans (OAR 333-061). Water demand projections presented in this section also include a 50-year projected water demand for long-range water supply planning.

2.3 Water Demand Description

Water demand refers to all finished water required by the system including residential, commercial, industrial, and institutional uses. Water demands are described using three water use metrics: average daily demand (ADD), max day demand (MDD), and peak hour demand (PHD). Each of these metrics is stated in gallons per unit time such as million gallons per day (MGD) and in gallons per capita per day (gpcd). Peaking factors can be used to convert between ADD, MDD, and PHD.

- ADD is the total annual water volume used system-wide divided by 365 days per year.
- MDD is the largest daily water volume for a given year. In The Dalles, MDD typically occurs each year in July or August.
- PHD is estimated as the largest hour of demand on the peak water use day.

2.3.1 Water Consumption vs. Production

Water demand can be calculated using either water consumption or water production data. Water consumption data is taken from the City's customer billing records and includes all revenue metered uses. This data can be analyzed by geographical location and customer type which is useful for quantifying typical water use for different land uses. However, consumption data does not capture any water loss or unmetered usage and is typically only recorded in monthly totals, making it less useful in determining system-wide peak daily demands.

Water production is measured as the water supplied to the distribution system. The City's total daily water production is the sum of the recorded finished water flow measured at the Mill Creek and High Line pipelines and three wells located within the City (Lone Pine, Jordan, and Marks Wells). Total water production is used for analyzing seasonal water demand trends, supply, and storage capacity. Water production includes billed consumption (customer billing records), unmetered usage such as hydrant flushing, and water loss through minor leaks and unregulated use.

2.3.2 Non-Revenue Water (Water Loss)

The difference between water production and water consumption is known as water loss and typically consists of two components:

- Unbilled authorized consumption that can be tracked, such as operational, flushing, and construction use, and unbilled consumption that cannot be tracked such as firefighting.
- Real and Apparent Water Loss, such as leaks, main breaks, metering inaccuracies, illegal connections, and other types of unauthorized, unmetered water use.

2.4 Historical Water Demand

System-wide historical water demand is presented in Table 2-1. Six years of historical production data and four years of consumption data were used to evaluate system demands.

Water consumption was calculated from the City's monthly billing data. Unmetered water usage in the City is minimal and is not recorded. Water production is calculated daily from recorded finished water flow measured in the Mill Creek and High Line pipelines at the Wicks Water Treatment Plant and three wells located within the City (Lone Pine, Jordan, and Marks Wells). There are a few periods where production data was unavailable including July-August 2019, March-April 2020, and August-September 2021. To estimate ADD on an annual basis, the average production from the available data for the specific month was used to estimate monthly usage where missing data.

The City's average water loss for 2019-2022 was approximately 10%. This represents a reduction in average water loss compared to the previous WSMP completed in 2006. The City continues to work on management and conservation as outlined in the City Water Management and Conservation Plan (WMCP). The WMCP is currently in the process of being updated.

Table 2-1 | Historical Water Demand

Year	Production Total (MG)	Consumption Total (MG)	Water Loss (MG)	Water Loss (%)
2017	1,150	-	-	-
2018	1,260	-	-	-
2019	1,210	1,070	140	11.6
2020	1,300	1,150	150	11.5
2021	1,460	1,320	140	9.6
2022	1,300	1,190	110	8.5
Avg	1,280	1,190	135	10.3

2.4.1 Historical Demand and Peaking Factors

Average day and maximum day (ADD and MDD) were calculated based on historical production data (2017-2022 data was evaluated). Peak hour demands (PHD) were evaluated using available supervisory control and data acquisition (SCADA) data from part of 2023 (see System Analysis chapter for additional discussion). Peaking factors to convert from ADD to MDD and MDD to PHD were calculated. Historical ADD, MDD, and MDD:ADD peaking factors are summarized in **Table 2-2**. MDD and peaking factor for 2019 were not evaluated because the peak months, July and August, data was unavailable that year. SCADA data was limited to partial 2023 data, so PHD:MDD and corresponding PHD was not evaluated for each annual year. A PHD:MDD peaking factor of 1.3 was evaluated for the system.

Table 2-2 | Historical ADD and MDD

Year	ADD (MGD)	MDD (MGD)	ADD:MDD Peaking Factor
2017	3.14	6.96	2.22
2018	3.42	7.42	2.17
2019[1]	3.29	-	-
2020	3.52	8.43	2.39
2021	3.98	9.02	2.27
2022	3.54	8.38	2.37
Max	3.98	9.02	2.39

Note:
1. July and August 2019 data was unavailable so MDD analysis was not included.

2.4.2 Historical Water Demand by Pressure Zone

Consumption records provided by the City were used to document average daily water consumption by pressure zone. **Table 2-3** presents ADD, MDD, and PHD by zone, based on the geolocated billing records. The pressure zone with the highest water use (MDD basis) in the system is the 310 Zone, which accounts for approximately half of system demand. As described in the previous section, PHD was estimated using a PHD:MDD peaking factor derived from operator-provided SCADA data in 2023.

Table 2-3 | Historical Water Demand by Pressure Zone

Zone	ADD (MGD)	MDD (MGD)	PHD (MGD)
310	2.19	4.83	6.30
352	0.12	0.27	0.35
395	0.45	0.99	1.29
395W	0.02	0.05	0.06
460	0.09	0.19	0.25
475	0.18	0.40	0.52
507	0.23	0.50	0.66
513	0.06	0.13	0.16
560	0.03	0.06	0.08
632	0.05	0.11	0.15
660E	0.18	0.40	0.52
660W	0.16	0.35	0.46
786	0.18	0.39	0.52
880 High Line	0.03	0.06	0.07
880 Mill Creek	0.08	0.18	0.24
Brenner	0.06	0.14	0.18
Sunridge	0.01	0.02	0.03

2.4.3 Historical Per Capita Residential Water Demand

Per capita usage is calculated by dividing the demand metric by the corresponding population. Historical consumption data for residential customers and service area population estimates were used to estimate residential ADD per capita. Additional information on population data and service area is discussed in the following section. MDD per capita was calculated using a ADD:MDD peaking factor of 2.39 (see **Table 2-2**). **Table 2-4** summarizes the historical service area population and residential ADD and MDD per capita usage. For the purposes of water demand projections, 107 gpcd residential ADD and 257 gpcd residential MDD will be used.

Table 2-4 | Historical Residential Water Demand per Capita

Year	Population	ADD (gpcd)	MDD (gpcd)
2019	11,820	106	254
2020	13,010	101	240
2021	13,047	107	257
2022	13,344	92	220
Max Value:	-	107	257

2.5 Future Water Demand Forecast

Future water demand is estimated using a combination of residential per capita water demand, population forecasts, and non-residential demands as presented in this section. System usage was evaluated by residential and non-residential demands. Residential demands are expected to grow proportionally to population with the estimated residential per capita use of 107 gpcd ADD and 257 gpcd MDD. Non-residential demands include government, commercial, and industrial users within the service area. Non-residential demand projections are estimated using a combination of population data, historical

consumption data, undeveloped land use estimates, input from industrial water users, and input from City staff. Future water demands were forecast at 5, 10, 15, 20, and 50 years.

2.5.1 Population Projections

Population projections within the existing city limits are developed by the Portland State University (PSU) Population Research Center (PRC). The City water system service area population is estimated by the City population minus the Chenowith PUD service population (within city limits). The Chenowith PUD is estimated to serve 3,000 people within city limits. The Chenowith PUD service population has remained constant in historical years and is expected to continue to remain constant throughout the planning period. The population forecast for the City shows an average annual growth rate (AAGR) of 0.6% through 2074 (Wasco County Forecast, 2020). This AAGR reflects steady growth pattern for the UGB that includes the City. The PSU PRC provides annual population estimates for all Oregon cities. US Census data and PSU PRC population estimates were used to estimate historical populations for 2010, 2020, 2022, and 2023. The assumed Chenowith PUD service population of 3,000 has been subtracted from the City estimates to estimate the service area population. The historical population is the basis for projections using the AAGR from PSU PRC. Historical and projected population estimates are summarized in **Table 2-5** and **Figure 2-1**.

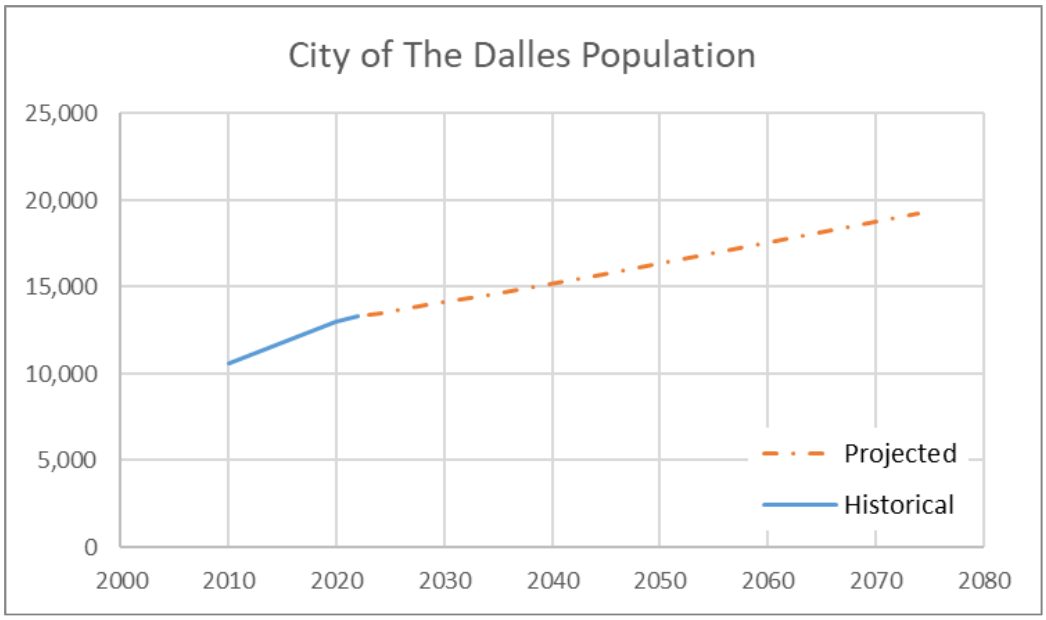
Table 2-5 | Historical and Projected Population Estimates

Year	Service Area Population[1]	AAGR[2]	Population Basis[3]
2010	10,620	-	PSU PRC
2020	13,010	-	2020 Census Data
2022	13,344	-	PSU PRC (Revised Estimate, 2023)
2023	13,417	-	PSU PRC (Preliminary Estimate)
2024	13,516	0.60%	Projected using The Dalles AAGR developed by PSU PRC (Wasco County Forecast 2020)
2029	14,017	0.60%	
2034	14,534	0.60%	
2039	15,066	0.60%	
2044	15,615	0.60%	
2074	19,247	0.60%	

Notes:

1. Service Area Population estimated from PSU PRC population data minus approximate service population of Chenowith PUD (3,000 people). Chenowith PUD service population is assumed to remain constant throughout.
2. Average annual growth rate (AAGR)
3. Portland State University (PSU) Population Research Center (PRC)

Figure 2-1 | Historical and Projected Population Estimates



2.5.2 System Wide Demand Forecast

Future system demands are the sum of projected residential and non-residential demands. Non-revenue water use in the system is low and was assumed to remain proportional with population growth. In the City system, existing non-revenue water was estimated around 10% and maintained at the same percentage through the 20-year and 50-year planning period. Projected ADD was calculated using the maximum historical residential per capita ADD, population projections, and non-residential demand forecasts. Projected MDD was calculated using peaking factors for residential and non-residential demands. A separate peaking factor was used for industrial customers. Projected PHD was calculated using a system PHD:MDD peaking factor. **Table 2-6** summarizes projected system-wide ADD, MDD, and PHD for the 50-year planning period. The 50-year demand projections account for the addition of a large industrial user with approximately 1 MGD average use.

Table 2-6 | Projected Water Demand Summary

Year	Population	ADD (MGD)			System MDD (MGD)	System PHD (MGD)
		Residential	Non-Residential	System Total		
2024	13,516	1.6	2.6	4.2	9.3	12.1
2029	14,017	1.7	4.2	5.9	12.1	15.8
2034	14,534	1.7	5.7	7.4	14.9	19.4
2039	15,066	1.8	5.8	7.6	15.3	19.9
2044	15,615	1.8	5.9	7.7	15.6	20.4
2074	19,247	2.3	7.3	9.6	19.4	25.3

2.6 Projected Water Demand by Pressure Zone

Projected water demand for the 20-year planning period (2044) by pressure zone is summarized in **Table 2-7** and used with performance criteria presented in **Chapter 3** to analyze the capacity of water facilities

supplying each zone. The projected demand by pressure zone is based on the system-wide projections summarized above and geolocated billing data as evaluated with the historical consumption data.

Table 2-7 | Projected 2044 Water Demand by Pressure Zone

Zone	ADD (MGD)	MDD (MGD)	PHD (MGD)
310	5.21	10.54	13.76
352	0.16	0.32	0.42
395	0.58	1.17	1.53
395W	0.03	0.05	0.07
460	0.11	0.23	0.30
475	0.23	0.47	0.62
507	0.30	0.60	0.78
513	0.07	0.15	0.20
560	0.03	0.07	0.09
632	0.07	0.14	0.18
660E	0.23	0.47	0.62
660W	0.21	0.42	0.55
786	0.23	0.47	0.61
880 High Line	0.03	0.07	0.09
880 Mill Creek	0.11	0.22	0.28
Brenner	0.08	0.16	0.21
Sunridge	0.01	0.02	0.03

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CHAPTER 3

Performance Criteria

3.1 Introduction

This chapter documents the performance criteria used for analyses of the City's water supply and distribution system. Criteria are established for evaluating water supply, distribution system piping, service pressures, and storage and pumping facilities. Recommended water needs for emergency fire suppression are also presented. These criteria are used in conjunction with the water demand forecasts developed in Chapter 2 to complete the analyses of the City's supply and distribution systems presented in Chapter 4 and Chapter 5 of this WSMP.

3.2 Performance Criteria

The water distribution system should be capable of operating within certain performance limits under varying customer demand and operational conditions. The recommendations of this plan result from evaluations based on the performance criteria listed in this chapter and summarized in Table 3-3. The performance guidelines have been developed through review of City design standards, State requirements, American Water Works Association (AWWA) acceptable practice guidelines, the *Ten States Standards*, the *Washington State Water System Design Manual*, and practices of other water providers in the region.

3.3 Water Supply Criteria

The water supply should be capable of providing adequate peak season (summer) supply and firm capacity to meet the future maximum daily demand (MDD) projections. Water supply adequacy is typically measured based on firm capacity of facilities. For a treatment plant, this is the total plant capacity with the largest single treatment train out of service. For a well, this is the capacity with the largest pump out of service. If the City develops additional supply sources/systems, consideration should be given to the firm capacity of the source/s. Specific application of this criteria relative to the City source and treatment facilities in Chapter 4.

3.4 Transmission Mains

The finished water transmission mains should be capable of passing projected MDD for customers served by the transmission main. Where possible, transmission mains should not have customer services directly connected. Typical recommended maximum velocity for a transmission main is five (5) feet per second (fps).

3.5 Service Pressures and Distribution Piping

Water distribution systems are separated by ground elevation into pressure zones to provide service pressures within an acceptable range to all customers. Typically, water from a reservoir will serve customers by gravity within a specified range of ground elevations to maintain minimum and maximum water pressures at each individual service connection. When it is not feasible or practical to have a separate reservoir for each pressure zone, pump stations or PRVs are used to serve customers in different pressure zones from a single reservoir.

3.5.1 Normal Service Pressure

Consistent with the criteria used in the City's 2006 WSMP, the acceptable service pressure range under ADD and normal operating conditions is 40 to 100 psi, measured at the customer's water service meter. Where mainline pressures exceed 80 psi, services must be equipped with individual PRVs to maintain their static pressures at no more than 80 psi in compliance with the Oregon Plumbing Specialty Code (OPSC 608.2).

The distribution system should be capable of supplying the peak hour demand (PHD) while maintaining service pressures of not less than 75 percent of normal system pressures, and not less than 30 psi.

3.5.2 Service Pressure in an Emergency

During a fire flow event or emergency, the minimum service pressure is 20 psi, as required by Oregon Health Authority (OHA) Drinking Water Services (DWS) and OAR 333-061-0025(7). The system should be capable of providing fire flow capacity while simultaneously delivering MDD and maintaining 20 psi throughout the distribution system. The system should meet this criterion with operational, equalizing and fire storage in the City's reservoirs depleted. **Table 3-1** summarizes the service pressure criteria during various system operation scenarios.

Table 3-1 | Recommended Service Pressure Criteria

Service Pressure Criterion	Pressure (psi)
Normal range, during ADD	40-100
Maximum, without PRV	80
Minimum, during emergency or fire flow	20
Minimum, during PHD	75% of normal, not less than 30

3.5.3 Distribution Main Criteria

The distribution system will be evaluated under two demand scenarios: 1) MDD + fire flow and 2) PHD. These two scenarios typically account for the largest instantaneous demands on the system. Evaluating the system under these conditions helps identify deficiencies in the distribution network and suggest improvements to be included in the Capital Improvements Projects list.

Typically, new water distribution mains should be at least 8 inches in diameter and looped to supply minimum fire flows. A minimum 6-inch diameter main may be acceptable in special cases with approval of the City Engineer if no fire hydrant connection is required, there are limited services on the main, the main is dead-ended and looping or future extension of the main is not anticipated. Potential water quality issues will be considered on a case-by-case basis when sizing pipes for proposed water main improvements identified during distribution system analysis. Typical recommended maximum velocity in new distribution mains is eight (8) fps.

3.6 Fire Flow Recommendations

While the water distribution system provides water for domestic uses, it is also expected to provide water for fire suppression. The amount of water required for fire suppression purposes is associated with the building size and type or land use of a specific location within the distribution system. Fire flow requirements are typically much greater in magnitude than the MDD in any local area. Adequate hydraulic capacity must be provided for these potentially large fire flow demands. Recommended fire flow

requirements by land use type are based on the 2022 Oregon Fire Code (OFC) and the Insurance Services Office (ISO) Supply Gradings for Public Protection Classification (PPC).

The ISO PPC ratings are used to inform property insurance rates throughout the United States. Public water system performance accounts for approximately 30 percent of a City's PPC rating. Overall, City ratings are not impacted by individual properties with fire flow demands over 3,500 gpm.

Additionally, the 2022 OFC (B106) limits required fire flow to a maximum of 3,000 gpm for buildings in protected areas with adequate and reliable water systems, such as the City's system. Therefore, the maximum fire flow considered within the City's service area is 3,000 gpm.

Fire flow requirements by land use type are summarized below and in Table 3-2.

3.6.1 Low Density Residential

The OFC guidelines specify a minimum fire flow of 1,000 gpm for single-family and two-family dwellings with square footage less than 3,600 square feet. For the purposes of this WSMP, distribution piping within low density residential zoning will be tested in the water system hydraulic model with a minimum fire flow requirement of 1,000 gpm.

3.6.2 Medium and High Density Residential

A required fire flow of 2,000 gpm is recommended for medium and high density residential properties. Properties zoned for neighborhood services and community services commercial are anticipated to require similar flows for fire suppression. While onsite fire sprinkler use can reduce the fire flow requirement for specific structures, it is recommended that the City plan for system storage, pumping, and distribution capacity to meet a 2,000 gpm fire flow in all pressure zones with potential multi-family development.

3.6.3 Commercial, Industrial, and Institutional

A 3,000 gpm fire flow is recommended for commercial, industrial, and institutional development consistent with OFC maximum fire flow guidelines. This maximum fire flow requirement is also appropriate for institutional facilities, although 2,500 gpm fire flow may be allowed for some public facilities and should be evaluated on a case-by-case basis if a 3,000 gpm fire flow rate cannot be achieved.

Table 3-2 | Recommended Fire Flow Summary

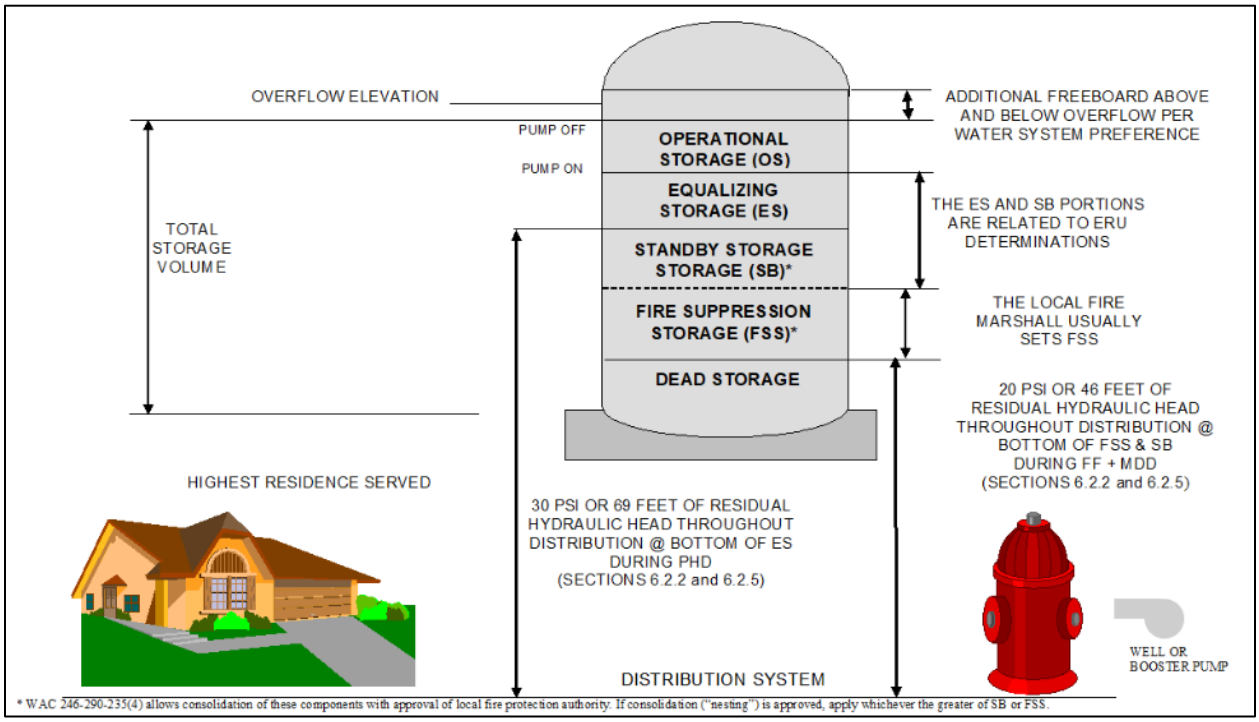
Land Use Designation	Recommended Available Fire Flow (gpm)	Fire Flow Duration (hours)
Low Density Residential	1,000	2
Medium and High Density Residential	2,000	2
Commercial, Industrial, and Institutional	3,000	3

3.7 Storage Capacity

The City's water storage reservoirs should provide capacity for four purposes: operational storage, equalization storage, standby (emergency) storage, and fire suppression storage. Additionally, dead storage and headroom for seismic sloshing should also be included in storage volume calculations, where tanks have not been constructed to include seismic slosh height. While storage is typically discussed as a volume, limiting factors may actually be based on vertical space in a tank, flow rates, or actual volume of water. Adequate storage capacity for each purpose must be provided for each pressure zone, although the volume

may be divided among multiple tanks. **Figure 3-1** provides a visual of five storage volume components and is followed by a brief discussion of each storage element below, from the *Washington State Water System Design Manual* guidelines. The *Washington State Water System Design Manual* guidelines are often used for planning in Oregon because the Oregon Health Authority does not have specific guidance on storage requirements.

Figure 3-1 | Storage Volumes



3.7.1 Operational Storage

Operational storage is the volume of water stored between the nominal on/off reservoir level set points for the supplying pump stations or supply valves. Operational storage supplies the water system while the pumps that supply the reservoir are "off". This volume is dedicated to minimizing pump cycling and align with the pump manufacturer's recommendations for cycling (typically no more than six starts per hour). Operational storage can be varied throughout the year to provide reservoir turnover. For example, winter tank levels are normally set lower than summer levels to allow for continued turnover with lower winter demands. Operational storage volume, however, does not apply to systems operating under a continuous supply mode.

3.7.2 Equalization Storage

Equalization storage is required to meet water system demands when zone demands exceed supply delivery capacity due to diurnal fluctuations in water usage. Equalization storage is calculated as,

$$(\text{Peak Hour Demand} - Q_s) \times 150 \text{ minutes}$$

Where Q_s is the total supply available to the zone excluding emergency supply.

Per the *Washington State Water System Design Manual* guidelines, equalization storage may be eliminated if the supply sources meet or exceed the PHD for the water system.

3.7.3 Standby Storage

Standby storage is provided to supply water from storage during emergencies such as supply pipeline failures, equipment failures, power outages, or natural disasters. The amount of standby storage provided can be highly variable depending upon an assessment of risk and the desired degree of system reliability. The *Washington State Water System Design Manual* recommends the standby volume be based on locally adopted standards for water supply under emergency or abnormal operating conditions. The manual provides an equation based on an equivalent residential unit (ERU) basis,

$$SB = N * SB_i * T_d$$

Where,

SB = standby volume

N = number of ERUs based on the ERU_{MDD} value

SB_i = locally adopted unit SB volume per day per ERU (number of ERUs based on the ERU_{MDD} value).

Overall, the basis of this equation equates to a standby volume of 1 X MDD for the zones served by a reservoir but the section and equation are written to allow for incorporation of local standards if they differ. For the WSMP and because system demands were not specifically evaluated on a ERU basis, it is recommended the City use 1 x MDD as the required standby storage component.

3.7.4 Fire Suppression Storage

Water stored for fire suppression is typically provided to meet the single most severe fire flow demand within each pressure zone. Fire services in the City's water service area are provided by Mid-Columbia Fire & Rescue (MCFR). Although the final fire flow requirement for any one property is determined by the Fire Marshal, MCFR follows the Oregon Fire Code (OFC).

The maximum required fire flow for any future development in the service area is 3,000 gpm for a recommended duration of three hours (OFC). The recommended fire storage volume is determined by multiplying the fire flow rate by the duration of that flow. Fire flow requirements by land use type and zoning are discussed later in this section and summarized in Table 3-2.

3.7.5 Dead Storage and Seismic Volume

Some reservoirs may include two additional, non-usable volumes of air or water. Dead storage is the volume of water at the base of the reservoir that does not provide a minimum 20 psi or exists below the outlet pipe inlet level. Seismic volume is only required in older reservoirs that do not meet current seismic standards. It includes the volume of space between the maximum water surface allowed and the base of the tank roof. This space is maintained as a buffer in the event of a seismic event to minimize forces on the tank caused by uplift and the resultant sloshing. For older reservoirs with inadequate freeboard, this volume of space may require the reservoir to be operated such that the maximum operational level is below the set overflow elevation of the tank.

3.8 Pump Station Capacity

Pumping capacity requirements vary depending on how much storage is available, the number of pumping facilities serving a pressure zone, and the zone's maximum fire flow requirement. Pumping recommendations are based on firm capacity which is defined as a pump station's capacity with the largest pump out of service.

3.8.1 Pump Station Supplying Pressure Zone with Gravity Storage

For pump stations supplying pressure zones with gravity storage available, the station must have adequate firm capacity to supply MDD for the zone.

3.8.2 Standby Power

Standby power facilities are needed for at least one pump station serving each pressure zone, assuming the pump station is the primary source for the zone and has adequate total capacity to meet the pressure zone's MDD. Standby power is typically provided in the form of an on-site backup generator sized to operate the pump station at firm capacity with automatic transfer switches and on-site fuel storage.

3.9 Performance Criteria Summary

Table 3-3 summarizes the planning criteria described in the sections above.

Table 3-3 | Performance Criteria Summary

Water System Component	Evaluation Criteria[1]	Value[1]	Design Standards/Guideline
Water Supply	Transmission Capacity	MDD	Ten State Standards, Washington Water System Design Manual
	Supply Capacity	MDD and peak season (summer)	
Service Pressure	Normal Range (ADD Conditions)	40-100 psi	Ten State Standards, City Public Works Standards
	Maximum	110 psi system pressure, with individual PRVs at services over 80 psi	Oregon Plumbing Specialty Code, Section 608.2
	Minimum, during MDD with Fire Flow	20 psi	OHA Drinking Water Services (DWS) and OAR 333-061-0025(7)
Distribution Mains	Velocity during PHD	Not to exceed 8 fps	AWWA M32, Washington Water System Design Manual
	Minimum Pipe Diameter	8-inch diameter, 6-inch acceptable for short mains without fire service	City Public Works Standards
Storage	Total Available Storage Capacity	Sum of operational, equalization, fire suppression, and emergency storage volumes (does not include seismic or dead volumes)	Washington Water System Design Manual
	Operational	Tank level set points	
	Equalization	(PHD - Q_s) * (150 minutes)	
	Standby (Emergency)	1 x MDD	
	Fire Suppression	Highest required fire flow x flow duration	
Pump Stations	Firm Capacity	MDD	Washington Water System Design Manual
	Backup Power	At least one pump station serving each pressure zone (if PS is primary source and meets MDD of zone/s)	Industry Standard Recommendation
Required Fire Flow and Duration	Low Density Residential	1,000 gpm for 2 hours	2022 Oregon Fire Code
	Medium and High Density Residential	2,000 gpm for 2 hours	
	Commercial, Industrial, and Institutional	3,000 gpm for 3 hours	

Note:

1. ADD: Average daily demand, defined as the average volume of water delivered to the system during a 24-hour period = total annual demand/365 days per year. MDD: Maximum day demand, defined as the maximum volume of water delivered to the system during any single day. PHD: Peak hour demand, generally the peak hour of MDD. Estimated as 1.3xMDD.

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CHAPTER 4

Water Supply Analysis

4.1 Introduction

To adequately plan for future water supply needs, multiple factors must be considered including demand for water; the physical availability of water; infrastructure to produce, store, treat, and transmit water; and the legal right to divert water under the City's State of Oregon water rights. The purpose of this section is to present an analysis of sources of supply and their availability and adequacy to meet current and future demands. Supply planning requires preparation for emergencies, consideration of water rights, and evaluation of long-term supply options to meet demand on a system-wide basis.

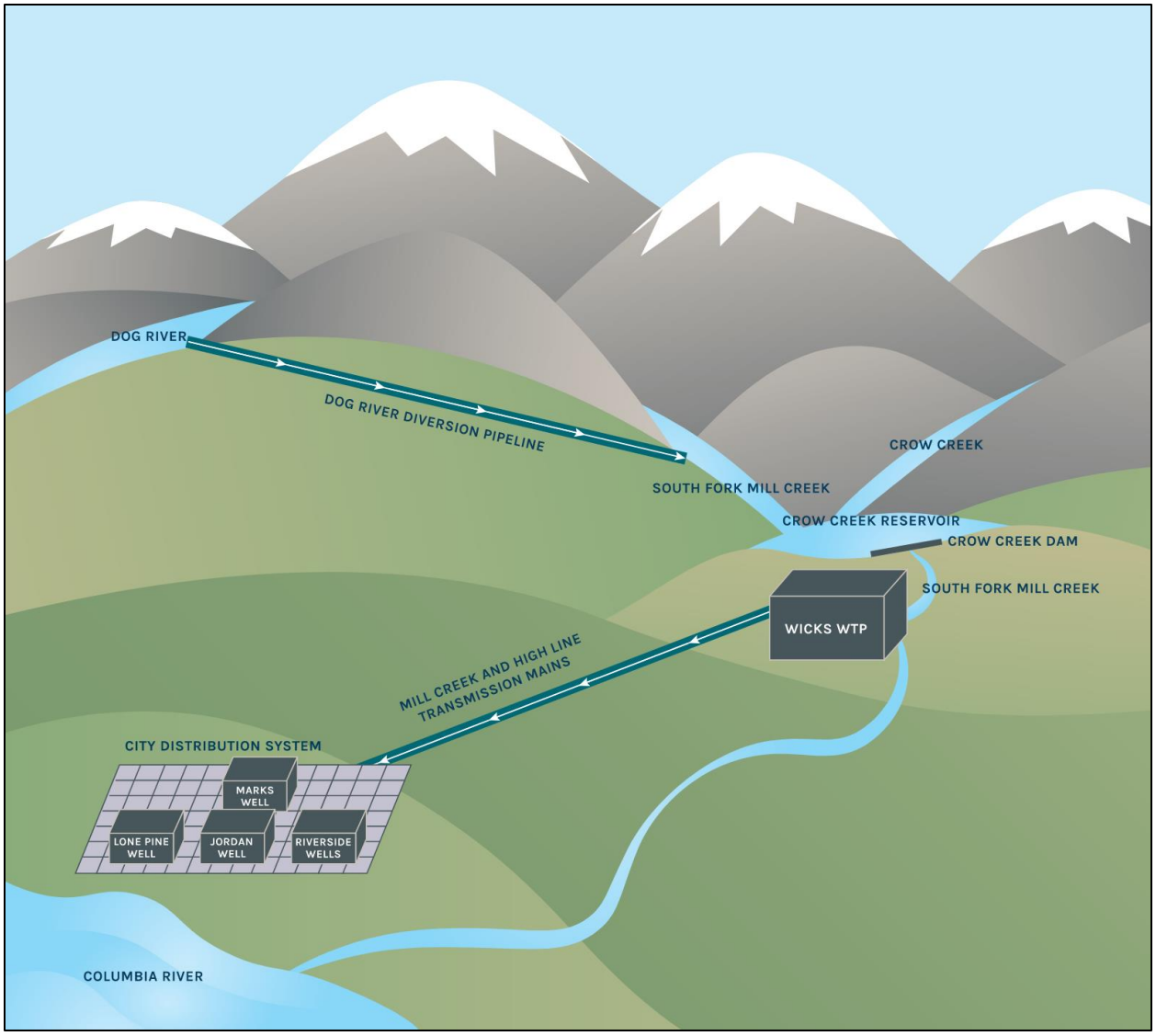
This chapter describes current supplies and presents recommendations for development and expansion of the City's supply sources. The 2006 WSMP identified the need for future supply expansion. Given the understanding that the City's existing supply sources and/or infrastructure will not be adequate to meet all future water demands, the City is exploring long-term supply options while continuing to maintain and develop their existing sources. Topics included in this chapter are water rights, capacities, and expansion potential.

While the WSMP is based on a 20-year planning period, the long-term supply analyses included evaluation of 50-year demand projections as described in Chapter 2. Evaluating alternative water supply options now and on a longer planning horizon allows the City to plan for improvements which will offer maximum flexibility in providing reliable potable water to existing and future customers. Alternative and expanded water supply source options for the City are considered including analysis of potential fatal flaws to long-term supply options. The conceptual alternatives considered include aquifer storage and recovery (ASR) using the City's existing aquifer source, expanded raw water storage, development of the deeper Grande Ronde Basalt groundwater aquifer, and Columbia River water.

4.2 Supply Overview

As described in Chapter 1, the City supplies both surface water and groundwater to its customers. An overview of the City's water supply system is illustrated in Figure 4-1. The Crow Creek Reservoir behind the Crow Creek Dam is on South Fork Mill Creek (SFMC) and provides raw water storage for the City. The City treats surface water at the Wicks WTP from SFMC which includes flows supplemented by water released from Crow Creek Dam (including water diverted from the Dog River watershed through the Dog River Diversion Pipeline). Historically, surface water has been the primary source water for the City. In recent years, the City has obtained approximately 78 percent of its water from surface water supplies located south of the City. The remaining 22 percent is provided by groundwater wells which are utilized in late spring through early fall to supplement supply during peak demand season. This split between surface water and groundwater supplies represents an increase in groundwater usage in comparison to the 2006 WSMP data.

Figure 4-1 | Water Supply System Overview



4.3 Performance Criteria

Performance criteria for supply are presented in Chapter 3 and summarized here. The water supply should have firm capacity to meet the future maximum daily demand (MDD) projections and be capable of providing adequate peak season (summer) supply. Water supply adequacy is measured based on firm capacity of facilities. Additional discussion on assumed firm capacity of different supply facilities is included in analysis discussions throughout the chapter. In order to be considered a feasible option for the City, a long-term water supply source must meet several criteria which are aligned with those used by other communities in the region. The criteria that will be used to evaluate the supply source options are:

- Ability to consistently meet all, or a substantial portion, of the City's long-term water supply needs.
- Ability to cost-effectively integrate source options into current treatment, supply, and distribution system.

4.4 Max Day Demand Evaluation

The City's supply sources and infrastructure should be capable of meeting MDD. Supply capacities are typically evaluated based on firm capacity for reliability and redundancy of the system. After discussion with City staff, this evaluation assumes firm capacity for MDD is defined as the supply capacity with the largest well offline. Currently, the City's largest well is the Lone Pine Well with a capacity of approx. 3.0 MGD. **Table 4-1** summarizes existing and projected system MDD, supply firm capacity, and estimated supply surplus or deficit to meet system MDD. The existing wells include Marks and Jordan Wells and the proposed wells include Riverside Wells 1&2 (which were constructed but not yet operational at the time of the study).

Table 4-1 | MDD Supply Evaluation

Year	Demands	Supply				MDD Surplus/Deficit (MGD)
	System MDD (MGD)	Existing Wells (MGD)[1]	Proposed Wells (MGD)[2]	Wicks WTP Est. Capacity (MGD)[3]	Total (MGD)	
2024	9.28	4.68	3.88	5.31	13.87	4.59
2029	12.08	4.68	3.88	5.31	13.87	1.79
2034	14.90	4.68	3.88	5.31	13.87	-1.02
2039	15.26	4.68	3.88	5.31	13.87	-1.38
2044	15.63	4.68	3.88	5.31	13.87	-1.75
2074	19.40	4.68	3.88	5.31	13.87	-5.53

Notes:
1. Assumes Lone Pine Well offline (firm capacity of wells) and 24 hr/day operation of wells
2. Proposed Riverside Wells capacities are water rights limited when pulling native groundwater
3. Assumes effective finished water capacity of existing Wicks WTP (see Chapter 6 for more discussion)

It should be noted that while the capacities of the Jordan, Marks, and Lone Pine Wells are limited by equipment (pumping capacities), the proposed combined capacity of Riverside Wells 1&2 are currently limited by the maximum authorized rate of the City's groundwater rights. The City's water rights, evidenced by inchoate transfer T-13904, authorize the use of a maximum instantaneous rate of 6.01 cfs (approx. 3.88 MGD) from the Riverside Wells. The combined design capacity of the two wells' equipment is 8.0 cfs (approx. 5.18 MGD). The maximum authorized rate of the City's current groundwater rights for the Riverside Wells was considered to be a limiting factor for the purpose of this analysis.

The Wicks WTP existing peak capacity is assumed to be 5.31 MGD (see **Chapter 6** for additional evaluation and discussion on Wicks WTP). The availability of surface water to supply Wicks WTP is not assessed in this MDD evaluation. Discussion of the availability of surface water is included in the peak season supply considerations in the following sections.

As shown in **Table 4-1**, there is a projected MDD deficit within the 10-year planning period. To meet projected MDD demands, it is recommended the City submit a water right transfer application to add the Riverside Wells as an authorized point of appropriation under its existing groundwater rights. This would allow the City to maximize the use of the Riverside Wells' design capacity. It is recommended the City complete testing of the wells and confirm the effective capacity/design rate before submitting the final application for the water right transfer. If approved and the wells can produce the design rate, this would increase instantaneous capacity by approximately 1.3 MGD to meet future MDD. Part of the strategy to meet long-term projected supply requirements requires capacity expansion of Wicks WTP. Additional discussion and recommendations for overall supply system requirements are included at the end of the chapter.

4.5 Peak Season and Annual Supply Considerations

There are a number of factors that impact the City's supply availability and capacity on a peak season and annual basis. For the WSMP, supply was evaluated on an average monthly flows basis and annual volumes for a water year (October to September). The WSMP evaluation considered the following in developing an understanding of the City's existing supply system and peak season and annual capacity.

- Surface water
    - Streamflow (surface water availability)
    - Surface water rights
    - Raw water storage
    - Wicks WTP capacity
- Groundwater
    - Critical groundwater area
    - Groundwater water rights

The following sections describe the factors above and data limitations and summarize relevant assumptions made for the supply analysis.

4.5.1 Surface Water Availability (Streamflow)

The City's surface water is sourced from the Dog River, Crow Creek Reservoir, and SFMC watersheds. Based on discussions with City staff, this analysis uses the 10th percentile streamflow to evaluate surface water availability. The 10th percentile streamflow represents the flow that is exceeded in 9 out of 10 years.

A high-level climate change impact evaluation on surface water availability was included as part of the WSMP. This evaluation characterized the historical and projected future climate and flows from the Dog River, Crow Creek Reservoir, and SFMC watersheds by analyzing potential changes in streamflow, ambient (air) temperature, precipitation, and snowmelt in the watershed areas. The complete evaluation is documented in the Climate Change Impacts technical memorandum found in Appendix A. The evaluation assessed changes in future conditions by developing three representative periods: historical (data from water year 1980-2010), mid-century (data from water year 2030 to 2060), and late-century (data from water year 2065-2095). A general summary of the findings for the parameters evaluated is as follows.

- There is a clear shift in seasonal hydrograph of the mid- and late-century projections compared to historical. The historical hydrograph illustrates a system predominantly based on snowmelt with peak runoff in May. Mid-century projections show this shifting to a rain/snow mixed system with two similar magnitude peaks, one in winter (February) and one in spring (May). Late-century projections show a system dominated by rain with a single peak in winter (February).
- Peak summer temperatures are projected to increase from historical average by up to 2.5 degrees Celsius (°C) in mid-century and up to 5.5°C by late-century.
- Projected mid and late-century precipitation is higher in the winter months and slightly lower in the summer months compared to historical averages.
- Snowmelt is projected to increase in winter months and decrease in spring months compared to historical averages. More winter precipitation falling as rain instead of snow and winter

temperatures being high enough to melt some existing snowpack leads to significantly less snowpack available for melt in the spring and summer months.

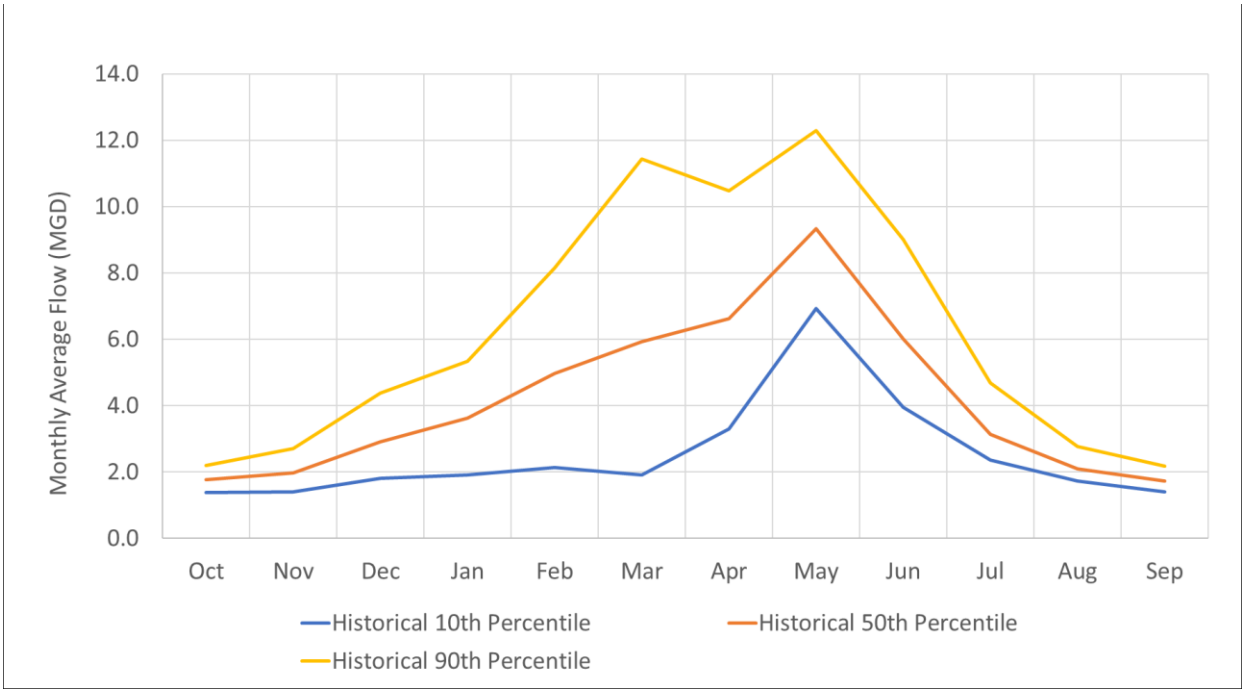
- Low (10th percentile) and median (50th percentile) of range of projections show an approximate 5-6% decrease in overall watershed runoff at mid-century and approximately 10-11% watershed runoff decrease at late-century compared to historical watershed runoff. While there is a projected increase in annual precipitation, the projected decrease in watershed runoff is primarily due to increases in evapotranspiration and higher atmospheric temperatures.

As noted previously, the climate change impact evaluation included assessing the monthly historical average streamflow of the watersheds contributing to the City's surface water supply. This information and analysis were used to form the basis of existing surface water availability for the supply analysis. A summary of the relevant streamflow assumptions is included in the following paragraphs. Additional information can be found in the technical memorandum in Appendix A.

Historical streamflow data for the Dog River are sparse, but there is a period from 2012–2021 with consistent flow data provided from the City. These data are a combination of flow measurements at the diversion point, as well as streamflow measurements at an old USGS v-notch weir gage just upstream of the diversion (USGS gage ID 14113400, located at Latitude 45°24'30", Longitude 121°31'10"). The combined data is evaluated as the greater recorded value of the diversion flow or v-notch weir streamflow each day. The combined streamflow data are used as the basis for the historical streamflow for the Dog River at the location of the diversion facilities. Observed historical low (10th percentile), median (50th percentile, and high (90th percentile) average monthly flows on Dog River at the point of diversion were developed from this data and are summarized in Figure 4-2. Additional information of the data and process can be found in Appendix A.

Streamflow data for Crow Creek and SFMC discharging into the Crow Creek Reservoir are not readily available. The Climate Change Impacts technical memorandum compared watershed datasets and concluded that the simulated data could be reasonably applied over all three watersheds – Dog River, Crow Creek, and SFMC for this level of evaluation. A runoff value in units of depth per time was applied across all watersheds. Based on acreage of the watersheds, the Crow Creek Reservoir watershed is approximately twice as large as the Dog River watershed at the Dog River pipeline point of diversion. Estimated average monthly streamflow at Crow Creek Reservoir and SFMC at the Wicks WTP intake facility are included in the technical memorandum. The monthly streamflow in SFMC at the Wicks WTP intake indicates that the current water right (2 cfs) is limiting, not streamflow. City staff agrees and has qualitatively observed the water right limit rather than streamflow even during low flows in the year.

Figure 4-2 | Historical Dog River Average Monthly Streamflow



4.5.2 Natural Flow Surface Water Rights

The City has natural flow water rights on the Dog River, SFMC, and the Columbia River. Natural flow water rights do not include the City's right to store water in or use water released from Crow Creek Reservoir. Currently, the City diverts water from the Dog River and SFMC and has not developed the water right on the Columbia River. The Dog River water right allows the City to divert "all the water in stream at point of diversion". Through Special Use Agreement with the USDA Forest Service, the City has agreed to bypass to Dog River a minimum of 0.5 cfs at the Dog River Diversion during August, September, and October annually. The SFMC water right has an authorized rate of 2.0 cfs (1.29 MGD). As noted in the previous section, estimated monthly streamflow and City staff observations indicate that the maximum rate of the water right limits SFMC intake at the Wicks WTP, rather than streamflow. The Columbia River water right has a maximum authorized rate of 40 cfs (approx. 25.8 MGD). It should be noted that the City does not currently have any live water rights on Crow Creek.

4.5.3 Raw Water Storage

The existing Crow Creek Reservoir can physically impound approximately 800 ac-ft (260 MG). Current City operations do not lower the reservoir water elevation more than 10 feet above the outlet pipe, which results in approx. 210 MG of useable raw water storage for the City. The City holds two storage water rights. Certificate 44917 authorizes storage of 955 ac-ft (310 MG), which exceeds the physical capacity of the existing reservoir. Extended permit R-13105 authorizes storage of 2,100 ac-ft (685 MG).

Crow Creek Reservoir receives diverted flow from Dog River through the Dog River Diversion Pipeline, as well as runoff from the Crow Creek and portions of the SFMC watersheds. The reservoir is located at the confluence of SFMC and Crow Creek.

4.5.4 Wicks WTP Capacity

Discussion and evaluation of the Wicks WTP is included in **Chapter 6**. For the supply evaluation, **Table 4-2** summarizes the assumed Wicks WTP average monthly treatment capacities.

Table 4-2 | Wicks WTP Average Monthly Capacity

Month	Capacity (mgd)
10	4.25
11	3.98
12	3.98
1	3.98
2	3.98
3	3.98
4	4.25
5	4.78
6	5.31
7	5.31
8	5.31
9	4.78

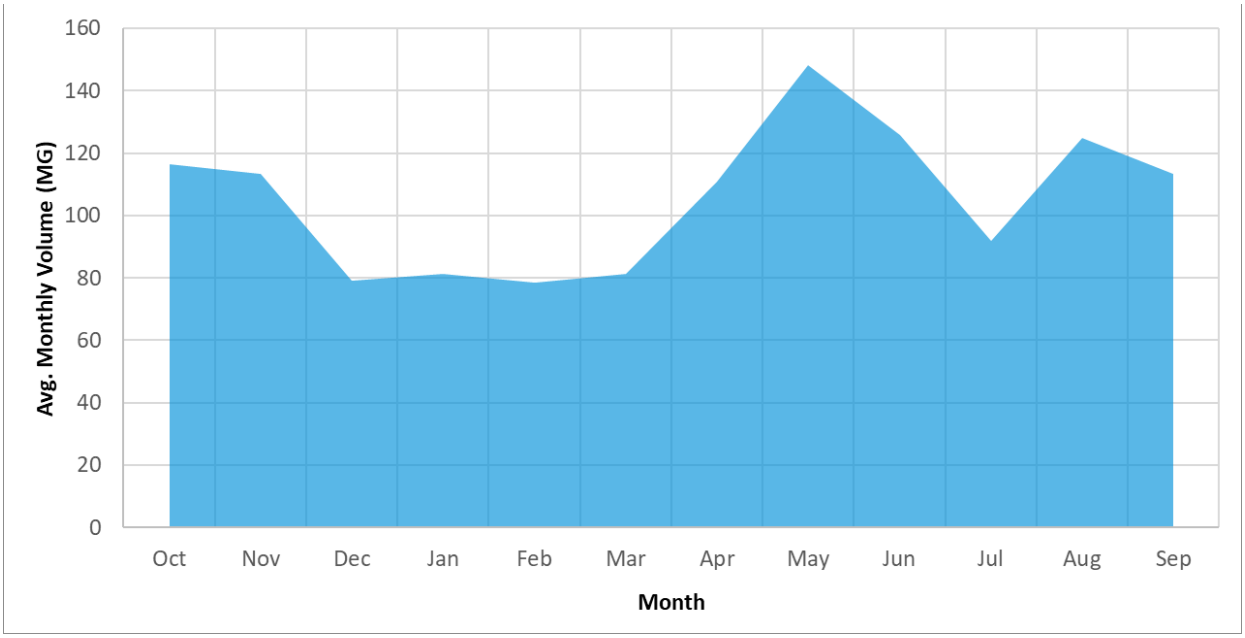
4.5.5 Surface Water Supply

Based on the data and assumptions described in the sections above, the average monthly surface water supply available to the City is limited by a combination of streamflow, water rights, raw water storage, and the WTP capacity throughout the year. The base assumptions for each component that form the basis of the estimated existing surface water supply available to the City are summarized below.

- Dog River water availability assumes 10th percentile flows
  - 85% streamflow capture rate for diversion to City supplies
- SFMC water right limits SFMC flows diverted and treated at Wicks WTP to 2.0 cfs
- Crow Creek Reservoir has an annual storage capacity of 210 MG
  - Filled by Crow Creek and SFMC watershed run off (not diverted Dog River flows)
- Wicks WTP monthly average capacities as stated in **Table 4-2**

Figure 4-3 illustrates the average monthly volume of surface water supply for the City. All the months except for May are constrained by available streamflow and water rights as opposed to Wicks WTP capacity. Raw water storage contributions are limited by existing physical raw water storage capacity (Crow Creek Reservoir volume). The estimated annual volume of existing surface water accessible for City supply is 1,260 MG.

Figure 4-3 | Estimated Average Monthly Existing Surface Water Supply



4.5.6 Critical Groundwater Area

The area in which the City's wells are located has been designated The Dalles Critical Groundwater Area (CGWA) by the Oregon Water Resources Department (OWRD) because of historically declining water levels in the aquifer. Wells within The Dalles CGWA require monitoring of groundwater use by existing users and prohibition of new groundwater rights for applications filed after 1959. Although the levels have stabilized in recent years, OWRD may restrict annual withdrawals by the City and other groundwater users if water levels begin again to decline.

Data and observations collected from the Dalles Groundwater Reservoir (DGWR) in support of the CGWA designation in 1959 and in the years since its establishment show that groundwater levels in the DGWR continued to decline following the CGWA designation in 1959 through the mid-1990s, when groundwater levels stabilized with annual pumping of between 5,000 and 5,500 acre-feet (1,629 to 1,792 MG) (Golder, 1999). In the past decade and a half (since 2010 and the closure of Northwest Aluminum operations), the annual volume of groundwater pumped from the DGWR has decreased significantly to approximately 1,800 ac-ft (586 MG) (Water Supply Analysis for Buildable Lands Assessment in the 310 Zone, GSI, 2021).

Assuming that the natural recharge conditions and annual volume of groundwater used by others in the DGWR remains consistent with the past decade of use, being approximately 1,300 ac-ft, it is assumed the City can use approximately 4,200 ac-ft (1,370 MG) annually without exceeding the level of pumping at which groundwater levels stabilized in the 1990s (GSI, 2021).

4.5.7 Groundwater Rights

The Dalles CGWA limitations as described above limit the annual groundwater supply more than the City's existing groundwater rights (which are limited to a maximum instantaneous rate, as summarized in **Table 1-3**). The City's groundwater rights are incorporated in the MDD analysis presented earlier in the chapter.

4.5.8 Annual Water Balance Analysis

Annual water balances were evaluated for surface water and groundwater supply as described in the preceding sections and existing and projected demands presented in **Chapter 2**. Annual balances were evaluated on an average monthly basis for a water year (from October to September). **Table 4-3** and **Figure 4-4** summarizes the annual water balances and estimated supply surplus or deficits compared to demands (all volumes presented in MG). As shown in the summary table, there is a projected supply deficit within the 10-year planning projections. The magnitude of supply deficit increases by the 50-year, long-term projections.

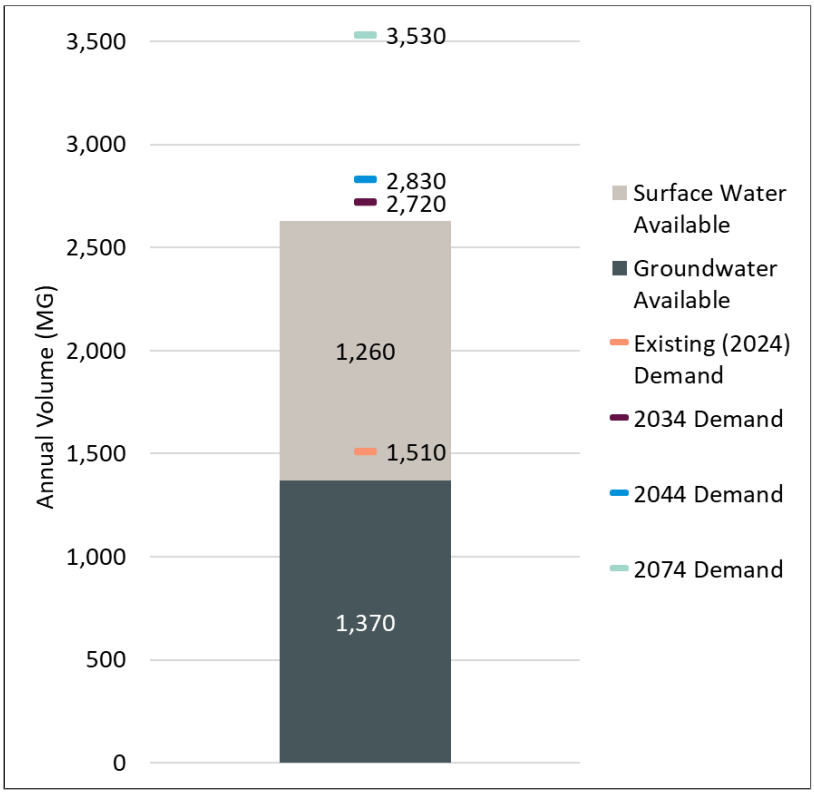
The climate change impact evaluation on surface water availability (**Appendix A**) estimated annual reductions in watershed runoff of approximately 6% by mid-century and 11% by late-century for 10th percentile streamflow. These reductions would be primarily due to increases in evapotranspiration and higher atmospheric temperatures. The last column in **Table 4-3** shows the estimated annual deficit with a 6% reduction in Dog River streamflow available for the 10- and 20-year horizons and an 11% reduction in Dog River streamflow available for the 50-year horizon.

Table 4-3 | Annual Water Balance Summary (MG)

Projection Year	Demands	Groundwater Available	Surface Supply Available	Annual Surplus/Deficit	Climate Impact Deficit
Historical Use (2017-2022)[1]	1,260	220	1,040	-	-
Existing (2024)	1,510	1,370	1,260	1,120	-
2029	2,130	1,370	1,260	500	-
2034	2,720	1,370	1,260	-90	-140
2044	2,830	1,370	1,260	-200	-250
2074	3,530	1,370	1,260	-900	-990

Note:
1. Based on historical 2017-2022 water production data

Figure 4-4 | Annual Water Balance Summaries



4.6 Supply Expansion Options

As shown in the annual water balance summary, there is a projected supply deficit within the 10-year planning horizon that increases significantly by the 50-year, long-term planning horizon. As described in previous sections, some of the primary limitations on current City supply resources are,

- Dog River streamflow
- Water right on SFMC
- Raw water storage capacity
- Wicks WTP capacity
- Sustainability of critical groundwater area pumping

A number of options to address these limitations and/or expand the City's supply are discussed and evaluated at a high level in the following sections. Based on the estimated long-term deficit in annual supply and the variety of unknown and unpredictable variables of supply sources, it is likely that the City will need to pursue a combination of options moving forward to secure and maintain a resilient supply to meet growing demands. The options discussed include,

- Aquifer storage and recovery (ASR)
- Artificial groundwater recharge (AR)
- Expanded raw water storage
- Deep groundwater
- Columbia River source

4.6.1 ASR

4.6.1.1 Overview of Concept and Water Availability

The City holds a limited license for ASR testing to store treated surface water from Wicks WTP in the DGWR (LL#25). The use of surface water for ASR is authorized by the City's existing certificated surface water rights for the Dog River, SFMC, and Crow Creek Reservoir. ASR generally allows for storage of water during winter and early spring when there is a surplus of flow available and recovery when surface water sources are diminished (during the summer). The limited license allows for up to four proposed ASR wells to store a volume of up to 1,200 MG of treated surface water for subsequent recovery and use. The water stored by ASR is a separate volume of water (source) available that is not restricted by water rights or CGWA constraints.

The ultimate storage volume that can be achieved by an ASR project depends on the hydraulic response of the aquifer and well to injection and recovery, the potential for loss of stored water, and water quality impacts, among other factors. In early 2025, the City plans to begin implementation of ASR pilot testing at either Riverside Well 1 to help understand these factors. The LL#25 (GSI, 2018) allows for instantaneous recovery rates up to 2,500 gpm. The final recovery and subsequent recharge rates are dependent on many site/aquifer specific variables. The pilot testing approach presented in the City's ASR Limited License (GSI, 2018) and GSI's Riverside Well 1 Aquifer Storage and Recovery Testing Plan (GSI, 2024) will be used as a starting point to evaluate various factors and assess the ultimate storage volume (and rates of recovery and recharge) of the City's ASR system.

Potential limitations to the use of ASR include (1) existing treatment capacity at Wicks WTP and (2) water availability under the City's existing water rights.

(1) **Existing Treatment Capacity.** Wicks WTP is located along SFMC and is the source of treated water to be used in the ASR pilot testing program at the Riverside Wells. During the winter, existing treatment capacity is assumed to be limited to approximately 4 mgd (2,750 gpm). This is sufficient for the planned injection rate of 75% of recovery rate (assumed to be 1,875 gpm: 75% of design recovery rate of 2,500 gpm) for Riverside Well 1. However, it may not be possible for the City to meet other water demands without pumping from its other groundwater wells, reducing the benefit of the ASR project as a means of reducing pumping impacts on water levels. Additionally, current winter WTP capacity is not sufficient for continuous injection at both Riverside Well 1 and Riverside Well 2. Expanded treatment capacity during the winter months would alleviate this limitation when sufficient water is available under the City's water rights. See **Appendix D** for the complete evaluation of Wicks WTP.

(2) **Water Availability.** The City diverts a mixture of natural flow from SFMC, natural flow from Dog River (conveyed via the Dog River Diversion Pipeline), and Crow Creek Reservoir storage releases at the Wicks WTP intake. During winter, the City is generally working to fill Crow Creek Reservoir, including using water from Dog River to be released during peak season and summer when streamflow decreases. During low runoff winters, the City may not have enough water available under its natural flow surface water rights to meet its winter water demands, fill Crow Creek Reservoir, and provide a surplus of water for ASR recharge. With the expansion of Wicks WTP winter treatment capacity and increases in winter water demand, the City's surface water rights may become the primary limitation on the amount of water available for injection. It may be possible to obtain a limited license of permit to increase water availability for aquifer storage (see **Section 4.6.2**).

4.6.1.2 Aquifer Conditioning

ASR recharge will occur during the winter when the surface source water is colder than native groundwater in the receiving aquifer. The temperature of groundwater in the receiving aquifer and, therefore recovered groundwater, will become colder because the temperature of the source water is retained during storage, provided that the injected water is not fully recovered. The process of improving water quality through ASR is called "aquifer conditioning." The benefit of aquifer conditioning in this application is that cooler groundwater temperatures in the DGWR could result in a lower industrial cooling water demand because industrial groundwater uses (when water is used primarily for cooling purposes) could be more efficient.

4.6.1.3 ASR Implementation

The ultimate storage volume that can be achieved by an ASR project depends on the hydraulic response of the aquifer and well to injection and recovery, the potential for loss of stored water, and water quality impacts, among other factors. The pilot testing approach presented in the City's ASR Limited License (GSI, 2018) and the City's Riverside Well 1 ASR Testing Plan (GSI, 2024) will be used as a starting point to evaluate these factors and assess the ultimate storage volume of the City's ASR system.

The City plans to conduct recharge at Riverside Well 1 generally during the non-peak season (winter), and generally recover the water during the peak season (summer). Based on a 30-hour constant rate aquifer test at Riverside Well 1 in March 2024, GSI anticipates that recovery at Riverside Well 1 can occur at about 1,800 gpm, and recharge at Riverside Well 1 can occur at about 1,350 gpm. The first step in ASR cycle testing will be a shakedown test to assess the performance of the piping, pumps, valves, and controls, and will last about one day. Following the shakedown test, a full recharge-storage-recovery cycle will occur.

The recharge and recovery rates and durations, and the storage account volume for the pilot testing cycles will be determined on the basis of previous years' operations and the water needs to the City. The ultimate objective of pilot testing is to develop a larger storage volume using the wells developed under the limited license to store up to 1,200 MG (inclusive of ASR account carryover) during the first five years of pilot testing.

4.6.2 Artificial Groundwater Recharge (AR)

4.6.2.1 Overview of Concept and Water Availability

The City may be able to obtain a water right for the use of SFMC for artificial groundwater recharge (AR). AR would be conceptually similar to ASR, involving the City storing treated surface water from Wicks WTP in the DGWR during winter/spring months when surplus surface water is available. However, unlike ASR, the water added to the aquifer by AR does not create a separate volume of water (source); rather, the water recharged to the aquifer by AR would be used to offset native groundwater withdrawals by the City that would otherwise be unsustainable volumes of pumping for the aquifer. The same wells used for ASR could be used for AR.

Obtaining a limited license or permit for AR would increase the maximum rate the City is authorized to divert winter flows on SFMC beyond the City's existing 2.0 cfs water right for that source. In contrast to ASR, for which water stored in the aquifer is diverted under the City's existing water rights, a limited license or permit for AR would be additive to the City's existing water rights. This is especially beneficial during times when Dog River flows are low or diversion of water from Dog River is prioritized for filling Crow Creek Reservoir.

When evaluating an application for a limited license or permit for AR, OWRD evaluates water available for diversion at the 50 percent exceedance flow for a source. OWRD's Water Availability Reporting System (WARS) shows that a minimum of 4.12 cfs (2.66 mgd) is available at the 50 percent exceedance flow for SFMC from January through April. OWRD evaluates water available at the 80 percent exceedance flow when evaluating an application for a new water right for direct diversion. OWRD's WARS shows that there is not water available from SFMC at the 80 percent exceedance flow, which is why the City could pursue an AR permit but not a new direct diversion water right on SFMC.

AR could be operated in conjunction with an ASR Program. Similar to ASR, Wicks WTP existing winter capacity could limit the ability to maximize use of an AR limited license or permit when water is available in SFMC. Expanded treatment capacity during the winter months would help to alleviate this limitation.

4.6.2.2 Application Process

AR can be authorized through either a limited license or a new water use permit. Like ASR, OWRD generally expects that applicants will first pursue a limited license for AR testing. The rules for obtaining an AR permit require a detailed understanding of aspects of the project that may not be available before artificial recharge begins, including, for example, determinations about the amount of water that is recoverable.

The City plans to initiate testing of ASR in early 2025. Depending on when the City would submit an application for an AR permit, limited license, or both, the City may have more information about the aquifer response to artificial recharge than is typical for submittal of a limited license application for AR. As a result, it may be possible for the City to pursue a permit for AR without first obtaining a limited license for AR. Additional communication with OWRD regarding the appropriate application pathway for the City's project will be needed.

Similar to ASR, an application for a permit for AR requires submittal of supplemental information, including a hydrogeologic feasibility report, information about potential impacts of artificial recharge, and a water availability statement. One important requirement is that, if a stream is the proposed recharge source, it must have a minimum perennial streamflow or instream water right. There is an instream water right for SFMC.

An AR permit would include conditions requiring a monitoring program, designation of monitoring wells and target water levels in those wells, and submittal of annual reports. Because the City's AR project would utilize the same system and wells for recharge as the City's already authorized ASR project, the City will likely be able to re-use much of the information already developed in support of the ASR feasibility study for the AR permit application or limited license application, including water quality information. Likewise, the monitoring and reporting requirements for the ASR project would likely overlap with those included in an AR permit or limited license.

Notable relevant differences in the AR permit application process from the ASR limited license application process include (1) water quality standards, (2) required monitoring, and (3) demonstration of financial ability. A summary of these differences is included below and discussion of these differences as they apply to the City's potential application is included after.

- Water Quality Standards. Source water to be injected as part of ASR projects is generally required to be treated to human health standards. However, for AR, OWRD uses Department of Environmental Quality's (DEQ) anti-degradation standards to evaluate the suitability of source water. This simply requires that source water be of equal or better water quality as in the target aquifer any worse than pre-injection conditions.

- **Monitoring Requirements**. AR permits require more effort in developing and implementing a monitoring plan in that a monitoring well network needs to be identified (similar to ASR) and that water level targets need to be identified for key monitoring wells (not required for ASR). These targets are used to determine the availability of water for recovery.

- **Financial Capability**. AR projects that aim to inject 5 cfs or more of source water must include proof of financial capability to construct and operate the project in the form of written statements from a lending institution.

Practically, many of these components of the application process are already covered by the ASR limited license application materials. Given that the source water is the same, and is treated water, water quality concerns should not be an issue. Despite the AR rules not requiring a mixing analysis, one would still be advisable given that the AR source water will be injected into a confined aquifer; this already exists as part of the ASR limited license and is applicable to AR as well. The establishment of target water levels in key monitoring wells and demonstration of financial capability would likely be the only "new" work required beyond what was already submitted for the ASR limited license. Should OWRD approve the proposed path, injection under AR rules would serve to provide an additional source of injection water to the City's Riverside Wells.

4.6.3 Expanded Raw Water Storage – Crow Creek Dam Expansion

Crow Creek Dam is an earth and rockfill dam that was constructed in 1967 and 1968. The dam has a maximum height of 100 feet above the streambed and a crest length of approximately 780 feet. The spillway is an unlined, open cut spillway channel located on the left abutment.

A 1996 study prepared for the City assessed the feasibility of expanding Crow Creek Dam and the spillway capacity (Woodward Clyde, 1996). The study found that it was feasible to raise the dam height by 35 feet to increase the storage capacity from approximately 800 ac-ft (260 MG) to 1,970 ac-ft (640 MG). The study also identified the spillway capacity as insufficient to handle the probable maximum flood (PMF) which is a typical requirement of dam safety rules.

Further evaluation of a dam raise and spillway improvement options or concept design updates were not included in the scope of this WSMP. It is assumed the general findings of feasibility are still applicable, though it is acknowledged that project details and requirements have likely changed. In particular, it should be noted that at a high level the 1996 study does not reference or capture regulatory settings that reflect the current regulatory setting for a project to increase a dam's height in Oregon. The Oregon Dam Safety Rules provide a stringent list of requirements that need to be followed for approval for construction by the Oregon State Engineer. The 1996 concept design may need significant reformulation to conform with all current Dam Safety Rules in Oregon.

General items to consider and include in project understanding and cost estimating.

- Project documentation is expected to be significant and extends beyond just final design and as-built documents. It will be important to identify early a clear list of required documentation for the project such as, Emergency Action Plan (EAP), Operations & Maintenance Manual update, Record of Construction (per OAR requirements), etc.

- Additional geotechnical investigation and lab testing will need to be performed to support the geotechnical analyses and design.

- Dam breach inundation analyses, site specific probable maximum precipitation (PMP)/PMF study, and other hydraulic analyses would be major design tasks to be included.

- The cost estimate is subject to change pending coordination with Oregon Dam Safety on specific project requirements.

It should be noted that the 1996 study identified spillway improvements as necessary regardless of a dam raise to provide adequate capacity for the PMF. This should be further evaluated as part of an updated concept design.

4.6.3.1 Water Right Considerations

The City's raw water storage in Crow Creek Reservoir is authorized by Certificate 44917, which allows the City to store up to 955 acre-feet of water. The City also holds a secondary water right, certificate 60410, for the use of the 955 acre-feet of stored water.

The City holds a separate permit, R-13105, for storage of an additional 2,100 acre-feet in an expanded Crow Creek Reservoir, and a secondary water use permit, S-53930, for the use water from the expanded reservoir. OWRD approved an Application for Extension of Time extending the deadline for making full beneficial use of water under the permit to October 1, 2041. This order also imposed additional conditions on the use of water under the permit, including that the use of water under Permit S-53930 shall only be authorized upon issuance of a final order approving a WMCP. The City is currently developing a second 10-year WMCP and plans to request access to water under Permit S-53930 ("greenlight water") to retain the option to develop this water right over the next ten years. If the City's WMCP and request for access to the permit are approved, the City would have access to use the volume of water requested in the WMCP (2,100 ac-ft) from an expanded Crow Creek Reservoir. The City will need to continue to request access to greenlight water in future WMCPs (updates are due every 10 years). There are no fish persistence conditions affecting the use of Permit S-53930 and the City is not required to request access to water under Permit R-13105 to begin storing water in an expanded Crow Creek Reservoir.

The specific rate and volume of water to which the City will be able to request access is based on the City's projected 20-year demands, as documented in the WMCP, and the availability of water from the City's other sources. The current draft of the City's WMCP includes a request for access to the full volume of 2,100 ac-ft.

4.6.3.2 Surface Water Availability

Streamflow data on tributaries to the Crow Creek Reservoir (Crow Creek, Alder Creek, and SFMC) as well as SFMC streamflow upstream of the Wicks WTP intake screen facilities is not available for any consistent period of time. There is some streamflow data for SFMC at the confluence with Mill Creek that has been used by OWRD for the online water availability analysis. The limited data on streamflow contributing to Crow Creek Reservoir (not including contributions from the Dog River Diversion Pipeline) and SFMC upstream of the WTP intake presents a challenge and inability to understand or quantify potential surface water available for storage in an expanded Crow Creek Reservoir. Operators and limited historical data from the Crow Creek Dam outlet pipe and spillway suggest there is typically a good amount of flow that passes through the dam during late winter and spring months after Crow Creek Reservoir has been close to or filled. Statistical evaluation of percentile volumes available for raw water storage (such as raw water available in a 10^{th} percentile streamflow year, etc.) is not possible without consistent data on streamflow contributions to the reservoir over multiple years.

4.6.4 Deep Groundwater (Grande Ronde Basalt)

4.6.4.1 Overview of Concept

One alternative for expanding groundwater supply may be to apply for a new groundwater right in a different, deeper aquifer. Currently, the City's wells pump groundwater from the DGWR, which is comprised of basalt flows of the French Springs Member of Wanapum Basalt Formation[1]. The Wanapum Basalt Formation is underlain by the Grande Ronde Basalt Formation, and OWRD considers the units to be hydraulically separate, distinct aquifers. Therefore, a Grande Ronde Basalt groundwater source would not be subject to the limitations of the existing CGWA designation for a Wanapum Basalt source. The Grande Ronde Basalt Formation which underlies the Wanapum Basalt (where the Dalles Pool Aquifer resides) would be the target aquifer for a new well.

This section provides an overview of the process for developing a Grande Ronde Basalt supply source, well capacity and source sustainability, and uncertainties associated with a Grande Ronde Basalt supply source. The information in this section reflects GSI current understanding of upcoming changes to how OWRD is evaluating and processing new groundwater right applications; new groundwater allocation rules were adopted by the Water Resources Commission in September 2024.

4.6.4.2 Process for Development

The general process for developing a Grande Ronde Basalt supply would involve the following steps:

- **Desktop Study.** Perform a desktop due diligence review for applying for a new groundwater right and developing a Grande Ronde Basalt groundwater supply. The desktop study would involve:
  - Reviewing information regarding existing water demands.
  - Assessing criteria currently used by OWRD to evaluate permit applications for appropriation of groundwater for municipal use, which will include basin program rules, water availability, and interagency additional public interest review.
  - Estimate water supply that could potentially be obtained from groundwater, including evaluating any available information about the status of groundwater in the Grande Ronde aquifer (including the stability of groundwater levels and well yields in the area).
  - Refine cost estimates for constructing a new well in the Grande Ronde Basalt.
- **Permit Application.** Assuming the desktop study is favorable to development of a Grande Ronde Supply source, the next step could be for the City to move forward with submitting an application to use groundwater. It is likely that a pilot well will be needed for final approval of an application. Moving forward with the application first could allow for OWRD to bring up any other concerns or provide conditional approval if the pilot well data shows favorable results for development before the City invests additional funds to drill a pilot well.
- **Pilot Well.** If there are no other concerns or considerations from the OWRD application process, drill a pilot well completed in the Grande Ronde Basalt to evaluate whether groundwater levels are stable. The pilot well is necessary because there are few wells completed in the Grande Ronde aquifer near the City, and therefore it would be difficult to establish whether groundwater levels

[1] Specifically, the DGWR consists of the Sentinel Gap, Sand Hollow, and Ginkgo flows of the Frenchman Springs member.

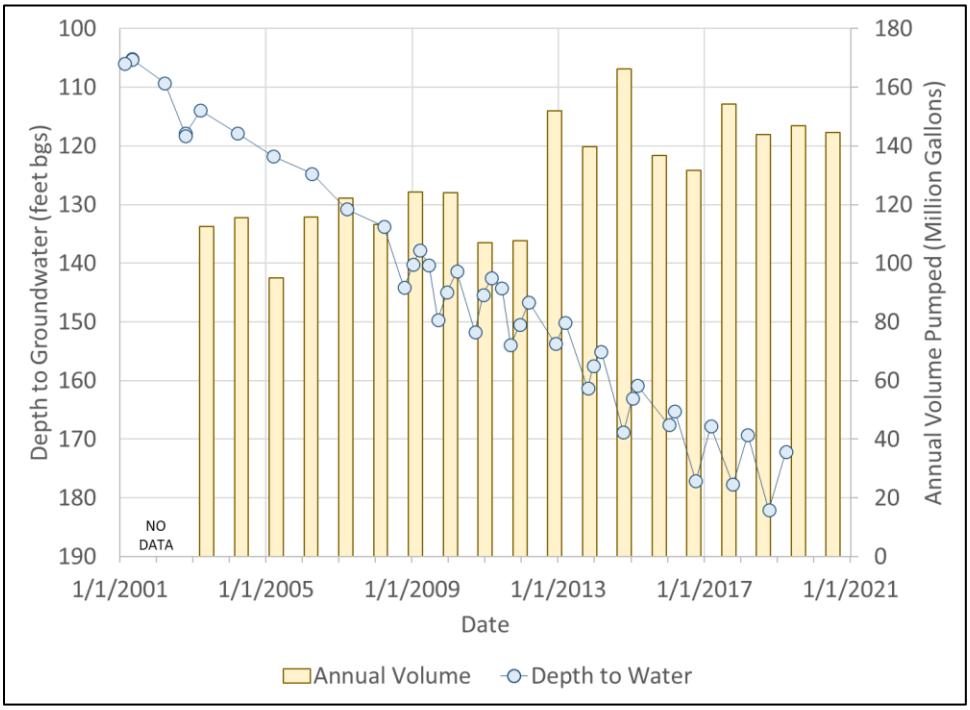
are stable using existing data. Depending on the approach selected by the City, the purpose of the pilot hole may be: (1) to evaluate the presence of apparently productive water-bearing units (i.e., a geology borehole) or to evaluate productivity of the aquifer (i.e., a test well borehole), and (2) to measure water levels for five years to evaluate stability.

4.6.4.3 Well Capacity and Source Sustainability

The Grande Ronde Basalt appears to be a productive aquifer based on data from vicinity wells. A geologic log for water well WASC 50312, located about 5 miles southeast of the City, indicates that pillow lavas occur in the Grande Ronde Formation (pillow lavas are typically highly productive). The driller log for water well WASC 50922, which is completed only in the Grande Ronde Basalt, was tested at a rate of 1,500 gallons per minute (gpm), and the geologic log for the well notes flow top breccias, which are typically highly permeable.

However, groundwater levels in the Grande Ronde Basalt south and west of the City do not appear to be stable, indicating that a Grande Ronde groundwater source may not be sustainable. **Figure 4-5** shows groundwater elevations and pumping volumes from a well located about 12 miles south of the City completed in the Grande Ronde Basalt. Note that the annual pumping volume ranges from about 100 MG to 150 MG, and water level declines of about 70 feet have occurred since 2021. Based on the data from this well, the Grande Ronde Basalt does not appear to be able to sustainably produce 100 MG annually.

Figure 4-5 | Groundwater Levels and Pumping Volumes in WASC 50922 (Permit G-15094)



4.6.4.4 Uncertainties

There are several uncertainties associated with development of a Grande Ronde Basalt supply source. The stability of groundwater levels in the Grande Ronde Basalt in the vicinity of the City is not known and water levels in the Grande Ronde Basalt south and west of the City exhibit significant declines (see **Figure 4-5**);

and productivity of the Grande Ronde Basalt in the City is not known (which could be mitigated to some extent following the desktop due diligence review).

4.6.5 Columbia River

The City holds water use Permit S-49653 which authorizes up to 40 cfs from the Columbia River for municipal use. The City has not yet developed any infrastructure to divert water from the Columbia River. There are multiple potential restrictions on the use of water from the Columbia River should the City pursue development of this source, including restrictions imposed by the City's water rights, as well as potential restrictions that could be imposed through federal permitting processes depending on how the City develops its diversion structure. The infrastructure required to divert, treat, and transmit Columbia River water to the distribution system is significant and would also change how water moved throughout the distribution system.

4.6.5.1 Water Right Limitations

On October 16, 2012, OWRD approved an Application for Extension of Time extending the deadline for making full beneficial use of water under the permit to October 1, 2073. This order also imposed additional conditions on the use of water under the permit, including:

- A development limitation stating that the use of water under Permit S-49653 shall only be authorized upon issuance of a final order approving a WMCP. The City is currently developing a WMCP and plans to request access to water under Permit S-49653 to retain the option to develop this water right over the next ten years. If the City's WMCP and request for access to the permit are approved, the City would have access to the rate of water requested in the WMCP. The City will need to continue to request access to "greenlighted water" not yet used and additional amounts of water in future WMCPs (updates are due every 10 years). The current draft WMCP requests access to up to 24.1 cfs of water under Permit S-53930. The request is based on the City's projected need for water under the permit over the next twenty years.

- A "fish persistence" condition limiting the use of water under the permit when flows drop below specified thresholds at McNary Dam during certain times of year, as shown in Table 4-4. The table also shows the frequency that the flow targets were met from 1950 through 1981 when USGS operated a gage above McNary dam. There is no longer a gage in place, but the U.S. Army Corps of Engineers (USACE) uses models of dam operations to estimate inflows. These estimates indicate that flow targets have been met more frequently since the year 2000 than from 1950 through 1981.

  The fish persistence conditions contemplate a proportional reduction in access to the permit based on the percent shortfall of the flow target. However, the fish persistence conditions under the City's permit are capped at no more than a reduction of 20 percent of the maximum authorized rate of 40 cfs. For planning purposes, it is assumed the City's maximum rate of diversion could be limited to a maximum rate of diversion of between 32 cfs (20.7 mgd) and 40 cfs (25.8 mgd) from April 10 through August 31, with the maximum rate of 40 cfs available during the remainder of the year.

Table 4-4 | Permit S-49653 Fish Flow Targets

Time Period	Flow Target (cfs)	Frequency Flow Target Met at USGS Gage 14019200, 1950 - 1981
April 10 – June 30	260,000	45.2%
July 1 – August 31	200,000	59.6%

4.6.5.2 Other Potential Limitations

The City currently has no infrastructure on the Columbia River and would likely need to obtain permits to construct a new intake, water treatment plant, and transmission line through multiple agencies including a removal-fill permit from the USACE and the Oregon Department of State Lands. The permit request for a new surface water diversion typically triggers consultation with the National Marine Fisheries Service (NMFS). NMFS will complete a biological opinion containing recommended conditions to protect listed fish.

Based on biological opinions issued over the last 25 years, it is expected that the biological opinion would require water withdrawals to result in no net reduction in streamflow. This generally means permanently transferring water rights to instream use as mitigation for out-of-stream uses, such as irrigation, on the Columbia River or its tributaries. There are discussions about the possibility of providing mitigation in other ways, such as through completion of restoration projects on tributary streams, but there is limited precedent for approval using these alternatives. Additional investigation would be required to better understand these options.

If electing to go through this process, the City should assume that it will take at least five years to obtain the necessary permits.

Depending on local conditions, it may be possible for the City to obtain water from the Columbia River through a collector well or other water supply intake that would not trigger the need for USACE to consult with NMFS. Additional hydrogeologic investigation would be needed to determine if local conditions are suitable for a large collector well with a strong hydraulic connection to surface water. The specific design of the well and its relationship to the need for a biological opinion would also require additional investigation as would the need and feasibility of implementing a water use permit amendment to change from a surface water diversion to a groundwater diversion.

Historically, there has been clear aversion to the Columbia River as a water source by the public as well as City Council. The primary concern with using Columbia River water was because it has an uncontrolled watershed and the City's withdrawal point is downstream of the Hanford Nuclear Site. A water supply study completed in 1991 recommended planning for the abandonment of Wicks WTP and constructing a new WTP near Sorosis Reservoir that would treat Columbia River water. Following the report, the city rejected this plan and City Council at the time made the decision to develop the existing Wicks water supply to maximum extent possible and postpone development of the Columbia River until needed due to growth, catastrophic loss of the Mill Creek supply, or future groundwater restrictions. The 2006 WMP did not re-evaluate the decision as part of the plan update. The City does not have new or recent information on public perception of using the Columbia River as a water source. The primary concern of a City intake being downstream of the Hanford Nuclear Site has not changed and there is no specific known reason to believe public opinion would have changed significantly.

4.6.5.3 Infrastructure and System Operation Considerations

As noted in previous sections, the City currently has no infrastructure to access or utilize Columbia River water to supply the system. New intake facilities including a pump station, treatment plant, transmission mains, and distribution pump stations would all be required to use the Columbia River for source water. Additionally, it is unlikely that it would be operationally or financially viable to utilize both the Wicks WTP and a Columbia River WTP at the same time because the operation and maintenance needs to manage both sets of infrastructure would be more than either individually. Therefore, developing the Columbia River source would most likely coincide with the abandonment of the Wicks WTP and the Mill Creek source water system. The City has just recently completed major investments in replacing and expanding the Dog River Diversion Pipeline which adds supply to the SFMC and Crow Creek Reservoir, a project that the City has been developing and working on for over 10 years.

Operationally, the Wicks WTP and clearwell are at a much higher elevation than the distribution system and can supply nearly all of the City's system by gravity. In contrast, the Columbia River is at the lowest elevation of the City and pumping would be required to serve the entire distribution system. This would be a fundamental change in how the system is supplied and operated. An intake pump station and distribution pump stations would need to be evaluated, designed, and constructed to provide Columbia River water to the existing distribution system.

4.7 Summary and Supply Program Recommendations

There are many variables that impact the City's overall capacity and resiliency to provide supply to meet projected demands. These systems are complex, with many components of the supply systems are highly variable and challenging to quantify. Generally, consistent empirical data over long time periods is critical to understanding and predicting supply sources. The City is in a water scarce environment and ongoing data collection, planning, and iterative analysis of the supply program will be needed for the City to continue to provide resilient water supplies to the growing community. The recommendations outline the initial steps and provide guidance for future steps based on results and findings.

ASR operations are anticipated to play a key role in addressing short to medium-term supply deficits. ASR alone will not address long-term supply deficits because it is limited by surface water availability and water rights. There is also uncertainty in how well the ASR system will perform, which can only be answered through pilot testing for this specific application. As described in previous sections, the recommended options for the City to explore to increase recharge water availability are AR and raw water storage expansion. The AR limited license and/or permit could be completed on a relatively short timeline. A raw water storage expansion project, Crow Creek Dam raise, is a significant undertaking that will require decades of planning, permitting, and implementation. There are continuing interim steps that will be critical for a successful dam raise project to be completed. The path forward to continue providing resilient water to the City will require adaptability and diligence.

The key supply analysis findings and recommendations within the 10-year planning horizon are summarized below,

- There is a MDD capacity deficit by the end of the 10-year planning horizon.
    - It is recommended to address the 10-year planning horizon MDD deficit through,
        - Transfer of unused water rights for use at the Riverside Wells

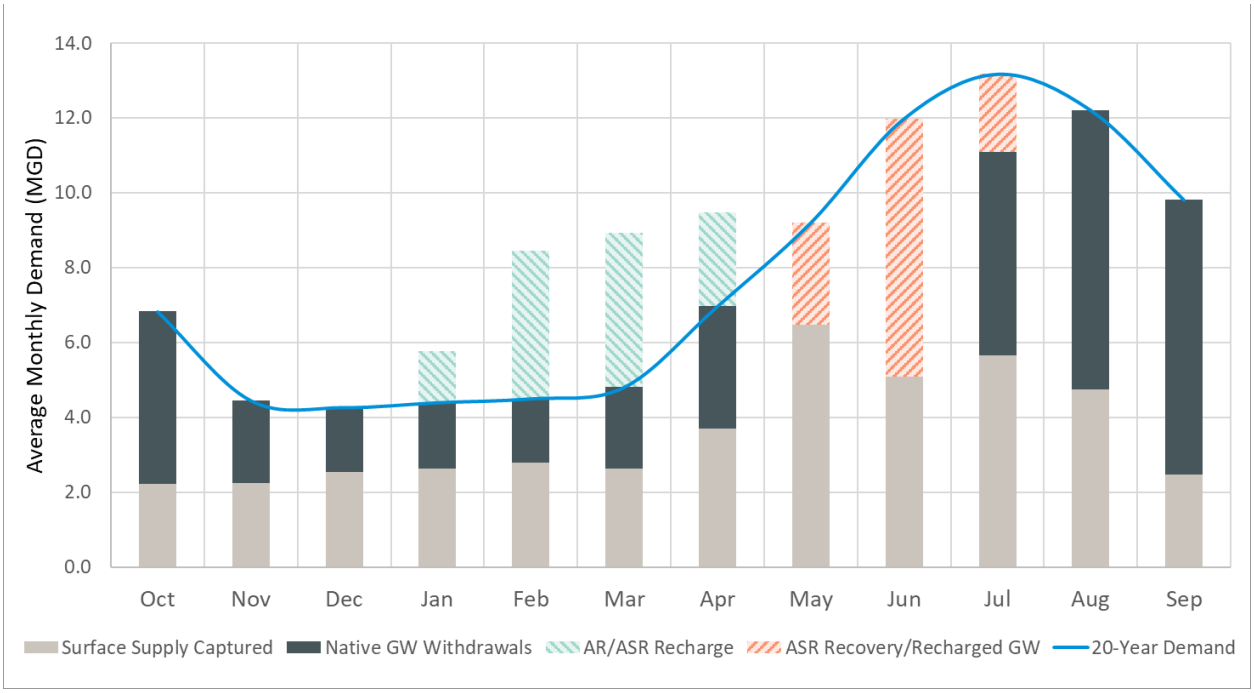
- For the 20- and 50-year planning horizons, it is recommended MDD capacity be increased through the replacement and expansion of the Wicks WTP and associated finished water transmission main. Potential ASR contributions to MDD capacity should be considered and evaluated as part of ASR Program Planning once pilot and testing plans have been completed at Riverside Well 1.

- There is an annual/peak season supply deficit by the end of the 10-year planning horizon.
  - To address short-term annual supply deficits, a combination of the following is recommended,
    - Begin ASR operations, monitoring, and pilot testing at the Riverside Wells in early 2025.
    - Apply for an AR limited license or permit using SFMC as the source of supply. This would be used and operated in conjunction with the ASR program.
    - Replace and expand the Wicks WTP capacity and associated finished water transmission main (see Appendix D for additional details on recommended WTP improvements).
    - Complete ASR Program planning.
      - An initial step of the program will be to track ongoing progress of ASR pilot testing at the Riverside Wells in order to evaluate the ability to obtain a permit for ASR in the future. While it is possible to continue to renew an ASR limited license for testing for many years, the reliability of the City's ASR program would be enhanced by obtaining a permit for ASR.
      - There are a variety of unknowns at this time about ASR operations. The City will need to follow the pilot and testing plans they have developed to be used as a starting point to evaluate various factors and assess the ultimate storage volume, rates of recovery and recharge, and future operations of the City's ASR Program. Expansion of ASR facilities will need to be evaluated within the context of the City's overall supply system.

Figure 4-6 below provides a conceptual illustration of monthly water supply source management to meet the projected 20-year demands. This supply source management strategy is based on the following assumptions,

- 10th percentile streamflow.
- Crow Creek Reservoir releases are estimated from June through September, with higher release rates during July and August to meet peak season demands.
- Approved AR permit using SFMC as the source of supply. This allows recharge with surface water that would otherwise not be accessible to the City (primarily based on water right limitations).
- Expanded Wicks WTP capacity with peak finished water capacity of 9.0-9.5 MGD. Wicks WTP expanded capacity is important to maximize AR/ASR recharge volumes.
- Expansion of ASR facilities to include recharge and recovery at Riverside Well 2 at a minimum.
- Native groundwater withdrawals are within the assumed annual sustainable pumping volumes for the CGWA.

Figure 4-6 | Conceptual Monthly Supply Source Management for 20-Year Horizon



It is important for the City to start planning and completing initial evaluations and steps to address long-term supply deficits early because of the complexity and interconnected components of the City's overall supply system. The unknowns and uncertainty as discussed in the previous sections, mean the timing for needing a Crow Creek Dam raise is variable. It is recommended the City begin the following to prepare for addressing long-term supply needs,

- Complete a seismic evaluation and Emergency Action Plan (EAP) for the Crow Creek Dam.
- Maintain and collect consistent Dog River Diversion flow and Crow Creek Dam outlet and spillway flow data.
- Complete a concept design update for expansion of the Crow Creek Dam and spillway improvements.
- Develop additional ASR wells (depending on recommendations of the ASR Program planning).
- Update the WSMP to continue to track existing demands and demand projections and refine long-term supply planning as more information, details, and timing are available.
- Update financial planning/rate study as long-term supply planning is refined.
- Assuming the ASR Program is at least moderately productive, an AR limited license or permit is approved, and Wicks WTP and finished water transmission main are replaced and expanded, it is anticipated that a Crow Creek Dam raise could be needed sometime in the 20- to 50-year planning horizon.

These recommended steps and projects to improve and expand the City's reliable water supply system are reflected in the CIP in Chapter 7.

CHAPTER 5

Distribution System Evaluation

5.1 Water Distribution System Model Update

The existing water distribution system model was created in 2006 with Innovyze's H20Map, which was used for the 2006 Water Master Plan. The 2006 water model has been updated using AutoDesk's (formerly Innovyze) InfoWater Pro. The system facilities were updated using the latest Geographic information System (GIS), as-built drawings, and system information like facility records in spreadsheets provided by the City. Updates to the model include the following data:

- Pipe diameters, lengths, and roughness factors based on age and pipe material
- Installation years for all facilities (wells, water treatment plant, pumps, valves, storage tanks, and pipes)
- Elevations assigned to nodes with lidar from the Oregon Department of Geology and Mineral Industries
- Pump curves except for Garrison Booster Pump Station
- PRV settings
- Pressure zone boundaries

5.2 Model Demands

Water distribution system evaluations require water demands to be accurately allocated in the model. The process for allocating water demands is discussed in the following subsections.

5.2.1 Existing System Demand Allocation

Assigning the existing system demands in the model requires an estimation of the total system demand followed by allocation of the total system demand to the appropriate model node locations.

5.2.1.1 Existing System Demand

Existing system demand estimates were developed using recent historical records provided by the City. The historical records include the following:

- Monthly water system billing records (January 2019 – December 2022)
- SCADA records in 5-minute and 1-hour time intervals (February 2023 – October 2023)

The two primary conditions that were considered for use in the hydraulic model are,

- Minimum Day Demand (MinDD), the water demand on the day of lowest use

- Maximum Day Demand (MDD), the water demand on the day of highest use

MinDD and MDD were calculated using available consumption (billing records) and production (SCADA records) information. Monthly customer consumption records were scaled to the daily MinDD and MDD records from SCADA. Calculated values for MinDD and MDD by pressure zone are presented in Table 5-1.

Table 5-1 | 2023 Minimum and Maximum Demands

Pressure Zone	Minimum Day Demand[1] (gpm)	Maximum Day Demand[2] (gpm)
310	1,078	2,518
352	29	207
395	148	753
395W	8	35
460	22	147
475	43	304
507	60	384
513	13	96
560	7	44
632	15	87
660E	41	303
660W	34	270
786	26	301
880	23	183
Brenner	15	103
Sunridge	3	15
TOTAL	1,565	5,750

Note:
1. The available SCADA shows the Minimum Day Demand occurred on February 26, 2023.
2. The available SCADA shows the Maximum Day Demand occurred on August 15, 2023.

5.2.1.2 Existing System Demand Allocation

The total system demand was allocated to the model junctions by utilizing The Dalles' GIS customer meter data. The customer meter data has spatial coordinates that map the location of each customer to the connection location. Assigning customer demands to the closest demand node or junction location in the water system model can be achieved by linking the customer billing data to the customer meter locations.

The steps used to allocate customer demands to the hydraulic models are listed below. These steps were applied for both the minimum and maximum month customer water use.

1. Calculate the usage for each customer (minimum and maximum month).

2. Link customer consumption to customer meters with unique identifier, customer account numbers. This approach was effective because most of the data cleanly matched between the

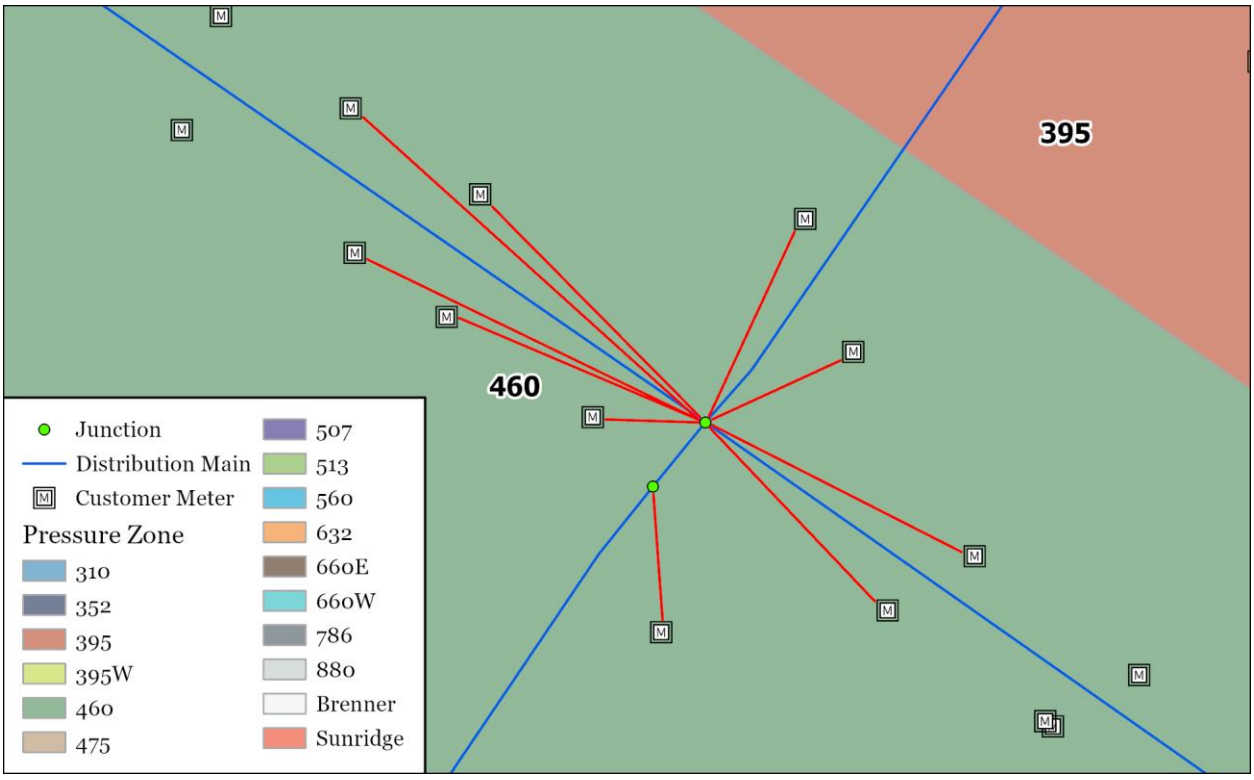
billing data set and the GIS meter data. Customer water use that could not be matched based on the meter number were allocated by:

a. Spreading the remaining unmatched consumption across the remaining customer meters that had not yet been matched up with a customer. This approach ensured that all water system demands were allocated to an existing water meter location.

3. Flag each junction in the model as a demand node or non-demand node. Non-demand nodes include junctions on a transmission pipeline, at a pump station, at a storage tank, fire hydrants, or near PRV stations.

4. Assign each customer demand to the closest model demand node. Customer consumption assigned to a demand node may be a summation of several customers near the node or one customer near the node. See **Figure 5-1**.

Figure 5-1 | Existing Demand Allocation



5.2.2 Future System Demand Allocation

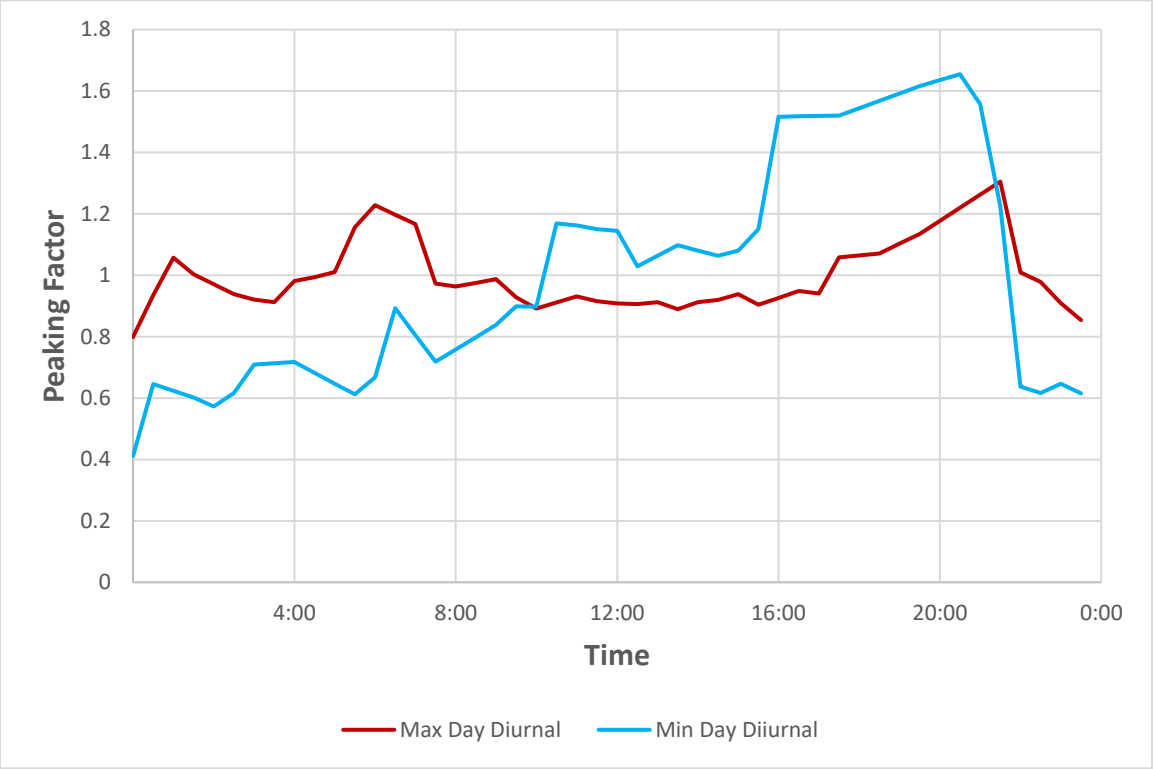
Future demands for 2044 were allocated to the nodes by scaling up existing system demands per zone basis. A scaling factor of 1.88 was multiplied to the existing demands to establish a 2044 demand set. The scaling factor is a ratio of the 2044 demand and existing demand.

5.2.3 Diurnal Patterns

Diurnal patterns for MinDD and MDD were developed with flow from supply and tank level time-series data from SCADA records. The diurnal patterns are useful for evaluating extended period simulations where

demands will fluctuate over a 24-hour period. **Figure 5-2** illustrates the diurnal patterns developed for the minimum and maximum day demands.

Figure 5-2 | Diurnal Patterns

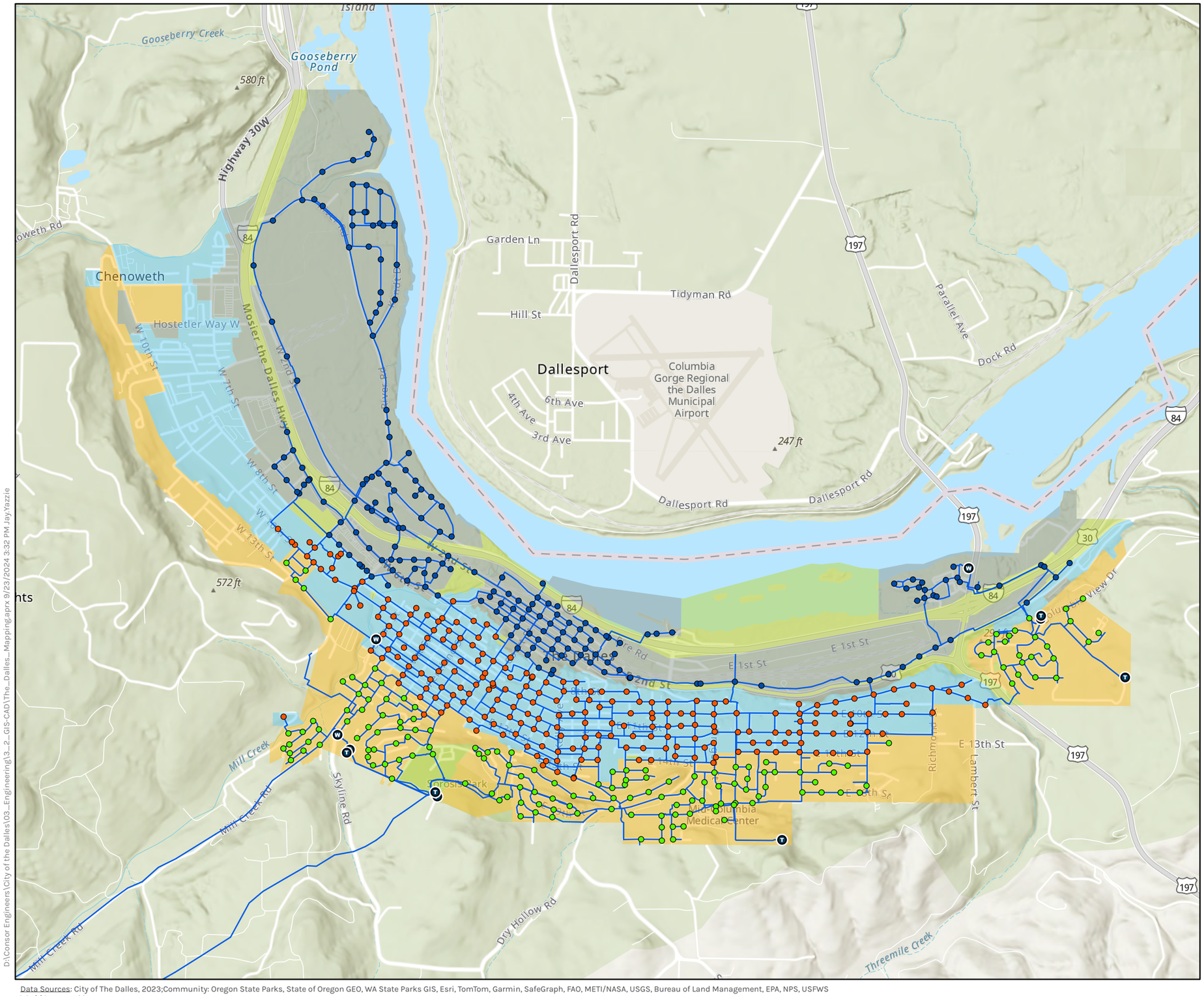


5.2.4 Fire Flow Demand Allocation

Fire flow demand was assigned to model nodes near or at locations of existing fire hydrants according to GIS data. For future modeling, future development areas based on land use, fire demands were assigned to nodes on water mains. The fire flow demand was assigned based on the land use being served. **Table 5-2** lists fire demands per zoning type assigned to nodes in the model. **Figure 5-3** illustrates fire demands assigned to nodes in the model per zoning type.

Table 5-2 | Fire Demand per Zone Type

Zoning	Fire Demand (gpm)	Duration (hour)
Low Density Residential	1,000	2
Medium and High Residential	2,000	2
Commercial, Industrial, and Institutional	3,000	3



Legend

- Well
- Tank
- Pump

Fire Flow Demand (gpm)

- 1000
- 2000
- 3000
- Distribution Main

Zoning

- Low Density Residential
- Medium and High Density Residential
- Commercial/Industrial/ Institutional
- Parks, Open Spaces and Other

N
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S

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Figure 5-3. Assigned Fire Flow Demands Per Zoning

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Data Sources: City of The Dalles, 2023;Community: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS
World Imagery: Maxar
Coordinate System:
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5.3 Model Calibration

The model was calibrated to verify model results are representative of actual system operations. The calibration process included hydraulic calibration and operational calibration. The hydraulic calibration includes assigning fire flows recorded from fire flow tests into the model, demands for each test were scaled to match system demands at the time of each fire hydrant flow test, and tank levels and pumping rates from supplies were matched for each test. Simulating each fire flow test and comparing hydrant flow rates and residual pressures from model results to field results were performed. Appropriate adjustments and corrections to the computer model were made until the results closely match the data gathered during field testing. Adjustments and corrections include adjusting pipe roughness factors, adjusting the pumping water levels for wells to achieve a pumping head that matches the expected flow rates, and matching PRV settings to records provided by The Dalles.

Operational calibration includes setting up the model to simulate a 24-hour extended period simulation (EPS) for the minimum and maximum day demand conditions. A minimum and maximum day demand conditions and diurnal patterns were developed for the two conditions from 2023 SCADA records. In addition, appropriate tank levels and pumping rates were assigned in the model. The EPS model was then simulated, and results were compared against SCADA.

The model calibrated well during the hydraulic calibration process. Results for most of hydrant flow tests were matched to an acceptable degree of accuracy. Hydraulic calibration results are presented in Appendix B. The hydraulic calibration presents the comparison of the model results to field measurements for the fire hydrant flow tests. Additional assumptions on findings of the hydraulic calibration and general comments are also included in Appendix B.

Plots from the operational calibration efforts are included in Appendix B and show two days of operational calibrations performed. These two days represent the minimum and maximum day demand conditions. The minimum and maximum day demand conditions occurred on February 26, 2023, and August 15, 2023.

5.4 Existing System Evaluation

This section describes the evaluation of existing distribution system model. It summarizes the evaluation criteria, the evaluation of the existing water system performance, and evaluation of proposed system improvements to address current issues and support projected future demands.

The distribution system evaluation includes an evaluation of the following performance criteria.

- Pressures and velocities
- Fire flow availability

The hydraulic model was used to evaluate the water distribution system. The following model scenarios were analyzed:

- PHD
- MDD and fire flow

5.4.1 System Pressures

Each pressure zone was evaluated for low pressure under the peak hour demand (PHD). The evaluation criteria require pressures at all points under PHD conditions to be at least 30 pounds per square inch (psi).

Pressures below 30 psi may indicate insufficient hydraulic capacity and can also increase risk of system backflow/cross connection contamination. **Figure 5-4** shows minimum pressures in the water distribution system under PHD conditions.

5.4.2 System Piping Velocity

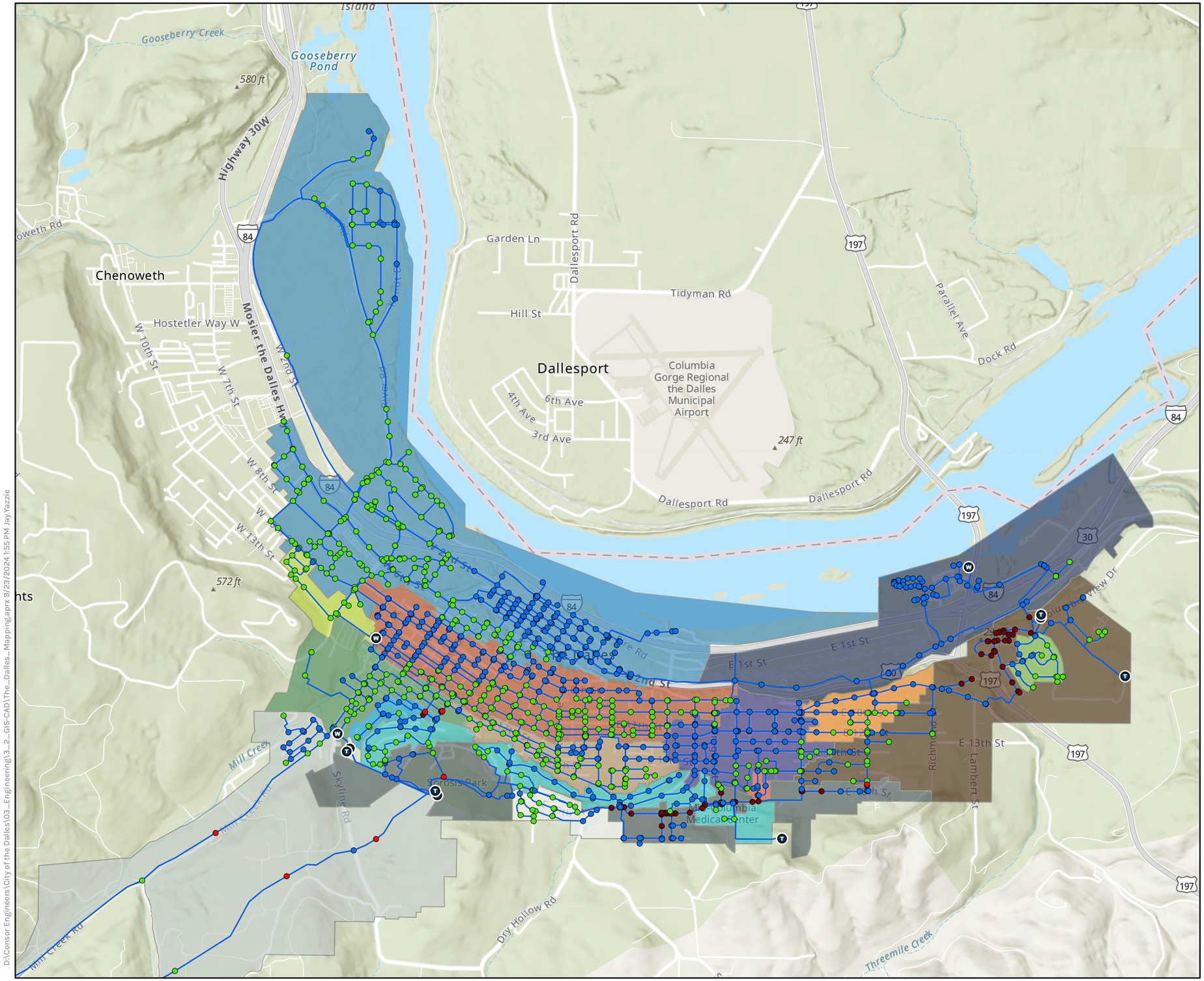
High flow velocities in pipes cause high friction and head loss along pipe walls which decreases pressures at the service connections and can increase pump energy costs. In addition to high head loss, high velocities can cause cavitation that could lead to pipe failures over time. Proposed pipe improvements will be sized to maintain velocities below 8 fps under PHD conditions. **Figure 5-5** shows maximum velocities in the water distribution system during PHD conditions. There are no areas of velocities over 8 fps during PHD conditions in the current system.

5.4.3 System Fire Flow Capacity

The fire flow capacity of the existing system was evaluated at locations where fire hydrants are present and where fire flow is intended to be provided in the future. Existing hydrant locations were determined from the City's GIS database. For future system evaluations, hydrant demands were added in the model to future development areas. The criteria specify that a hydrant must be able to deliver the required fire flow while maintaining a minimum pressure of 20 psi at all points in the distribution system. Fire flow requirements are based on adjacent or proposed land presented in **Section 5.2.4**. The MDD plus fire flow evaluation results are presented in **Table 5-3** and **Figure 5-6**. **Table 5-3** lists the total number of deficient hydrants based on the percentage of needed flows (e.g., 50 percent of needed flow of 2,000 gpm at a minimum pressure of 20 psi). **Figure 5-6** shows the percentage of required fire flow for fire hydrants in the water distribution system.

Table 5-3 | MDD Plus Fire Flow Results

Condition	Number of Hydrants Deficient		
	≤ 50% of Needed Fire Flow	50-75% of Needed Fire Flow	>75% of Needed Fire Flow
MDD + Fire Flow	32	56	104



Legend

- Well
- Tank
- Pump
- Distribution Main

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Minimum Pressure (psi)

- Less than 30
- 30 - 70
- 70 - 120
- Greater than 120

N
W
E
S

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Water System Master Plan

Figure 5-4. Existing Minimum Pressures during PHD

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Data Sources: City of The Dalles, 2023;Community: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS
World Imagery: Maxar
Coordinate System:
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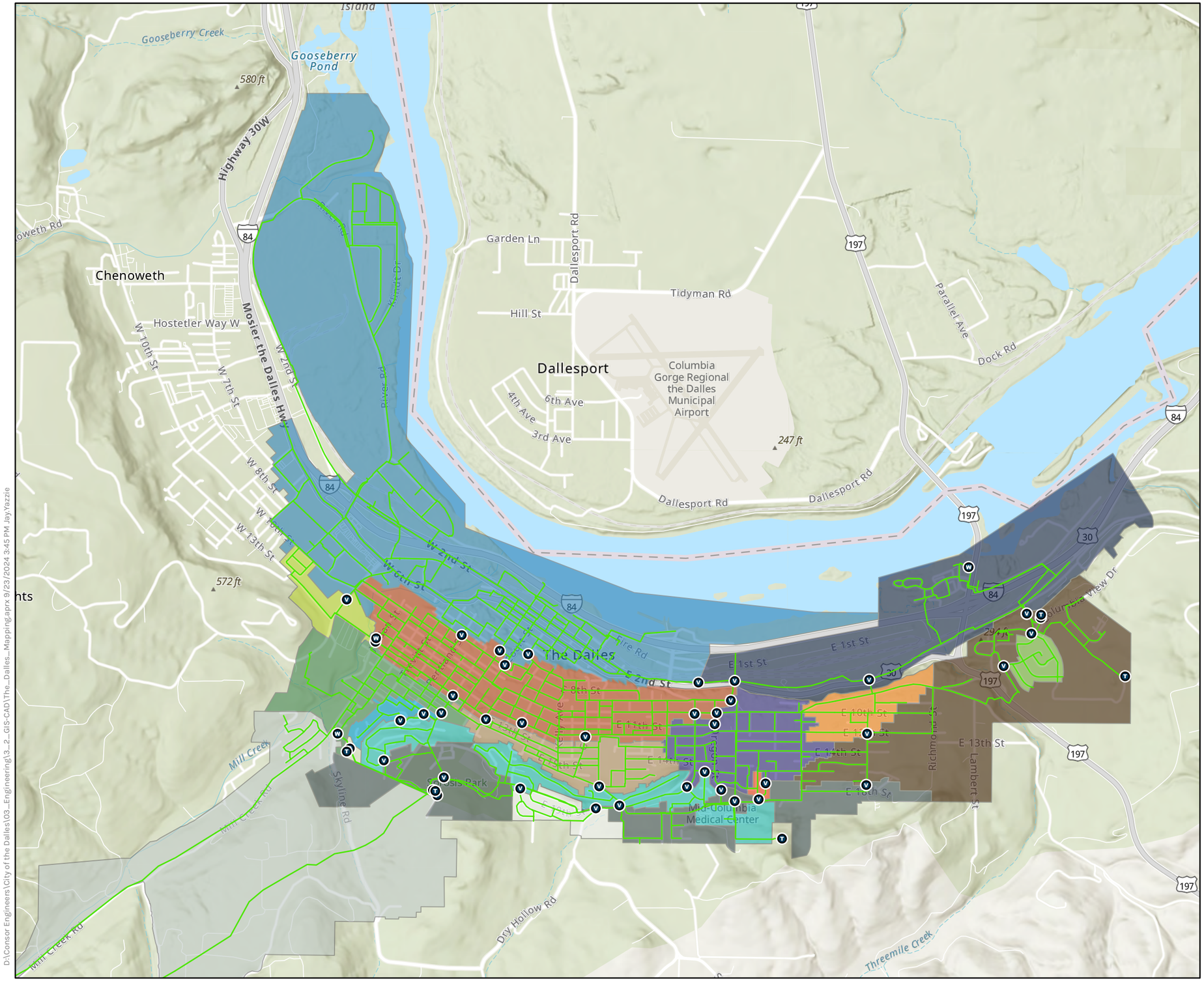

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Legend

- Well
- Tank
- Pump
- PRV

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Maximum Velocity (ft/s)

- Less than 8
- Greater than 8

N
W
E
S

City of The Dalles
Water System Master Plan

Figure 5-5. Existing System Maximum Velocities during PHD

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Data Sources: City of The Dalles, 2023;Community: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS
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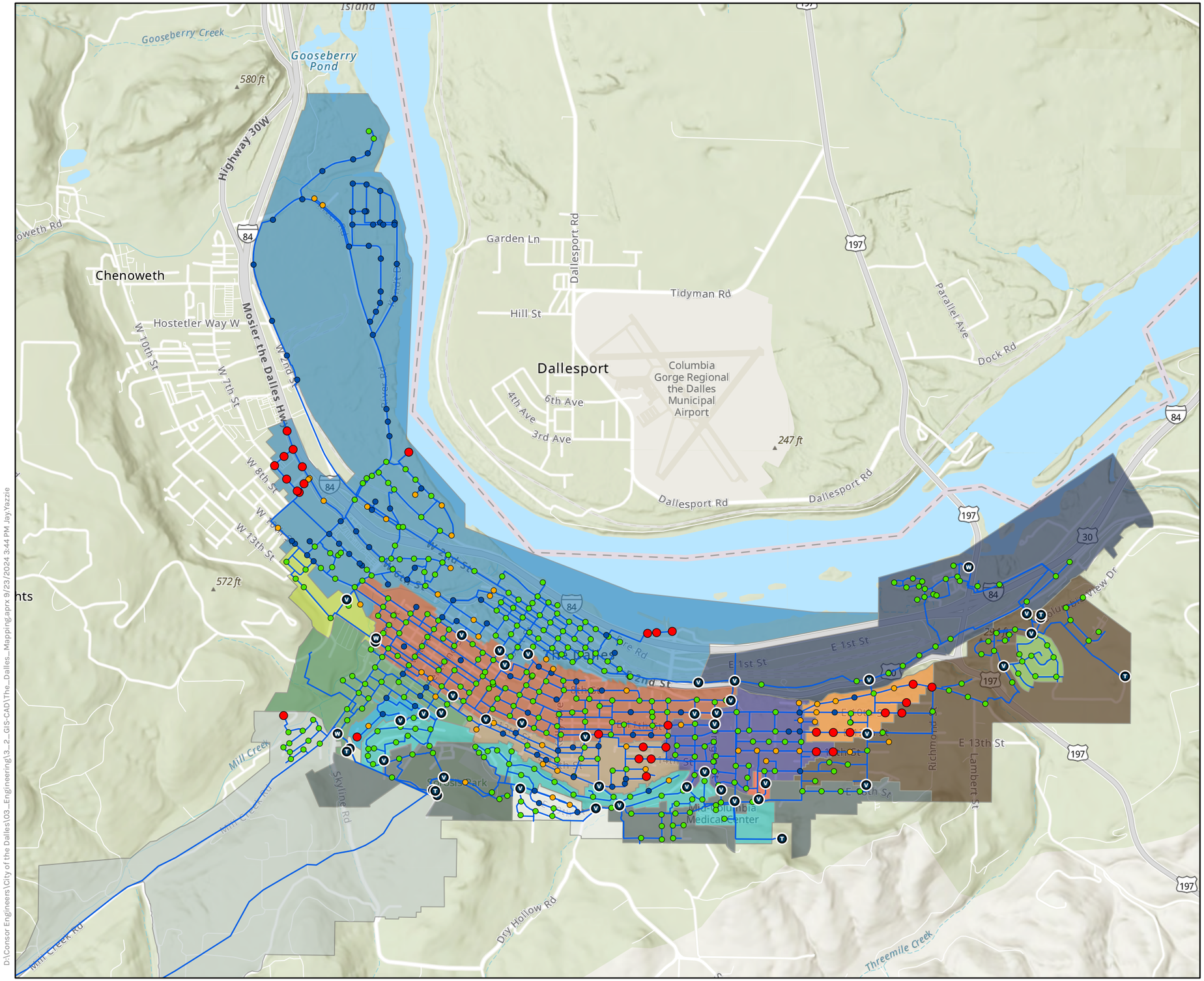

Legend

- Well
- Tank
- Pump
- PRV
- Distribution Main

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Hydrants with Deficient Flow, % of Required

- Less than 50
- 50 - 75
- Greater than 75
- Hydrant Not Deficient

N
W
E
S

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Figure 5-6. Existing MDD Plus Fire Flow

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5.5 Future System Evaluation

This section describes the evaluation of future demand projections on water distribution system. The hydraulic model evaluation includes an evaluation of the following performance criteria.

- Pressures and velocities
- Fire flow availability

The following model scenarios were analyzed:

- 2044 PHD
- 2044 MDD and fire flow

A model scenario for the 2034 projections was developed and reviewed to help prioritize and understand timing of needed future improvements. The evaluation results presented here show the 2044 scenario, which include any findings of the 2034 scenario evaluation.

5.5.1 System Pressures

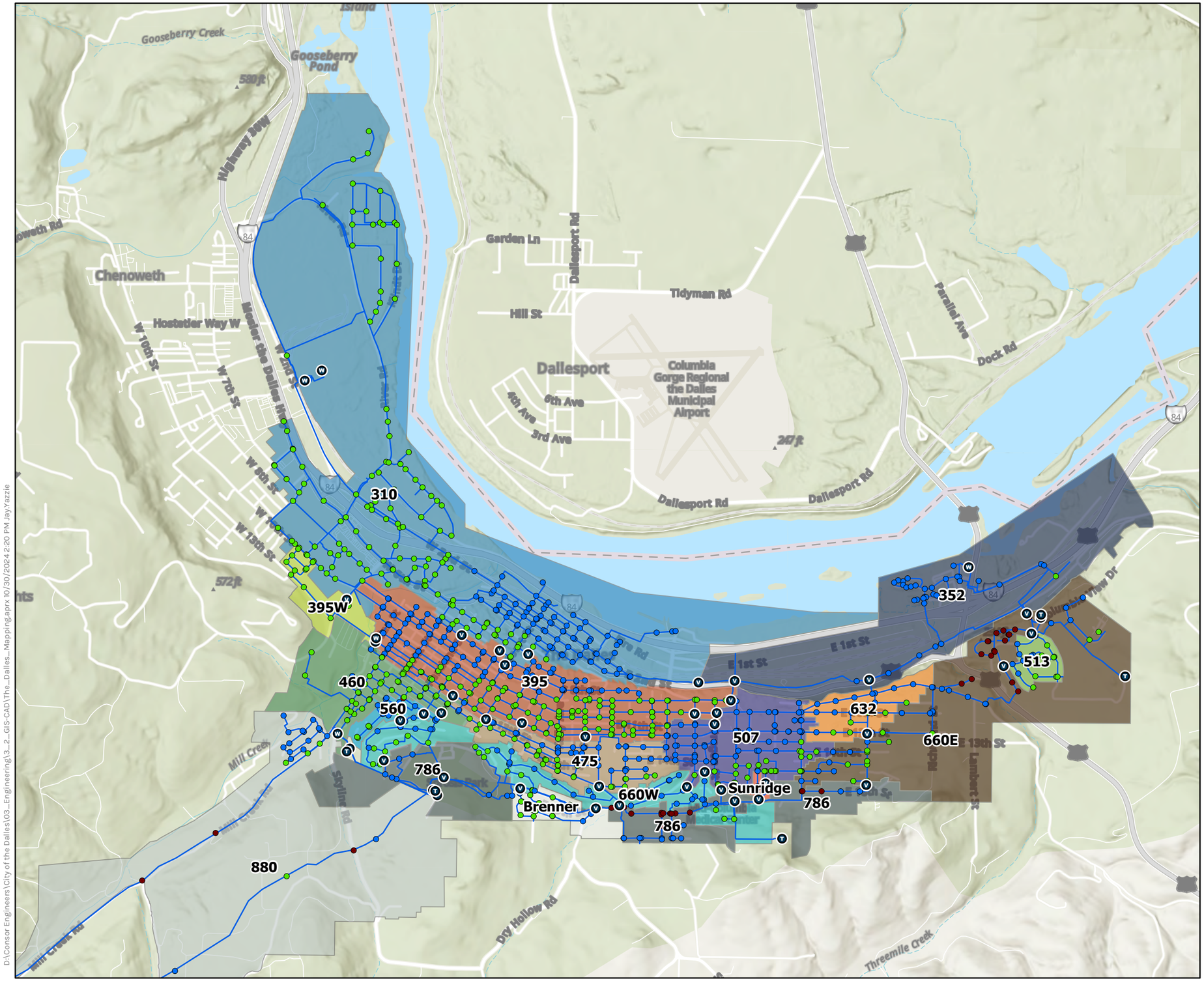
System pressures for 2044 demand scenario and under PHD were evaluated. Figure 5-7 shows the minimum pressures in the water distribution system under these conditions.

5.5.2 System Piping Velocity

Figure 5-8 shows maximum velocities in the water distribution system for the 2044 planning horizon under PHD conditions.

5.5.3 System Fire Flow Capacity

Fire flow capacities for 2034 and 2044 planning horizons were addressed with the existing fire flow system evaluation. The future system meets the required fire flow while maintaining a minimum pressure of 20 psi at all points in the distribution system. Fire flow deficiencies in the system are mostly due to small diameter piping, i.e., 6-inch diameter piping. Other factors adding to fire flow capacity deficiencies are pipe material and age. Eighty (80) percent of the piping that are deficient for fire flow capacity are cast iron pipe and were installed 49-99 years ago. Recommended piping improvements were prioritized into short-, mid- and long-term projects. Short-term projects are shown in Figure 5-9. All recommended piping improvements are included in the CIP in Chapter 7. Mid- and long-term improvement maps are included in Appendix B.



Legend

- Well
- Tank
- Pump
- PRV
- Distribution Main

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Minimum Pressure (psi)

- Less than 30
- 30 - 70
- 70 - 120
- Greater than 120

N
W E
S

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Figure 5-7. 2044 System Minimum Pressures during PHD

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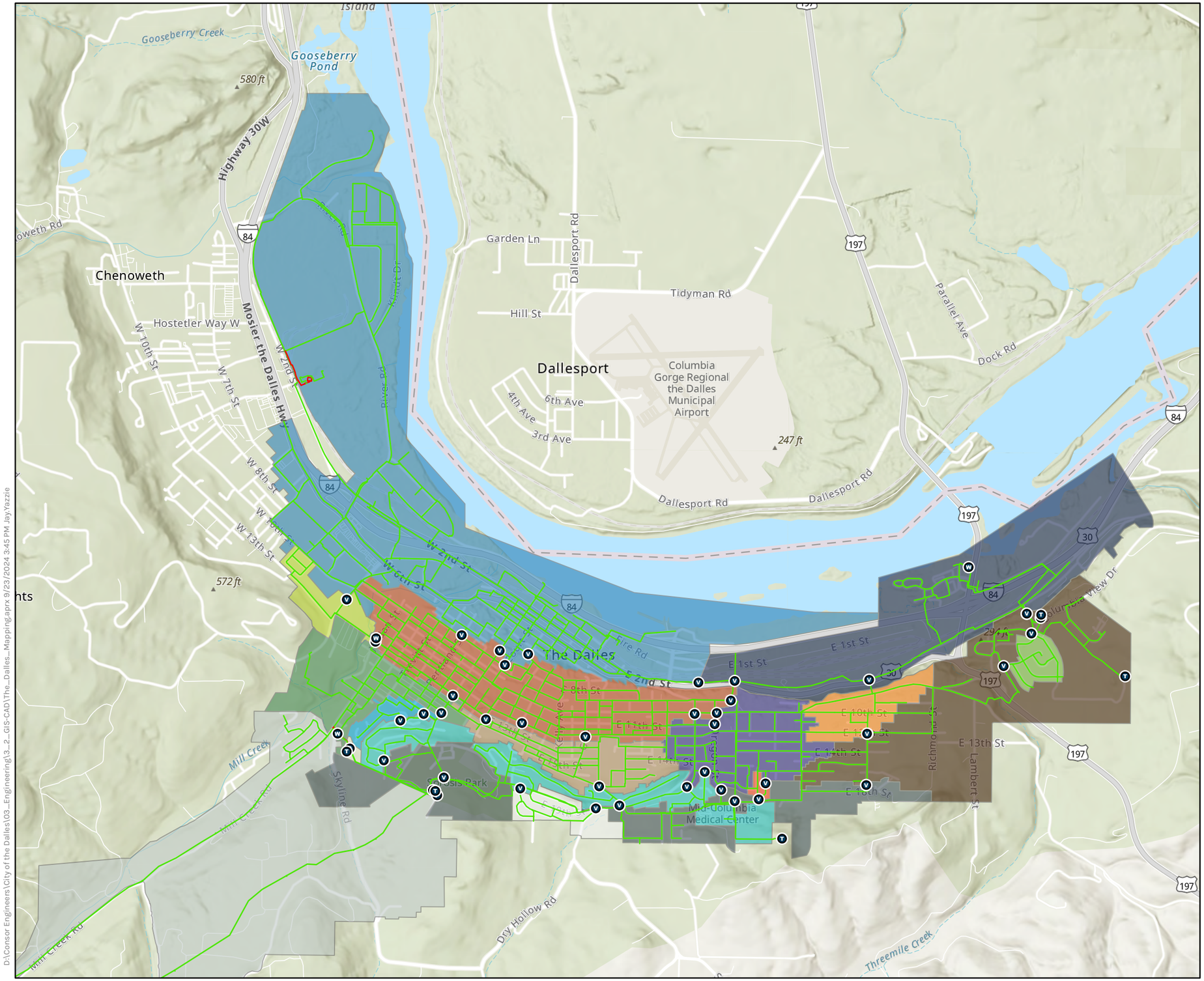

Legend

- Well
- Tank
- Pump
- PRV

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Maximum Velocity (ft/s)

- Less than 8
- Greater than 8

N W E S

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Figure 5-8. 2044 System Maximum Velocities during PHD

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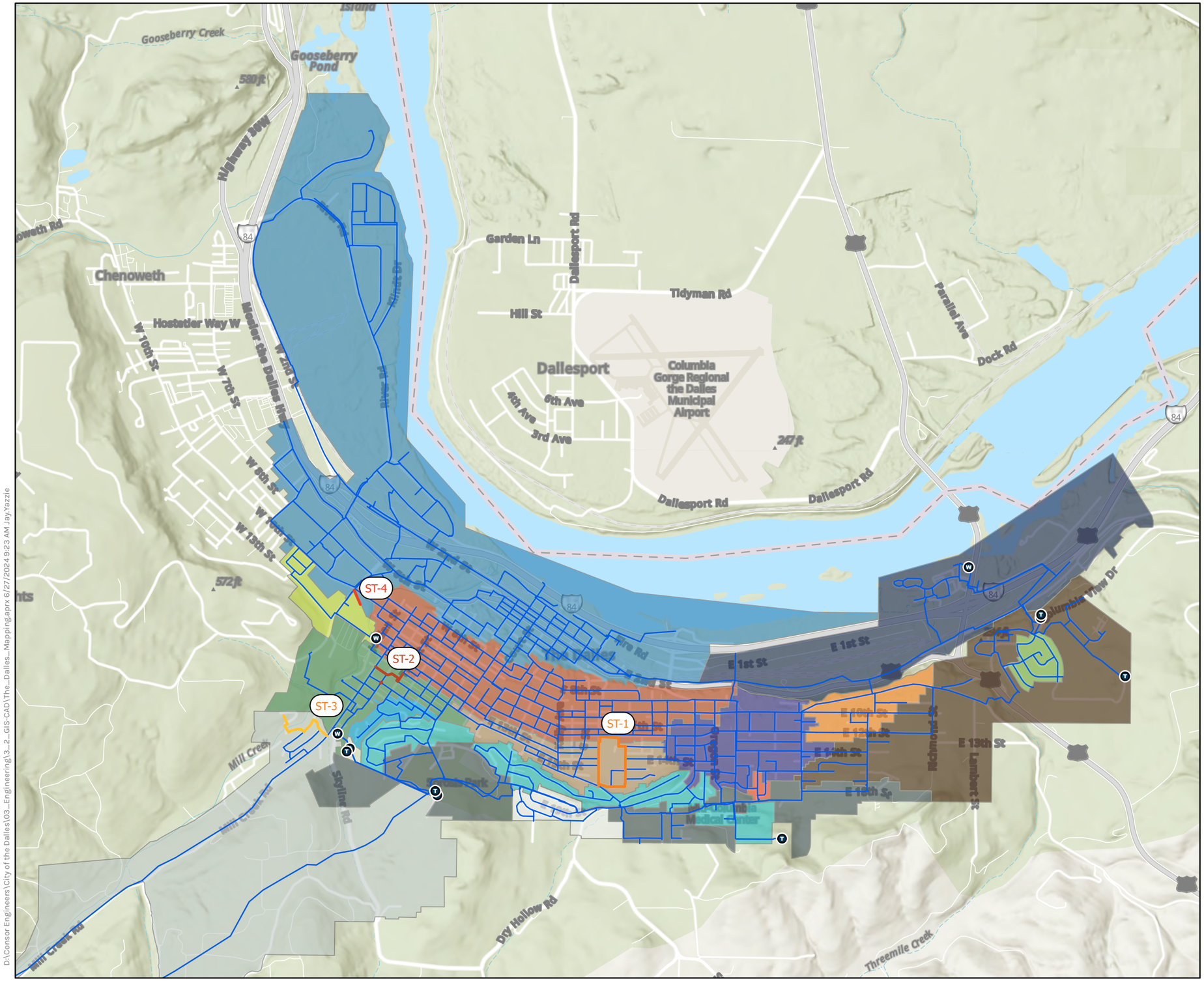

Legend

- Well
- Tank
- Pump
- Distribution Main

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Short-term CIP

- ST-1
- ST-2
- ST-3
- ST-4

N
W
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Figure 5-9.
Short-term Capital Improvement Projects

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5.6 Distribution Pipeline Seismic Hazard Evaluation

This section addresses the seismic risk assessment and mitigation planning required by the OHA for WSMPs. Water utilities located fully or partially within areas identified as VII to X, for moderate to very heavy damage potential, are required to include a seismic risk assessment and mitigation plan in their WSMP. According to the State of Oregon Department of Geology's Map of Earthquake and Tsunami Damage Potential for a Simulated Magnitude 9.0 (M9) Cascadia Earthquake, the City is mostly located within areas categorized as VI – Light, with a few portions potentially as VII - Moderate for damage potential. The requirements of the plan include the following:

- Identification of critical facilities associated with the supply of fire suppression, health and emergency response and community drinking water supply points
- Identification and evaluation of the likelihood and consequence of seismic failures at the critical facilities
- The mitigation plan shall encompass a 50-year planning horizon and include recommendations to minimize water loss from each critical facility, capital improvements, or recommendations for further study or analysis.

The objective of the mitigation plan is to provide the City with the knowledge and resources to maintain service, or return to service, within a prescribed timeframe following a M9 Cascadia Subduction Zone (CSZ) event.

Chapter 8 of *The Oregon Resilience Plan for Reducing Risk and Improving Recover for the Next Cascadia Earthquake and Tsunami* includes a table that describes target states of recovery for different regions within the State. Building codes change over time, sometimes due to seismic deficiencies discovered in older codes. No requirement currently exists that requires a city to upgrade facilities to keep up with the changes; however, revisions should be noted when assessing seismic vulnerabilities. There are no existing federal or state regulatory requirements associated with seismic retrofitting for potable water facilities. General guidelines for a seismic evaluation of existing buildings and reservoirs are to use the American Society of Civil Engineers (ASCE) 41-17, *Seismic Evaluation and Retrofit of Existing Buildings*. Figure 5-10 describes the target state of recovery for water systems in the area including the City.

Figure 5-10 | Target State of Recovery for Water Systems (Central/Eastern Oregon)

KEY TO THE TABLE

TARGET TIMEFRAME FOR RECOVERY:

Desired time to restore component to 80–90% operational — G

Desired time to restore component to 50–60% operational — Y

Desired time to restore component to 20–30% operational — R

Current state (90% operational) — X

TARGET STATES OF RECOVERY: WATER & WASTEWATER SECTOR (CENTRAL/EASTERN OREGON)

	Event occurs	0–24 hours	1–3 days	3–7 days	1–2 weeks	2 weeks–1 month	1–3 month	3–6 months	6 months –1 year	1–3 years	3 + years
Domestic Water Supply											
Potable water available at supply source (WTP, wells, impoundment)		X									
Main transmission facilities, pipes, pump stations, and reservoirs (backbone) operational		X									
Water supply to critical facilities available		X									
Water for fire suppression—at key supply points		X									
Water for fire suppression—at fire hydrants		X									
Water available at community distribution centers/points		X									
Distribution system operational		X									

5.6.1 Critical Facilities and Water System Backbone

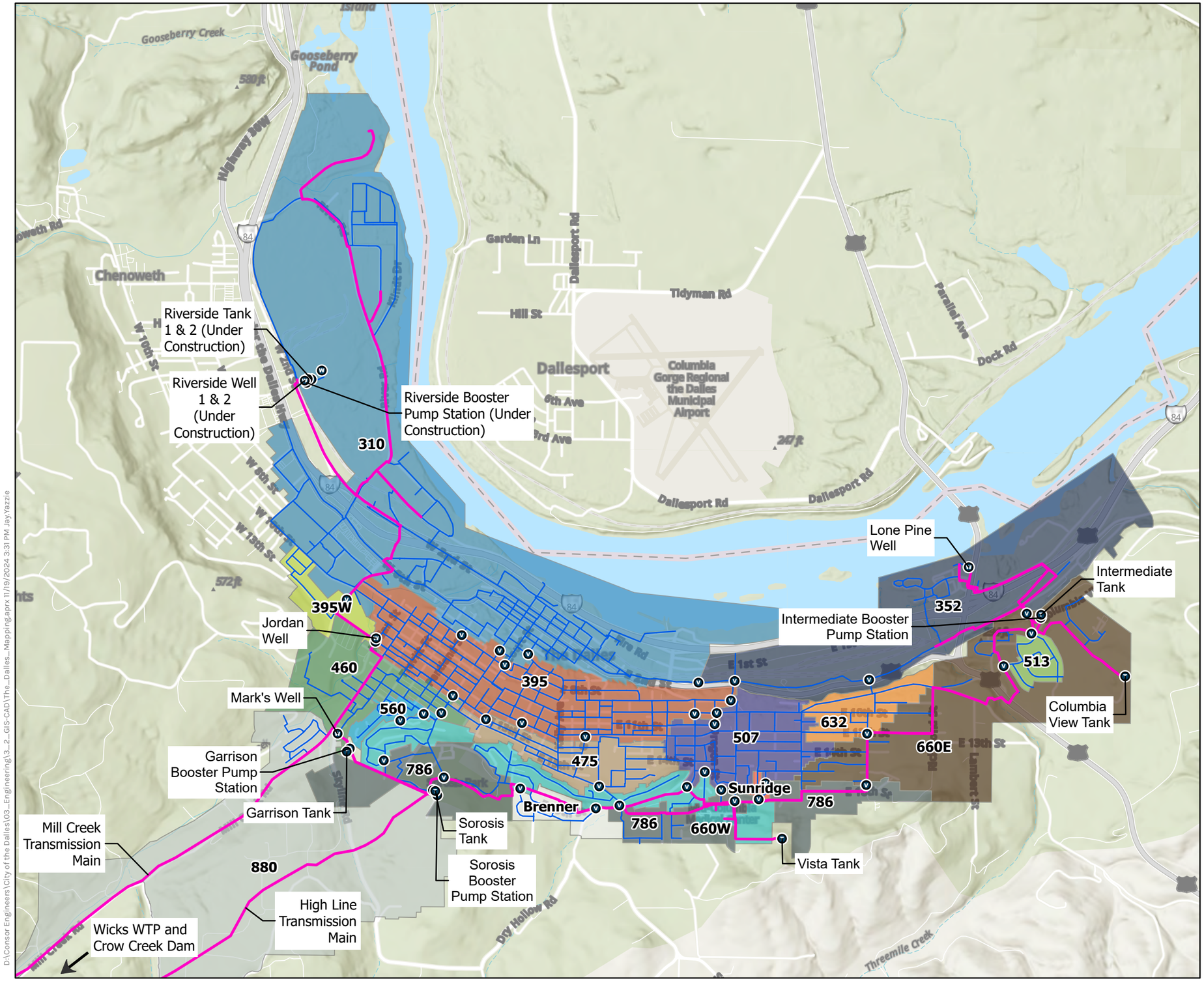
A water system backbone of key supply, storage, pumping, transmission, and distribution facilities was identified based on typical system operations. Supply and storage facilities are critical to producing and storing water for customers during an emergency. Pumping facilities, transmission mains, and distribution mains that connect these are key for minimal operations. Additionally, distribution mains connecting supply or storage to critical customers were included as part of the backbone system. Key City water facilities and their critical supply and distribution functions are summarized in **Table 5-4** and illustrated on **Figure 5-11** Water System Backbone Map.

Key water facilities were prioritized based on the criticality and serving customers with emergency water immediately following a seismic event. The priority list is summarized in **Table 5-4**.

Table 5-4 | Key Water System Facilities and Mitigation Prioritization

Priority	Facility Name	Critical Functions (Metered Connections Served)
1	Wicks WTP	Treats and supplies surface water to system
2	Sorosis Reservoir	Highest elevation reservoir to store Wicks WTP supply
3	Garrison Reservoir	Reservoir to store Wicks WTP supply and Jordan and Marks Wells
4	Marks and Jordan Wells	Supply to system
5	Lone Pine Well	Supply to system (on east side of City)
6	Riverside Wells 1 & 2	Supply to system (310 Zone)
7	Crow Creek Dam	Raw water supply
8	Sorosis BPS	Provides supply to Vista Reservoir (Highest elevation tank)
9	Vista Reservoir	Highest elevation reservoir – could provide supply to all zones[1]
10	Intermediate Reservoir	Stores Lone Pine Well supply (east side of City)
11	Intermediate BPS	Supplies Columbia View Reservoir
12	Riverside Reservoirs	Stores Riverside Wells supply
13	Riverside BPS	Allows Riverside Reservoirs to supply 310 Zone
14	Columbia View Reservoir	Reservoir for storage (east side of City)
15	Garrison BPS	Provides supply to Sorosis Reservoir in case of loss of High Line transmission main

Note:
1. PRV facilities are not included in this table but provide sole supply to some pressure zones.



Legend

- Well
- Tank
- Pump
- PRV
- Distribution Main

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge
- Backbone Piping

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Figure 5-11. Backbone Piping System

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5.6.2 Geotechnical and Seismic Hazard Evaluation

The seismic hazards evaluation was conducted through a review of the Oregon Department of Geology and Mineral Industries (DOGAMI) seismic hazard maps. Seismic hazards were evaluated based on existing M9 CSZ earthquake hazard maps published for the region by DOGAMI. For this assessment, the evaluation focused on the City's water service area. The finished water transmission mains extend outside of City limits and the full extents were not included in this seismic hazard evaluation because the mains are already recommended to be replaced due to existing conditions. It will be important to consider and evaluate seismic hazards and standards during the design of the transmission main replacement.

5.6.2.1 Seismicity and Seismic Hazards

The likelihood and relative magnitude of three seismic hazards were analyzed, as these hazards all have the potential to damage buried water mains and other water facilities. Seismic hazards observed within the City's limits are discussed below.

Three primary sources of seismicity that could impact the City area are:

- Shallow crustal faults within the North American plate;
- CSZ intraplate faults within the subducting Juan de Fuca plate;
- CSZ megathrust events generated along the boundary between the subducting Juan de Fuca plate and the overriding North American plate.

Of those three sources, CSZ megathrust events are considered to have the most potential for damage due to the anticipated magnitude and duration of ground shaking. Recent studies indicate that the CSZ can potentially generate earthquakes with magnitudes ranging between 8.0 and 9.2. The magnitude of a CSZ earthquake depends on the rupture length along the subduction zone. A full rupture will likely generate mega-magnitude 9.0 and above earthquake events, and a partial rupture will likely cause large-magnitude 8.0 to 8.5 earthquakes.

These earthquake events are estimated to recur approximately every 500 years for the mega-magnitude full rupture events (9.0-9.2) and every 200 to 300 years for the large-magnitude partial rupture events (8.0-8.5). Based on documentation of historic earthquakes, the probability of a future occurrence is high because the area is "past due." The CSZ earthquake with a magnitude greater than 8.5 (similar to recent events in Japan, Chile, and Indonesia) has an estimated 16 to 22 percent probability of occurring off the Oregon Coast in the next 50 years (Goldfinger and others, 2016).

While the City is mostly located within areas categorized as VI – Light, with a few portions as VII – Moderate, for damage potential, for the purposes of this evaluation, seismic hazards to the water system were assessed under a CSZ M9 earthquake as this is regarded as the greatest threat to the region. CSZ events may result in severe ground shaking, liquefaction settlement, lateral spreading, and/or seismic-induced landslides with the potential to damage pipelines, reservoirs, pump stations, etc.

The likelihood and magnitude of three seismic hazard sources were analyzed:

- strong ground shaking
- liquefaction settlement
- landslides

5.6.2.2 Peak Ground Velocity

The intensity or rate of ground shaking is known as peak ground velocity (PGV) and is expressed as inches per second (in/sec). The PGV is dependent on the magnitude of the event, the distance from the seismic source, and the ground material through which the seismic waves pass. This extreme shaking can damage pipelines if the pipe material and joints are not strong enough to withstand transient ground deformations. Damage from ground shaking can occur even when there is no permanent ground deformation (PGD).

The Peak Ground Velocity Hazard map (**Figure 5-12**) illustrates the estimated peak ground velocity levels relative to the location of the water system facilities. The City's water system is situated in areas where PGVs are predominantly very low or low, with the highest estimated PGVs within the City ranging from 8-16 in/sec (low range). Some of the City's water facilities, including Vista Tank, Columbia View Tank, as well as critical water transmission piping from the Wicks Water Treatment Plant (WTP) are located within areas where PGVs are in the low (8-16 in/sec) range.

5.6.2.3 Liquefaction Susceptibility

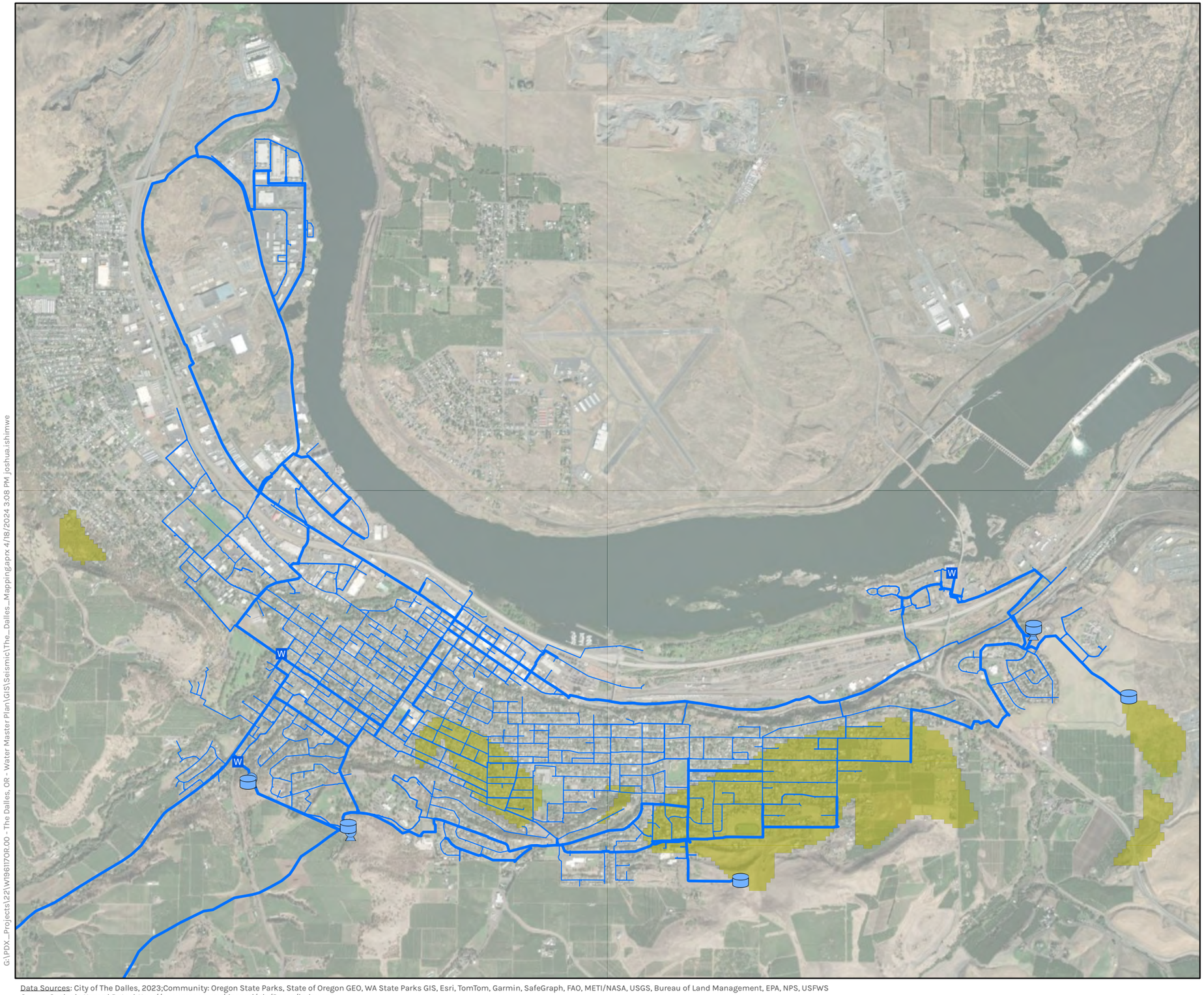
Liquefaction-induced ground deformation generally consists of post-liquefaction settlement (vertical movement) and lateral spreading (horizontal movement). Lateral spreading typically occurs along river/creek banks and other sloped areas. During seismic shaking, deposits of loose, saturated non-cohesive soil can contract, resulting in an increase in pore water pressure. The high pore water pressure can cause the deposit to become "liquefied" losing its strength and the ability to support loads (Kramer, 1996). The loss of strength and stability reduces the soil's ability to support the buried pipelines, and the soil movement can damage the pipeline joints. **Figure 5-13** illustrates the liquefaction susceptibility categorized into levels ranging from very low, to very high.

A significant portion of the City water system is situated in areas with moderate levels of liquefaction susceptibility, especially in areas near and along the Columbia River and Mill Creek. The loose, sandy soils, which are common along riverbanks are more prone to liquefaction. Sandy deposits along the Columbia River can liquefy more easily due to their granular nature.

5.6.2.4 Landslide Susceptibility

Landslides can occur due to the added load created by an earthquake induced inertial force on a slope. Slopes that are marginally stable prior to an earthquake can become unstable and fail. Landslide ground movement can be extremely damaging to pipelines.

There are varying levels of landslide susceptibility within the City limits. The City is predominantly situated within low levels of landslide susceptibility, with areas of moderate, high, and very high susceptibility interspersed. **Figure 5-14** illustrates the landslide susceptibility within the City area. The main areas of very high susceptibility are near E Scenic Drive, NE of the Community College; roughly NE of the Vista Reservoir and west of Highway 197; and SE of Columbia View Reservoir. These areas generally line up with areas of moderate liquefaction susceptibility.



Legend

- Well
- Tank
- Pump

Diameter

- 6"
- 10"
- 12"-18"
- 20"-36"

Peak Ground Velocity (PGV)

- 0 - 8 in/sec
- 8 - 16 in/sec
- 16 - 24 in/sec
- (24 - 30 in/sec

0 2,000 4,000 Feet

N
W E
S

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Figure 5-12.
Peak Ground Velocity (PGV) Hazard

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Oregon Geologic Hazard Data: https://www.oregon.gov/dogami/gis/Pages/index.aspx
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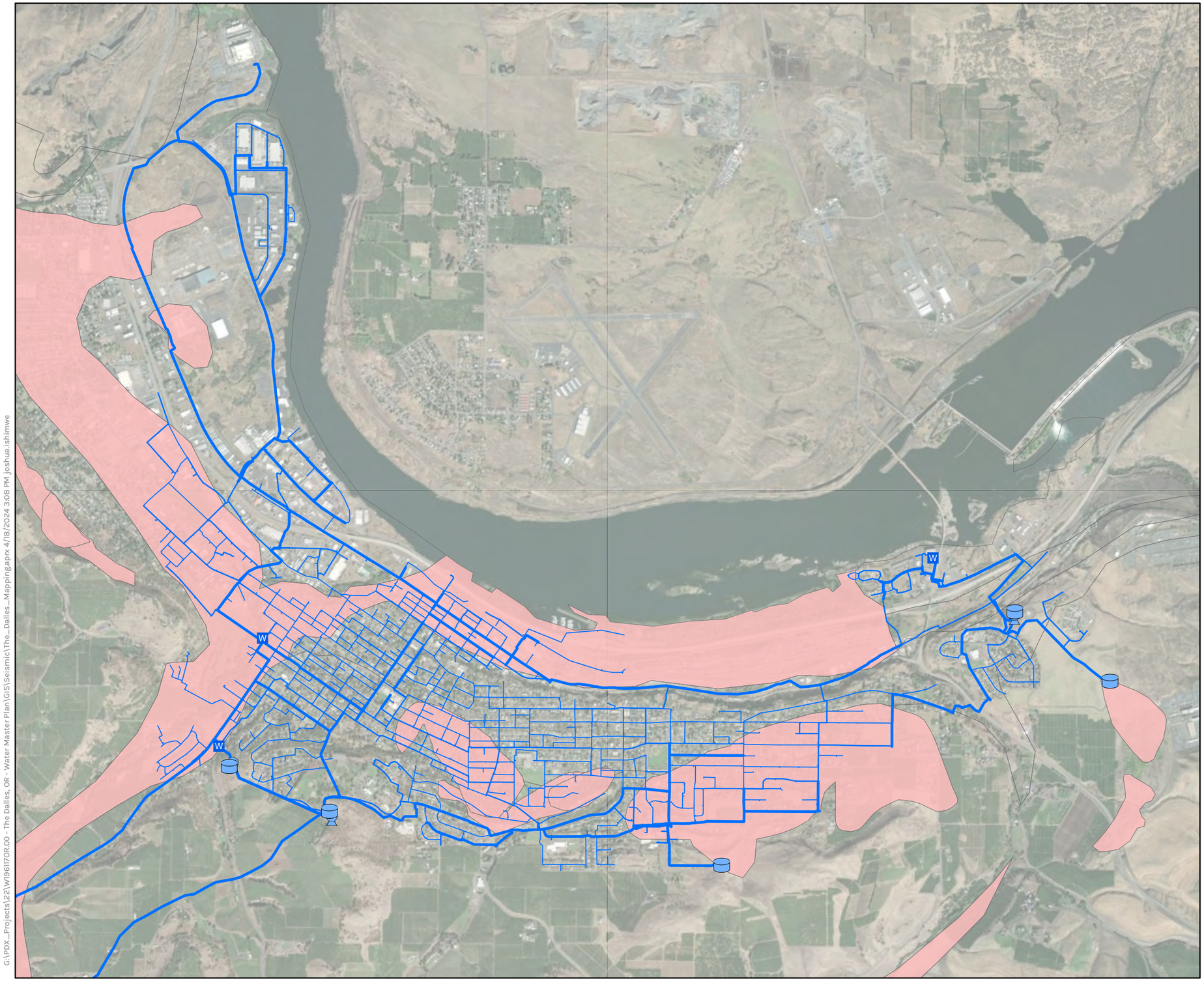

Legend

- Well
- Tank
- Pump

Diameter

- 6"
- 10"
- 12"-18"
- 20"-36"

Liquefaction Susceptibility

- None
- Very Low
- Low
- Moderate
- High
- Very High

0 2,000 4,000 Feet

N W E S

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Water System Master Plan

consor

Figure 5-13.
Liquefaction Susceptibility

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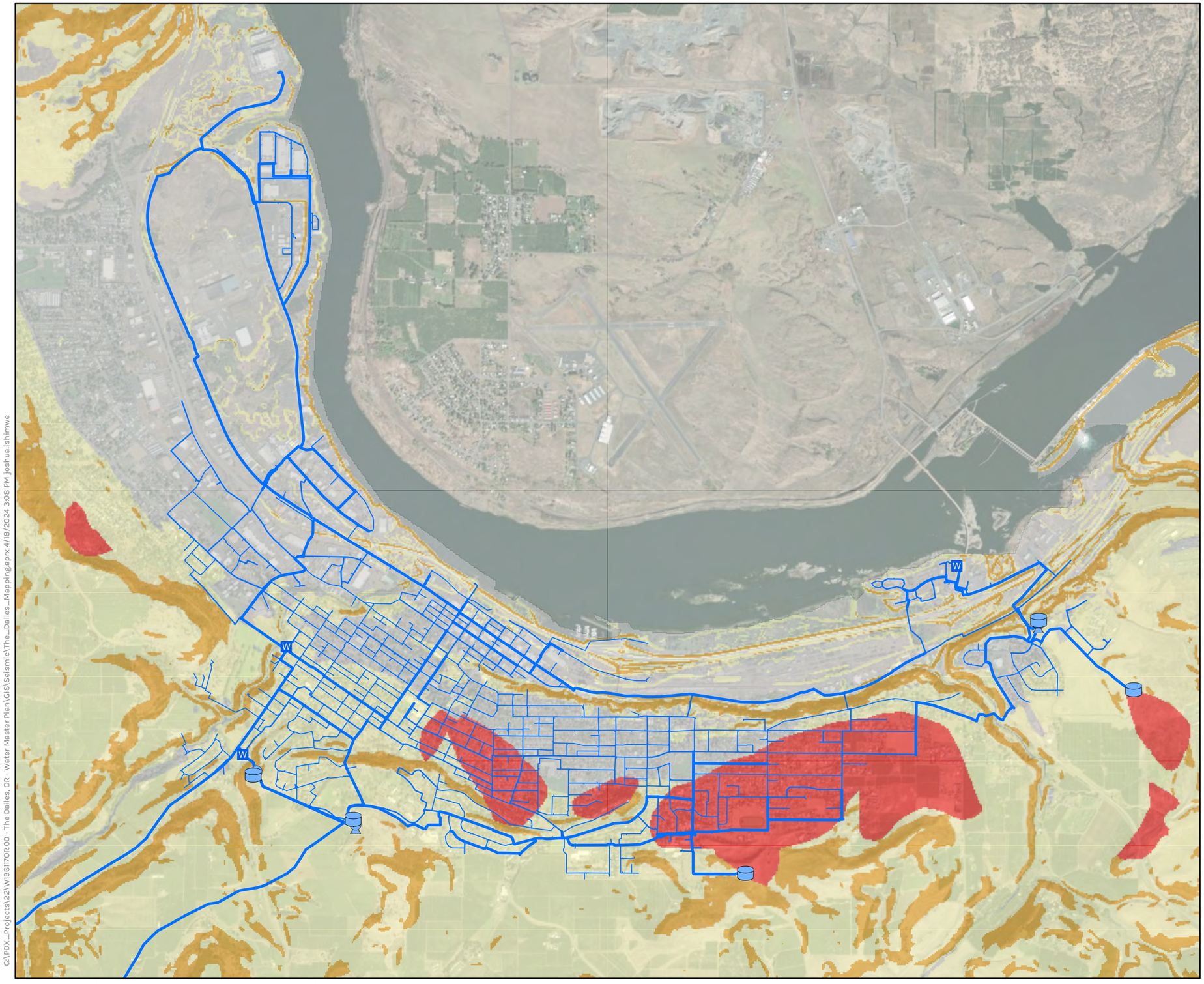

Legend

- Well
- Tank
- Pump

Diameter

- 6"
- 10"
- 12"-18"
- 20"-36"

Landslide Susceptibility

- Low
- Moderate
- High
- Very High

0 2,000 4,000 Feet

N W E S

City of The Dalles
Water System Master Plan

Figure 5-14.
Landslide Susceptibility

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5.6.2.5 Seismic Hazard Findings Summary

In general, the City is primarily in areas of low hazard from the seismic hazards considered. There are a few areas of moderate or high hazard that overlap with distribution piping as seen in Figure 5-13 and Figure 5-14. Seismic hazards in these areas were included in the high-level pipe condition assessment that is detailed in Section 5.7.

High-level seismic evaluation of the pump stations, wells, and reservoirs identified minor seismic improvements which are included in the CIP. See Sections 5.8.3, 5.9, and 5.10.8 for further discussion.

5.7 Pipe Condition Assessment

A high-level condition assessment of the City's water pipelines was completed based on material, age, potential seismic hazards, and critical backbone infrastructure. This assessment aims to categorize the City's water pipelines into prioritization tiers to that can be used to guide the City's Distribution Pipe Renewal and Replacement program in the CIP.

5.7.1 Assessment Criteria

The pipelines were evaluated based on the criteria discussed below.

Age: How old a pipeline has been in service for is critical in pipeline condition assessment. Like any other product, pipelines are composed of materials that have finite shelf life. Over time, pipelines deteriorate as corrosion weakens materials, pressure wear erodes interiors, and sedimentation increases head losses. All these factors can increase the potential for the pipeline to be damaged. Furthermore, as industry standards and environmental regulations evolve, older pipelines often become unsafe or unable to meet or exceed the minimum regulatory requirements established by the governing bodies. The information regarding the installation date of the pipelines was based on available data from the City's GIS database.

Material: Pipeline material is directly connected to the durability and integrity of the pipeline. Different materials have varying resistance to corrosion, chemical interactions, and mechanical stresses. The material of a pipeline also determines the degree of difficulty that is required to maintain and repair said pipeline. Similar to the pipelines' installation date, the information pertaining to the pipeline material was based on the City's GIS database as well as direct correspondence with City staff where material data was unclear or unknown in the database.

Seismic Hazard: Pipes in areas identified as highly susceptible to seismic hazards are at an increased risk of damage. As discussed in the previous section, the different seismic hazards can exert strong forces on the pipeline, potentially causing the pipes to shift, crack or rupture. Ground movement can exceed the maximum allowable deflections of the pipelines, leading to catastrophic failures.

Backbone / Critical Pipelines: backbone piping is defined as the critical piping that serves as the primary mode of transmitting water from the supply sources to the storage facilities and critical customers. This typically includes large-diameter transmission pipes and main distribution piping that connects to smaller lateral/branch distribution piping. Backbone piping would be the City's first priority within the distribution system piping to provide limited operations after an extreme disaster such as an earthquake.

5.7.2 Analysis

The pipes, excluding newer ductile iron pipe, were categorized into five prioritization categories, with Category 1 designated as the top priority. The categories are summarized below.

Category 1: This includes all steel, galvanized iron pipes, and asbestos cement (AC) pipes. Most of the steel and galvanized iron pipes in the City's water system are old and with thin walls these pipes are highly susceptible to damage and should be replaced as soon as possible. In addition to the challenges associated with steel and galvanized iron pipes, the City's system also includes a small amount of AC pipes, which were prevalent in the mid-20th century. These pipes were favored for their durability, resistance to corrosion, and ability to withstand high-pressure applications. However, the material is now recognized as hazardous material that can cause serious health problems if its fibers are released into the water supply or the surrounding environment. AC pipes are also brittle by nature and are typically joined by rigid bell and spigot joints. The lack of flexibility and joint restraint increases the vulnerability of AC pipes in seismic prone areas.

Category 2: This comprises of all cast iron piping installed prior to 1959 (65+ years old). Most of the City's water pipelines are cast iron. Cast iron piping older than 65 years is considered to have experienced significant deterioration and corrosion over time. Older cast iron piping was typically installed without modern protective lining or coatings that could prolong the pipeline's lifespan. Similarly, cast iron pipes are vulnerable to damage during ground movements because of their brittle, rigid joints. Furthermore, feedback from the City's operations and maintenance staff seems to indicate a high incidence of breaks associated with cast iron pipe installed in the 1950s.

Category 3: The fourth category consists of all cast iron pipes installed after 1959 that are part of the critical backbone piping and are in areas that have high risk of seismic hazards. The areas of high seismic hazards were identified as areas that have moderate to very high levels of liquefaction susceptibility as well as areas with high to very high levels of landslide susceptibility. In the event of a seismic hazard, backbone piping that is made of cast iron would be at a high risk of failure, compromising operations of the distribution system.

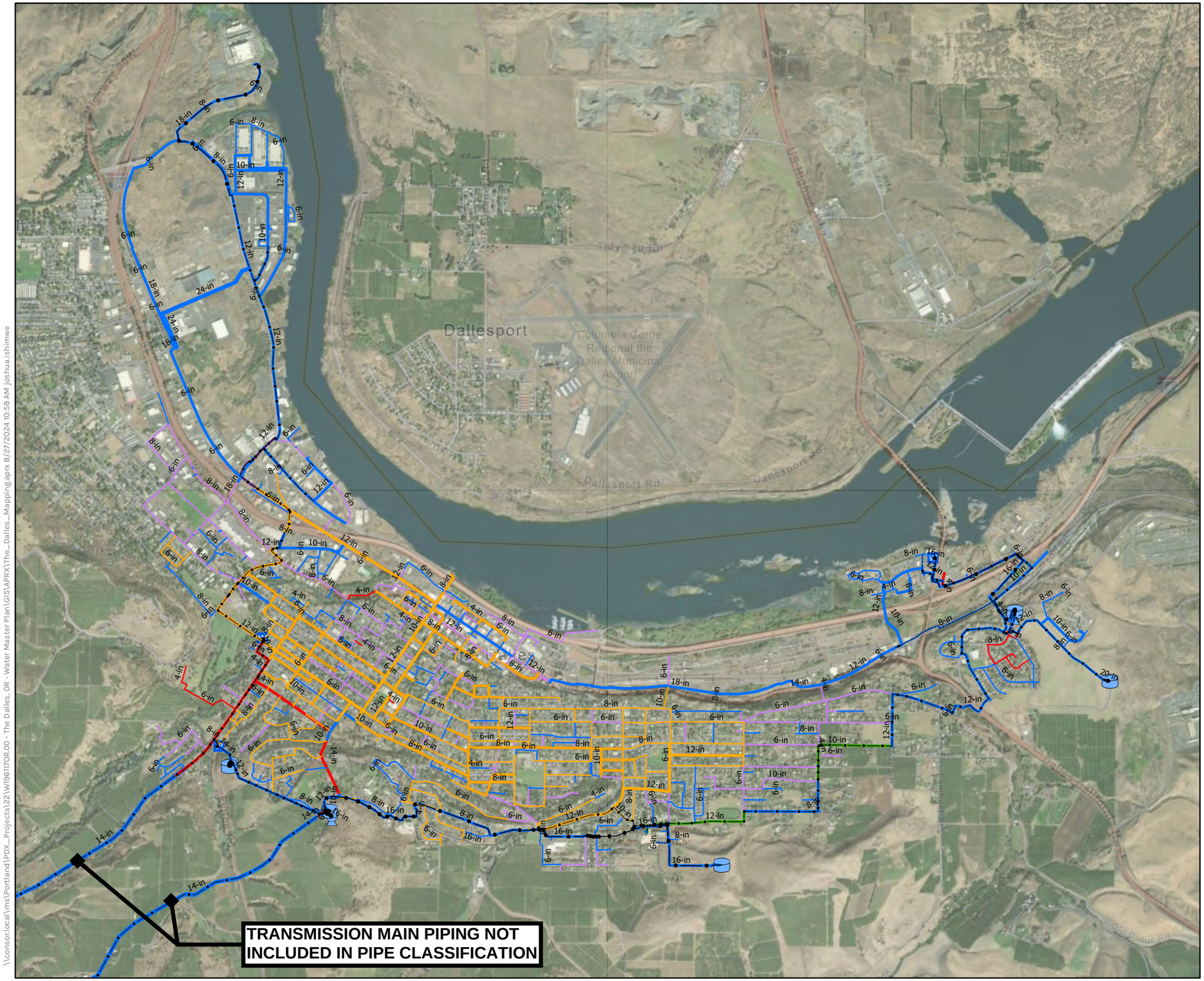
Category 4: This encompasses all the other backbone cast iron piping installed after 1959 that is not situated within designated high seismic hazard areas.

Category 5: Lastly, this category includes all remaining cast-iron piping that is not part of the critical backbone infrastructure and is less than 65 years old.

Table 5-5 summarizes the diameter and total linear length of pipes for each of the categories. Figure 5-15 illustrates the five pipe categories. Pipes in Categories 2 and 5 make up the vast majority of the approximately 55 miles of pipes identified across all five categories. The finished water transmission mains were not included in this assessment because the mains are already recommended to be replaced due to existing conditions. An annual Distribution Pipe Renewal and Replacement program is included in the CIP with a goal of replacing Category 1 and 2 pipes within 50 years. These categories and prioritization should be updated as the City gathers more and new information on the existing pipelines.

Table 5-5 | Pipe Classification Summary

Category	Diameter (in)	Total Length (LF)
1	4	1,600
	6	3,900
	8	800
	10	2,400
	12	1,400
	14	7,600
	16	50
	20	20
2	4	1,100
	6	90,000
	8	24,300
	10	8,300
	12	24,500
	16	2,400
3	8	200
	10	2,600
	12	4,300
	16	600
4	12	4,300
	16	100
5	4	700
	6	64,000
	8	24,200
	10	5,700
	12	12,500
	18	200



Legend

- Well
- Tank
- Pump

Pipe Classification

- Category 1
- Category 2
- Category 3
- Category 4
- Category 5
- Backbone Piping

0 2,000 4,000 Feet

N W E S

City of The Dalles
Water System Master Plan

Figure 5-15.
Replacement Prioritization Categories

consor

W196117OR

November 2024

Data Sources: City of The Dalles, 2023;Community: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS
World Imagery: Maxar
Coordinate System:
Disclaimer: Consor and CLIENT make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

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5.8 Pumping Analysis

This section summarizes the analysis of the City's booster pump stations (BPS) capacity against the existing system described in **Chapter 1**, the demand projections described in **Chapter 2**, and the performance criteria described in **Chapter 3**. The results of the analyses serve as the basis for capital improvements and capital maintenance of the pumping systems as described in the CIP in **Chapter 7**. Adequate pumping capacity in drinking water systems is necessary to ensure the following.

- System demand and fire suppression demand within individual pressure zones are reliably met.
- System demand and fire suppression demand within the total system are reliably met.

BPS operation is typically controlled by elevation levels in the reservoir. Lead and lag pump starts and stops are controlled by specific elevation setpoints when a BPS is equipped with two or more pumps. The City currently takes Columbia View Reservoir offline in the winter due to water stagnation concerns with lower wintertime demands. With this seasonal adjustment, the Intermediate BPS which typically supplies the Columbia View Reservoir is also taken offline.

The BPS performance criteria described in **Chapter 3** is summarized in **Table 5-6**. The following sections analyze the firm pumping capacity and backup power performance criteria for existing conditions and conditions over the planning period.

Table 5-6 | Pumping Performance Criteria Summary

Water System Component	Evaluation Criteria Component	Value	Design Standards/Guideline
Booster Pump Stations	Firm Capacity	MDD	Washington Water System Design Manual
	Backup Power	At least one pump station serving each pressure zone	Industry Standard Recommendation

5.8.1 Firm Pumping Capacity Analysis

The firm capacity of the BPS were compared to the current and projected MDD of the discharge pressure zones served by each BPS. The BPS and pressure zones served are illustrated in **Figure 1-2**. The Riverside BPS is currently under construction and is included in the evaluation with proposed design criteria for the BPS. The BPS will be located in and serve the 310 Zone. The Lone Pine Well operates as a typical BPS on the east side of the City and is included in this pumping capacity evaluation. Supply analysis for the system is included in **Chapter 4**. For the evaluation, it is assumed that the Garrison BPS should be able to meet MDD for the Sorosis and Vista Reservoirs zones in a situation where the Wicks WTP or the High Line transmission main is inoperable. **Table 5-7** summarizes the firm and total capacity of each BPS and compares firm capacity against the current and projected MDD allocated to the discharge pressure zones.

Table 5-7 | BPS Firm Capacity Analysis

Pump Station	Sorosis[1]	Garrison[2]	Intermediate	Lone Pine Well	Riverside[4]
Pumps from	Sorosis Reservoir	Garrison Reservoir	Intermediate Reservoir	Lone Pine Well	Riverside Reservoirs 1&2
Pumps to	Vista Reservoir	Sorosis Reservoir	Columbia View Reservoir	Intermediate Reservoir	310 Zone
Required Supply, MDD (gpm)					
Existing, 2023	740	1,300	450	640	3,360
10-year, 2033	800	1,410	490	690	7,110
20-year, 2043	870	1,540	530	750	7,330
Available Supply (gpm)					
Firm Capacity	1,500	500	1,500	--[3]	4,500
Total Capacity	2,250	1,000	3,000	2,100	6,300
Surplus/Deficit of Supply (gpm)					
Existing, 2023	760	-800	1,050	1,460	1,140
10-year, 2033	700	-910	1,010	1,410	-2,610
20-year, 2043	630	-1,040	970	1,350	-2,830

Notes:
1. Triplex BPS; only two pumps can run at once
2. Approx. Garrison pump capacity per operators
3. Lone Pine Well only has one pump; evaluated at total capacity
4. Riverside BPS evaluated at proposed initial firm capacity of 4,500 gpm; BPS to be built with buildout capacity of 9,000 gpm

As shown in **Table 5-7**, the firm capacities of the Sorosis and Intermediate BPS and the Lone Pine Well, meet the current and projected MDD for the discharge pressure zones. The firm capacity of the Garrison BPS is insufficient to meet the current and projected MDD for the discharge pressure zones. The initial phase firm capacity of the Riverside BPS meets existing MDD demands but is undersized for projected future MDD demands.

5.8.2 Back Up Power Supply

The WSMP recommended performance criteria is for each pressure zone to have at least one BPS that serves it equipped with backup power. The Sorosis BPS is equipped with an onsite standby generator. The Garrison and Intermediate BPS do not have onsite standby generators. The Riverside BPS is planned to be constructed with backup power facilities onsite.

The primary purpose of the Garrison BPS is to provide a pathway for well water to be moved up in the system and supply the higher elevation pressure zones in the case where the finished water transmission lines or Wicks WTP is unavailable. It is recommended that an onsite generator be included as part of any capacity increase project at the Garrison BPS. The Intermediate BPS does not have an onsite generator or any way to connect a portable one. This WSMP recommends, at a minimum, electrical improvements that would allow the connection of a portable generator.

5.8.3 BPS Resilience Considerations

The WSMP facility seismic risk assessment included completing an initial assessment of existing structures using record drawings, and identifying structural upgrades based on the age of the structures and building construction materials for seismic resiliency. Documentation of these assessments, potential changes in

regulatory requirements and other conditions, and recommended approach for future studies to refine the City's understanding of the structural conditions, seismic vulnerabilities, and potential expansions are detailed in Appendix C. Recommended BPS architectural improvements are mostly based on good practices for resilient facilities and specifically intended to reduce risk of damage due to wildfire. Electrical recommendations at BPS should be reviewed by the City's contract electrician for endorsement. These electrical improvements may also be considered for improved resilience if equipment is at the end of service life and should be included in any applications for grants based on utility resilience. The recommended improvements and cost estimates are included in the CIP in the Facilities Seismic and Wildfire Resilience Improvements.

5.8.4 BPS Security

The City completed a Risk and Resilience Assessment (RRA) in 2021 that identifies risks and provides recommendations for the system. As part of the WSMP, the RRA was reviewed, and any additional security comments or recommendations were provided. A technical memorandum summarizing the RRA review and additional recommendations will be included with the City's other confidential RRA documents. The primary recommendations for the BPS facilities included physical hardening (fences, locks, lighting) and adding intrusion detection contacts to all facilities that would be tied into the existing SCADA programmable logic controller (PLC).

5.8.5 Summary of BPS Recommended Improvements

Recommended capacity and other improvements associated with the BPS as outlined in the prior sections are summarized below and included in the CIP in Chapter 7.

- Garrison BPS Improvements
- Riverside BPS Phase 2
- Facilities Seismic & Wildfire Resilience Improvements

5.9 Supply Pumping

In addition to BPS, the City also has three groundwater well facilities (Marks, Jordan, and Lone Pine) with two additional facilities under construction (Riverside Wells). Supply capacity evaluation is addressed in Chapter 4.

The existing Marks, Jordan, and Lone Pine Wells facilities do not have onsite generators or a way to connect a portable one. This WSMP recommends, at a minimum, electrical improvements that would allow the connection of a portable generator at these three well facilities. It is recommended this be completed in conjunction with other electrical recommendations from the resilience assessment as noted below.

Similar to the BPS, an initial assessment of existing structures using record drawings, and identifying structural upgrades based on the age of the structures and building construction materials for seismic resiliency was completed for the existing three well facilities. Documentation of the assessment and recommendation are detailed in Appendix C. Recommended well buildings architectural improvements are mostly based on good practices for resilient facilities and specifically intended to reduce risk of damage due to wildfire. Electrical recommendations at Well facilities should be reviewed by the City's contract electrician for endorsement. These electrical improvements may also be considered for improved resilience if equipment is at the end of service life and should be included in any applications for grants based on utility resilience. The recommended improvements and cost estimates are included in the CIP in the Facilities Seismic and Wildfire Resilience Improvements.

5.10 Storage Analysis

This section summarizes the analysis of the City's storage capacity against the existing system described in Chapter 1, the demand projections described in Chapter 2, and the performance criteria described in Chapter 3. The results of the analyses serve as the basis for capital improvements and capital maintenance of the storage system as described in the CIP in Chapter 7. In drinking water systems, adequate storage capacity is necessary to ensure the following.

- Equalize demand on supply sources, booster pump stations, and transmission mains
- Stable system flow and service pressures
- Availability of reserve capacity in the distribution system for emergencies
- Reliable "on demand" capacity to meet fire suppression needs

The storage performance criteria described in Chapter 3 is summarized in Table 5-8. The following section analyzes the total required component storage capacity, pressure zone storage capacity, and system storage capacity for existing conditions and conditions over the planning period.

Table 5-8 | Storage Performance Criteria Summary

Water System Component	Storage Component	Value	Design Standards/Guideline
Storage	Total Available Storage Capacity	Sum of operational, equalization, standby, and fire suppression storage volumes (does not include seismic or dead storage volumes)	Washington Water System Design Manual
	Operational	Tank level set points Does not apply to continuous pumping systems	
	Equalization	(PHD - Q_s) * (150 minutes)	
	Standby (Emergency)	1 x MDD	
	Fire Suppression	Highest required fire flow x flow duration	
	Seismic Storage	Only required in reservoirs that do not meet seismic code	
	Dead Storage	The volume of storage that is not available at the minimum pressure	

5.10.1 Operational Storage

Operation of BPS are controlled by water depth in the reservoirs. The pumps start when depths reach a low setpoint and stop when depths reach a high setpoint. The volume between the two setpoints is the operational volume. The setpoints used by the City also include lead and lag pump configurations, but operational storage is based only on lead pump operation as it is assumed that reservoir levels are typically maintained by the lead pump. The setpoints are designed to minimize pump cycling for the typical demand, which may vary by season. Storage capacity should be based on high demand scenarios. The operational storage volume is not expected to increase over the planning period because the operational setpoints are not expected to change with higher demand.

The volume associated with the operation setpoints are summarized in Table 5-9.

Table 5-9 | Operational Storage Requirements

Reservoir	Vista	Sorosis	Garrison	Riverside 1 & 2[1]	Columbia View	Intermediate
Operational Storage						
Pumps on (ft)	32	22	38	-	23.5	20
Pumps off (ft)	34.5	26	48	-	28.5	27
Operational Storage (MG)	0.20	0.43	1.15	0.5	0.50	0.26

Note:
1. Operational storage as proposed in draft predesign. Pump operations and setpoints have not been finalized yet.

5.10.2 Equalization Storage

The Washington State Water System Design Manual only requires equalization storage when source pumping does not meet the PHD. **Table 5-10** compares the total supply capacity for each reservoir with its allocated PHD. For Sorosis and Garrison Reservoirs, typical peak season Wicks WTP supply capacity was split between the two reservoirs – first meeting the PHD needs of Sorosis and then Garrison. The total supply assumed for the Riverside Reservoirs 1 & 2 includes the design criteria of the Riverside BPS and capacities of Marks and Jordan Wells. Marks and Jordan Wells discharge to the 460 Pressure Zone which has PRV connections to the 310 zone where the Riverside Reservoirs are to be located. Marks and Jordan Wells supply were attributed to the Riverside Reservoirs because the Wicks WTP supply is sufficient to provide PHD for the zones served by the Sorosis and Garrison Reservoirs.

Table 5-10 | Equalization Storage Requirements

Reservoir	Vista	Sorosis	Garrison	Riverside 1 & 2	Columbia View	Intermediate
Equalization Storage						
PHD (gpm)						
Existing, 2024	955	734	1,111	4,377	579	246
10-year, 2034	1,038	798	1,208	9,273	629	268
20-year, 2044	1,132	870	1,317	9,553	686	292
Total Supply, Qs (gpm)	2,250	870	1,561	6,850	3,000	2,100
Equalization Storage (MG)						
Existing, 2024	0	0	0	0.00	0	0
10-year, 2034	0	0	0	0.36	0	0
20-year, 2044	0	0	0	0.41	0	0

The total supply for each reservoir is larger than the PHD for each reservoir, except the Riverside Reservoirs. The approximate required equalization storage capacity for the Riverside Reservoirs is as follows.

- 2034: 0.36 MG
- 2044: 0.41 MG

5.10.3 Standby (Emergency) Storage

As stated in the performance criteria, it is recommended the City use 1 day x MDD as the required standby storage component. Overall, this aligns with the method of calculation described in the Washington State Water System Design Manual for standby storage but does not require the use of equivalent residential unit (ERU) to calculate because system demands were not specifically evaluated on a ERU basis for the

WSMP. The major industrial customer in the Riverside service area has private onsite storage that reduces the volume needed for standby storage. This private storage has been accounted for in the calculations below. **Table 5-11** summarizes the standby storage requirements for each reservoir based on the MDD of the zones served.

Table 5-11 | Standby Storage Requirements

Reservoir	Vista	Sorosis	Garrison	Riverside 1 & 2	Columbia View	Intermediate
Standby (Emergency) Storage						
MDD (gpm)						
Existing, 2024	732	562	852	3.354	443	189
10-year, 2034	796	611	926	7,106	482	205
20-year, 2044	867	667	1009	7,321	526	224
Onsite Industrial Facility Storage (MG)[1]	-	-	-	2.5	-	-
Duration, Td (days)	1	1	1	1	1	1
Standby Storage (MG)						
Existing, 2024	1.05	0.81	1.23	2.33	0.64	0.27
10-year, 2034	1.15	0.88	1.33	7.73	0.69	0.30
20-year, 2044	1.25	0.96	1.45	8.04	0.76	0.32

Note:
1. Based on discussions with City staff, private onsite storage has been included in the calculation of standby storage requirements.

5.10.4 Fire Suppression Storage

Each pressure zone was analyzed for the land use with the highest fire flow requirement. Refer to **Figure 5-3** for land use designations and assigned fire flow. Vista, Sorosis, and Columbia View pressure zones do not include commercial or industrial land use areas. Land use designations and fire flow requirements are not expected to change over the planning period. **Table 5-12** summarizes the land use and maximum fire flow requirement for each pressure zone.

Table 5-12 | Fire Suppression Storage Requirements

Reservoir	Vista	Sorosis	Garrison	Riverside 1 & 2	Columbia View	Intermediate
Fire Suppression Storage						
Highest fire flow zoning	MDR	MDR	Com/Ind	Com/Ind	MDR	Com/Ind
Fire flow requirement (gpm)	2,000	2,000	3,000	3,000	2,000	3,000
Duration (min)	120	120	180	180	120	180
Fire Suppression Storage (MG)	0.24	0.24	0.54	0.54	0.24	0.54

5.10.5 Seismic Storage

A seismic analysis was completed in 2014 for the Sorosis, Garrison, Columbia View, and Intermediate Reservoirs (**Appendix C**). The report provides recommendations on overflow elevations for the reservoirs accounting for seismic risks. The overflow elevations for the Sorosis and Columbia View Reservoirs have been adjusted to these recommendations. The Garrison and Intermediate overflow elevations have not yet, but the City intends to in the future. For this evaluation, the recommended overflow elevations have

been assumed for these four reservoirs. The Vista Reservoir had been built recently when the seismic evaluation was completed and was designed to include seismic considerations, so additional storage is not required. The Riverside Reservoirs are assumed to be designed with seismic considerations and additional storage will not be needed.

5.10.6 Dead Storage Capacity

The outlet pipe elevation for all reservoirs is generally located at or near the reservoir floor. Required dead storage for the reservoirs is based this outlet elevation or maintaining a minimum pressure of 20 psi at the highest elevation in the pressure zone, whichever is greatest. Table 5-13 summarizes the reservoir base elevations, dead depths, max service elevations, minimum tank elevation for 20 psi at highest service, and required dead storage for each reservoir.

Table 5-13 | Dead Storage Capacity Summary

Reservoir	Vista	Sorosis	Garrison	Riverside 1 & 2[1]	Columbia View	Intermediate
Dead Storage						
Base Elevation (ft)	750.5	630.5	408	-	602	325
Dead depth (ft)	0	1	0.5	-	1	0
Max service elevation (ft)	600	580	347	195	562	185
Min tank elevation for 20 psi (ft)	646	626	393	n/a	608	231
Dead Volume (MG)	0.00	0.11	0.06	0.00	0.61	0.00

Note:
1. Riverside Reservoirs will be pumped storage so no dead volume is assumed be zero.

5.10.7 Summary of Total Storage Capacity Requirements

The individual component storage requirements were combined into the total required storage for each reservoir and the pressure zones they serve. These required storages were compared to the available storage and a storage surplus/deficit for each reservoir was calculated. Table 5-14 summarizes the required storage capacity, available capacity, and associated surplus or deficit for each reservoir and associated pressure zones. For a system wide evaluation, backup PRV connections between pressure zones typically served by separate reservoirs should be considered. Each calculated deficit in a reservoir is offset or supplemented by other connected storage, as described below.

- Deficits in the Riverside 1 & 2 Reservoirs are offset by approximately 2.47 MG of storage surplus in the Garrison Reservoir as this is additional gravity storage available from a higher elevation through connecting PRVs.
- Deficit in the Intermediate Reservoir are offset by approximately 0.65 MG of surplus storage in the Columbia View Reservoir which is at a higher elevation and connected through PRVs.

The overall storage analysis shows a deficit of approximately 4.5 MG in the Riverside Reservoirs service area in the 2044 planning horizon. It is recommended that additional storage be built to serve the 310 Zone in the 20-year planning horizon.

Table 5-14 | Storage Capacity Analysis

Reservoir	Vista	Sorosis	Garrison	Riverside 1 & 2	Columbia View	Intermediate
Storage Requirements (MG)						
Operational Storage	0.20	0.43	1.15	0.50	0.50	0.26
Equalization Storage						
Existing, 2024	0	0	0	0	0	0
10-year, 2034	0	0	0	0.36	0	0
20-year, 2044	0	0	0	0.41	0	0
Standby Storage[1]						
Existing, 2024	1.05	0.81	1.23	2.33	0.64	0.27
10-year, 2034	1.15	0.88	1.33	7.73	0.69	0.30
20-year, 2044	1.25	0.96	1.45	8.04	0.76	0.32
Fire Suppression Storage	0.24	0.24	0.54	0.54	0.24	0.54
Total Required Storage (MG)						
Existing, 2024	1.49	1.48	2.92	3.37	1.37	1.07
10-year, 2034	1.58	1.55	3.02	9.14	1.43	1.10
20-year, 2044	1.69	1.63	3.15	9.49	1.49	1.13
Storage Available (MG)						
Available Storage	2.77	2.64	5.62	2.56	2.14	0.94
Storage Surplus/Deficit (MG)						
Existing, 2024	1.28	1.17	2.70	1.66	0.77	0.52
10-year, 2034	1.18	1.10	2.59	-6.58	0.71	0.49
20-year, 2044	1.08	1.02	2.47	-6.93	0.65	-0.19
Higher HGL Reservoir/s Surplus (MG)	-	-	-	2.47	-	0.65
20-year, 2044 Adjusted (MG)	1.08	1.02	0	-4.46	0	0.46

Note:
1. Based on discussions with City staff, private onsite storage has been included in the calculation of standby storage requirements.

5.10.8 Reservoir Seismic Considerations

No new analyses of reservoirs condition or seismic considerations were conducted during this WSMP update, but a summary of the 2014 seismic assessment completed previously was completed. As noted previously, the assessment reviewed four of the City's AWWA D100 carbon steel reservoirs: Sorosis, Garrison, Intermediate, and Columbia view Reservoirs. The complete study and additional summary information is included in the technical memorandum in **Appendix C**. Minor recommended seismic improvements for the four reservoirs are included in the CIP in the Facilities Seismic and Wildfire Resilience Improvements.

5.10.9 Reservoir Security

As noted in the BPS evaluation section, review of the existing RRA and additional recommendations were completed for the master plan (the technical memorandum completed will be added to the City's confidential RRA documents). The primary recommendations for the reservoir facilities included physical

hardening (fences, locks, lighting) and adding intrusion detection contacts to all hatches on reservoirs that would be tied into the existing SCADA programmable logic controller (PLC).

5.10.10 Reservoir General Conditions and Operations

A site visit was completed to the Sorosis, Garrison, and Intermediate Reservoirs during the WSMP. General conditions and operations of all five reservoirs were discussed with City staff. Deficiencies and operational challenges noted include the following,

- Garrison Reservoir is in need of recoating and relining but there is no operational method to take the reservoir offline for maintenance.
- When Sorosis Reservoir is offline, a vulnerability in the system is created due to lack of redundancy for the operating systems in place.
- Vista Reservoir cannot be taken offline without loss of pressure in some of the higher service elevations.

All of the City's five reservoirs are of welded steel construction. The Riverside Reservoirs are proposed to be welded steel construction as well. If tank coatings are well maintained, the anticipated life expectancy of a welded steel tank could exceed 50 years. The failure of interior and exterior coatings can lead to steel plate pitting and structural steel deterioration. Coating inspections will examine dry film thickness, lead based paint detection, adhesion tests, and a visual inspection. Reservoirs are recommended to undergo coating inspections every five years. Inspections of the tank interior may require taking the reservoir out of service or a dive inspection.

Operational challenges noted for the reservoirs are discussed in more detail in Section 5.12.

5.10.11 Summary of Reservoir Recommended Improvements

The City's storage system meets the specified performance criteria for normal operation and emergency conditions through reservoir storage and redundant systems for existing demands. However, a deficit of approximately 4.5 MG is anticipated in the 10- and 20-year planning horizons for the Riverside Reservoir service area (310 Zone) to serve future development. Additional Riverside storage is recommended and included in the CIP.

Minor seismic improvements were recommended in the 2014 assessment. The recommendations that have not been completed yet are included in the CIP as part of a larger Facilities Seismic Improvements project. This WSMP also recommends re-coating the interior and exterior of the Garrison Reservoir within the 20-year planning horizon following system improvements noted in Section 5.12.1 to allow the reservoir to be taken offline.

Cost estimates and schedules for recommended reservoir improvement projects are summarized below and included in the CIP in Chapter 7.

- Riverside Storage Phase 2
- Facilities Seismic and Wildfire Resilience Improvements
- Garrison Reservoir Recoating and Lining

5.11 Distribution SCADA Considerations

The City's SCADA system has reached end of useful life and requires upgrades to current technology and incorporation of certain security features which have become required by the US Environmental Protection Agency (EPA) cybersecurity regulations since the last generation of upgrades were performed over 20 years ago. A technical memorandum summarizing the work currently underway and work required to provide an upgraded and secure SCADA system is included in Appendix C. The SCADA improvements have been separated into two phases – Phase 1 is the Wicks WTP and Phase 2 is the distribution system. These recommendations have been included in the CIP. Phase 2 planning and engineering are anticipated to begin in 2025 with the facilities intended to be operational by late 2027.

5.12 Distribution Operational Challenges

Based on discussions with City staff, a number of operational challenges and recommendations are described below.

5.12.1 Garrison Reservoir

Currently, the Garrison Reservoir cannot be easily taken offline due to lack of operating systems. Under normal operating conditions, the existing Mill Creek Line transmission main does not directly feed the 460 Zone. Operators are concerned with over pressurizing the transmission main and causing failures and/or overflows directly to the creek if control valves were manually adjusted to feed the zone directly from the transmission main. Additionally, there is not an existing pathway to feed the 460 Zone from the Sorosis Reservoir.

There are two recommendations to modify operations and allow the Garrison Reservoir to be more easily taken offline for maintenance. The first is replacement of the existing Mill Creek Line and installation of PRV facilities to allow the 460 Zone to be fed directly from the transmission main. More details and discussion on the transmission lines and recommended replacement are included in the following section. The second recommendation is to install a PRV facility near W 16th Street and Liberty Way to connect the 660W and 460 Zones. There is aging steel pipe both upstream (in the 660W Zone) and downstream (in the 460 Zone) that is recommended to be replaced at the same time as the PRV facility is installed. These steel pipelines have been identified in the top priority category for replacement based on the pipe condition evaluation presented previously. It is recommended the PRV facility be included in the project when these steel pipes are replaced.

5.12.2 Sorosis Reservoir

Currently, there is a vulnerability in the system when the Sorosis Reservoir is taken offline due to a lack of supply redundancy. There is one PRV facility that provides supply to the Sorosis zones and failure of the PRV could result in over-pressuring the High Line causing main failure or loss of pressure in the High Line main and for customers served directly off the main. The High Line transmission main is recommended for replacement due to condition and future capacity limitations. More details and discussion on the transmission lines replacement are included in the following section. Replacement of the High Line is expected to allow for the High Line to directly serve the 660W and subsequently the lower Sorosis zones, which will resolve the vulnerability of the system when Sorosis Reservoir is taken offline.

5.12.3 Vista Reservoir

If the Vista Reservoir is taken offline, there are low pressures in some of the higher elevation service areas. The Sorosis BPS has constant speed pumps and is not able to provide closed zone operations of the Vista service area. Similar to the challenges of taking Sorosis Reservoir offline, the recommended replacement of the High Line will provide some redundancy in supply to the zones and allow for easier operations while performing maintenance on the Vista Reservoir. There is the possibility of providing direct feed to the 786 Zone from the new High Line. Additional discussion is included following section on the transmission lines, and further evaluation is recommended during the design phases. A secondary option to address this vulnerability is to install variable frequency drives (VFDs) at the Sorosis BPS to allow for closed zone operation of the Vista service area when the reservoir is offline. A CIP project has been included to add VFDs to the Sorosis BPS as a conservative approach to addressing the operating challenge. If the transmission line design evaluation indicates that the 786 Zones and lower can be fed directly from the new High Line, installing VFDs at the Sorosis BPS may not be necessary. The priority of these CIPs is aligned so that design details can be used to inform the projects as necessary.

5.12.4 Winter Operations of Columbia View Service Area

The Columbia View Reservoir and Intermediate BPS are taken offline in the winter due to lower demands and water stagnation challenges with Lone Pine Well not running. Under these operating conditions, there is only one hydraulically operated PRV facility (at E 18th Street and Morton St) that provides supply to the Columbia View service area. In addition, the operations and maintenance efforts required to take Columbia View Reservoir offline and put it back online take significant time and effort from the operations staff. It is recommended that SCADA control be added to the E 18th Street and Morton St PRV facility which would allow the Columbia View Reservoir to remain online year-round by operating the PRV based on the reservoir level. This allows for regular turnover of the reservoir volume and eliminates the water stagnation challenge of existing operations. A CIP project has been included to add SCADA and power to the PRV facility. This project should be designed and completed in conjunction with the distribution system SCADA improvements described in Section 5.11 and planned to begin in fiscal year 25/26.

5.12.5 352 Zone PRVs

The PRV facility that provides backup supply to the 352 Zone from the 660E Zone experiences significant cavitation when open under current operations. This is particularly challenging if trying to take the Intermediate Reservoir offline. It is recommended operations staff consult with the valve manufacturer to evaluate if a specialty anti-cavitation valve trim would alleviate this issue or if a second PRV facility in series is recommended. This improvement is expected to be a low-cost solution and would be paid for from the annual operations budget.

5.12.6 395 Zone Sediment Buildup

City staff have noted some sediment buildup in the 395 Zone. The zone is long with relatively low demands/flows which can result in lower velocities and potential for solids to settle out of water. The sediment is believed to be iron and manganese from Marks and/or Jordan Well water that precipitates out with chlorination when the wells are in operation. The City has iron sequestration equipment at both wells which reduces precipitation within the distribution system. The operations staff also perform additional flushing in the zone to remove sediment buildup. Currently, both iron and manganese are secondary contaminants and only cause aesthetic water quality challenges. With the other priorities the water system is facing, it is recommended the City continue to current operations and monitor the water quality. If the

issue gets worse or the regulation for either contaminant changes to a primary contaminant, the City will want to re-evaluate if additional treatment is warranted. The City has seen success at the Discovery Center Well outside of town with a filtration system and could consider installing at Marks and Jordan Wells at that time.

5.13 Finished Water Transmission Lines

The two finished water transmission lines - the High Line and the Mill Creek Line – were both originally installed approximately 75 years ago. The original High Line pipe is 14-inch diameter welded steel; some sections have been replaced with 20-inch diameter ductile iron. The Mill Creek Line original pipe is 12-inch diameter welded steel; some sections have been replaced with 20-inch diameter ductile iron.

There are continued concerns with the conditions, resilience, and operations of the existing transmission lines. The 2006 WSMP highlighted these concerns and recommended the replacement of the transmission lines. Segments of both lines operate in an open-channel condition by controlling the flow rate entering the pipelines at the upstream WTP clearwell. If the upstream valve were fully opened or the downstream valves were closed or partially closed so that either line was allowed to flow fully under pressure, there is a risk of failures in pipe in areas of high pressure. The City operators have developed routine minimum and maximum flows and flow adjustment requirements for each line to protect the integrity of the lines and minimize the potential for damage to the lines from pressure/vacuum surges.

Additionally, the existing lines provide an approximate capacity of 7.5 MGD. As recommended in the Wicks WTP improvements and long-term supply analysis (see Chapter 6 and Chapter 4 for more discussion), the Wicks WTP is recommended to be upgraded to a larger capacity. These improvements will make the existing transmission lines undersized.

The 2006 WSMP evaluated the option to replace the transmission lines with two separate lines (matching existing) or with a single line. Providing transmission redundancy would be one of the main reasons for two separate lines. However, during the 1996 floods, both pipelines were damaged at creek crossings. The 2006 WSMP recommended replacing the transmission lines with a single pipe because two lines provides only limited redundancy and is much more expensive. There has been nothing since the previous analysis that would suggest the City should reconsider or re-evaluate two separate lines. The continued recommendation is for the transmission lines to be replaced with a single pipeline designed to reduce the risk of failures at creek crossings and to current seismic standards.

There are a handful of components and options that should be considered during the predesign and design of the replacement transmission line. These include,

- The existing transmission main alignments should be assessed for options to improve O&M and/or constructability for the new transmission main, such shifting alignment within public rights of way where possible and optimal creek crossing locations.

- Design for high operating pressures (back pressure) along portions of the lines. The new transmission lines are recommended to be controlled on the inlet side of the City reservoirs (current operations control flow at the WTP clearwell outlet). This change in operational control could result in typical operating pressures of upwards of 270 psi in portions of the transmission line. Typically, pipeline material and specifications are different for pipelines with operating pressures at or above 250 psi. Typical operating pressures along the proposed new lines should be evaluated and portions with expected high operating pressures (250 psi or greater) should be designed accordingly.

- Existing services on the current transmission lines. Each transmission line serves a limited number of customers on properties adjacent to the pipeline alignments. Most of these services were granted many years ago in exchange for having the customers provide pipeline easements while others have been authorized more recently. These connections should be evaluated as part of the design process to provide optimal service and operations for the City and existing customers.

- Opportunity for energy recovery along the new main. A screening-level desktop study of potential energy recovery (in-conduit hydropower) in the new transmission main was completed as part of the WSMP. The technical memorandum describing the evaluation can be found in Appendix C. The recommendation is to complete a more detailed evaluation during the transmission line design process to understand if there are local drivers and funding opportunities at that time to pursue the project further.

- Potential to serve the 786 Zone directly. At a high-level, it appears there is potential to feed the 786 Zone directly from the new High Line during many operating scenarios. This could provide energy savings for the City by significantly reducing the operating time of the Sorosis BPS. This should be further evaluated and pursued if found feasible during the design phases of the transmission lines.

- Direct feeds to 460 and 660E Zones. As noted in the pervious section, taking Garrison or Sorosis Reservoirs offline for maintenance is challenging with the existing operations of the transmission lines. The lines are not designed or controlled to directly feed the distribution zones. Replacement of the transmission lines design should include facilities and controls to allow direct feed of the 460 and 660E Zones.

Replacement of the finished water transmission lines is included in the CIP and estimated to cost $47,320,000. It is recommended the design start during the latter part of the Wicks WTP improvement projects so that operation of the new plant and transmission line can coincide for capacity and reliability purposes.

CHAPTER 6

Wicks WTP Analysis

6.1 Purpose

The Wicks WTP existing condition and alternatives for expansion were assessed as part of this WSMP process. The conditions and analysis are summarized in Appendix D. The results of the analyses serve as the basis for capital improvements and capital maintenance of the Wicks WTP as described in the CIP in Chapter 7.

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CHAPTER 7

Capital Improvement Plan

7.1 Purpose

This chapter summarizes the recommended water system improvements that are described in previous chapters into a Capital Improvement Plan (CIP) for the water system. The recommended improvements will correct system deficiencies associated with the performance criteria described in **Chapter 3** for the existing and future demand projections described in **Chapter 2**.

All recommended improvements are intended to serve existing development and planned growth that occurs within the service area. Projects that also increase system capacity may be eligible for System Development Charges (SDCs). Project cost estimates are presented for all recommended improvements.

7.1.1 System Development Charges

The SDC methodology, calculations, and project cost eligibility are also discussed in more detail in **Chapter 8**.

7.1.2 Prioritization and Scheduling

Through the analysis, identification of existing and future deficiencies and discussion with City staff, priorities were given to each project based on timing of need and consideration of the overall CIP needs on an annual basis. Improvements recommended during FY 24/25-FY 28/29 (years 1-5) are considered short-term projects, projects identified for FY 2030-FY 2044 (years 6-20) are considered medium-term projects, and those beyond the 20-year planning horizon are considered long-term improvements.

7.2 Cost Estimating Data

An estimated project cost has been developed for each recommended CIP project. The Association for the Advancement of Cost Engineering (AACE) classifies cost estimates depending on project definition, end usage, and other factors. The cost estimates presented in this document are considered Class 5 with an end usage being a study or feasibility evaluation and an expected accuracy range of -50 percent to +100 percent. As the projects are better defined the accuracy level of the estimates can be narrowed. The estimated planning level cost for each project includes construction, engineering, and contingencies and is presented in 2024 dollars. Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News Record Construction Cost Index is commonly used for this purpose (August 2024, 20-City ENR CCI = 13,593.65).

7.3 Capital Improvement Program

Based on the analysis of the water system's source, treatment, transmission, and distribution facilities presented in previous chapters, system-wide recommended improvements have been developed into the CIP. A brief description of each project is included below.

- **Wicks WTP SCADA Improvements (Phase 1) –** This project includes planned SCADA improvements at the existing Wicks WTP to replace equipment that is beyond its useful life, upgrade to current

technology, and incorporate certain security features which have become required by the US EPA cybersecurity regulations since the last generation of upgrades were performed over 20 years ago. SCADA system replacement is a priority and needed for continued, reliable, and resilient control system equipment.

- Wicks WTP Replacement and Expansion – This project includes design and construction of a new WTP on the existing site with expanded capacity of approximately 9.5 MGD. The new WTP is needed due to age and condition of the existing Wicks WTP and to provide expanded capacity for future demands. The new expanded WTP will incorporate improved water clarification and filtration processes to maximize treatment capacity across a wide range of water temperature and turbidity levels. The project includes short-term improvements, pilot studies and predesign, followed by three design and construction phases. See Appendix D for further details.

- 18th & Morton PRV Control Upgrades – This project includes adding SCADA control to the PRV facility at E 18th & Morton Streets. This project addresses current winter-time operational challenges and maintenance and would allow the Columbia View Reservoir to be kept online year-round. This project should be coordinated with the Distribution System SCADA Improvements (Phase 2) project.

- Distribution System SCADA Improvements (Phase 2) – This project is the second phase of system-wide SCADA improvements to replace equipment past useful life and incorporated improved security measures at water system facilities including pump stations, reservoirs, and wells. It is expected that the wastewater fund will be used to pay for half of project costs as the improvements benefit both utilities. The cost included in the CIP represents the portion to be funded by the water utility.

- Aquifer Storage and Recovery (ASR) Program

    - *Artificial Groundwater Recharge (AR) License* – This project allows the City to apply for an AR limited license or permit using South Fork Mill Creek (SFMC) as the source of supply. Obtaining a limited license or permit for AR would increase the maximum rate the City is authorized to divert winter flows on SFMC beyond the City's existing water right for that source. If approved, this supply would be used and operated in conjunction with the ASR program and facilities.

    - *ASR Expansion Planning* – The City has pilot and testing plans for the new ASR facilities that will begin operations in early 2025. This project would develop an ASR Expansion Plan based on the findings of the initial pilot and testing data. This plan would evaluate future options for expansion of the ASR Program, how it fits into the City's overall supply system, and recommendations for ASR operations and facilities.

    - *Additional ASR Wells* – After the Wicks WTP and transmission line capacities are expanded, it is likely that in an average streamflow year the available water for ASR could exceed the current design capacity of the Riverside ASR facilities. Assuming that initial operations and testing results of the ASR facilities are positive, it is likely that the ASR Expansion Planning will identify the need for additional ASR wells to optimize the volume of water stored and utilized by an ASR Program. This project assumes the need for design and construction of two additional ASR wells. The scope and size of this project could change based on recommendations from the ASR Expansion Plan and should be adjusted as needed at that time.

- **Facilities Seismic & Wildfire Resilience Improvements –** This project groups together recommended improvements at existing water system facilities including booster pump stations, wells, and reservoir facilities to improve seismic resilience and reduce risk of wildfire damage to facilities.

- **Crow Creek Dam Seismic Evaluation and Emergency Action Plan (EAP) –** This project would update seismic and flood studies on the Crow Creek Dam to be consistent with current State of Oregon Dam Safety Program guidelines. These studies will provide initial analyses as a screening exercise to confirm adequate or unacceptable performance, and document data needs for more in-depth analyses should it be determined that the dam has an unacceptable performance. This project assumes a desktop study and site visit, without additional field data collection. Additionally, this project would include an update to the EAP for the dam as it is classified as a high hazard.

- **Finished Water Transmission Main –** This project would replace the existing finished water transmission mains to address condition, reliability, and capacity concerns. The project includes design and construction of a single, resilient 24-inch diameter transmission main from the Wicks WTP clearwell to the distribution system with split discharge piping to the Garrison and Sorosis Reservoirs. During the predesign, it is recommended in-conduit hydropower be evaluated for the new transmission main design.

- **Sorosis BPS Variable Frequency Drives (VFDs)** – This project would add VFDs at the Sorosis BPS to address the vulnerability of potential for low pressures in some of the higher elevation service areas if the Vista Reservoir is taken offline. VFDs at Sorosis BPS would allow closed zone operation of these areas if this situation arises. There is potential this vulnerability may be addressed with the new finished water transmission main and need for this project should be re-evaluated after design of the transmission main.

- **Crow Creek Dam Updated Concept Design –** The last study completed on a Crow Creek Dam expansion and spillway improvement project was in 1996. Given changes to regulations, dam design and safety practices, and construction costs in the past 20 years; this project would complete an updated concept design for the Crow Creek Dam Expansion. The 1996 concept design may need to be significantly reformulated to conform with current Dam Safety Rules. Evaluation of spillway improvements with or without a dam raise at the same time should be evaluated as part of the updated concept design.

- **Planning Updates –** With the magnitude of projects identified in this CIP and potential for changes in demand projection timing and supply system unknowns, it is recommended a master plan update be completed every 5 years. The primary focus of the update should be the existing water usage, projected demands, and re-evaluating and prioritizing needs for the system to continue to provide safe, resilient drinking water to the customers. It is recommended to update the WMCP and financial evaluation on the same timeline.

- **Distribution Pipe Renewal & Replacement –** An annual renewal and replacement program for the distribution system can reduce the risk and high costs of responding to and repairing pipe breaks. An ongoing program allows the City to continue to invest in its distribution piping infrastructure and provide the desired level of service. Priorities for replacement are summarized in the Pipe Condition Assessment (see **Section 5.7**). The level of annual funding proposed in the CIP establishes a baseline for the City to replace high-priority pipes over the next 50 years.

- **Short-Term Distribution Piping Improvements –** These projects include the design and construction of recommended pipe improvements to increase fire flow capacity in the distribution system.

Short-term distribution system projects include approx. 7,700 linear feet of pipe ranging from 8-inch to 12-inch diameter.

- Riverside BPS Phase 2 – This includes design and construction of Riverside BPS Phase 2 to increase pumping capacity to match increasing demands in the 310 Pressure Zone.
- Riverside Storage Phase 2 – This project includes the design and construction of a 4.5 MG reservoir to increase storage serving the 310 Pressure Zone with increases in demands.
- Garrison Reservoir Recoating & Lining – This project includes spot repair and overcoat of the exterior coating and full removal and replacement of the interior lining of the Garrison Reservoir.
- Garrison BPS Improvements – This project includes the design and construction of an expanded Garrison BPS to provide reliability and redundancy for supply to the upper reservoirs and pressure zones within the system in the event that surface water supply to the Sorosis Reservoir is disrupted.
- Medium-Term Distribution Piping Projects – These projects include the design and construction of recommended pipe improvements to increase fire flow capacity in the distribution system as growth occurs. Medium-term distribution system projects include approx. 18,000 linear feet of pipe ranging from 8-inch to 16-inch diameter.
- Long-Term Distribution Piping Projects – These projects include the design and construction of recommended pipe improvements to increase fire flow capacity in the distribution system as growth occurs. Long-term distribution system projects include approx. 53,000 linear feet of pipe ranging from 8-inch to 12-inch diameter.
- Crow Creek Dam Expansion – Includes design and construction of a Crow Creek Dam raise. Additional raw water storage is part of the City's plan to meet long-term supply needs. The project cost estimate presented in this section is based on a higher degree of uncertainty and lower level of project definition than the remaining estimates given the long-range nature of this project and the need for updated conceptual designs identified earlier in the CIP.
    - Crow Creek Dam Spillway Improvements – Spillway improvements are recommended regardless of a dam raise as the existing spillway is undersized for current conditions and regulatory requirements. The spillway improvements options with or without a dam raise should be evaluated as part of the Crow Creek Dam Updated Concept Design, so that these improvements are coordinated with any future dam expansion.

Table 7-1 summarizes the estimated project costs in 2024 dollars and recommended schedule over the study period for the recommended CIP. The estimated total 20-year CIP is $205.2 million. For the long-term, 50-year supply and distribution system renewal and replacement, there are $151.3 million of additional capital improvements beyond the 20-year planning horizon. Table 7-2 summarizes estimated project costs for the 20-year CIP based on the recommended schedule and an assumed annual inflation rate of 3%.

Table 7-1 | Capital Improvement Plan (CIP) in 2024 Dollars

Project Type	Project Name	Total Project Cost	Year 0	5-Year					6-10 Year					11-20 Year										20-50 Year
			FY 24/25	FY 25/26	FY 26/27	FY 27/28	FY 28/29	FY 29/30	FY 30/31	FY 31/32	FY 32/33	FY 33/34	FY 34/35	FY 35/36	FY 36/37	FY 37/38	FY 38/39	FY 39/40	FY 40/41	FY 41/42	FY 42/43	FY 43/44	FY 44/45	FY 45/46-75/76
Other	Carryover Projects Budget	$ 402,000	$ 402,000																				
Supply	Wicks WTP Replacement and Expansion	$ 74,909,000		$ 3,602,000	$ 3,143,000	$ 14,005,000	$ 4,849,000	$ 4,849,000	$ 12,935,000	$ 21,018,000	$ 10,508,000													
Supply	Artificial Groundwater Recharge (AR) License	$ 250,000		$ 250,000																				
Supply	ASR Expansion Planning	$ 250,000			$ 250,000																			
Supply	Additional ASR Wells	$ 6,400,000					$ 300,000	$ 3,100,000	$ 3,000,000															
Supply	Crow Creek Dam Update Concept Design	$ 660,000				$ 660,000																		
Supply	Crow Creek Dam Expansion and Spillway Improvements	$ 70,340,000															$ 2,122,000	$ 2,122,000	$ 2,122,000	$ 2,122,000	$ 2,122,000		$ 59,730,000
Transmission	Finished Water Transmission Main	$ 47,320,000							$ 7,530,000	$ 19,895,000	$ 19,895,000													
Storage	Garrison Reservoir Recoating & Lining	$ 2,500,000											$ 1,250,000	$ 1,250,000										
BPS	Garrison BPS Improvements	$ 4,424,000											$ 700,000	$ 3,724,000										
BPS	Riverside BPS Phase 2	$ 1,600,000							$ 210,000	$ 1,390,000														
Storage	Riverside Storage Phase 2	$ 16,590,000						$ 2,625,000	$ 13,965,000															
Operations	18th & Morton PRV Control Upgrades	$ 200,000		$ 200,000																				
Operations	Sorosis BPS VFDs	$ 250,000							$ 250,000															
SCADA	Wicks WTP SCADA Improvements (Phase 1)	$ 2,000,000	$ 1,370,000	$ 630,000																				
SCADA	Distribution System SCADA Improvements (Phase 2)	$ 1,645,000		$ 1,000,000	$ 322,500	$ 322,500																		
Seismic & Resilience	Facilities Seismic & Wildfire Resilience Improvements	$ 2,575,000			$ 515,000	$ 515,000	$ 515,000	$ 515,000	$ 515,000															
Seismic & Resilience	Crow Creek Dam Seismic Evaluation and EAP	$ 425,000				$ 425,000																		
Other	In-Conduit Hydropower Feasibility Study	$ 100,000							$ 100,000															
Distribution Pipe	LT-1: River & Columbia Rds	$ 1,590,000																						$ 1,590,000
Distribution Pipe	LT-10: Thompson & 10th St	$ 3,120,000																						$ 3,120,000
Distribution Pipe	LT-11: Old Dufur Rd & 9th, 10th, and 12th St	$ 3,800,000																						$ 3,800,000
Distribution Pipe	LT-12: 10th, 13th, & 14th St	$ 1,290,000																						$ 1,290,000
Distribution Pipe	LT-13: Sorosis Park & 18th St	$ 1,450,000																						$ 1,450,000
Distribution Pipe	LT-14: Garrison St, Scenic Dr, & 16th St	$ 2,120,000																						$ 2,120,000
Distribution Pipe	LT-2: Highway 30 - Myrtle to Cherry Heights	$ 4,780,000																						$ 4,780,000
Distribution Pipe	LT-3: W 6th St to 3rd St	$ 3,810,000																						$ 3,810,000
Distribution Pipe	LT-4: Walnut, 7th, & Myrtle St	$ 1,880,000																						$ 1,880,000
Distribution Pipe	LT-5: 8th, 10th, & Webber St	$ 2,660,000																						$ 2,660,000
Distribution Pipe	LT-6: Webber, 2nd, 1st St & off Bargeway Rd	$ 3,310,000																						$ 3,310,000
Distribution Pipe	LT-7: 6th, 7th, & Lincoln St	$ 1,660,000																						$ 1,660,000
Distribution Pipe	LT-8: Boat Launch, Fire Rd, Washington, Federal, & Madison St	$ 3,570,000																						$ 3,570,000
Distribution Pipe	LT-9: E 8th, 10th, & 11th St	$ 1,970,000																						$ 1,970,000
Distribution Pipe	MT-1: W 15th St from Liberty to Trevitt St	$ 1,420,000													$ 1,420,000									
Distribution Pipe	MT-2: W 14th St from Liberty to Trevitt St	$ 1,030,000														$ 1,030,000								
Distribution Pipe	MT-3: W/E 14th St from Liberty to Short St	$ 1,050,000															$ 1,050,000							
Distribution Pipe	MT-4: E 13th St Federal to Kelly St, 16th St west of G St	$ 1,690,000																$ 1,690,000						
Distribution Pipe	MT-5: W/E 13th St & E 11th St	$ 1,410,000																	$ 1,410,000					
Distribution Pipe	MT-6: G to I St between E 11th & 12th St	$ 640,000																		$ 640,000				
Distribution Pipe	MT-7: E 13th, 14th, & 16th east of Riverview St	$ 1,660,000																			$ 1,660,000			
Distribution Pipe	MT-8: W 9th St, E 7th & 9th St, Kelly Ave	$ 1,720,000																				$ 1,720,000		
Distribution Pipe	ST-1: E 12th St, Riverview St, E 17th St, & H St	$ 2,330,000					$ 2,330,000																	
Distribution Pipe	ST-2: W15th St & Trevitt St, Bridge St at W 16th St	$ 720,000					$ 720,000																	
Distribution Pipe	ST-3: W 23rd St, Wright St & Dr	$ 1,150,000					$ 1,150,000																	
Distribution Pipe	ST-4: Diagonal off Cherry Heights Rd & W 10th St	$ 250,000					$ 250,000																	
Renewal & Replacement	Distribution Pipe Renewal & Replacement	$ 69,000,000	$ -	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 54,500,000
Planning	Master Plan Updates	$ 1,900,000					$ 200,000					$ 750,000					$ 200,000					$ 750,000		
Planning	WMCP Updates	$ 400,000					$ 50,000					$ 150,000					$ 50,000					$ 150,000		
Planning	Financial Evalaution Updates	$ 200,000					$ 50,000					$ 50,000					$ 50,000					$ 50,000		
	Annual Subtotals:		$ 1,772,000	$ 5,932,000	$ 4,480,500	$ 16,177,500	$ 10,664,000	$ 11,589,000	$ 39,005,000	$ 42,803,000	$ 30,903,000	$ 1,450,000	$ 2,950,000	$ 5,974,000	$ 2,420,000	$ 2,030,000	$ 2,350,000	$ 4,812,000	$ 4,532,000	$ 3,762,000	$ 4,782,000	$ 5,792,000	$ 1,000,000	$ 151,240,000

Notes:

CONSOR's construction cost estimate (estimate) is in 2024 dollars. This estimate is an opinion of probable cost based on information available at the time of its development. Final costs will depend on actual field conditions, actual material and labor costs, market conditions for construction, regulatory factors, final project scope, method of implementation, schedule, and other variables. This estimate is based on our perception, which is based on experience and research, yet nevertheless, an assessment of current conditions at the project location. This estimate reflects our professional opinion of current costs and is subject to change as the project design evolves. CONSOR has no control over, nor can it forecast variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means, and methods of executing the work, or of determining prices, of the impact of competitive bidding or market conditions, practices, or bidding strategies. CONSOR neither warrants nor guarantees that proposals, bids, or actual construction costs will reflect the costs presented, which are for illustrative purposes only.

Table 7-2 | Capital Improvement Plan (CIP) with Inflation

Project Type	Project Name	Total Project Cost	Year 0	5-Year					6-10 Year					11-20 Year									
			FY 24/25	FY 25/26	FY 26/27	FY 27/28	FY 28/29	FY 29/30	FY 30/31	FY 31/32	FY 32/33	FY 33/34	FY 34/35	FY 35/36	FY 36/37	FY 37/38	FY 38/39	FY 39/40	FY 40/41	FY 41/42	FY 42/43	FY 43/44	FY 44/45
Other	Carryover Projects Budget	$ 402,000	$ 402,000																				
Supply	Wicks WTP Replacement and Expansion	$ 88,038,000		$ 3,711,000	$ 3,335,000	$ 15,304,000	$ 5,458,000	$ 5,622,000	$ 15,446,000	$ 25,850,000	$ 13,312,000												
Supply	Artificial Groundwater Recharge (AR) License	$ 258,000		$ 258,000																			
Supply	ASR Expansion Planning	$ 266,000			$ 266,000																		
Supply	Additional ASR Wells	$ 7,515,000					$ 338,000	$ 3,594,000	$ 3,583,000														
Supply	Crow Creek Dam Update Concept Design	$ 722,000				$ 722,000																	
Supply	Crow Creek Dam Expansion and Spillway Improvements	$ 17,555,000																$ 3,307,000	$ 3,406,000	$ 3,508,000	$ 3,613,000	$ 3,721,000	
Transmission	Finished Water Transmission Main	$ 58,664,000							$ 8,992,000	$ 24,469,000	$ 25,203,000												
Storage	Garrison Reservoir Recoating &	$ 3,411,000											$ 1,680,000	$ 1,731,000									
BPS	Garrison BPS Improvements	$ 6,096,000											$ 941,000	$ 5,155,000									
BPS	Riverside BPS Phase 2	$ 1,961,000							$ 251,000	$ 1,710,000													
Storage	Riverside Storage Phase 2	$ 19,719,000						$ 3,044,000	$ 16,675,000														
Operations	18th & Morton PRV Control Upgrades	$ 206,000		$ 206,000																			
Operations	Sorosis BPS VFDs	$ 299,000							$ 299,000														
SCADA	Wicks WTP SCADA Improvements (Phase 1)	$ 2,019,000	$ 1,370,000	$ 649,000																			
SCADA	Distribution System SCADA Improvements (Phase 2)	$ 1,726,000		$ 1,030,000	$ 343,000	$ 353,000																	
Seismic & Resilience	Facilities Seismic & Wildfire Resilience Improvements	$ 2,903,000			$ 547,000	$ 563,000	$ 580,000	$ 598,000	$ 615,000														
Seismic & Resilience	Crow Creek Dam Seismic Evaluation and EAP	$ 465,000				$ 465,000																	
Other	In-Conduit Hydropower Feasibility Study	$ 120,000							$ 120,000														
Distribution Pipe	MT-1: W 15th St from Liberty to Trevitt St	$ 2,025,000													$ 2,025,000								
Distribution Pipe	MT-2: W 14th St from Liberty to Trevitt St	$ 1,513,000														$ 1,513,000							
Distribution Pipe	MT-3: W/E 14th St from Liberty to Short St	$ 1,589,000															$ 1,589,000						
Distribution Pipe	MT-4: E 13th St Federal to Kelly St, 16th St west of G St	$ 2,633,000																$ 2,633,000					
Distribution Pipe	MT-5: W/E 13th St & E 11th St	$ 2,263,000																	$ 2,263,000				
Distribution Pipe	MT-6: G to I St between E 11th & 12th St	$ 1,058,000																		$ 1,058,000			
Distribution Pipe	MT-7: E 13th, 14th, & 16th east of Riverview St	$ 2,827,000																			$ 2,827,000		
Distribution Pipe	MT-8: W 9th St, E 7th & 9th St, Kelly Ave	$ 3,017,000																				$ 3,017,000	
Distribution Pipe	ST-1: E 12th St, Riverview St, E 17th St, & H St	$ 2,623,000					$ 2,623,000																
Distribution Pipe	ST-2: W15th St & Trevitt St, Bridge St at W 16th St	$ 811,000					$ 811,000																
Distribution Pipe	ST-3: W 23rd St, Wright St & Dr	$ 1,295,000					$ 1,295,000																
Distribution Pipe	ST-4: Diagonal off Cherry Heights Rd & W 10th St	$ 282,000					$ 282,000																
Renewal & Replacement	Distribution Pipe Renewal & Replacement	$ 21,377,000	$ -	$ 258,000	$ 266,000	$ 274,000	$ 282,000	$ 580,000	$ 598,000	$ 615,000	$ 634,000	$ 653,000	$ 1,344,000	$ 1,385,000	$ 1,426,000	$ 1,469,000	$ 1,513,000	$ 1,558,000	$ 1,605,000	$ 1,653,000	$ 1,703,000	$ 1,754,000	$ 1,807,000
Planning	Master Plan Updates	$ 2,824,000					$ 226,000					$ 979,000					$ 303,000					$ 1,316,000	
Planning	WMCP Updates	$ 593,000					$ 57,000					$ 196,000					$ 76,000					$ 264,000	
Planning	Financial Evaluation Updates	$ 287,000					$ 57,000					$ 66,000					$ 76,000					$ 88,000	
		Annual Subtotals:	$ 1,772,000	$ 6,112,000	$ 4,757,000	$ 17,681,000	$ 12,009,000	$ 13,438,000	$ 46,579,000	$ 52,644,000	$ 39,149,000	$ 1,894,000	$ 3,965,000	$ 8,271,000	$ 3,451,000	$ 2,982,000	$ 3,557,000	$ 7,498,000	$ 7,274,000	$ 6,219,000	$ 8,143,000	$ 10,160,000	$ 1,807,000

Notes:
CONSOR's construction cost estimate (estimate) is based on an annual inflation rate of 3% with Year 0 being FY 2024/2025. This estimate is an opinion of probable cost based on information available at the time of its development. Final costs will depend on actual inflation, field conditions, actual material and labor costs, market conditions for construction, regulatory factors, final project scope, method of implementation, schedule, and other variables. This estimate is based on our perception, which is based on experience and research, yet nevertheless, an assessment of current conditions at the project location. This estimate reflects our professional opinion of current costs and is subject to change as the project design evolves. CONSOR has no control over, nor can it forecast variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means, and methods of executing the work, or of determining prices, of the impact of competitive bidding or market conditions, practices, or bidding strategies. CONSOR neither warrants nor guarantees that proposals, bids, or actual construction costs will reflect the costs presented, which are for illustrative purposes only.

CHAPTER 8

Financial Evaluation

8.1 Introduction

A Water System Financial Plan (WSFP) has been developed to identify potential future funding sources for the recommended CIP projects and to project changes to the City's water rates that may be needed to support WSMP recommendations and fund ongoing operations and maintenance costs. The building blocks of the WSFP include projections of revenues from existing rates (which have not been increased in over a decade)[2] and projected rate increases and costs or "revenue requirements" that the City will incur during the 20-year WSFP planning period. To better align rates with customer class service demands and characteristics, the WSFP also includes an updated rate structure analysis.

The WSFP provides important information for decision-makers to help define expectations related to future capital financing needs and associated water rate increases. Because circumstances and priorities change, these projections typically vary (at least marginally) from future approved budgeting and rate-setting decisions. Prospective financial and rate planning should involve periodic updating of revenue requirement and cost of service projections in the context of changing economic and credit market conditions, more refined CIP cash flows and cost estimates, and customer water demands. Accordingly, the WSFP elements presented in this section are intended to serve as a benchmark and reference for the City's prospective budgeting, capital planning, and rate setting decisions.

8.2 Water System Revenue Requirements

The WSFP includes projections of annual revenue requirements that the City will incur for the water system during the 20-year planning period. The primary components of water system revenue requirements are:

- Operation and maintenance (O&M) costs – Ongoing personnel, materials and internal and external services costs associated with water system operation and routine facility maintenance.
- Capital expenditures – Funding for capital improvements in the form as annual "pay-as-you-go" (PAYGO) funding from user charges and other revenue sources and debt service expenses (principal and interest) on long-term debt used to finance prior investments and WSMP recommended capital improvements.
- Reserves – Annual contingencies and reserves needed to maintain system financial integrity and service reliability, and rate stability. Designated cash reserves benefit the system by strengthening credit quality (supporting more favorable borrowing terms) and the City's ability to address unforeseen emergencies.

Each component of revenue requirements is discussed below.

8.2.1 Operation and Maintenance Costs

Operation and maintenance costs include all costs associated with operating and maintaining the system, including personnel (salary and benefits) costs, materials and services costs, internal service charges (the

[2] The City's last rate adjustment (in December 2014) was a five (5) percent rate decrease, that was facilitated by water sales to a new industrial customer.

water system's portion of shared City services), and transfers. Water system operating costs are projected for the WSFP planning period based on the City's Fiscal Year (FY) 2024-25 budget and the following annual escalation factors, reflecting current general economic conditions and City policies:

- Personnel costs (salaries and wages and benefits) = 4 percent
- Materials and services costs = 3.5 percent
- Internal service charges = 4.0 percent
- Non-CIP capital expenses = annual projections reflect the City's 5-Year CIP through FY2027-28; subsequent years include 3.0 percent cost escalation
- Street transfers = 3.0 percent of annual user charge revenue

Table 8-1 shows FY 2024-25 budgeted O&M costs by major expense category and future projections (in five-year increments) based on the assumptions noted above.

Table 8-1 | Projected O&M Cost Summary ($ Millions)

Category	Budget 2024-25	Projected (Fiscal Year)			
		2029-30	2034-35	2039-40	2044-45
Salary Expenses	$2.03	$2.47	$3.01	$3.66	$4.46
Benefits	1.00	1.21	1.48	1.80	2.19
Material & Services	1.64	1.92	2.28	2.71	3.22
Non-CIP Capital Expenses	0.37	0.40	0.47	0.54	0.63
Internal Fees & Charges1	0.97	1.24	1.58	1.94	2.29
Total O&M	**$6.01**	**$7.26**	**$8.82**	**$10.65**	**$12.78**

Note:
1. Includes internal service charges and street transfers

8.2.2 Capital Expenditures

8.2.2.1 WSMP CIP

The 20-year CIP based on the WSMP recommendations is summarized in **Table 8-2**. The total projected improvement costs are approximately $259 million, including an adjustment for inflation of 3.0 percent per year based on long-term growth in construction costs, as estimated from 20-city average cost indices published by the Engineering News Record (ENR). Projects anticipated to be constructed beyond the 20-year WSFP period are estimated to be $151.3 million in 2024 dollars.

To estimate potential future funding of the WSMP CIP from System Development Charges (SDCs),[3] each project was reviewed to determine the portion of project costs associated with expanding capacity for future growth versus replacing existing capacity or addressing existing deficiencies. **Table 8-2** shows these preliminary estimates as a percentage of each project's costs. Capacity-increasing project costs are eligible for funding through SDCs or other developer contributions.[4]

[3] System Development Charges are one-time charges assessed on new development upon connection to the local water system.
[4] Developers may be required to advance-fund infrastructure needed to extend service to their development. To the extent that facilities constructed directly by developers have capacity beyond the individual need of the development, the City may provide SDC credits for the over-sized portion or otherwise establish a mechanism for reimbursement directly by future developments.

Table 8-2 | Capital Improvement Plan

Category	Total 20-Year ($)[1]	Beyond 20-Year ($)[2]	Growth Share
Carryover Budget Projects	401,521	-	0%
Wicks WTP Replacement and Expansion	88,032,798	-	41%
Artificial Groundwater Recharge (AR) License	257,500	-	100%
ASR Expansion Planning	265,225	-	100%
Additional ASR Wells	7,513,559	-	100%
Crow Creek Dam Update Concept Design	721,200	-	100%
Crow Creek Dam Expansion and Spillway Improvements	17,552,039	59,730,000	100%
Finished Water Transmission Main	58,661,945	-	52%
Garrison Reservoir Recoating & Lining	3,410,188	-	0%
Garrison BPS Improvements	6,095,628	-	16%
Riverside BPS Phase 2	1,960,276	-	100%
Riverside Storage Phase 2	19,718,035	-	100%
18th & Morton PRV Control Upgrades	206,000	-	40%
Sorosis BPS VFDs	299,000	-	40%
Wicks WTP SCADA Improvements (Phase 1)	2,018,900	-	52%
Distribution System SCADA Improvements (Phase 2)	1,724,545	-	52%
Facilities Seismic & Wildfire Resilience Improvements	2,900,718	-	52%
Crow Creek Dam Seismic Evaluation and EAP	464,409	-	52%
In-Conduit Hydropower Feasibility Study	119,405	-	52%
LT-1 thru 14: Distribution Pipe Fire Flow Improvements	-	37,010,000	34-60%
MT-1: W 15th St from Liberty to Trevitt St	2,024,580	-	29%
MT-2: W 14th St from Liberty to Trevitt St	1,512,590	-	44%
MT-3: W/E 14th St from Liberty to Short St	1,588,219	-	55%
MT-4: E 13th St Federal to Kelly St, 16th St west of G St	2,632,965	-	44%
MT-5: W/E 13th St & E 11th St	2,262,636	-	50%
MT-6: G to I St between E 11th & 12th St	1,057,822	-	44%
MT-7: E 13th, 14th, & 16th east of Riverview St	2,826,039	-	44%
MT-8: W 9th St, E 7th & 9th St, Kelly Ave	3,016,030	-	47%
ST-1: E 12th St, Riverview St, E 17th St, & H St	2,622,436	-	0%
ST-2: W15th St & Trevitt St, Bridge St at W 16th St	810,366	-	0%
ST-3: W 23rd St, Wright St & Dr	1,294,335	-	0%
ST-4: Diagonal off Cherry Heights Rd & W 10th St	281,377	-	0%
Distribution Pipe Renewal & Replacement	21,367,262	54,500,000	52%
Master Plan Updates	2,821,329	-	52%
WMCP Updates	590,647	-	52%
Financial Evaluation Updates	284,819	-	52%
Total	**$259,316,344**	**$151,240,000**	

Notes:
1. 1Includes 3.0% annual inflation.
2. 2Presented in 2024 dollars.

8.2.2.2 Funding Sources

A key element of the WSFP is the preliminary capital funding strategy that identifies the projected annual sources of funds that may be available to implement the WSMP CIP. Grant funding opportunities are generally limited, so agencies must rely on local funding from system revenues (primarily user fees and SDCs) to fund capital expenditures. Furthermore, because water systems generally require intermittent capital projects that are larger in scale than available current revenue funding, utilities utilize longer-term debt to fund a portion of the CIP. Fixed rate financings in the form of loans made available through state

and federal financing programs and revenue bonds issued through the municipal credit market are the most common debt instruments used to fund large-scale improvements on an "as-needed" basis.

Because the WSMP CIP includes several large-scale capital investments, the WSFP funding strategy assumes the majority (approximately 76 percent) of projects costs will be funded with proceeds from long-term debt financing, The projected annual WSMP CIP costs and annual debt service costs and proceeds and other funding sources for the 20-year period are shown in **Table 8-3**.

Table 8-3 | Projected Cash Flow Capital ($ Millions)

Fiscal Year	Expenditures		FUNDING SOURCES			
	Debt Service[1]	CIP[2]	Rates/ Reserves	SIP[3]	Debt Proceeds[4]	Other [5]
2024-25	$1.06	$1.78	$2.62	-	-	0.22
2025-26	$1.21	$6.11	$1.00	3.00	$4.17	0.06
2026-27	$1.33	4.75	$1.00	3.00	3.60	0.08
2027-28	$1.91	17.68	$2.00	3.00	16.49	0.11
2028-29	$2.29	12.00	$2.00	3.00	10.80	0.15
2029-30	$2.58	13.43	$3.00	3.00	9.22	0.19
2030-31	$3.56	46.57	$4.00	3.00	45.77	0.18
2031-32	$5.92	52.64	$4.00	3.00	43.08	0.23
2032-33	$7.44	39.15	$6.00	3.00	44.36	0.07
2033-34	$8.91	1.89	$7.00	3.00	-	0.21
2034-35	$9.62	3.96	$8.50	3.00	-	0.20
2035-36	$9.62	8.27	$10.50	3.00	-	0.16
2036-37	$9.62	3.45	$9.90	3.00	-	0.08
2037-38	$9.62	2.98	$9.50	3.00	-	0.08
2038-39	$9.62	3.55	$10.20	3.00	-	0.08
2039-40	$9.62	7.50	$10.00	3.00	20.00	0.09
2040-41	$10.69	7.27	$10.50	3.00	-	0.41
2041-42	$11.02	6.22	$11.00	3.00	-	0.33
2042-43	$11.02	8.14	$11.25	3.00	-	0.28
2043-44	$11.03	10.16	$13.50	3.00	-	0.19
2044-45	$11.03	1.81	$9.62	3.00	-	0.10
Total	**$148.75**	**$259.32**	**$147.09**	**$60.00**	**$197.49**	**$3.49**
Total Expend.	$408.07					
Total Sources	$408.07					

Notes:

1. 1Includes existing debt service and projected debt service.
2. 2FY2024-25 budgeted expenses include $0.35 M materials & services costs
3. 3Strategic Investment Program revenue
4. 4Includes projected $128 M WIFIA and $68.8 M other debt proceeds
5. 5Includes SDC and interest revenue; FY2024-25 includes grant proceeds

As shown in **Table 8-3**, the City intends to dedicate a portion of its annual revenue from the Strategic Investment Program (SIP) to the water system. The WSFP includes $3.0 million per year in SIP (or other General Fund) revenues beginning in FY 2025-26 that may be used for cash funding CIP costs or repayment

of future debt service.[5] The remaining WSMP CIP and debt service costs are assumed to be funded through user charges, SDCs[6], and limited existing reserves. While the City will continue to explore grant funding opportunities, assumed grant proceeds for the WSFP period are limited to $120,000 included in the FY 2024-25 budget.

8.2.2.3 Debt Service

8.2.2.3.1 Future Debt

As shown in **Table 8-3**, debt proceeds of $197.5 million are assumed to fund a portion of the CIP costs. Specifically, the City intends to pursue a loan agreement with the U.S. Environmental Protection Agency (EPA) to borrow up 80 percent of the funds needed for the Wicks WTP, aquifer storage and recovery (ASR) improvements, and finished water transmission and short-term distribution main projects through the Water Infrastructure Finance and Innovation Act (WIFIA) loan program. While a formal invitation to apply for WIFIA generally occurs at some point following 30 percent project design, for purposes of the WSFP, the following debt assumptions are incorporated into the capital financing plan:

- WIFIA proceeds structured as two separate loans: 1) $81.9 million total construction draws between FY 2025-26-FY 2031-32) for Wicks WTP, ASR, and other improvements, 2) $46.8 million total draw between FY 2030-31 and FY 2032-33 for finished water transmission main project. Debt service for both loans assume:
    - 3.5 percent interest rate
    - Interest paid during construction
    - Repayment period = 35 years (beginning FY 2032-33 for loan 1 and FY 2033-34 for loan 2)
- Additional debt proceeds structured as three separate revenue bonds: 1) 17.8 million in 2031 to provide a match for WIFIA Loan 1 projects, 2) $31 million in 2033 to provide a match for WIFIA Loan 2 projects and fund other projects, and 3) $20 million in FY 2040 to fund a portion of the Crow Creek Dam and distribution projects. Estimated debt service payments for the revenue bonds assume:
    - 4.5 percent interest rate
    - Repayment period = 30 years (beginning one year following year of issuance)

The City may ultimately secure more favorable financing terms for the WIFIA debt repayment (e.g., lower interest rate, capitalized interest, delayed principal repayment) and one or more lower interest loans for the non-WIFIA debt (e.g., state revolving loans instead of revenue bonds.) However, for WSFP purposes, a "middle case" (i.e., not best or worst case) capital financing scenario is assumed for purposes of evaluating potential future rate impacts of the WSMP CIP. As future WSMP CIP costs and available financing terms are better defined, the City may elect to change the amount of debt vs. PAYGO funding or adjust other elements of the preliminary CIP funding strategy to reduce projected water system revenue requirements and rate increases.

[5] Proceeds from the SIP are anticipated for the first 15 years of the plan, followed by other General Fund supported transfers through retirement of the WSMP debt.
[6] Projected SDC revenue for the WSFP period is based on the City's existing SDC levels. The City may consider increases to SDCs in the future as it further evaluates housing and other development needs.

8.2.2.3.2 Existing Debt

In addition to capital expenditures related to the WSMP CIP, the water revenue requirements for the planning period include existing debt service associated with prior investments including:

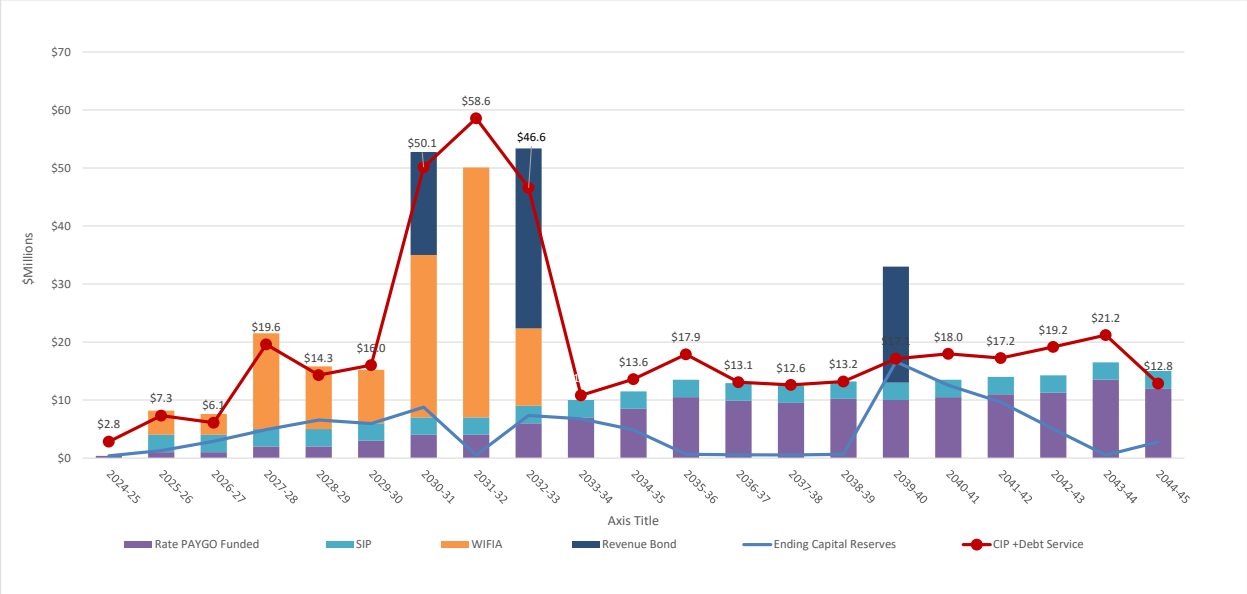
- 2007 Water Revenue Bonds ($0.5 million through FY 2031-32)
- Terminal Reservoir Project debt ($0.24 million through FY 2032-33),
- East Port Local Improvement District (LID) debt ($0.03 million through FY 2028-29), and
- Dog River Pipeline Safe Drinking Water loan ($0.3 million throughout the WSFP planning period).

Total annual debt service on the existing debt ranges from $0.3 million to $1.1 million throughout the WSFP period.

8.2.2.4 Projected Capital Cash Flow

Figure 8-1 shows the projected annual WSMP CIP and debt service costs and funding sources and capital fund balances. The first half of the plan is dominated by debt to fund the large-scale legacy investments. Pay-as-you-go rate funding increases incrementally each year, with the goal of building a sustainable level of CIP funding capacity from rates to meet WSMP CIP needs in the second half of the plan. The phasing in of larger amounts of PAYGO requires utilization of other available resources (SIP and debt) in years where CIP costs exceed PAYGO funding capacity from projected rate increases (discussed in the following section). In years where CIP costs are below the funding capacity of annual revenue sources, capital reserve levels increase and are then used to fund CIP costs later in the plan.

Figure 8-1 | Projected CIP Cash Flow and Capital Reserves



As mentioned previously, future financial and CIP planning may give rise to re-evaluation of the planned use of debt vs. current revenues to fund WSMP costs, as estimated CIP costs and credit market conditions continue to evolve.

8.2.3 Projected Requirements and Rate Increases

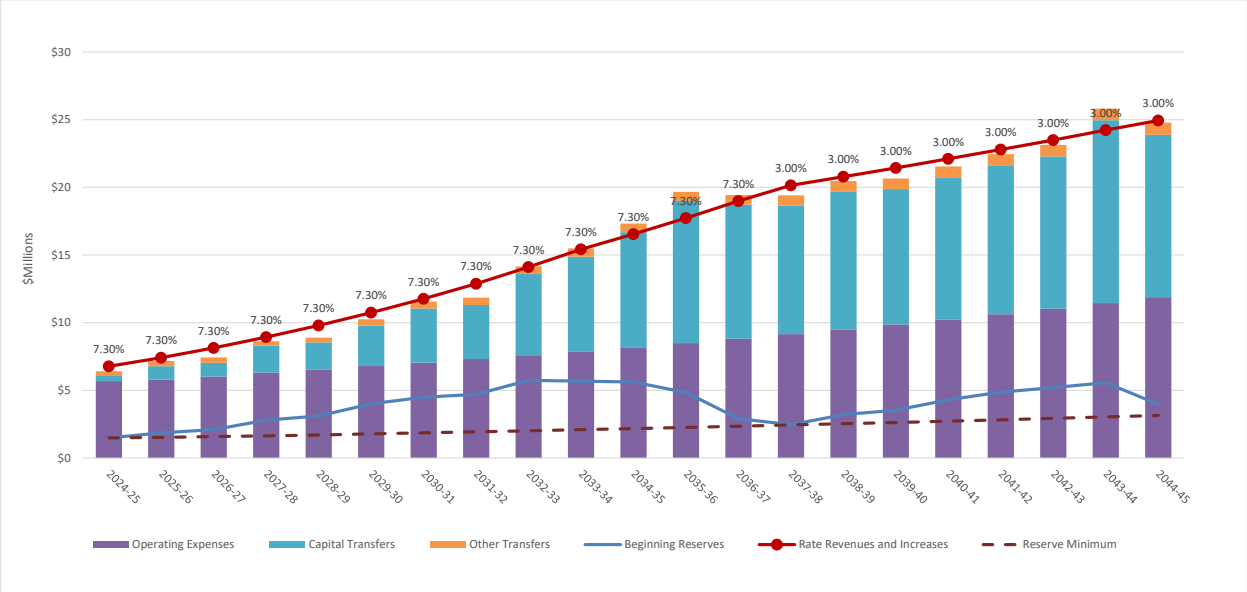
The WSFP was developed to project system revenue requirements and estimate water rate adjustments to meet those requirements, in accordance with the capital funding strategy and cost escalation assumptions described previously. **Figure 8-2** shows the projections for O&M and rate-supported capital expenditure

(transfers) and operating reserves over the planning period, and the annual rate revenues (and percent increases), projected to meet the planned expenditures and minimum reserves [7].

Forecast revenue from user rates is based on assumptions related to customer growth, water consumption trends, and future industrial water demands. The following key assumptions are used to forecast future revenue from rates for the purpose of evaluating overall rate increases:

- Customer growth will average 0.35 percent per year, reflecting recent historical growth in accounts
- Water use per account for non-industrial uses is projected to decline an average of 0.50 percent per year from the most recent FY 2023-24 estimates. These reductions are intended to reflect water conservation measures by customers.
- Industrial water use is forecast to increase annually by 5 percent and 9 percent between FY 2024-25 and FY 2033-34, reflecting planned expansion of industrial processes.

Figure 8-2 | Projected Water Rate Revenues, Requirements, and Operating Cash Reserves*



*Excludes SDC revenue and capital-related reserves

The revenue from existing rates that is available for capital expenses is currently less than $0.5 million per year, while required capital transfers are projected to be $8.5 million by FY2034-35 and $13.5 million by FY 2043-44. Therefore, rate increases will be needed to build capital funding capacity (both for PAYGO CIP and future debt service costs), and to adequately fund future projected O&M costs.

The pace of rate increases is projected to be greatest in the first half of the planning period due to the phasing of the WSMP CIP shown in **Table 8-3**. During these years, system-wide rate increases are projected to exceed assumed general cost inflation (3.5 percent) and result in a more than doubling of the FY 2023-24 rates. As shown in **Figure 8-2**, projected annual rate increases are as follows:

- FY 2024-25 through FY 2033-2034 = 7.3 percent
- FY 2034-35 and beyond – inflationary increases of about 3.0 percent

[7] Minimum operating reserve contingency is assumed to be 90 days of annual operating expenses. The contingency is included in annual requirements but is assumed to be unspent and therefore roll forward in each year to the following year's beginning fund balance.

The projected rate adjustments are based on customer growth and water use trends discussed previously, as well as the initial capital funding strategy. As noted previously, the City may be able to secure more favorable financing terms over the planning period to further reduce revenue requirements from rates and projected rate increases in the shorter term. The projected rate of growth in industrial water use may also impact rate increases. The WSFP is intended to provide a framework for the City to begin conversations around CIP and debt phasing, and plan for future rate increases. The base assumptions should be monitored closely and rate increases adjusted as needed to reflect actual circumstances.

8.2.3.1 Operating Revenues and Debt Service Coverage

Table 8-4 shows projected annual revenues, operating requirements, and debt service coverage, based on the preliminary capital funding strategy and rate increases. A revenue bond repays creditors from net revenues generated by the overall system, so the utility is required to set its rates and charges in a manner that generates the funds to repay bondholders from system revenues, pay O&M costs, and contribute to the replacement of system facilities. Debt service "coverage" is calculated as the ratio of net revenues (total system revenues less O&M expenses) to annual debt service. Typically, revenue bond (and some loan) covenants require the utility to charge rates that target coverage ratios between 1.20 and 1.30 times the annual debt service requirement. Projected debt service coverage targets meet or exceed these minimum benchmarks, as shown in Table 8-4.

Table 8-4 | Summary of Projected Revenues, Requirements, Debt Service Coverage ($ Millions)

WSFP Component	Projected Fiscal Year									
	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34
Revenues										
Water User Fees[1]	$6.59	$7.25	$7.96	$8.75	$9.60	$10.53	$11.55	$12.65	$13.86	$15.18
SIP/General Funds	$0.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00
Other Operating Revenue	$0.18	$0.16	$0.17	$0.18	$0.19	$0.20	$0.21	$0.22	$0.24	$0.24
Total Revenues	$6.77	$10.41	$11.13	$11.93	$12.79	$13.73	$14.76	$15.87	$17.10	$18.42
Operation & Maintenance	$4.67	$4.83	$5.01	$5.20	$5.40	$5.61	$5.83	$6.05	$6.28	$6.52
Debt Service	$1.06	$1.07	$1.06	$1.06	$1.06	$1.03	$1.03	$1.89	$5.80	$8.91
Debt Service Coverage										
Net Rev. Available for Debt Service[2]	$2.10	$5.58	$6.12	$6.72	$7.38	$8.12	$8.93	$9.82	$10.82	$11.90
Debt Service Coverage	1.98	5.24	5.76	6.32	6.94	7.88	8.68	5.21	1.86	1.34
Revenues										
Water User Fees[1]	$16.30	$17.51	$18.80	$19.98	$20.60	$21.23	$21.89	$22.57	$23.27	$23.99
SIP/General Funds	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00
Other Revenue	$0.24	$0.22	$0.18	$0.17	$0.19	$0.19	$0.21	$0.22	$0.23	$0.23
Total Revenues	$19.54	$20.73	$21.98	$23.15	$23.78	$24.43	$25.10	$25.79	$26.49	$27.22
Operation & Maintenance	$6.77	$7.03	$7.30	$7.58	$7.87	$8.17	$8.49	$8.81	$9.15	$9.50
Debt Service	$9.62	$9.62	$9.62	$9.62	$9.62	$9.62	$10.69	$11.02	$11.02	$11.03
Debt Service Coverage										
Net Rev. Available for Debt Service[2]	$12.77	$13.70	$14.68	$15.57	$15.91	$16.25	$16.61	$16.98	$17.34	$17.72
Debt Service Coverage	1.33	1.42	1.53	1.62	1.65	1.69	1.55	1.54	1.57	1.61

Notes:

1. 1Revenues assume rate adjustments effective in the third quarter of each fiscal year.
2. 2Total revenue less operation & maintenance costs.

8.3 Rate Analysis

In addition to the development of the WSFP to determine overall water rate increases needed to support the WSMP CIP, an important objective of the financial analysis is development of a revised rate structure. The rate analysis follows a cost-of-service (COS) framework that considers how water system costs are incurred in relationship to the specific services provided to each customer class. The COS analysis estimates the portion of annual revenue requirements attributable to each customer class and rate component (fixed and volume charges).

8.3.1 COS Framework

The general process of developing COS rates begins with the development of utility revenue requirements (i.e., the annual costs to be recovered from rates as determined by the WSFP analysis). The annual revenue requirements are then distributed to customer classes based on a multi-step allocation process described below.

8.3.1.1 System Functions and Service Characteristics

A water system comprises several different types of facilities that function to make water available to customers year-round, including peak demand periods and under emergency conditions. The primary functional categories that comprise the City's water system are listed in Table 8-5. Some costs incurred by the utility are a function of the quantity of water consumed (on an average demand or peak demand basis), while other costs are associated with serving customers regardless of their water use (e.g., standby capacity for fire protection or other emergencies, customer service, meter repair, and billing costs). The American Water Works Association (AWWA) recommends a COS framework comprised of average and peak water demand, meter, customer, and fire protection service characteristics, as well as utility-specific cost factors. For the City's system, planned ASR facilities will provide supply to a limited area (Zone 310), so water use in the 310 zone is included as a separate service category.

Table 8-5 | Allocation of Costs to Service Characteristics

Functional Category	Average Demand	Peak Day Demand	Peak Hour Demand	Zone 310 Demand	Standby & Emerg. Storage	Fire Protect	Customer	Meter
Dog River/ Crow Creek	100%	0%	0%	0%	0%	0%	0%	0%
Treatment	44%	56%	0%	0%	0%	0%	0%	0%
Water Quality Lab	100%	0%	0%	0%	0%	0%	0%	0%
Wells	44%	56%	0%	0%	0%	0%	0%	0%
ASR	0%	0%	0%	100%	0%	0%	0%	0%
Transmission	44%	56%	0%	0%	0%	0%	0%	0%
Storage & Pumping	8%	10%	0%	0%	70%	12%	0%	0%
Distribution	34%	43%	23%	0%	0%	0%	0%	0%
Customer	0%	0%	0%	0%	0%	0%	100%	0%
Meter	0%	0%	0%	0%	0%	0%	0%	100%
Fire Protection	0%	0%	0%	0%	0%	0%	0%	0%

The cost allocation percentages shown in Table 8-5 are based on facility design considerations from the WSMP and historical system production data. These percentages are applied to annual O&M and capital requirements from the WSFP to determine annual costs by service characteristics for the rate-setting period. Table 8-6 shows costs by service characteristics for FY 2024-25 and FY 2030-31. The utility cost structure (i.e., how costs align with system functions and service characteristics) changes over time due to

varying investments in system O&M and capital facilities. A 5-year COS rate-setting period (beyond the current budget year) was analyzed to determine how the overall rate increases projected in the WSFP could be applied to the rates of each of the City's customer classes. In general, cost-of-service rates should be updated every 3-5 years, as costs and customer demands change.

Table 8-6 | Costs by Service Characteristic and Customer Class ($ Million)

Service Characteristic	Total		Residential		Non-residential	
	$	% Total Costs	$	% Service Category	$	% Service Category
FY 2024-25 (Current Rates)	$6.52	100%	$3.17	49%	$3.35	51%
Updated Cost of Service[1]						
FY 2024-25						
Avg. Demand	$2.45	35%	$0.86	35%	$1.59	65%
Max Day Demand	$2.29	33%	$1.05	46%	$1.24	54%
Peak Hour Demand	$0.24	3%	$0.10	41%	$0.14	59%
ASR Zone 310 Demand	$0.14	2%	$0.00	3%	$0.14	97%
Standby/Emergency Storage	$0.50	7%	$0.21	41%	$0.29	59%
Fire - Pump/ Storage	$0.08	1%	$0.02	19%	$0.07	81%
Fire - Distribution	$0.32	5%	$0.19	60%	$0.13	40%
Customer	$0.67	10%	$0.58	87%	$0.09	13%
Meter	$0.29	4%	$0.17	56%	$0.13	44%
Total	**$6.99**	**100%**	**$3.19**	**46%**	**$3.80**	**54%**
FY 2030-31						
Avg. Demand	$4.38	36%	$1.28	29%	$3.10	71%
Max Day Demand	$4.08	33%	$1.60	39%	$2.48	61%
Peak Hour Demand	$0.30	2%	$0.10	35%	$0.20	65%
ASR Zone 310 Demand	$0.27	2%	$0.01	2%	$0.26	98%
Standby/Emergency Storage	$1.03	8%	$0.36	35%	$0.67	65%
Fire - Pump/ Storage	$0.18	1%	$0.03	19%	$0.14	81%
Fire - Distribution	$0.84	7%	$0.51	61%	$0.33	39%
Customer	$0.83	7%	$0.72	87%	$0.11	13%
Meter	$0.35	3%	$0.20	57%	$0.15	43%
Total	**$12.25**	**100%**	**$4.81**	**39%**	**$7.44**	**61%**

Note:
1. Total requirements are adjusted from revenues shown in **Table 8-4** to reflect a full budget year.

8.3.1.2 Allocations to Customer Classes

Costs by service characteristic are allocated to each customer class in proportion to their service requirements, as estimated from billing records that contain information on each customer's meter size(s) and annual and summer peak month water use. **Table 8-6** shows the allocation of costs to the City's primary customer classes (residential and non-residential). For rate-setting purposes, residential customers include single-family, duplex, triplex and quadplex customers. Non-residential customers include larger (five units and above) multifamily customers, as well as commercial, government, and industrial customers.

As shown in **Table 8-6**, rates from residential customers currently generate about 49 percent of total annual revenue from user charges, and the portion of revenue from nonresidential customers is about 51 percent. Based on the updated COS analysis, the residential cost share decreases to 46 percent (based on FY 2024-25 revenue requirements) and the non-residential share increases to 54 percent. By FY 2030-31, additional shifts from residential to non-residential customers are projected, as both the costs by service characteristics change due to the increase in capital investment, and annual water demands from non-

residential customers are projected to increase more significantly (from 65 percent of total annual demand to 71 percent).

8.3.2 Rate Design

The last step in the rate development process is the design of the rate structure and the development of rates to recover the COS of each class. There are a variety of rate structure options available to meet a range of policy objectives. The primary objective of the WSMP rate analysis is to update rates to reflect the revised COS analysis and to evaluate the fixed and volume rates of each class in the context of resource efficiency and customer affordability.

Water rates are generally comprised of a fixed ("base") charge per customer per billing period, and a variable ("volume") rate that is charged based on the quantity of water used. **Table 8-7** shows the City's current rate structure (in effect since 2014) which includes a monthly base rate that varies by meter size and a volume rate applied to each unit of volume over the base quantity. The base and volume rates and the base quantities differ for residential and non-residential customer classes.

Table 8-7 | Current (Effective December 2014) and Updated Water Rates

Rate Component	Current (Effective 2014)	FY 2024-25		FY 2030-31 Updated	Avg Annual Increase (FY 2025- FY 2031)
		Updated	% Change		
Systemwide Average Increase			*7.3%*		*7.3%*
Volume Rates ($/kgal)* **(per kgal > base qty)*					
Residential	$1.68	$1.87	11.6%	$2.64	5.9%
Non-residential	$3.61	$4.08	13.0%	$5.90	6.4%
Base Charge ($/month)					
Residential					
Quantity (kgal) included	*10*	*7.5*		*7.5*	
1" and below	$55.30	$53.21	-3.8%	$79.50	6.9%
1.5"	$55.30	$53.21	-3.8%	$79.50	6.9%
2"	$66.36	$70.28	5.9%	$116.94	8.9%
Non-residential					
Quantity (kgal) Included	*5*	*5*		*5*	
3/4"	$44.56	$46.72	4.8%	$80.23	9.4%
1"	$50.30	$50.81	1.0%	$92.95	10.6%
1.5"	$61.56	$69.20	12.4%	$150.17	13.8%
2"	$78.95	$89.65	13.5%	$213.75	15.6%
3"	$119.00	$183.68	54.4%	$506.23	18.4%
4"	$181.93	$306.33	68.4%	$887.71	19.4%
6"	$325.06	$612.96	88.6%	$1,841.43	20.1%
8"	$518.67	$1,021.81	97.0%	$3,113.05	20.4%
10"	$763.17	$1,471.53	92.8%	$4,511.83	20.5%
12"	$1,056.71	$1,839.49	74.1%	$5,656.29	20.6%

The updated rates follow the same basic structure as the current rates, however, the quantity included in the base rates for residential customers is reduced from ten (10) 1,000 gallons (kgal) per month to 7.5 kgal reflecting the City's desire to balance customer affordability and water efficiency goals. Based on recent years' water usage data, approximately 70 percent of residential customer bills are based on volumes lower than 10 kgal per month, while about 52 percent of customer bills reflect volumes less than 7.5 kgal per month.

The updated rates for FY 2024-25 and FY 2030-31 shown in **Table 8-7** include the overall 7.3 percent per year rate increases discussed in **Section 8.2.3** distributed to the customer classes in proportion to the updated COS framework shown in **Table 8-6**. Under the updated COS framework, residential rates increase over the rate-setting period slightly less than the systemwide average, while non-residential rates increase slightly more.

Residential base rates decrease initially for small water meters, reflecting the reduction in the base quantity. In future years, the base rates for all customers will increase at a higher rate than the volume rates reflecting the updated COS framework (specifically, a larger portion of costs attributable to emergency storage and fire protection capacity needs which are recovered through the base charges and scaled based on meter size).

Another difference between the existing and revised rates are the scaling factors used to determine the relative base charges for each non-residential meter size. Base charges include some costs (customer billing costs) that are assessed uniformly to all customers regardless of their meter size. However, other costs (meter replacement, fire protection and standby storage costs) are scaled based on the size of the water meter, as larger non-residential customers are more costly to serve. The updated scaling factors shown in **Table 8-8** reflect AWWA standard hydraulic capacities for each meter size relative to a ¾" meter. As shown in **Table 8-7**, meter sizes over 2" experience proportionately larger rate increases in FY 2024-25, due to the re-alignment to the new factors.[8] Subsequent year's increases reflect moderate shifts in the projected utility cost structure with some increase in base cost components relative to volume components.

Table 8-8 | Meter Factors

Customer Class/ Meter Size	High-Normal Flow Rate (gpm)	Meter Factor
Residential[1]		
<1"	15	1.0
1"	25	1.7
1-1/2"	50	3.3
2"	80	5.3
Nonresidential[2]		
3/4"	15	1.0
1"	25	1.7
1-1/2"	70	4.7
2"	120	8.0
3"	350	23.3
4"	650	43.3
6"	1,400	93.3
8"	2,400	160.0
10"	3,500	233.3
12"	4,400	293.3

Notes:
1. AWWA c700-15 Positive Displacement meters
2. 2" and above based on AWWA c701-15 Turbine Class II meter capacities. 1.5" based on average Positive Displacement and Turbine Class II meter capacity.

Currently, the base rates generate about 52 percent of total water rate revenues (residential and non-residential combined). With the reduction in the residential base quantity and projected growth in industrial water demands, projected revenue from base charges is projected to be about 45 percent by FY

[8] The portion of base costs scaled based on meter size is about 15 percent in FY2024-25 and almost 25 precent in FY2030-31.

2030-31. Given that the majority (over 80 percent) of water system costs are fixed (do not vary with water use), it is important for the utility to maintain sufficient revenue recovery from fixed charges in the future.

8.3.2.1 Projected Customer Bills

A typical residential customer has an average monthly volume of eight (8) units (8,000 gallons);[9] thus, the current monthly bill is equal to the base rate of $55.30. As shown in **Table 8-9**, future monthly bill increases during the first 10 years of the planning period would average approximately $4.50 per month. During the second half of the plan, projected bill increases would average slightly over $5.00 per month.

Customers with water use less than 7.5 kgal per month would experience bill reductions in FY 2024-25 of almost 4 percent due to the reduction in the fixed charge. Larger volume water users with usage greater than 10 kgal per month would experience bill increases of 5-10 percent in the first year because of the increase in the volume rate and an additional 2.5 units (2,500 gallons) subject to the volume charges as a result of the rate structure change.

Table 8-9 | Current and Projected Residential Water Rates and Typical Bills[1]

Fiscal Year	Base Rate[2]	User Rate Per Unit[3]	Typical Res. Bill per Month[4]	Increase in Monthly Bill	% Change
2023-24	$55.30	$1.68	$55.30	--	--
2024-25	$53.21	$1.87	$54.15	($1.15)	-2.1%
2025-26	$56.66	$1.98	$57.65	$3.50	6.5%
2026-27	$60.42	$2.10	$61.47	$3.82	6.6%
2027-28	$64.53	$2.23	$65.64	$4.17	6.8%
2028-29	$69.04	$2.36	$70.22	$4.58	7.0%
2029-30	$74.01	$2.50	$75.26	$5.04	7.2%
2030-31	$79.50	$2.64	$80.82	$5.56	7.4%
2031-32	$85.30	$2.83	$86.72	$5.90	7.3%
2032-33	$91.53	$3.04	$93.05	$6.33	7.3%
2033-34	$98.21	$3.26	$99.84	$6.79	7.3%
2034-35	$105.38	$3.50	$107.13	$7.29	7.3%
2035-36	$113.07	$3.76	$114.95	$7.82	7.3%
2036-37	$121.33	$4.03	$123.34	$8.39	7.3%
2037-38	$124.97	$4.15	$127.05	$3.70	3.0%
2038-39	$128.72	$4.28	$130.86	$3.81	3.0%
2039-40	$132.58	$4.41	$134.78	$3.93	3.0%
2040-41	$136.56	$4.54	$138.83	$4.04	3.0%
2041-42	$140.65	$4.67	$142.99	$4.16	3.0%
2042-43	$144.87	$4.81	$147.28	$4.29	3.0%
2043-44	$149.22	$4.96	$151.70	$4.42	3.0%

Notes:

1. 1Reflects revised rate structure and cost-of-service analysis through FY 2030-31. Subsequent year increases based on systemwide average rate increase.
2. 2Current rates include base quantity of 10 Kgal/month; projected rates include 7.5 Kgal/month
3. 3Charged only on water use that is greater than the base quantity.
4. 4Bill based on total consumption of 8 units (8,000 gallons).

[9] As noted previously, billable water volumes per account are projected to decline marginally over the planning period such that a typical residential customer's monthly volume is anticipated to be less than eight units; however, for purposes of projecting bill impacts in Table 8-8, a consistent monthly volume is used throughout the planning period.

Bill impacts for non-residential customers vary based on the meter size and volume used. Table 8-10 shows sample bill impacts for non-residential customers. Bill increase for customers with meters larger than 1" are more significant initially due to the updated meter factors. The subsequent average annual increases range from 7-9 percent for all of the sample customers shown reflecting the updated COS framework and the 7.3 percent overall projected annual rate increases.

Table 8-10 | Current and Projected Sample Non-residential Water Bills[1]

Sample Customers	Monthly Water Use (kgal)	Current (Eff. 2014)	Updated FY2024-25	% Change	Projected FY2030-31	Avg Ann. Inc. (2025-2031)
3/4" meter Customer	10	$62.61	$67.12	7.2%	$109.76	8.5%
1"-meter Customer	20	$104.45	$112.00	7.2%	$181.52	8.4%
1.5"-meter Customer	50	$224.01	$252.79	12.8%	$415.89	8.7%
2"-meter Customer	100	$421.90	$477.21	13.1%	$774.72	8.4%
3"-meter Customer	300	$1,183.95	$1,387.16	17.2%	$2,248.18	8.4%
4"-meter Customer	600	$2,329.88	$2,733.70	17.3%	$4,401.14	8.3%
6"-meter Customer	2500	$9,332.01	$10,791.58	15.6%	$16,574.22	7.4%
8"-meter Customer	10000	$36,600.62	$41,797.45	14.2%	$62,132.77	6.8%

8.4 Conclusions

The WSFP and rate analysis provide a framework for the City to begin initiating rate changes to support the WSMP CIP and to further develop the capital financing strategy as project costs are further defined. The preliminary capital funding strategy contained herein relies on a combination of debt and PAYGO funding from user rates and SIP proceeds to pay for the estimated $259 million (inflation-adjusted) capital project costs over the next 20 years. While the WSFP does not assume an increase in SDCs, the City may consider adjustments in the future to recover the growth-related portion of CIP project costs shown in Table 8-2.[10]

Annual rate increases, based on this preliminary funding strategy, are initially projected at 7.3 percent per year for the first half of the WSFP and are projected at inflationary levels in the second half of the plan. The WSFP funding strategy relies on SIP/General Fund revenues to offset rate increases.[11] Projected growth in industrial water sales revenues also help moderate rate increases for other customers. The WSFP provides a framework to assess the financial implications of a variety of alternative capital funding scenarios that may include re-balancing of debt and equity financing, revised project scheduling, or debt payment restructuring, while adhering to financial management targets (i.e., maintenance of operating reserves and debt service coverage levels).

The updated COS framework provides the opportunity to realign rates by customer class and rate components to reflect current customer service requirements. Changes to the residential rate structure to reduce the monthly quantity included in the base charges will initially reduce bills for smaller customers and send stronger pricing signals to customers who use more than 7.5 kgal of water. Realignment of non-residential base charges will shift some costs to larger customers and help the utility maintain a minimum amount of revenue from fixed charges.

[10] The SDC analysis conducted as part of the WSMP estimated an SDC of $9,334 (for a ¾-inch meter) to support the growth-related CIP costs. The City's current SDC is $2,317 for a ¾-inch meter.
[11] The $3 million in annual SIP/General Fund revenue represents a 46 percent increase in current water system revenue that otherwise would need to come from rate increases.

The projected cash flows and COS analysis are based on available information on revenue, expenditures, customer accounts, and water use as of August 2024. There will usually be differences between assumed and actual conditions because events and circumstances frequently do not occur as expected, and those differences may be significant. Among the variables that could impact future rate increases are changes in customer growth, economic and other factors impacting water consumption patterns (particularly for industrial customers), cost escalation, and interest rates on long-term debt. Furthermore, any changes to CIP funding or other key assumptions would likely necessitate changes to the rate increases.

It is important that the City monitors the WSFP and regularly updates the overall rate increases and COS framework in the future.

APPENDIX A
CLIMATE CHANGE IMPACTS TECHNICAL MEMORANDUM

consor

Jacobs

Technical Memorandum

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Subject	**Task 4.1 Water Supply Evaluation – Climate Change Impacts**
Project Name	City of The Dalles Water Master Plan
City Project Number	2022-005
Jacobs Project Number	D3718900
To	Dave Anderson/City of the Dalles
From	Tyler Jantzen/Jacobs Mark Lee/Jacobs
Reviewed by	Brady Fuller/Jacobs
Date	July 25, 2023

1. Purpose

The City of The Dalles (City) is developing a water system master plan to guide system investments over the next 50 years. As part of that master plan, the City has contracted Consor (with Jacobs as subconsultant) to provide an evaluation of climate change impacts on the overall City surface water supply. The City's surface water is sourced from portions of the Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds. Additional groundwater wells supplement the surface water flows, but analysis of climate change impacts on groundwater was specifically excluded from this analysis due to complexity and lack of available data to inform the analysis, and such groundwater resources could be evaluated in the future. This report characterizes the historical and projected future climate and flows from the Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds (Figure 1), but also generally applies to climate in the vicinity of the Wicks Water Treatment Plant (WTP) as well as the City itself.

The Intergovernmental Panel on Climate Change (IPCC) identified that changes in temperature and rainfall patterns have already been observed and will worsen significantly over the 21st century across the planet (IPCC, 2022). These observations make planning for climate change an important component of planning for future water supply and watershed management.

To determine these risk exposures, this study collected data and performed analysis for the following parameters:

- Stream flow
- Ambient (air) temperature
- Precipitation
- Snowmelt

Figure 1. Dog River, Crow Creek Reservoir, and South Fork Mill Creek Watersheds

2. Approach

Climate change is projected to affect many parameters that impact surface water supplies, including precipitation, temperature, snowpack, and snowmelt. Global climate models (GCMs) developed by academic and government research agencies around the globe are used to develop future climate projections, based on assumed future human greenhouse gas emissions. These climate models can be used to make projections of specific parameters of interest, including those that affect surface water supplies, and for specific locations of interest. As with all models, GCMs represent simplifications of natural processes, and each different model resolves climate processes slightly differently, reflecting

uncertainties in the science. This, in combination with the range of greenhouse gas emissions scenarios used as input to the GCMs, results in a range of projections for future conditions. The industry standard approach to understanding and planning for future climate uncertainty is to use a range of climate projections from multiple GCMs, known as an *ensemble approach*. Using an ensemble approach helps to communicate the range of uncertainty in plausible future climate projections.

This memorandum describes the industry standard methods used for the analysis of Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds.

Future climate projections for snowmelt, temperature, precipitation, and runoff were informed by a 32-member ensemble of Coupled Model Intercomparison Project Phase 5 (CMIP5)[1] GCMs under Representative Concentration Pathway 8.5 (RCP8.5) and downscaled to 1/16th degree (roughly 6 kilometers) resolution using the Localized Constructed Analogs (LOCA) method. Wildfire projections used an ensemble of 18 CMIP5 GCMs. The GCMs model atmospheric interactions across the globe at a relatively coarse temporal and spatial scale. The LOCA downscaling method increases the spatial resolution of the GCM results to be more appropriate to watershed scale water supply planning. Most GCMs use a temporal scale of 1-day, and so are more appropriate for long duration events (such as annual, seasonal and monthly volumetric projections used for water supply planning) and less for short duration (such as sub-daily) precipitation event projections. For this reason, the projections are more accurate for annual and seasonal volumes than for short duration peaks.

RCP8.5 is one of the four greenhouse gas emissions scenarios used in CMIP5, and represents continued use of fossil fuels through the end of the 21st century. It is often used to represent a realistic to slightly conservative level of climate change. Raw climate model projection parameters (temperature, precipitation) were run through the Variable Infiltration Capacity (VIC) land surface model to generate hydrologic parameters such as snow water equivalent, runoff, and stream flow. The VIC model is calibrated at a broad spatial scale to historical flow and volumes in large watersheds that are substantially larger than the Dog River, Crow Creek Reservoir, and South Fork Mill Creek Watersheds. But the results are still meaningful at smaller watershed scales, especially when interpreted as relative change (comparing future projected to historical). The VIC model includes all major aspects of the hydrologic cycle, including precipitation, evapotranspiration, infiltration, and runoff, at a 6-kilometer grid scale. The 6-kilometer grid means that smaller features such as Crow Creek Reservoir are included in the overall land cover contributing to hydrologic calculations but are not explicitly represented.

For all projections except wildfire, data were requested using Lawrence Livermore National Lab's *Downscaled CMIP3 and CMIP5 Climate and Hydrology Projections* tool for the entirety of the Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds (Figure 1) (LLNL, 2023). Given the coarse resolution of these data, the fine-scale boundaries of the watershed are not captured; however, it was assumed that this was likely to have little difference in the output results as only the spatial average of this watershed was assessed. For the purposes of this report, information from this source will be referred to as "LOCA-CMIP5 data."

LOCA-CMIP5 and resultant VIC data are available for projected future conditions for any given variable. For future projections, daily data from January 1, 1950, to December 31, 2099, are available for all climate models in a given RCP. To assess changes in future conditions, three representative 30-year time periods were considered and centered on 1995, 2040, and 2080:

- Historical Simulated: Daily data from water year 1980 to 2010 and centered on 1995.
- Mid-Century: Daily data from water year 2030 to 2060 and centered on 2045.

[1] More recent climate model results, known as CMIP6, are recently published in their raw form. However, CMIP6 results are not yet readily available through the LLNL portal and have not been processed for hydrologic parameters such as stream flow and runoff. Because this analysis focuses on stream flow, older CMIP5 climate model results were utilized.

- Late-Century: Daily data from water year 2065 to 2095 and centered on 2080.

Statistics (10th percentile, 50th percentile, and 90th percentile) for the ensemble of 32 climate models for each time period were generated and compared to capture a range of future climate model results. These statistics summarize the range of plausible future conditions projected by the GCM ensemble. For this report, projections representing the 10th percentile, 50th percentile, and 90th percentile of the ensemble of climate models are referred to as the low, median, and high projections, respectively.

For precipitation and runoff projections, LOCA-CMIP5 data are provided in units of millimeters per day (mm/day). This can be converted to equivalent streamflow in cubic feet per second (cfs) by using the watershed area. Historical simulated results from the LOCA-CMIP5 data were compared to and validated using available gage data for Dog River. Because there is observed flow data for Dog River but not Crow Creek or South Fork Mill Creek, the Dog River watershed area is used to calculate the streamflow values.

Wildfire projections utilized climate model data processing and visualization obtained through Risk Factor (2022) and *Climate Toolbox* provided by Hegewisch and Abatzoglou (2022). The *Climate Toolbox* wildfire projections evaluate number of fire danger days above three separate thresholds: high, very high, and extreme. The *Climate Toolbox* future climate outputs are presented in this report as box and whisker style plots, presenting the variability of climate model ensemble results, where the box represents the 25th to 75th percentile of the ensemble result, and the middle line represents the median (50th percentile) (Figure 2).

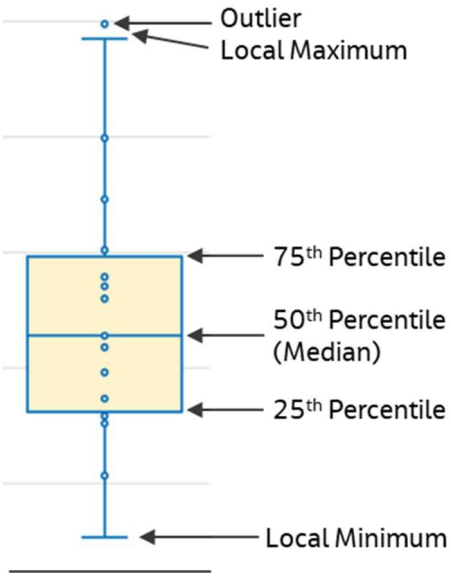

Figure 2. Climate Toolbox Box and Whisker Style Plots

3. Climate Characterization

The following historical and future climate parameters were characterized: stream flow, temperature, precipitation, and snowmelt. Because wildfire conditions can impact runoff and drinking water quality, projections for future wildfire conditions were also analyzed.

3.1 Stream Flow

3.1.1 Historical Stream Flow

The Dog River watershed is located southwest of the City, directly east of Mt. Hood and is tributary to East Fork Hood River. The historical diversion of Dog River into South Fork Mill Creek provides connectivity of Dog River to the City of The Dalles water supply. The Dog River diversion is located at approximately River

Mile (RM) 6. Historically, seasonal peak flows in the Dog River are driven by rain-on-snow as well as snowmelt runoff. The City is currently replacing the existing diversion pipeline in the Dog River to increase capacity to 26.3 cfs and will continue to divert water into the South Fork Mill Creek and the Crow Creek Reservoir watershed. Water released from the Crow Creek reservoir flows downstream in South Fork Mill Creek and is treated at the Wicks WTP, and is then supplied to the City distribution system. See Figure 1 for location of the Dog River watershed, Dog River diversion, and Crow Creek watershed.

Historical stream flow data for the Dog River are sparse, but there is a period from 2012–2021 with consistent flow data provided from the City. These data are a combination of flow measurements at the diversion point, as well as stream flow measurements at an old USGS v-notch weir gage just upstream of the diversion (USGS gage ID 14113400, located at Latitude 45°24'30", Longitude 121°31'10"). The combined data assume the greater recorded value of the diversion flow or v-notch weir streamflow each day. The combined stream flow data are used in this report as the basis for historical and projected stream flows, and referred to as Dog River stream flows at the location of the diversion facilities (approximately RM 6).

Figure 3 shows historical observed daily flow, aggregated across the water year to median (50th percentile), low (10th percentile), and high (90th percentile). Figure 4 shows the same data, aggregated to monthly average.

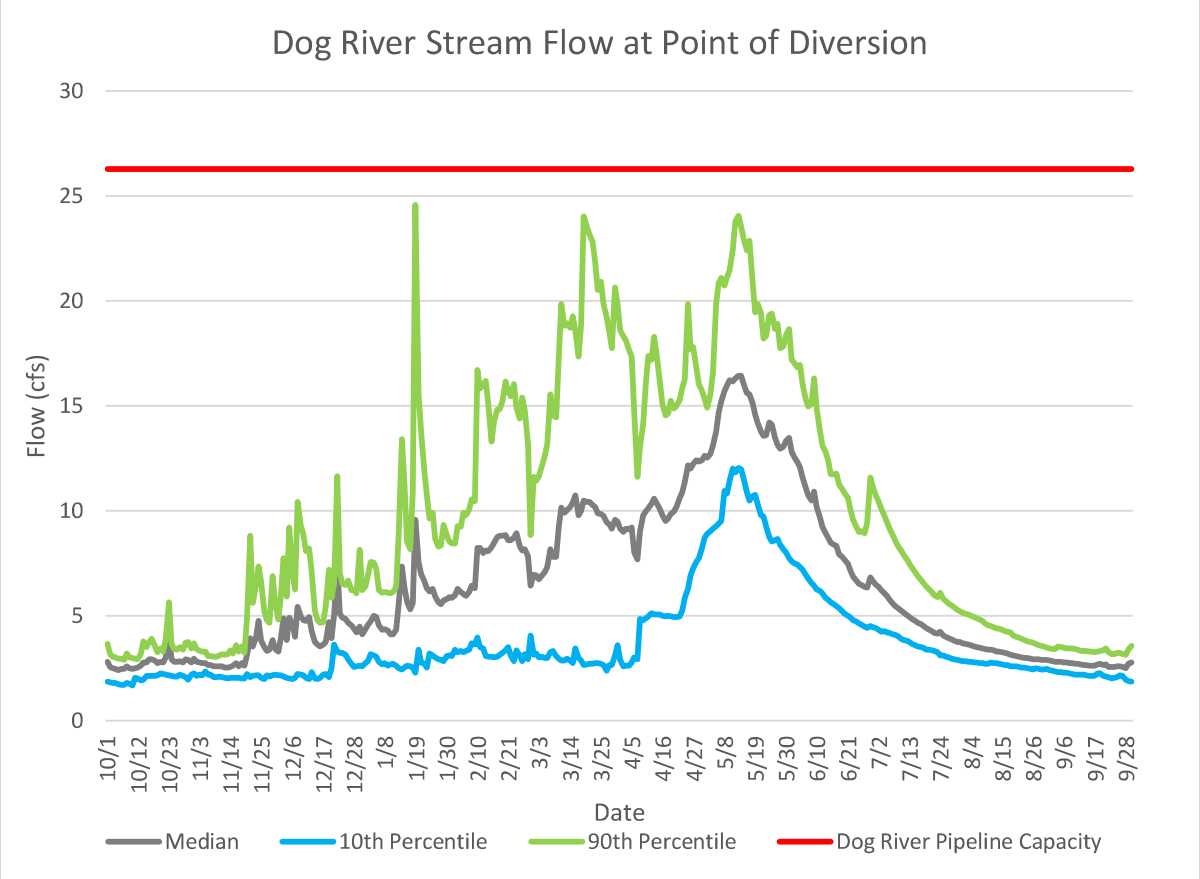

Figure 3. Historical Dog River Daily Observed Stream Flow at Point of Diversion

Median (50th percentile), Low (10th percentile), and High (90th percentile) of daily gauged flow from 2012–2021

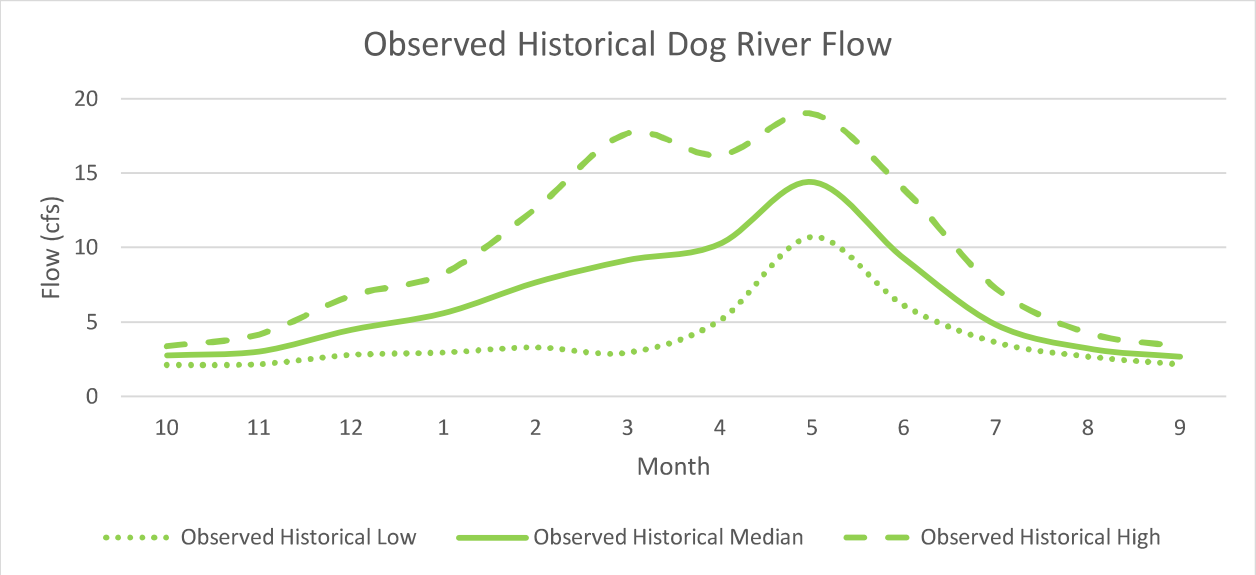

Figure 4. Historical Dog River Average Monthly Observed Stream Flow at Point of Diversion
Median (50th percentile), Low (10th percentile), and High (90th percentile) of monthly gauged flow from 2012–2021

3.1.2 Projected Stream Flow

LOCA-CMIP5 data were extracted for the Dog Creek, Crow Creek and South Fork Mill Creek watersheds. These spatially averaged runoff data were converted to equivalent Dog River stream flows at the point of diversion (approximately RM 6), using the Dog River watershed area to convert from mm/day, in units of depth per time, over a unit area to cfs, in order to compare the climate model results to observed values. This comparison was used to validate use of the LOCA-CMIP5 simulated historical data as a baseline for future climate data projection. While the datasets are not a perfect match, they show similar seasonal peak flow timing and magnitude, especially for the median of the observed and the median of the simulated. The observed data show higher variation (low and high values), due to natural variability, whereas the climate model tends to produce more seasonally consistent values. The comparison of the median values is sufficiently similar to justify using simulated data over the entire watershed (Dog River, Crow Creek Reservoir, and South Fork Mill Creek) to project changes in overall watershed runoff due to climate change. Figure 5 shows the comparison of the simulated historical data and the observed historical data for the Dog River watershed.

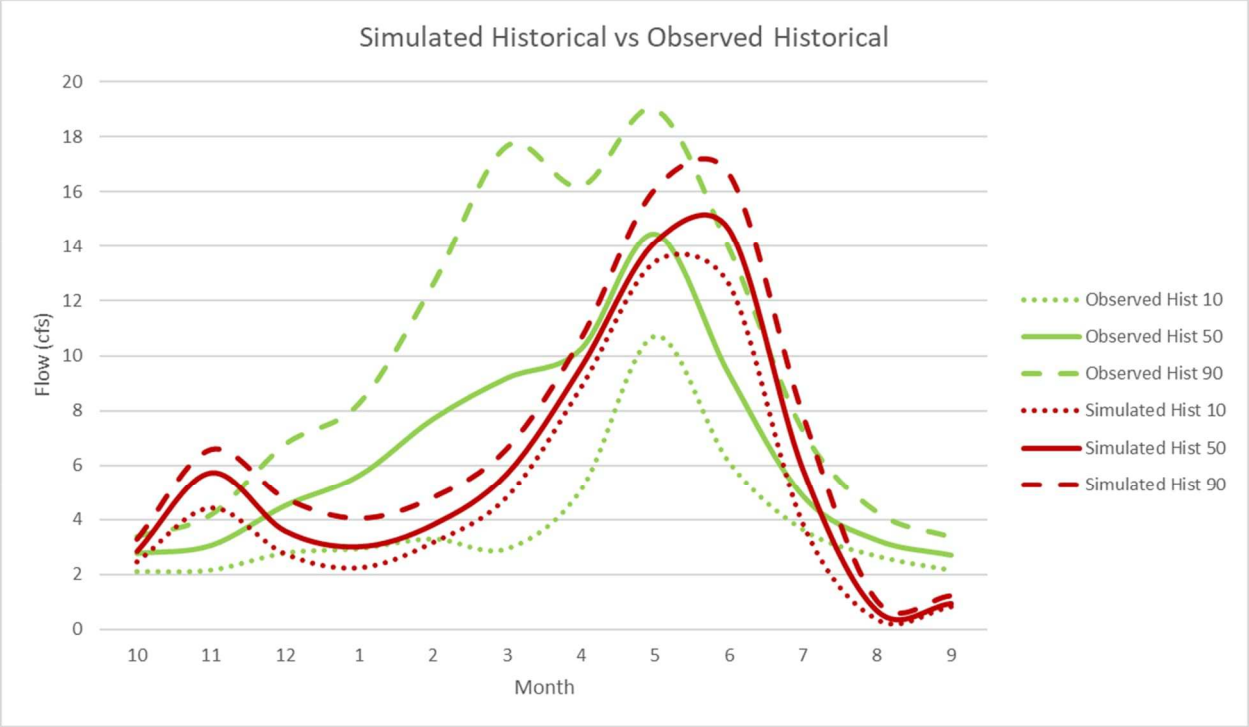

Figure 5. Dog River Average Monthly Observed Historical Stream Flow Compared to Simulated Historical Flow

Median (50th percentile), Low (10th percentile), and High (90th percentile) of monthly gauged flow from 2012–2021, and of simulated historical average monthly flow

Figure 6 shows the low, median, and high scenarios for all LOCA-CMIP5 data. Note that these data are in area-normalized units of mm/day. Future projected stream flows were developed using the change between historical and future LOCA-CMIP5 climate model runoff data (Figure 6). Future climate streamflow change factors were applied to historical observed Dog River flow data to develop future projected streamflow at an average monthly time scale (Figure 7). Full watershed total projected flow rates (Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds) were developed by increasing the Dog River flows proportional to the total watershed size (Figure 8).

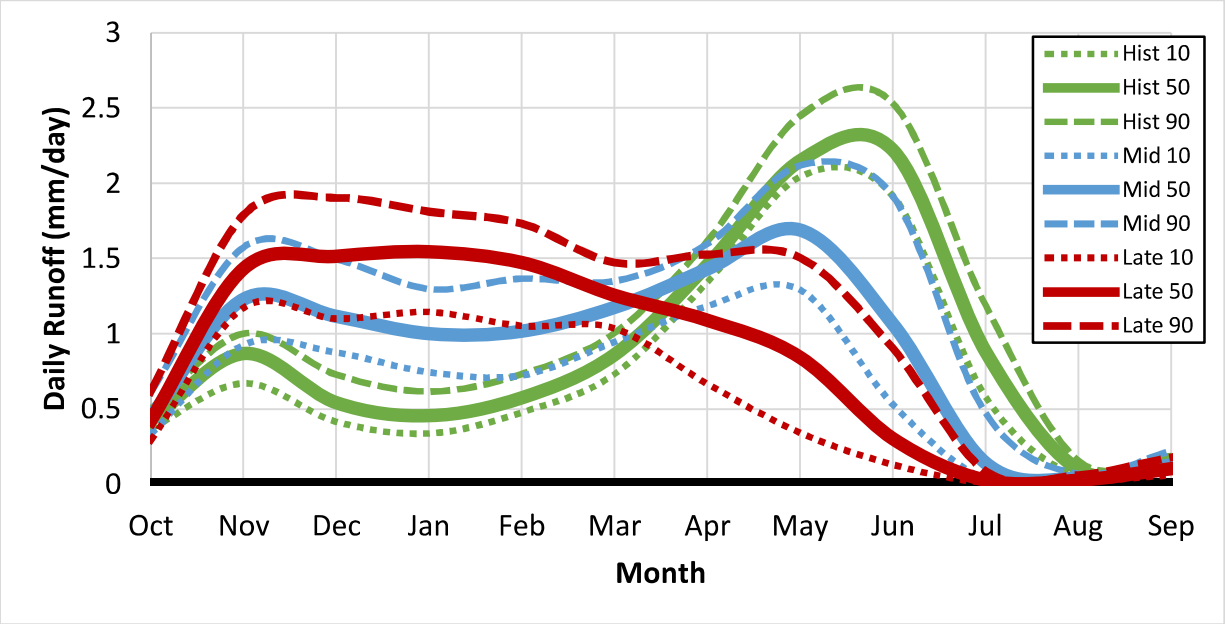

Figure 6. LOCA-CMIP5 Projected Daily Runoff for Dog River, Crow Creek Reservoir, and South Fork Mill Creek Watersheds

Median (50th percentile), Low (10th percentile), and High (90th percentile) of LOCA-CMIP5 simulated historical, mid-century, and late-century daily runoff projections

Future climate projections were developed for both mid-century and late-century time periods. Figure 7 shows these mid-century and late-century data projections for the Dog River stream flow along with the observed historical data. Figure 8 shows the similar patterns as Figure 7, but upscaled to the combined full watershed. Figure 9 shows the individual watershed components of the full watershed runoff, based on proportion of the full watershed area. The Dog River watershed makes up 18% of the full watershed, Crow Creek Reservoir watershed makes up 39% of the full watershed, and the South Fork Mill Creek watershed makes up 43% of the full watershed. These projections show a clear shift in the seasonal hydrograph. Historically, the combined watershed system was predominantly a snowmelt based system (with peak runoff in May). By mid-century, projections show this shifting to a rain/snow mixed sytem, with two similar magnitude peaks, one in winter (February) due to precipititon runoff and one in spring (May) due to snowmelt runoff. By end of century, this system shifts to a precipitation runoff dominant system, with a single peak in winter (February).

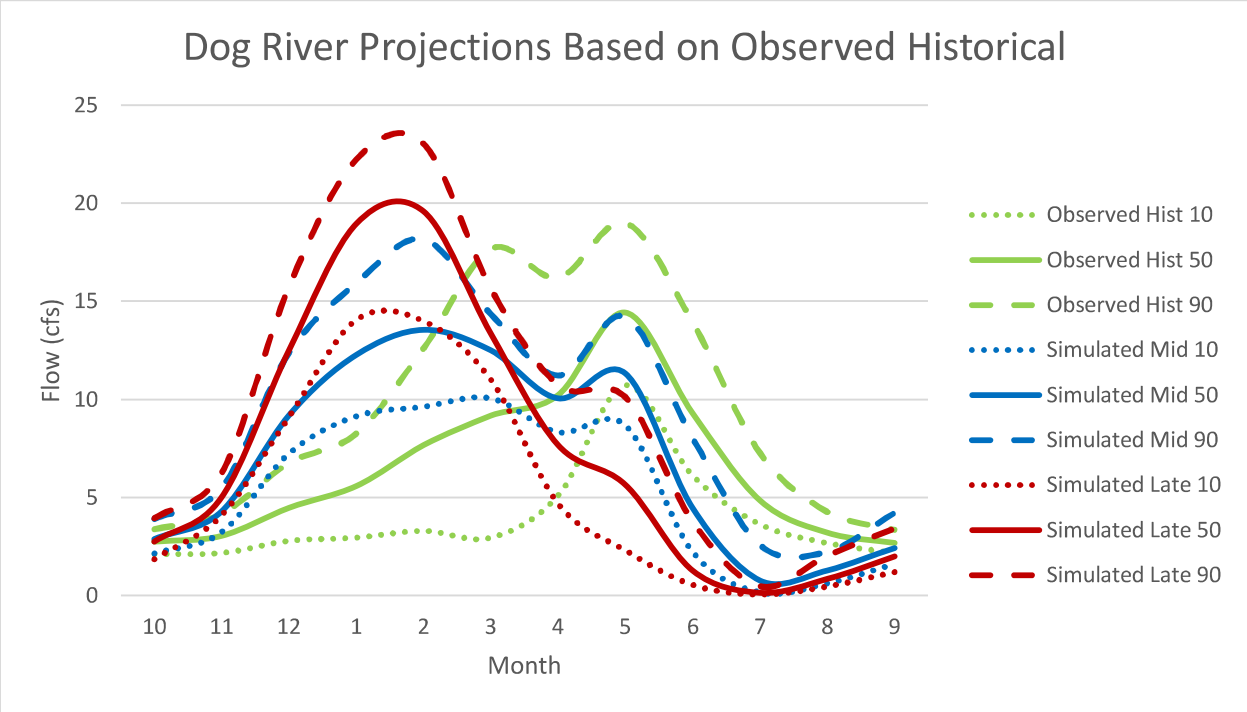

Figure 7. Projected Dog River Stream Flow Using Observed Historical Flow as Baseline

Median (50th percentile), Low (10th percentile), and High (90th percentile) of monthly gauged flow from 2012–2021; Median, Low, and High of Mid-Century and Late-Century projected future average monthly flows

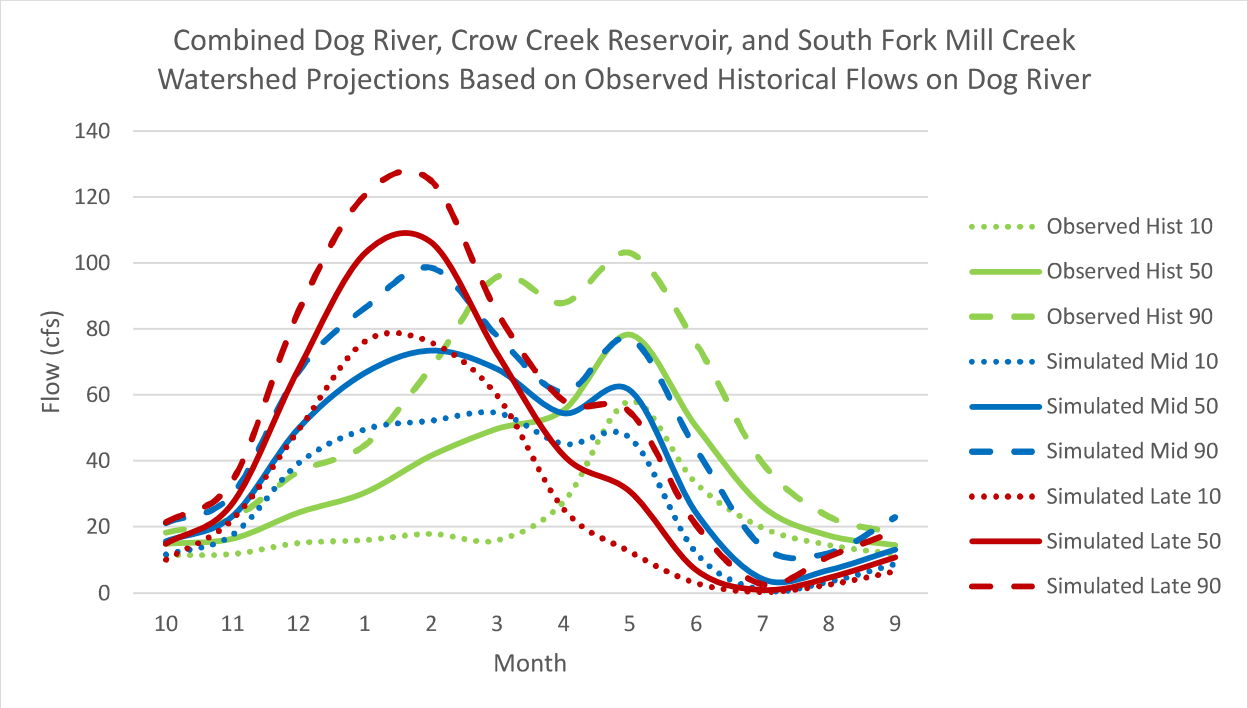

Figure 8. Combined Projected Dog River, Crow Creek Reservoir, and South Fork Mill Creek Watershed Flow Using Observed Historical Flow as Baseline

Median (50th percentile), Low (10th percentile), and High (90th percentile) of monthly gauged flow from 2012–2021; Median, Low, and High of Mid-Century and Late-Century projected future average monthly flows

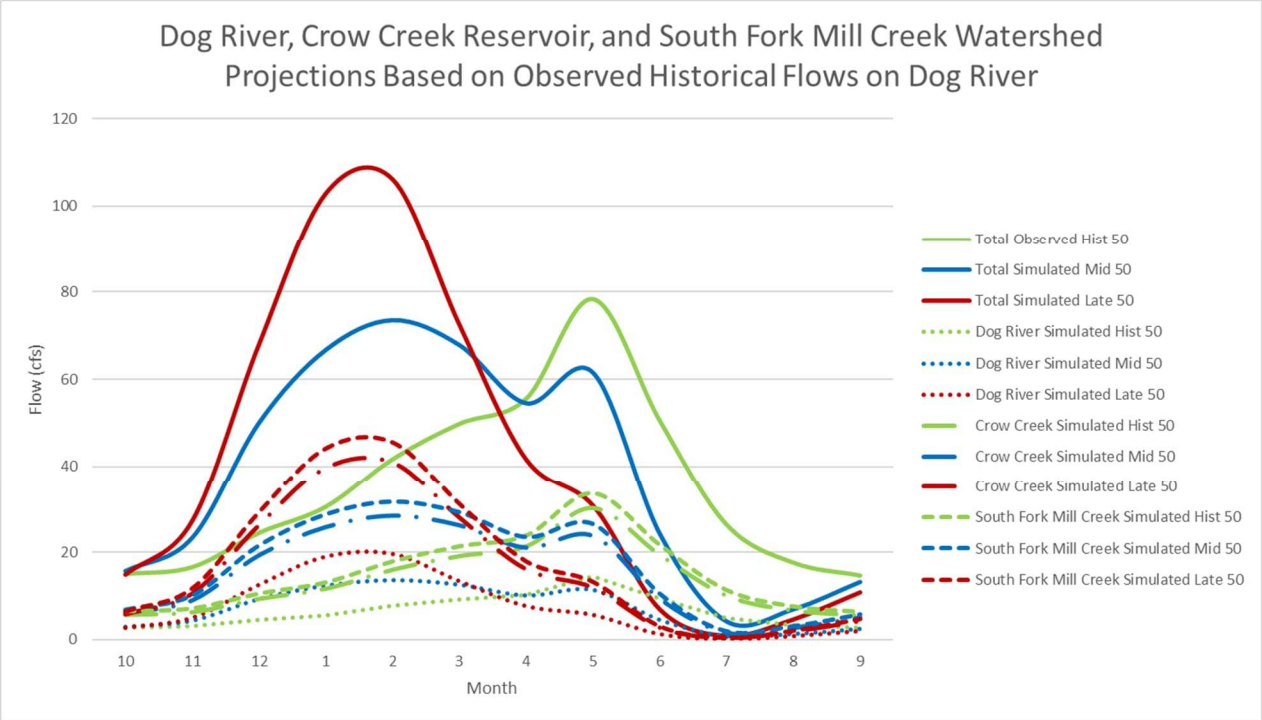

Figure 9. Projected Dog River, Crow Creek Reservoir, and South Fork Mill Creek Watershed Flow as Using Observed Historical Flow as Baseline

Median (50th percentile), monthly gauged flow from 2012–2021; Median of Mid-Century and Late-Century projected future average monthly flows

In addition to daily and monthly flow data, cumulative yearly flow volume was calculated for all LOCA-CMIP5 data and observed historical data. The results of these calculations are shown for the Dog River watershed in Figure 10. At the median (50th percentile), the projections show a decrease in total annual runoff volume of about 5% decrease by mid-century and about 9% decrease by end of century. This decrease in projected runoff is despite a projected increase in annual precipitation (Section 3.3), and is due primarily to increase in evapotranspiration due to higher atmospheric temperatures. Note that the observed historical values have much higher and lower volumes in the low and high scenarios. This is due to high variation found in observed data. Annual volume projections for the entire watershed (Dog River, Crow Creek Reservoir, and South Fork Mill Creek) are shown in Figure 11. The change in annual projected runoff volume relative to historical simulated are the same as that for the Dog River (Figure 10), with total volumes upscaled to the larger watershed.

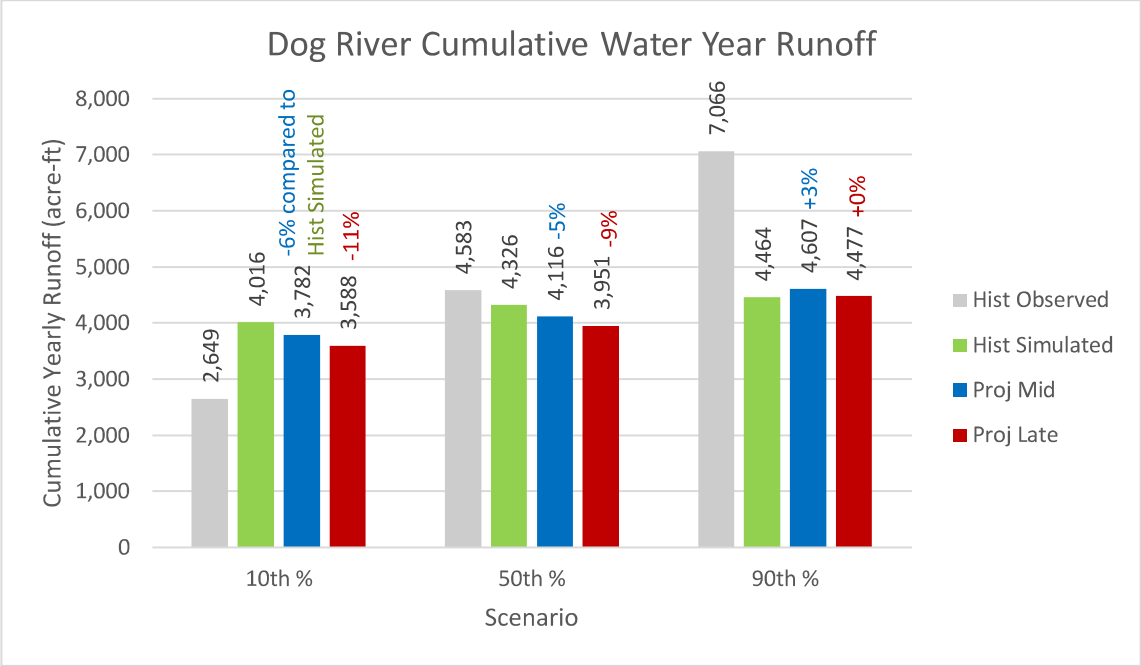

Figure 10. Cumulative Average Yearly Runoff in Dog River Watershed

Median (50th percentile), Low (10th percentile), and High (90th percentile) of cumulative yearly runoff for monthly gauged flow from 2012–2021, LOCA-CMIP5 simulated historical, mid-century, and late-century runoff projections

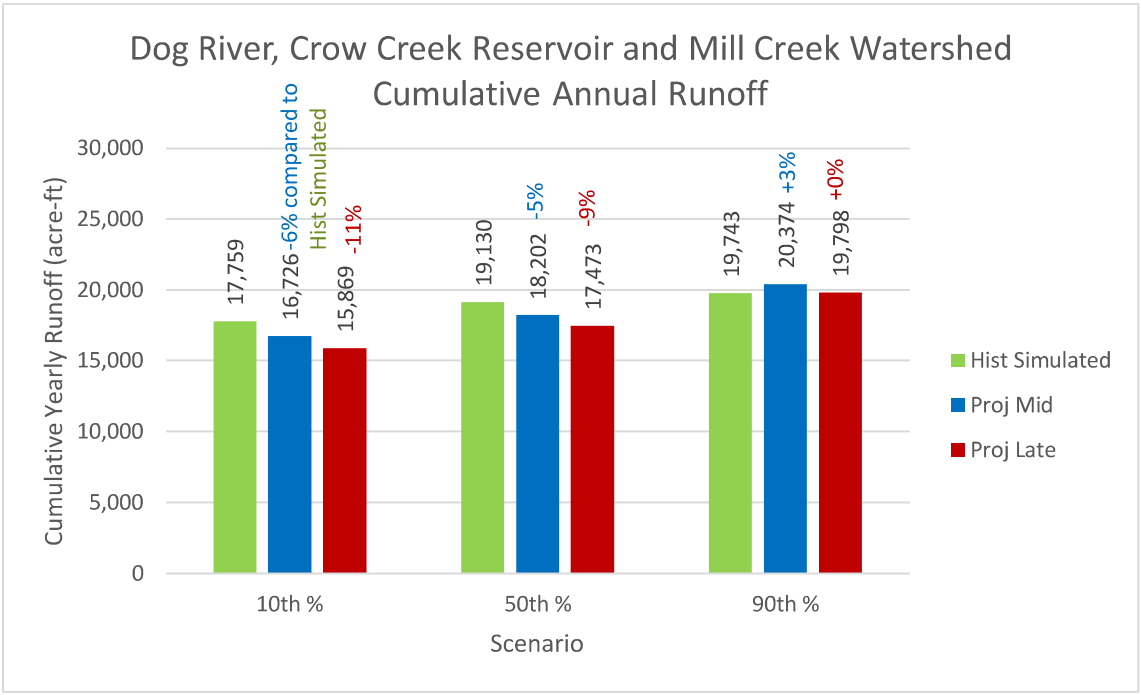

Figure 11. Cumulative Average Yearly Runoff in Dog River, Crow Creek Reservoir, and South Fork Mill Creek Watersheds

Median (50th percentile), Low (10th percentile), and High (90th percentile) of cumulative yearly runoff for LOCA-CMIP5 simulated historical, mid-century, and late-century runoff projections

3.2 Temperature

Temperature characterization utilized LOCA-CMIP5 data, both for historical and future climate projections. These temperature values are averaged across the entire LOCA-CMIP5 data extract area described in Section 2 and encompass the Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds. Projected mid-century and late-century temperatures are higher across all seasons. Peak summer temperatures in the mid-century projection reach up to 2.5 degrees Celsius (°C) above simulated historical average, and peak summer temperatures in the late-century projection reach as much as 5.5°C above simulated historical average. The temperature increases are generally higher in summer.

Figure 12 shows the average daily temperature for each month, while Figure 13 shows the difference in average daily temperature for the mid-century and late-century projections as compared to the simulated historical data.

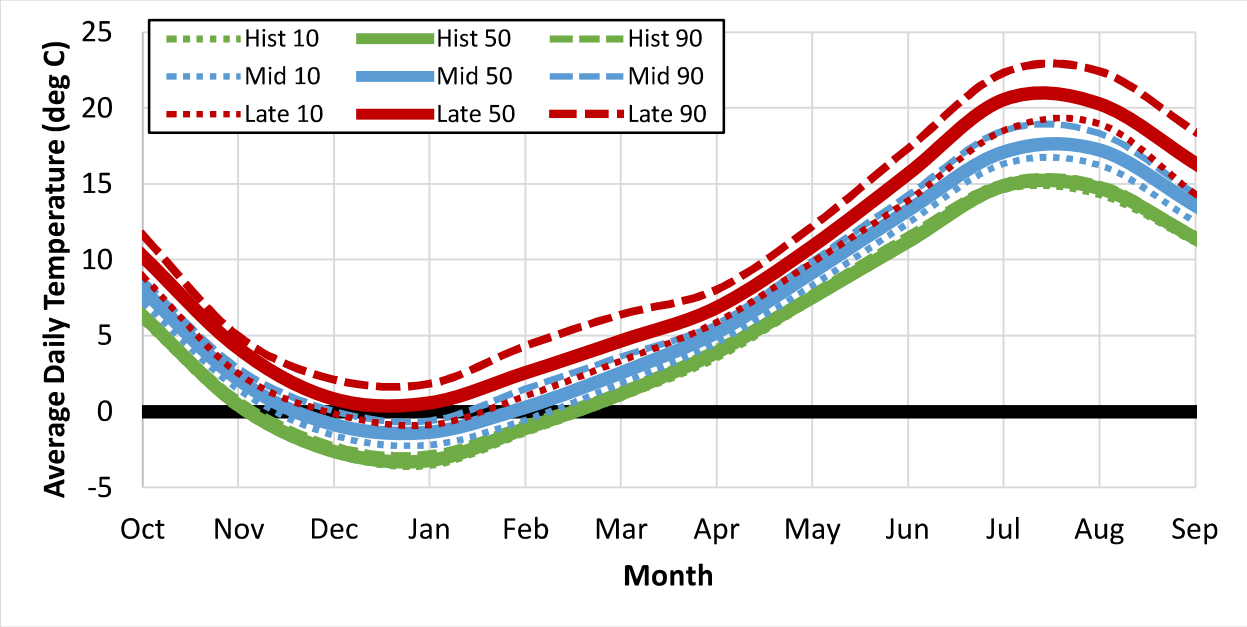

Figure 12. LOCA-CMIP5 Projected Daily Temperature

Median (50th percentile), Low (10th percentile), and High (90th percentile) for LOCA-CMIP5 simulated historical, mid-century, and late-century daily temperature projections

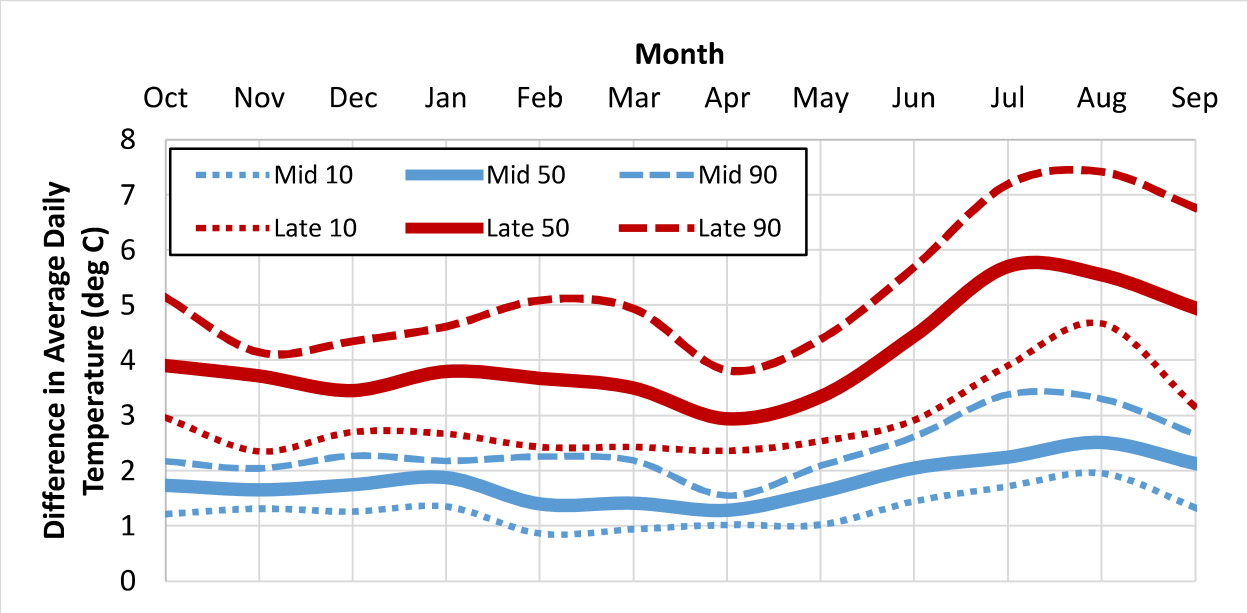

Figure 13. LOCA-CMIP5 Future Projected Change in Average Daily Temperature
Median (50th percentile), Low (10th percentile), and High (90th percentile) for the difference between LOCA-CMIP5 simulated historical daily temperature compared to LOCA-CMIP5 mid-century and late-century daily temperature projections

3.3 Precipitation

Precipitation characterization utilized LOCA-CMIP5 data, both for historical and future climate projections. These precipitation values are averaged across the entire LOCA-CMIP5 data extract area described in Section 2 and encompass the Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds. Projected mid-century and late-century precipitation is higher in the winter months and slightly lower in the summer months. Maximum summer precipitation in both the mid-century and late-century projections reaches as much as -0.2 mm/day below simulated historical average. Peak winter precipitation in the mid-century projection reaches as much as 0.35 mm/day higher than simulated historical average, and peak winter precipitation in the late-century project reaches as much as 0.65 mm/day higher than simulated historical average. Total annual precipitation for the median projection is projected to increase by 18 mm (0.7 inches) by mid-century and by 28 mm (1.1 inches) by end of century.

The increase in precipitation volume over the winter months in both the mid-century and late-century projections is one of the major drivers for the change in peak flow season in the Dog River, as shown in Section 3.1.2. When combined with the increase in projected average winter temperature, this means a larger proportion of this increased precipitation will fall as rain instead of snow. This increases the volume of winter runoff, while decreasing the amount of snowpack available for melt in the summer months. More detail on the impacts to snowmelt will be discussed in Section 3.4.

Figure 14 shows the average daily precipitation in mm/day for each month, while Figure 15 shows the difference in average daily precipitation for the mid-century and late-century projections as compared to the simulated historical data.

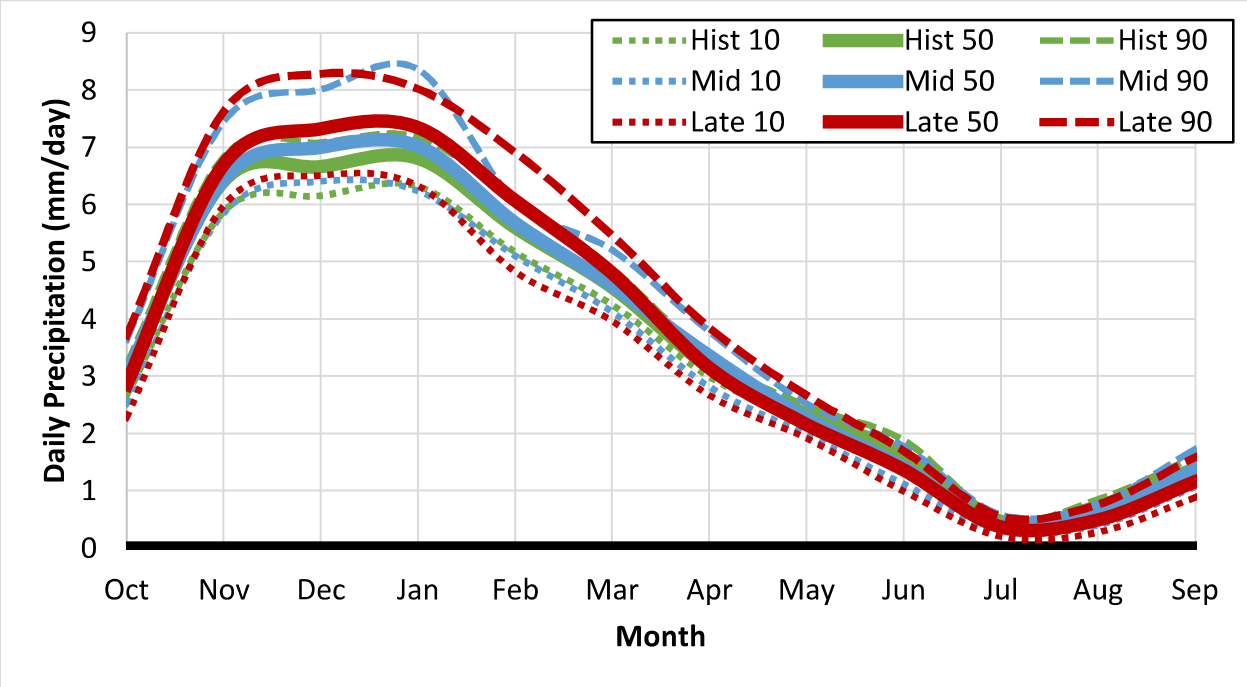

Figure 14. LOCA-CMIP5 Projected Daily Precipitation

Median (50th percentile), Low (10th percentile), and High (90th percentile) for LOCA-CMIP5 simulated historical, mid-century, and late-century daily precipitation projections

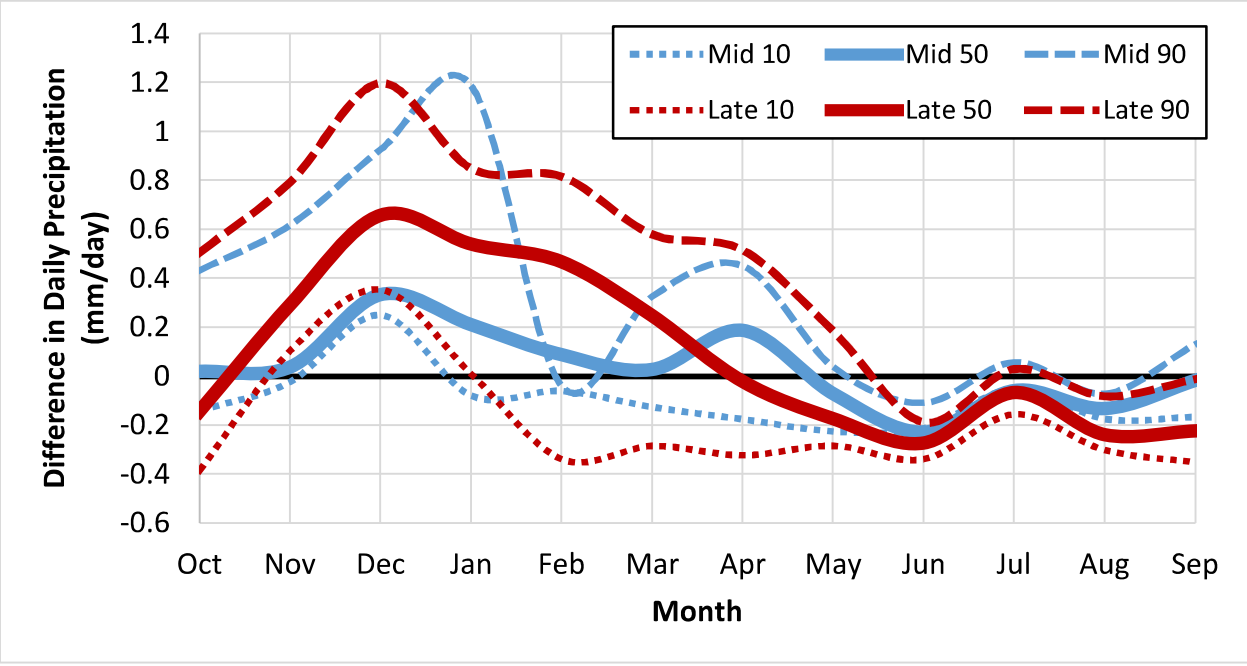

Figure 15. LOCA-CMIP5 Difference in Average Daily Precipitation

Median (50th percentile), Low (10th percentile), and High (90th percentile) for the difference between LOCA-CMIP5 simulated historical daily precipitation compared to LOCA-CMIP5 mid-century and late-century daily precipitation projections

3.4 Snowmelt

Snowmelt characterization utilized LOCA-CMIP5 data, both for historical and future climate projections. These snowmelt values are averaged across the entire LOCA-CMIP5 data extract area described in Section 2 and encompass the Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds. Projected mid-century and late-century snowmelt is higher in the winter months and much lower in the summer months. Maximum winter snowmelt in the mid-century projection reaches 1.5 mm/day higher than simulated historical average, and late-century projections reach as much as 2.0 mm/day higher than simulated historical average. Peak spring/summer snowmelt in the mid-century projection reaches as much as -3.0 mm/day less than simulated historical average, and peak spring/summer snowmelt in the late-century project reaches as much as -5.5 mm/day less than simulated historical average.

The increase in winter month snowmelt is driven by the increase in average winter temperature, seen in Section 3.2. Higher winter temperatures cause snowpack to melt earlier, which is compounded by winter precipitation falling as rain that increases the rate of melting. When most winter precipitation falls as rain instead of snow, and the winter temperatures are high enough to melt some existing snowpack, this leads to significantly less snowpack available for melt in the spring and summer months.

Figure 16 shows the average daily snowmelt rate in mm/day for each month, while Figure 17 shows the difference in average daily snowmelt rate for the mid-century and late-century projections as compared to the simulated historical data.

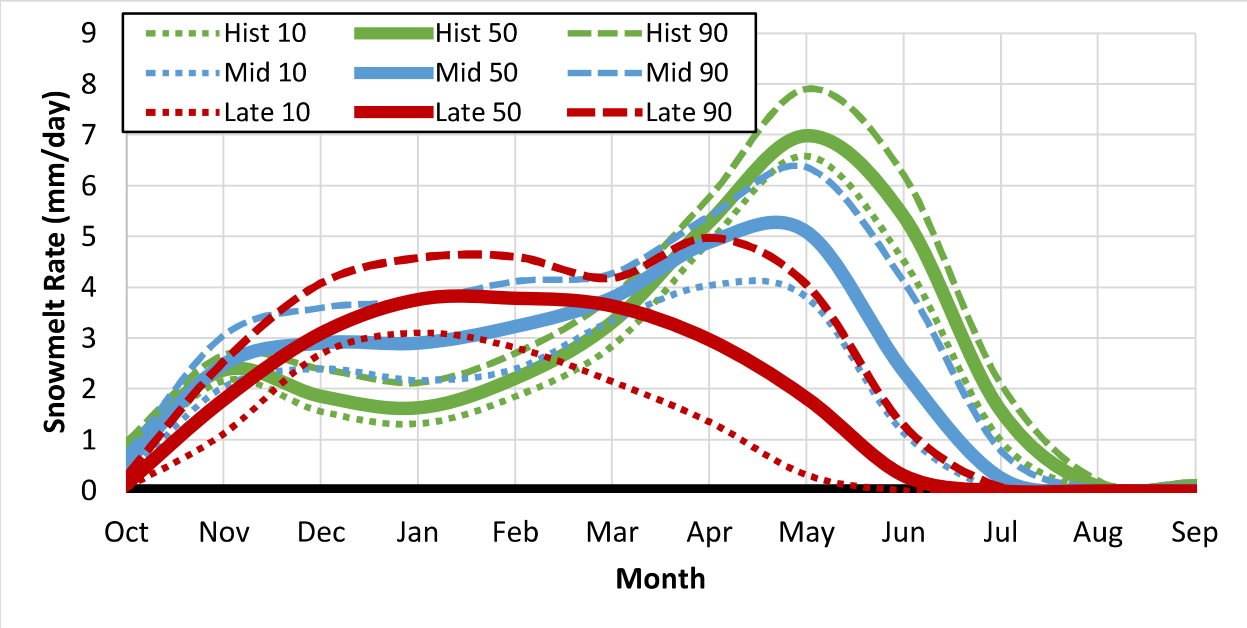

Figure 16. LOCA-CMIP5 Projected Monthly Snowmelt Rate

Median (50th percentile), Low (10th percentile), and High (90th percentile) for LOCA-CMIP5 simulated historical, mid-century, and late-century snowmelt rate projections

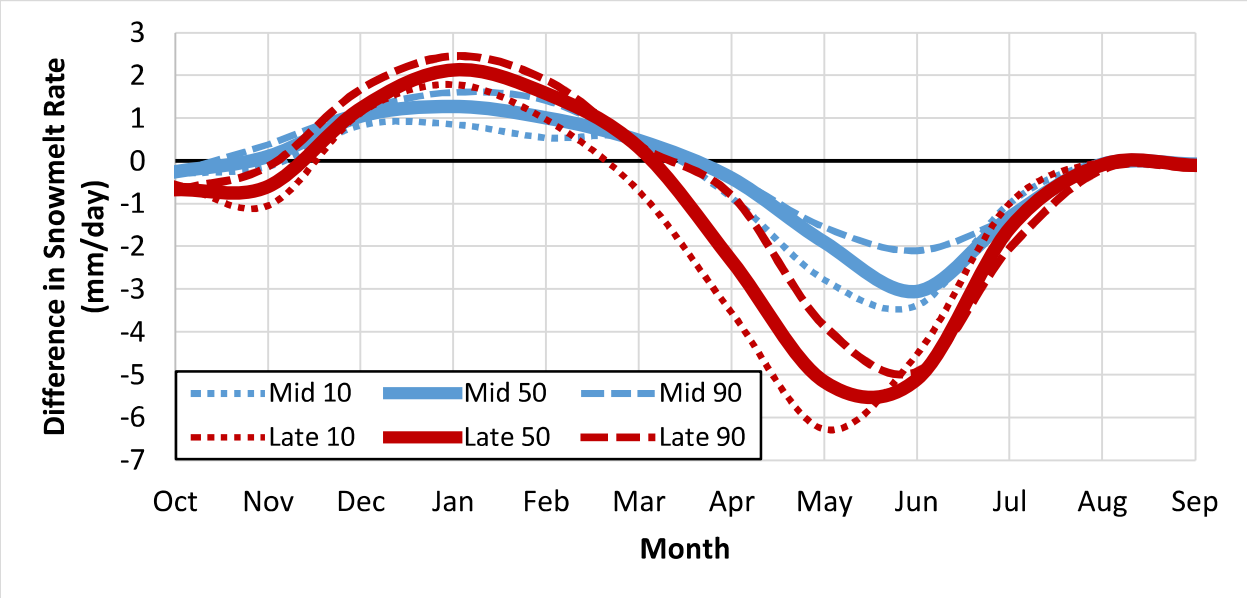

Figure 17. LOCA-CMIP5 Difference in Monthly Snowmelt Rate

Median (50th percentile), Low (10th percentile), and High (90th percentile) for the difference between LOCA-CMIP5 simulated historical snowmelt rate compared to LOCA-CMIP5 mid-century and late-century snowmelt rate projections

3.5 Wildfire

This section characterizes projected future wildfire trends, quantified as wildfire risk (Risk Factor, 2022), and fire danger days (Hegewisch and Abatzoglou, 2022). The forested Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds are characteristic of high Cascades mixed conifer forests. Substantial downed timber exists. Significant wildfires have occurred in the lower end of the watershed, below Crow Creek Dam and at elevations below 3000 feet, in both 1967 (School Marm Fire) and 2013 (Government Flats Complex Fire). Wildfires in the watershed will have material effects on water supply quality and quantity in the short term and long term. This section evaluates potential future impacts of climate change on wildfires, as wildfires may affect City water supplies.

Because nearly all the identified properties within the watershed in Hood River and Wasco Counties are identified as "at risk" for current conditions (today), the Risk Factor (2022) evaluation shows minimal numerical increase between today and future conditions (in 30 years) (Figure 18). However, the map does show substantial additional portions of the Counties with greater (1%) wildfire likelihood in the future than in the existing condition.

In addition to information on future projected wildfire risk, *Climate Toolbox* provides projections of Annual Fire Danger Days above the "high" (Figure 19), "very high" (Figure 20), and "extreme" (Figure 21) levels. Future projections show increases in each of these metrics by the middle of the 21st century. This parameter is a measure of the amount of moisture in dead vegetation in the 1-to-3-inch-diameter class available to a fire.

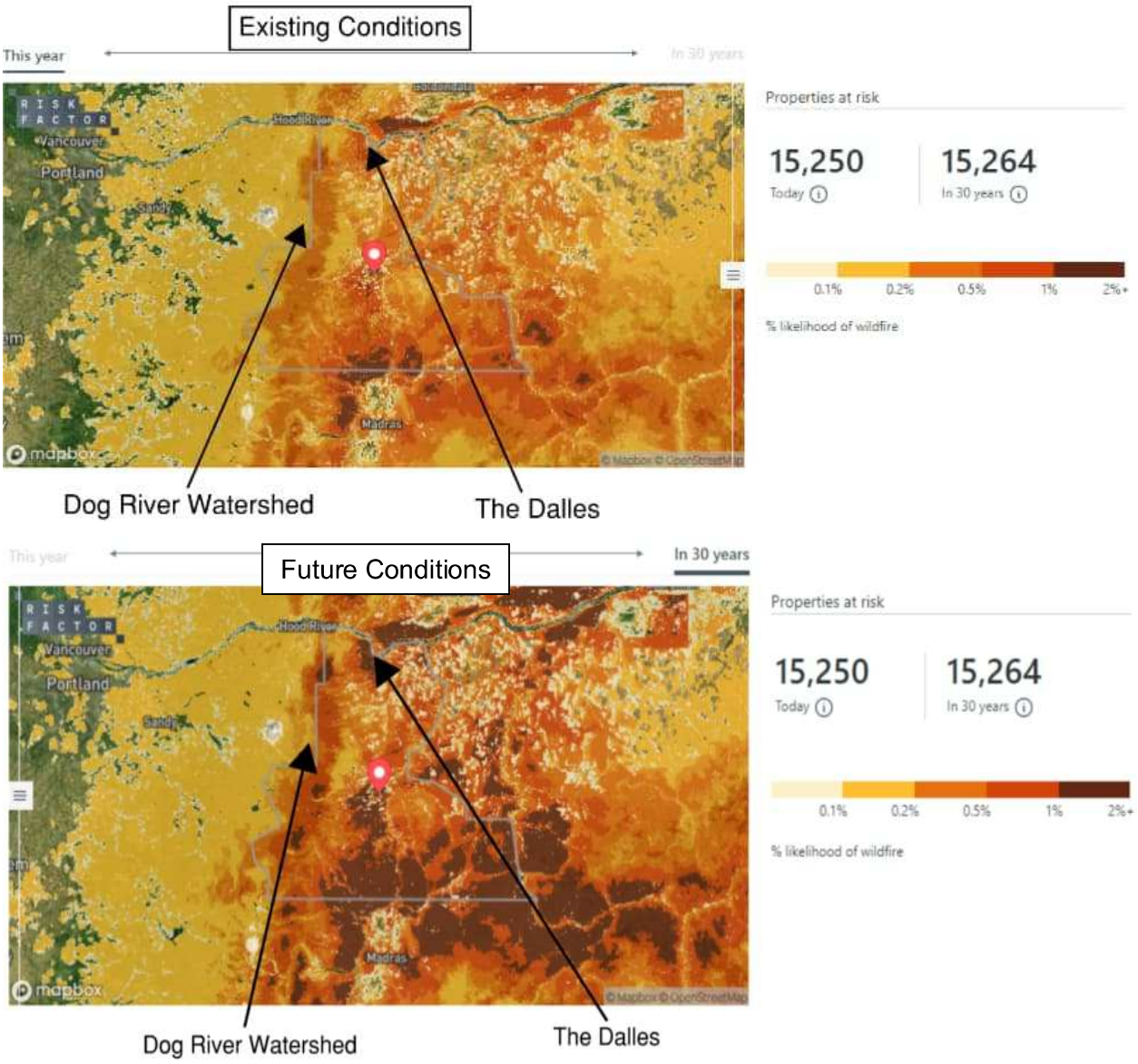

Figure 18. Existing and Future Projected Wildfire Risk in Hood River and Wasco County Near The Dalles
Source: Risk Factor, 2022

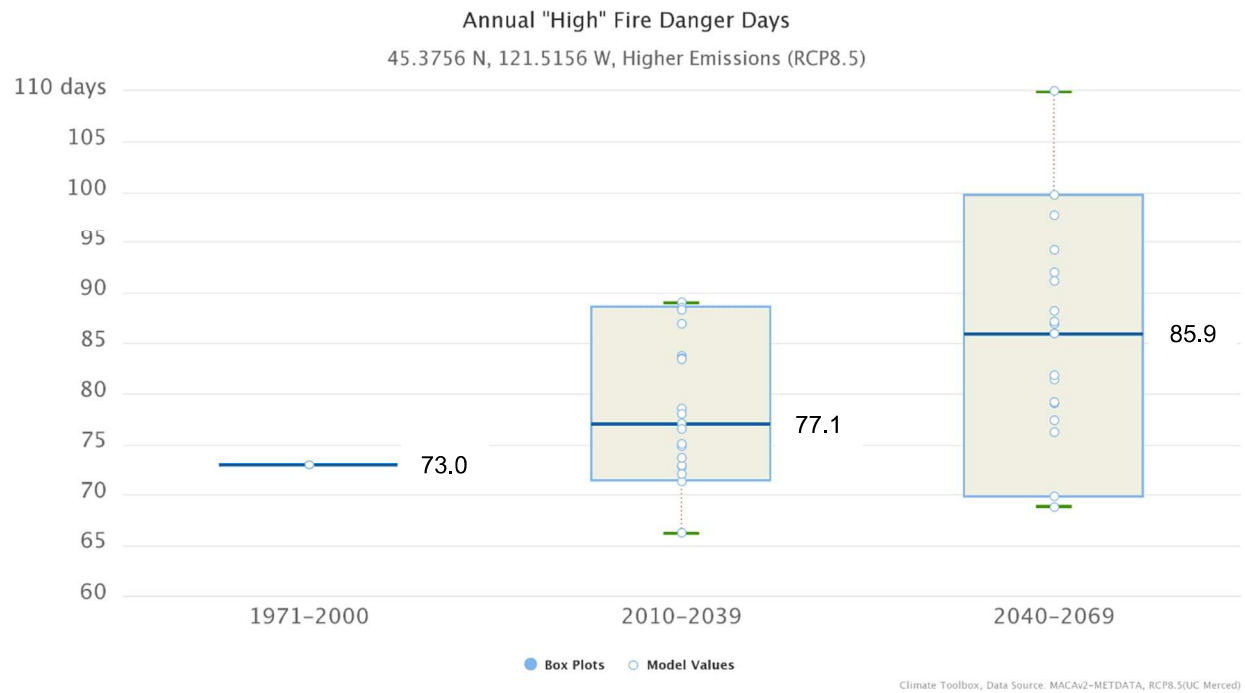

Figure 19. Dog River Watershed Future Projected Wildfire Exposure: Annual Number of "High" Fire Danger Days

Source: Hegewisch and Abatzoglou, 2022

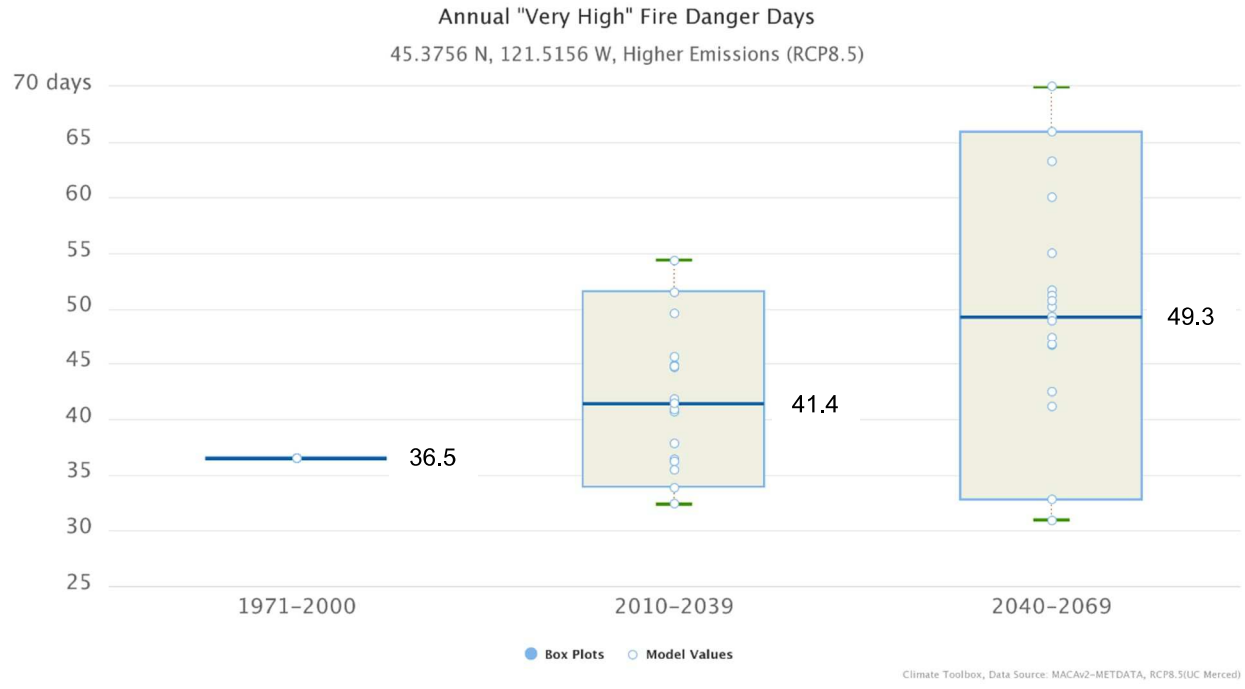

Figure 20. Dog River Watershed Future Projected Wildfire Exposure: Annual Number of "Very High" Fire Danger Days

Source: Hegewisch and Abatzoglou, 2022

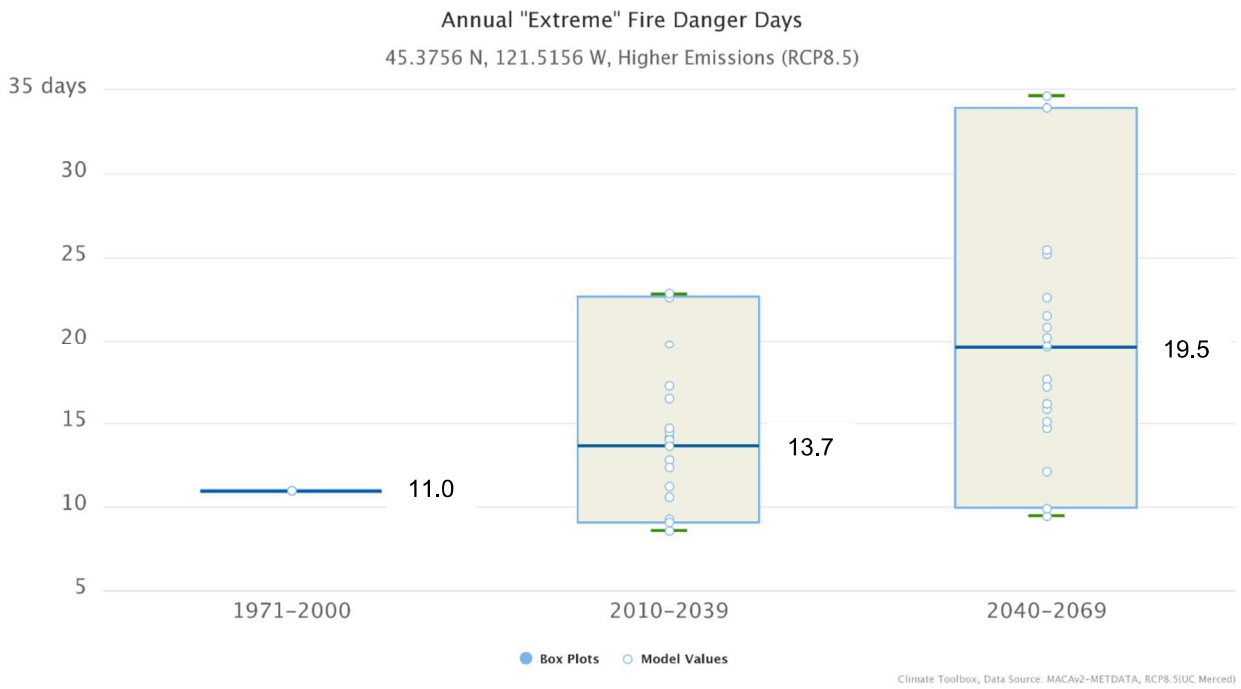

Figure 21. Dog River Watershed Future Projected Wildfire Exposure: Annual Number of "Extreme" Fire Danger Days

Source: Hegewisch and Abatzoglou, 2022

4. Summary

Future climate projections utilized LOCA-CMIP5 data (Section 2.1), with limited observed historical stream flow information used as a comparison point (Section 3.1.1). The results are summarized as follows (see Section 3 for additional detail about each parameter):

- **Runoff**: Future Dog River, Crow Creek Reservoir, and South Fork Mill Creek watershed stream flow hydrographs are expected to experience a substantial change in the timing of seasonal runoff (Figures 7, 8 and 9). This change is driven by higher winter temperatures and increased winter precipitation. These changes lead to peak seasonal runoff driven by winter rainfall rather than summer snowmelt. Seasonal peak runoff shifts from occurring in late spring (May) to occurring in winter (February) by late century. The overall trend is about 5% reduction in annual runoff by mid-century and 9% reduction by end-of century for the median (50th percentile) projection (Figure 10). The low (10th percentile) scenario also shows reduced future climate total runoff. This decrease is due mostly to increased evapotranspiration, which exceeds small increases in annual precipitation. The high (90th percentile) scenario shows a slight increase in annual runoff for the mid-century projection and no change for the late-century projection.
- **Temperature**: Average monthly temperatures at the Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds are projected to increase an average of 1.5 to 2.0°C in the mid-century projection, and by an average of 3.0 to 6.0°C in the late-century projection (median scenario).
- **Precipitation**: Average annual precipitation at the Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds is projected to increase slightly by about 0.7 inch per year in the mid-century projection and 1.1 inches per year in the late-century projection (median scenario). This annual increase is the product of a decrease in the summer and an increase in the winter (Figure 15).
- **Snowmelt**: Snowmelt rates in the Dog River, Crow Creek Reservoir, and South Fork Mill Creek watersheds are projected to increase over the winter months by as much as 1 mm/day in the mid-

century projection and 2 mm/day in the late-century projection (median scenario). Summer month snowmelt rates decrease by as much as -3 mm/day in the mid-century projection and -5.5 mm/day in the late-century projection (median scenario).

- **Fire Management:** Climate projections predict an increase in average temperature and increase of dry vegetation; it can be anticipated that wildfire frequency and intensity will also increase. The analysis for wildfire impact is qualitative rather than quantitative. As projected wildfire frequency increases, this can impact both the water supply quantity and water quality at Crow Creek Reservoir and Wicks WTP. After a wildfire, soils are more hydrophobic, which leads to increased peak runoff and decreased long-term baseflows. Wildfires also impact water quality, as the burned area will contribute increased sediment and burnt material into the water supply. A catastrophic fire in the watershed may occur this century and could substantially affect water quality from Dog River and runoff to Crow Creek Reservoir and South Fork Mill Creek.

5. Recommendations

To ensure resilient future water supply, the City of the Dalles should consider the projected future change in seasonal runoff in the Dog River, Crow Creek Reservoir, and South Fork Mill Creek Watersheds (Figures 7 and 8), relative to the City's current water usage and projected demands. The City should consider additional storage options as well as aquifer storage and recovery (ASR) as methods to capture earlier spring and winter projected peak runoff. Water demand forecasting being performed as part of this Water Master Plan must be compared in context to supply from watershed yield, groundwater supply, and storage options to develop treatment, conveyance and distribution alternatives that satisfy the City's need for resilient water supply.

6. References

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APPENDIX B
HYDRAULIC MODEL DATA

Table B-1 | Hydraulic or Steady-State Calibration Results

Flow Test No.	Location	Date of Test	Time	Hydrant Flow (gpm)	Model Results		Field Results		Difference	
					Static Pressure (psi)	Residual Pressure (psi)	Static Pressure (psi)	Residual Pressure (psi)	Static Pressure (psi)	Residual Pressure (psi)
1	701 W. 12th St	8/30/2023	12:43 PM	1,515	91	72	86	76	5	-4
2	1300 G St	8/30/2023	10:34 AM	1,184	47	40	45	37	2	3
3	E. 1st St and Federal St	10/4/2023	8:08 AM	1,695	79	74	88	78	-9	-4
4	2014 W. 7th St	10/4/2023	7:31 AM	1,562	62	10	72	48	-10	-38
5	3840 Crates Wy	6/1/2023	1:50 PM	1,348	67	52	72	51	-5	1
6	1520 W. 1st St	10/4/2023	8:33 AM	1,764	75	58	78	60	-3	-2
7	16th Pl and Scenic	5/8/2023	10:54 AM	1,814	92	75	98	65	-6	10
8[1]	E. 11th St off E. Morton St	8/30/2023	9:30 AM	-	51	-	59	-	-8	-
9	13th St & G St	8/30/2023	12:22 PM	662	78	61	82	54	-4	7
10	522 W. 14th St	6/2/2023	10:14 AM	1,324	57	41	54	38	3	3
11	12th St & Oregon Ave	8/30/2023	10:07 AM	1,327	108	86	100	80	8	6
12	Lone Pine Ln & Osprey at Water's Edge	6/2/2023	10:53 AM	1,545	102	92	102	95	0	-3
13	Brentwood Dr & Royal Crest Dr	6/1/2023	1:20 PM	1,448	82	67	80	62	2	5
14[2]	2503 W. Wright St	6/1/2023	12:30 PM	1,910	-	-	98	74	-	-
15	W. 22nd St & Garrison St	6/2/2023	9:59 AM	493	64	26	56	23	8	3
16	400 E. Scenic Dr (CGCC)	6/1/2023	10:53 AM	1,651	73	69	116	87	-43	-18
17	Oakwood Dr	6/1/2023	12:59 PM	780	74	68	72	64	2	4
18.1	755 E. 18th St	6/1/2023	10:13 AM	1,190	53	0	50	16	3	-16
18.2	919 E. 18th St	6/1/2023	10:31 AM	1,023	62	0	60	37	2	-37
19	2543 E 18th St	5/8/2023	1:13 PM	1,620	114	103	110	104	4	-1

Note:
1. Static pressure reading was the only measurement recorded during the hydrant fire flow test.
2. Due to open channel flow conditions upstream, the hydrant fire flow test was not modeled.

Table B-2 | Hydraulic or Steady-State Calibration Findings

Hydrant Flow Test No.	Comments/Notes
1	Calibration is acceptable.
2	Calibration is acceptable.
3	A 10 psi static pressure difference. PRV settings verified from system information on hand.
4	A static pressure difference of 10 psi. A large difference in residual pressure. Small diameter pipes in the area are limiting flow capacities.
5	Calibration is acceptable.
6	Calibration is acceptable.
7	Calibration is acceptable.
8	A difference in 8 psi in static pressure. PRV settings verified from system information on hand.
9	Calibration is acceptable.
10	Calibration is acceptable.
11	Calibration is acceptable.
12	Calibration is acceptable.
13	Calibration is acceptable.
14	Did not calibrate.
15	Calibration is acceptable.
16	A static pressure difference of 43 psi and residual pressure difference of 18 psi. The residual hydrant may be further east, south of 18th St and Jefferson.
17	Calibration is acceptable.
18.1	The residual pressure drops to zero due the limiting capacity of the 6-inch pipe along 20th St.
18.2	The residual pressure drops to zero due the limiting capacity of the 6-inch pipe along 20th St.
19	Calibration is acceptable.

Note:
1. Use a superscript number for your table notes
2. This is where your table notes go

Figure B-1 | Garrison Tank

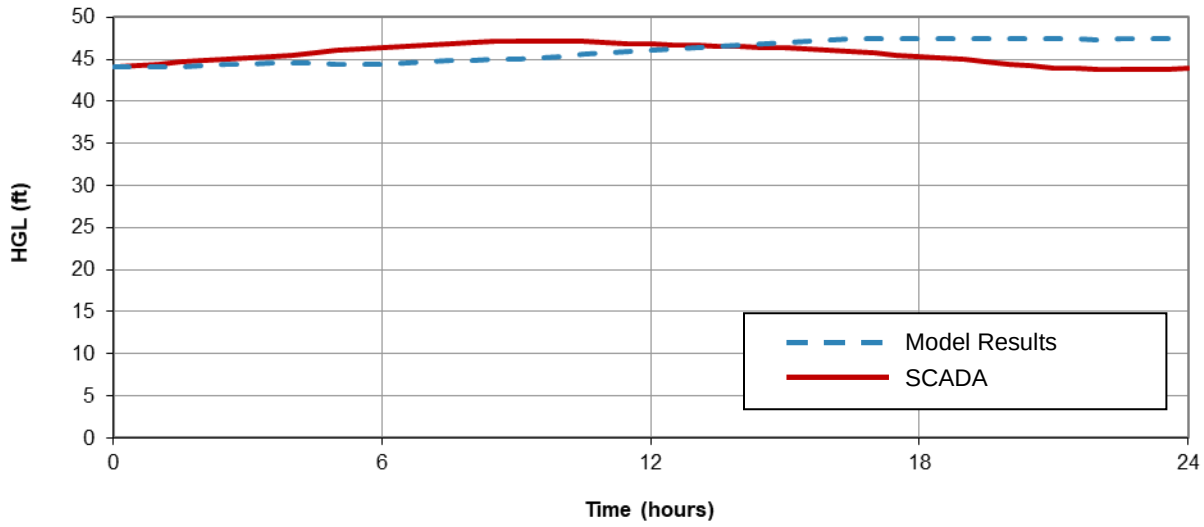


Figure B-2 | Intermediate Tank Level

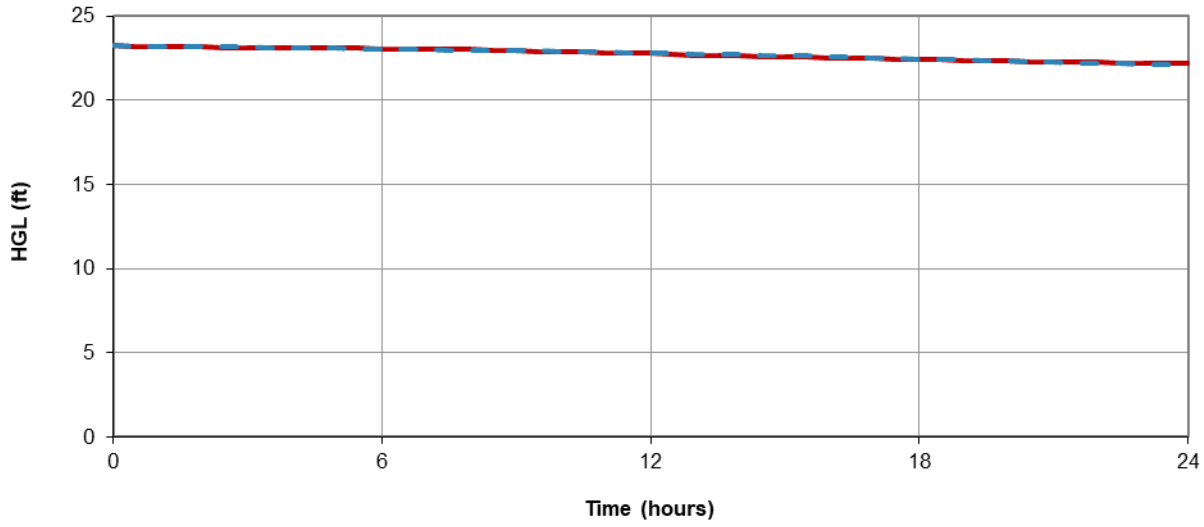


Figure B-3 | Sorosis Tank Level

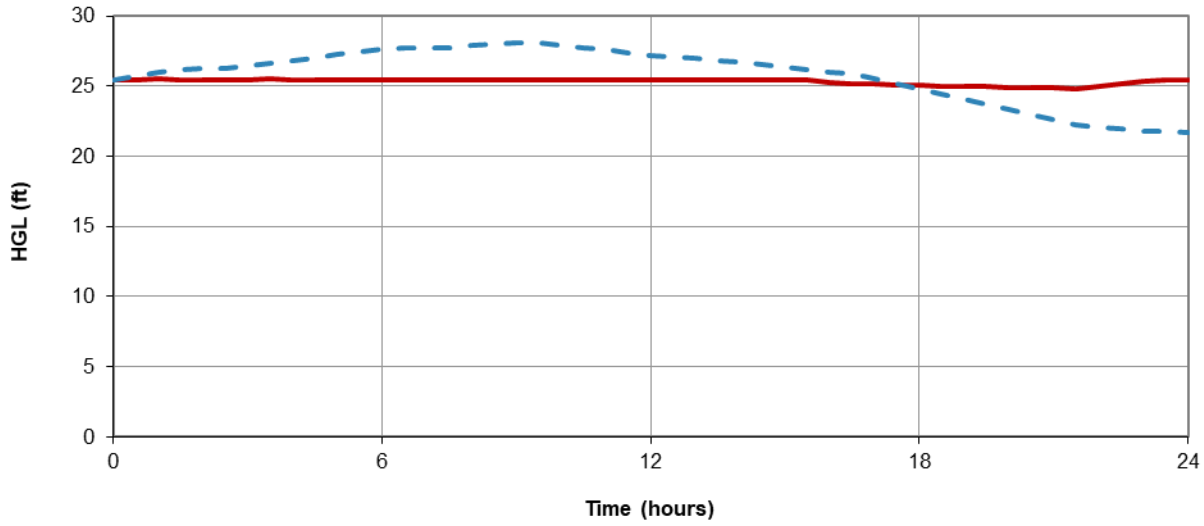


Figure B-4 | Wicks WTP High Line Flow

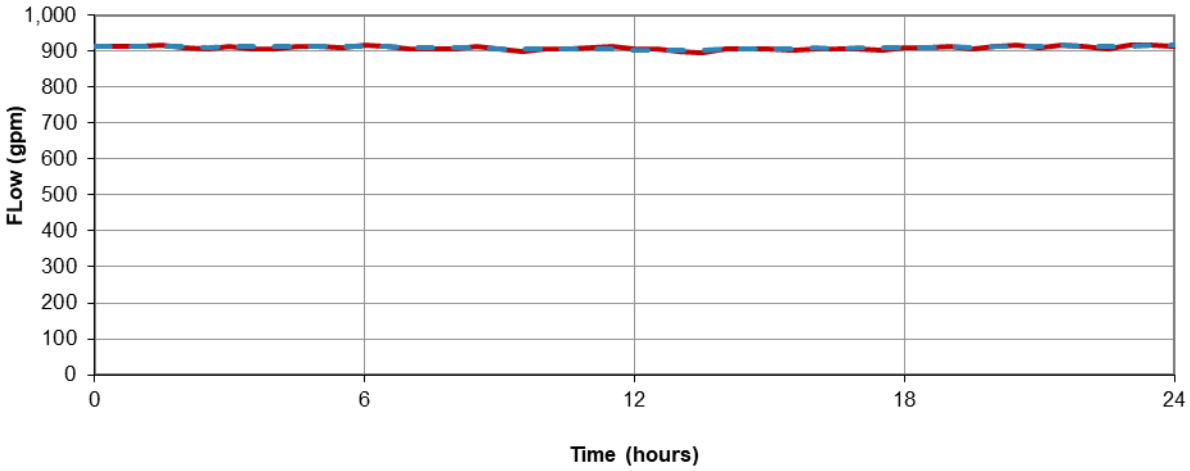
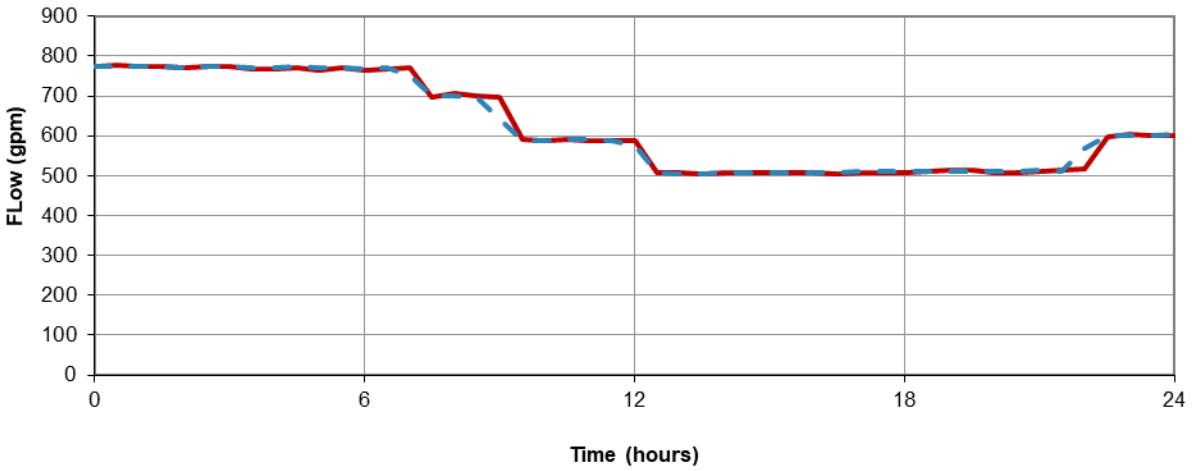


Figure B-5 | Wicks WTP Mill Creek Flow



Maximum Day Demand Operational Calibration (August 15, 2023)

Figure B-6 | Garrison Tank Level

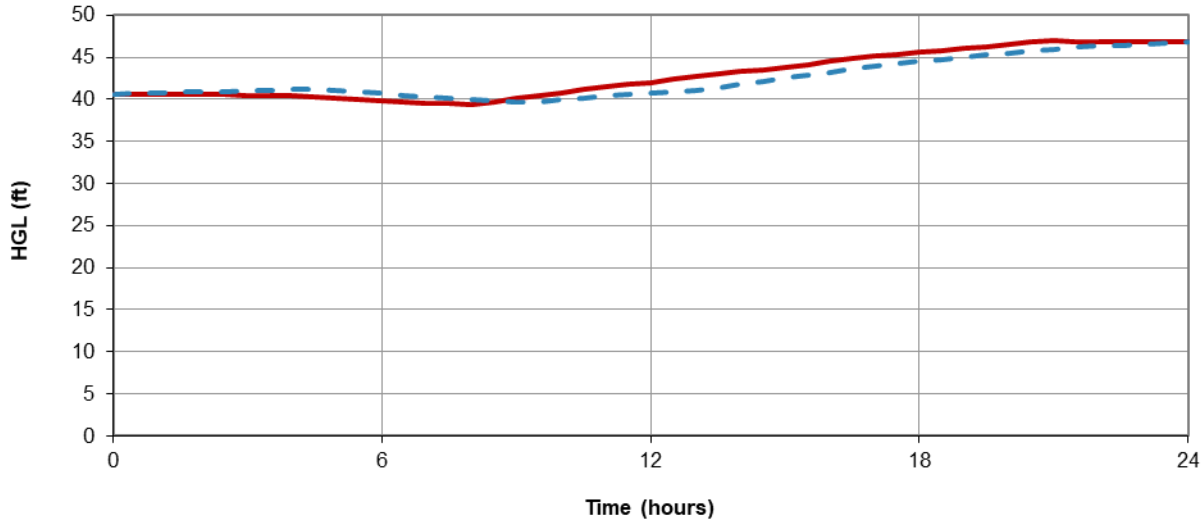


Figure B-7 | Intermediate Tank Level

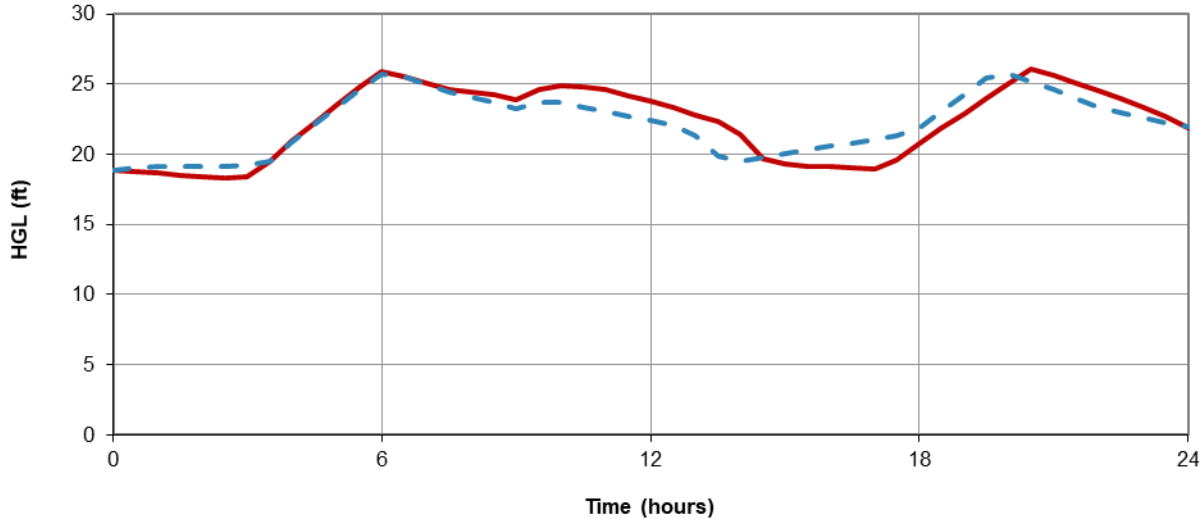


Figure B-8 | Sorosis Tank Level

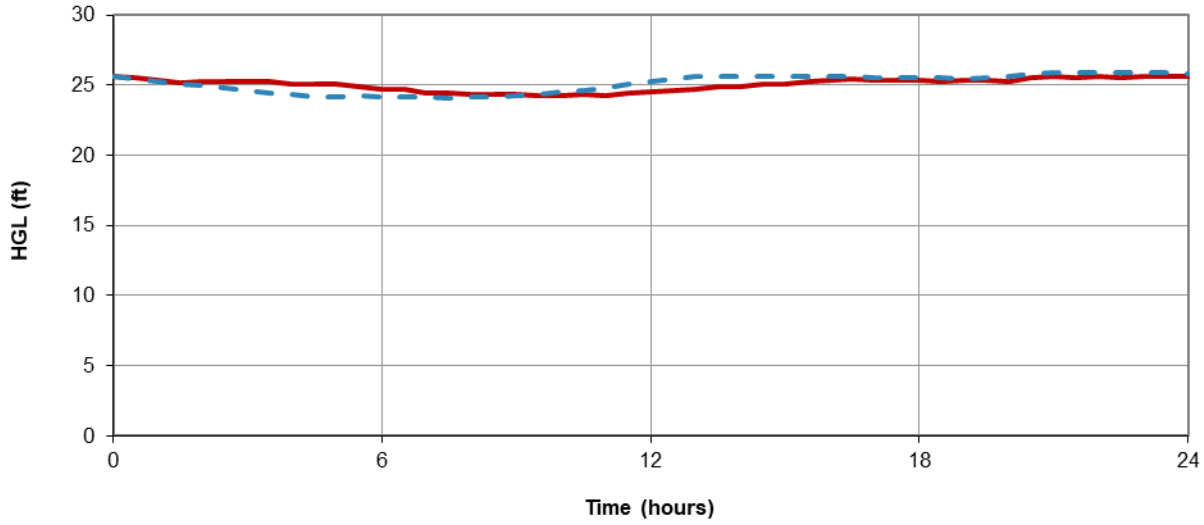


Figure B-9 | Columbia View Tank Level

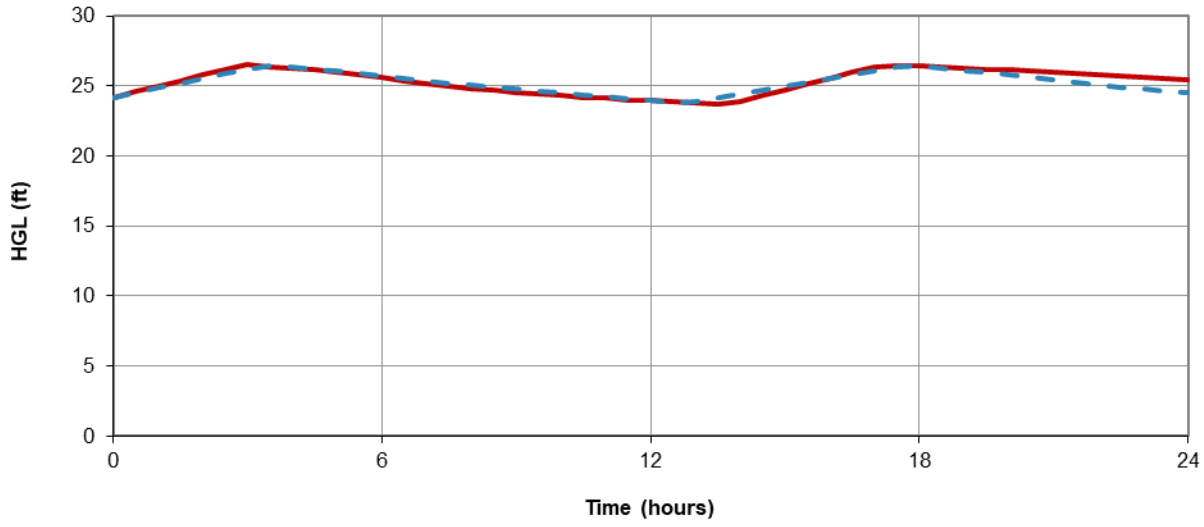


Figure B-10 | Wicks WTP High Line Flow

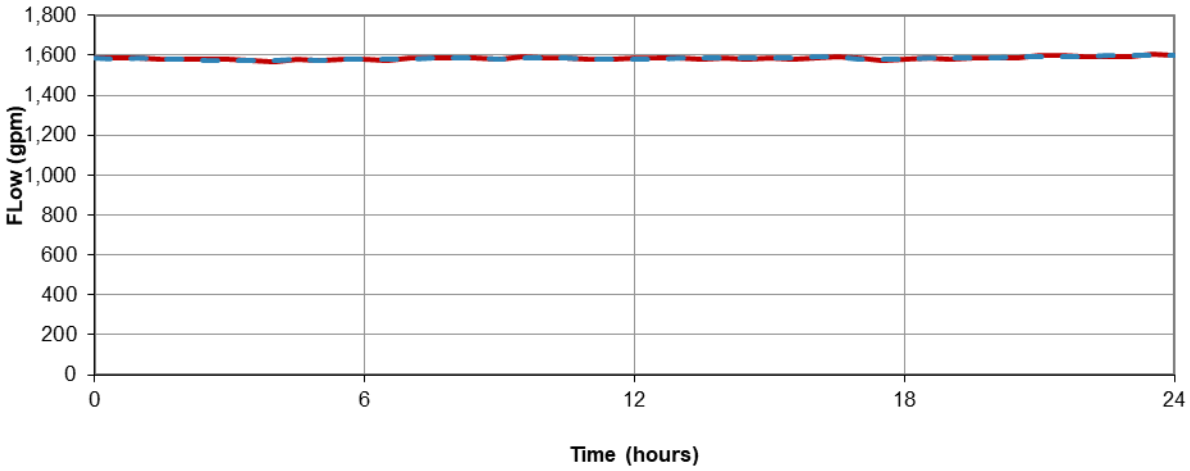


Figure B-11 | Wicks WTP Mill Creek Flow

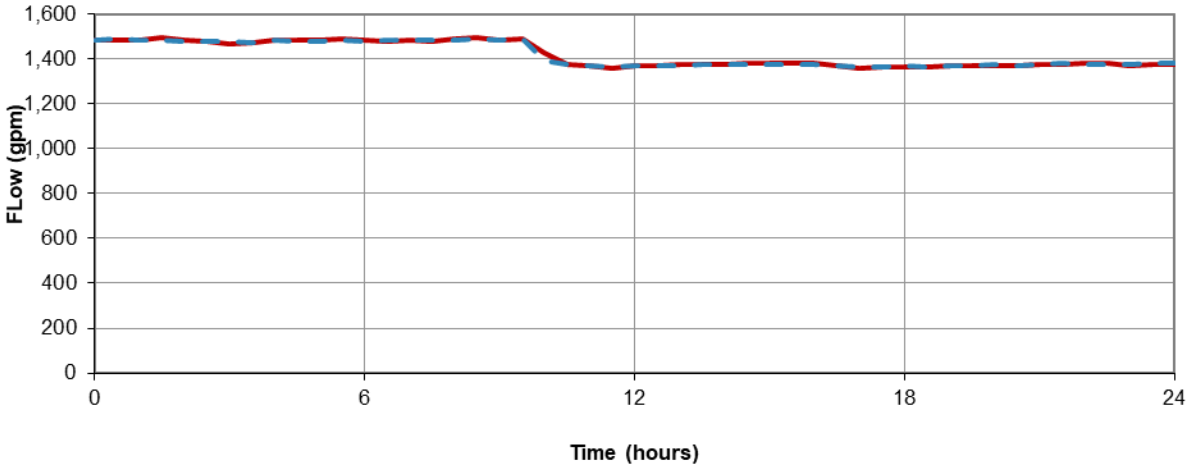


Figure B-12 | Jordan Well Flow

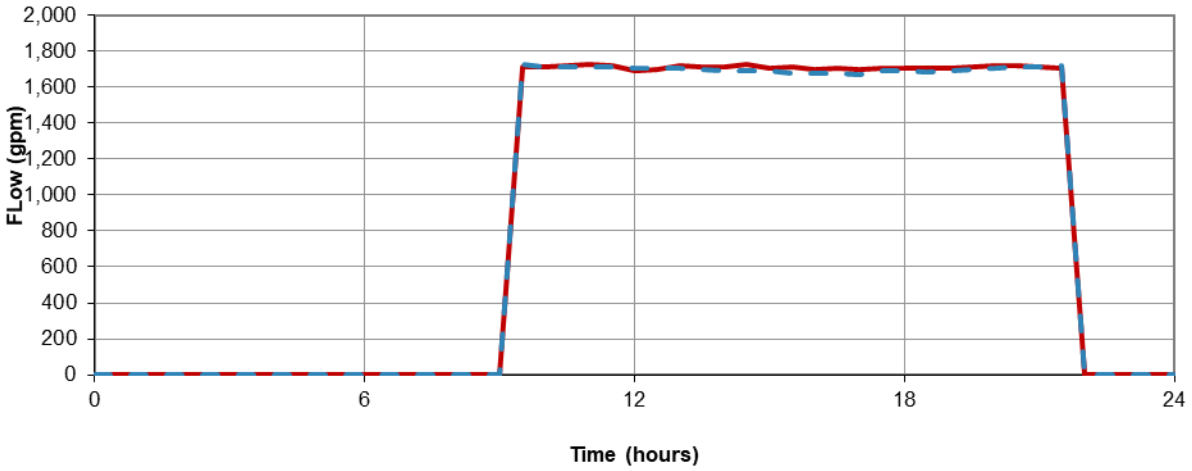


Figure B-13 | Lone Pine Well Flow

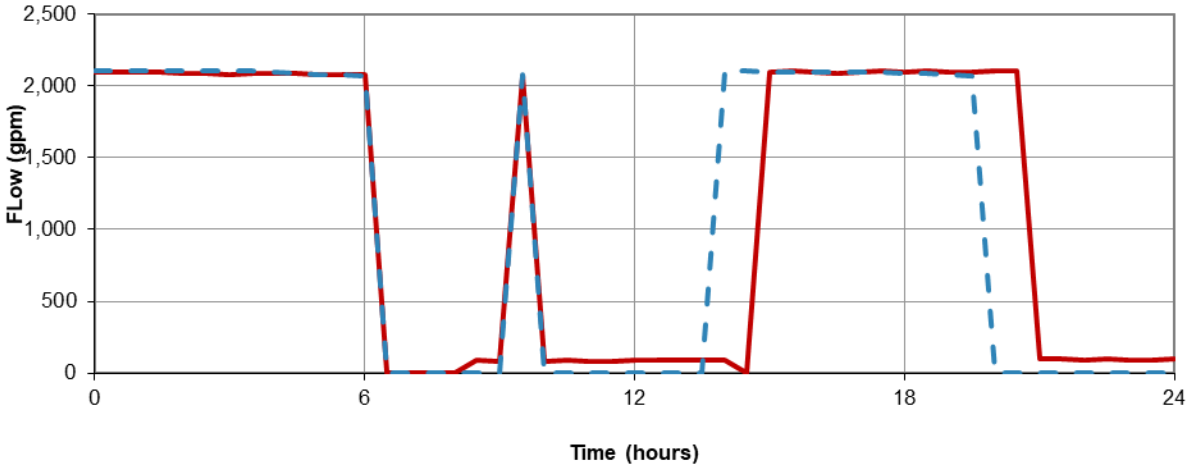
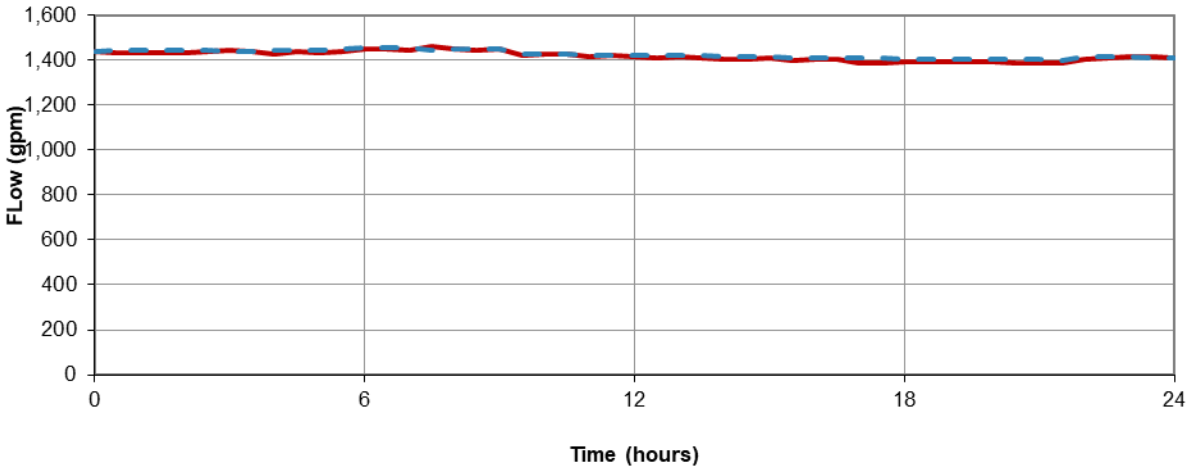
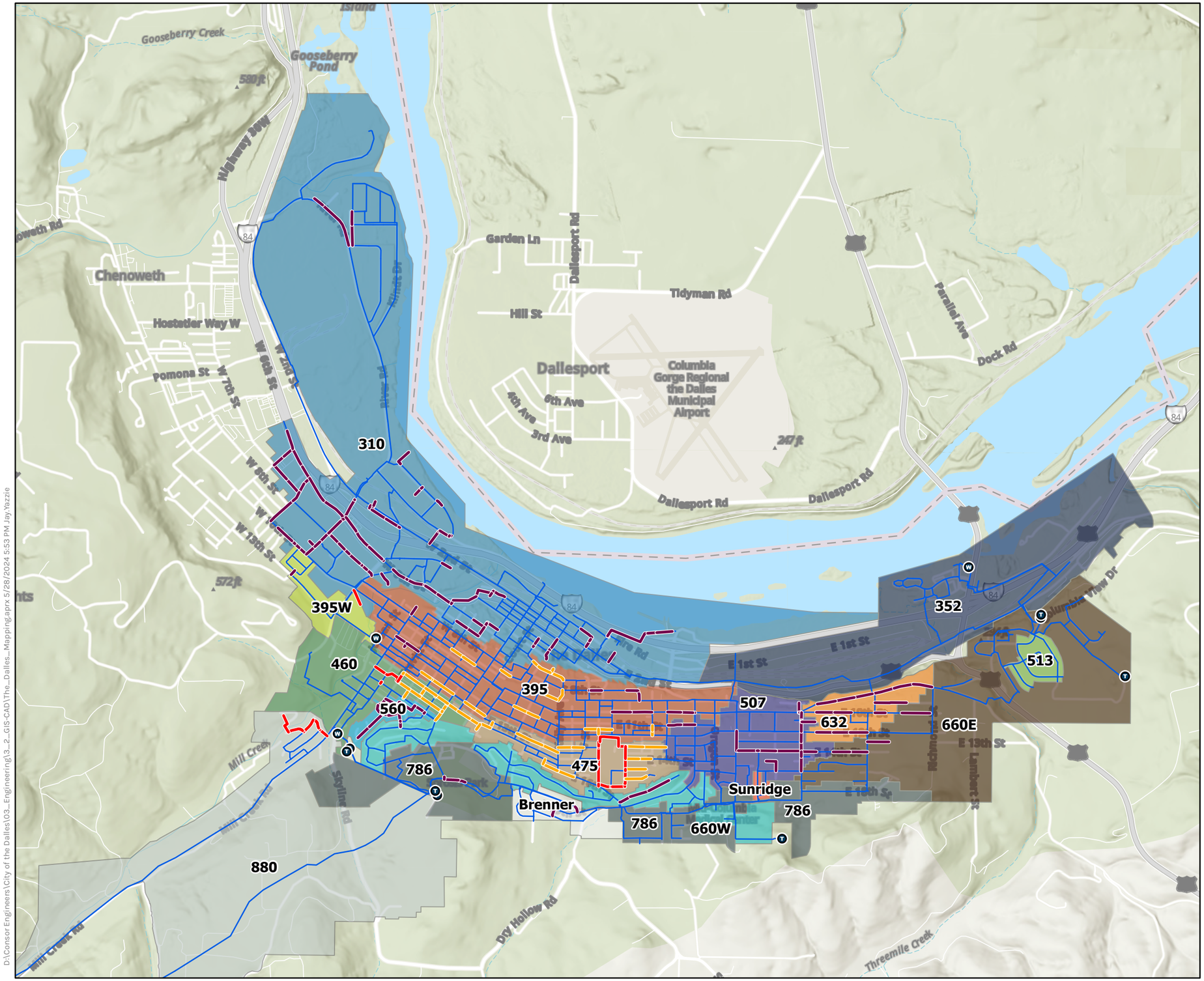


Figure B-14 | Marks Well Flow





- Well
- Tank
- Pump
- Distribution Main

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Improvement Year

- 2030
- 2035
- 2045

The Dalles
Water Master Plan

Figure B.15. Overview of Recommended Piping Improvements for Fire Flow

consor

Project No. W196117OR.00

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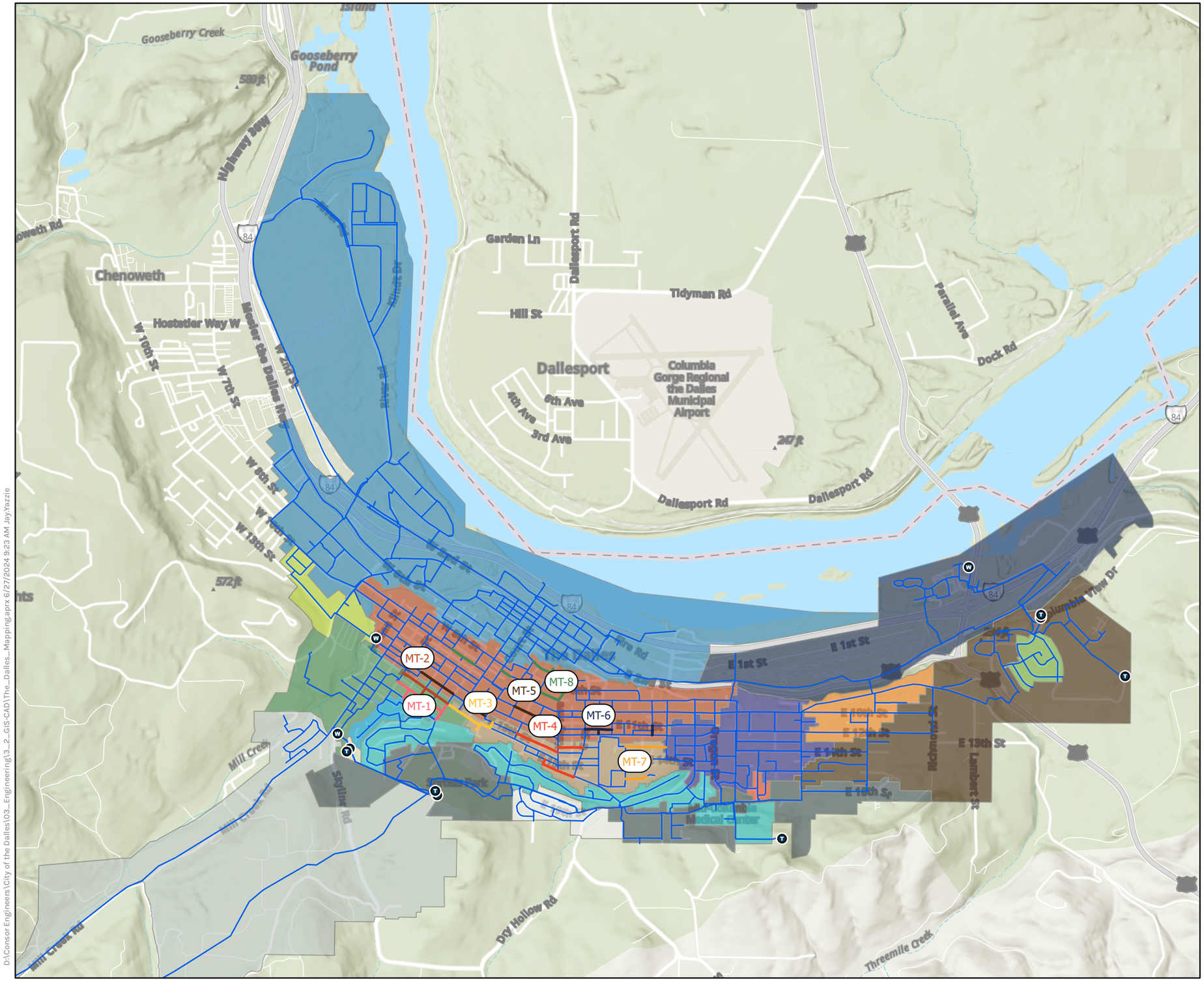
Data Sources: NTUA 2020; ESRI; World Topographic Map: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA, USFWS
World Hillshade: Esri, NASA, NGA, USGS, FEMA
Coordinate System: NAD 1927 StatePlane Oregon North FIPS 3601 NAD 1983 State Plane Coordinate System
Disclaimer: Consor and NTUA make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.



- Well
- Tank
- Pump
- Distribution Main

Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Mid-term CIP

- MT-1
- MT-2
- MT-3
- MT-4
- MT-5
- MT-6
- MT-7
- MT-8

The Dalles
Water Master Plan

Figure B.16.
Mid-Term Capital Piping Improvements

Project No. W196117OR.00

Data Sources: NTUA 2020; ESRI; World Topographic Map: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA, USFWS
World Hillshade: Esri, NASA, NGA, USGS, FEMA
Coordinate System: NAD 1927 StatePlane Oregon North FIPS 3601 NAD 1983 State Plane Coordinate System
Disclaimer: Consor and NTUA make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

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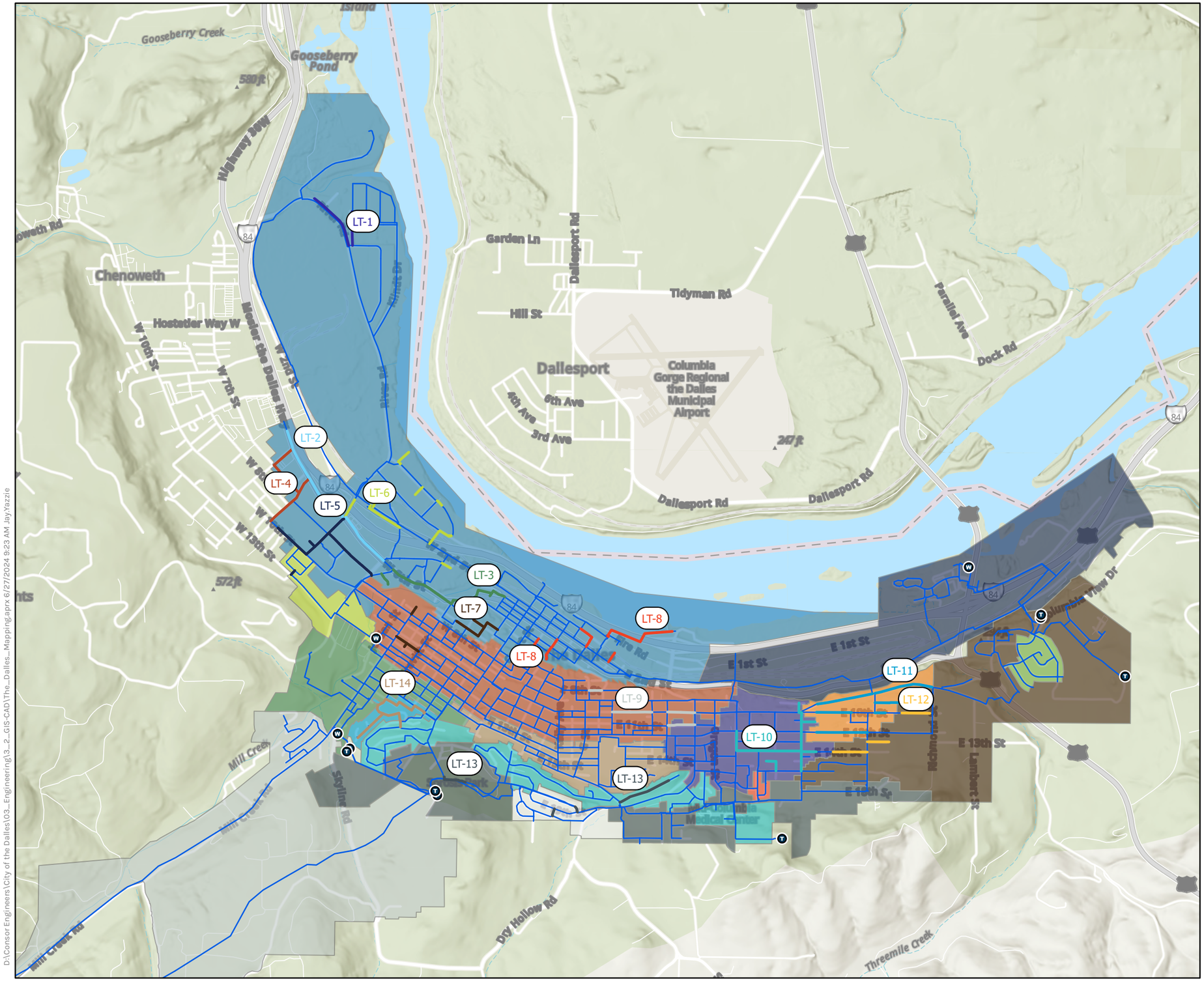

Well
Tank
Pump
Distribution Main

Pressure Zone
- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660E
- 660W
- 786
- 880
- Brenner
- Sunridge

Long-term CIP
- LT-1
- LT-2
- LT-3
- LT-4
- LT-5
- LT-6
- LT-7
- LT-8
- LT-9
- LT-10
- LT-11
- LT-12
- LT-13
- LT-14

The Dalles
Water Master Plan

Figure B.17.
Long-Term Capital Piping Improvements

consor

Project No. W196117OR.00

Data Sources: NTUA 2020; ESRI; World Topographic Map: Oregon State Parks, State of Oregon GEO, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA, USFWS
World Hillshade: Esri, NASA, NGA, USGS, FEMA
Coordinate System: NAD 1927 StatePlane Oregon North FIPS 3601 NAD 1983 State Plane Coordinate System
Disclaimer: Consor and NTUA make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

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APPENDIX C
DISTRIBUTION SYSTEM EVALUATION TECHNICAL MEMORANDA

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Jacobs

Technical Memorandum

2020 SW Fourth Avenue, 3rd Floor
Portland, OR 97201
503.235.5000
www.jacobs.com

Subject	**Task 6.1 Pipeline and Distribution Facility Seismic Risk Assessment**
Project Name	City of The Dalles Water Master Plan
City Project Number	2022-005
Jacobs Project Number	D3718900
To	Dave Anderson/City of the Dalles
From	Brady Fuller, PE/Jacobs Terri Tovey, PE, CWI/Jacobs
Reviewed by	Brady Fuller, PE/Jacobs
Date	July 26, 2024

EXP. 12/31/2025

1. Introduction

The project scope for the City of the Dalles Water Master Plan pipeline and distribution facility seismic risk assessment includes completing an initial assessment of existing structures using record drawings, and identifying structural upgrades based on the age of the structures, and building construction materials for seismic resiliency. The detailed evaluation of Crow Dam was not included in the scope of work for the Water Master Plan, but the 1996 Crow Dam seismic assessment was reviewed and recommendations made for further analyses.

This technical memorandum (TM) presents a summary of these assessments, potential changes in regulatory requirements and other conditions, and recommends an approach for future studies to refine the City's understanding of the structural conditions, seismic vulnerabilities, and potential expansions.

Depending on outcomes of Wick Water Treatment Plant (WTP) process evaluations, additional studies may be conducted to determine structural conditions and seismic performances of the Wick WTP facilities that are recommended to remain and/or be modified in proposed improvements.

The following buildings and structures were evaluated:

- Wells (Lone Pine, Jordan, Marks)
- Booster Pump Stations (Intermediate PS, Garrison PS, Vista PS located at the Sorosis Reservoir site)

Oregon Building Codes Division (OBCD) has established recommendations to improve fire resilience of existing structures. According to an OBCD publication, "Senate Bill 762 (2021) created a statewide approach to a wide range of wildfire mitigation measures. The legislature directed the Building Codes Division to adopt fire hardening building code standards that could be applied to areas of the state mapped as extreme or high risk and that are in the wildland urban interface. Fire hardening refers to building materials and practices that can reduce the risk of ignition of a home by embers from wildfires." While these recommendations are focused on residential structures, they are applicable to the structures considered under this evaluation. Improvements or modifications to these structures that are subject to building permits are expected to trigger code-required fire resilient construction materials and methods.

(See guidance from State of Oregon Department of Consumer and Business Services, Building Codes Division. For more information about fire hardening, contact the OBCD at bcd.firehardening@dcbs.oregon.gov.)

2. Review of Existing Facilities

2.1 Wells

The existing Lone Pine Well, Jordan Street Well, and Marks Well are reviewed below. The City Hall, Stadelman, and Mill Creek well sites are no longer in use and were not evaluated.

2.1.1 Lone Pine Well

The facility has four main rooms as shown in Table 1.

Table 1. Lone Pine Well Building Rooms

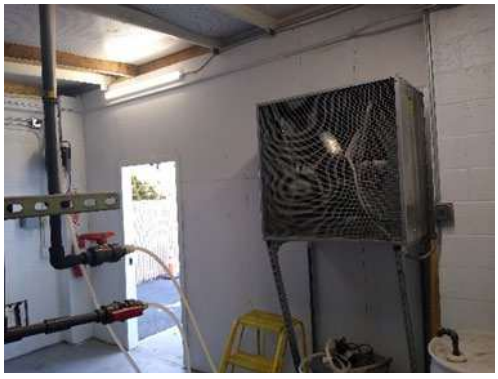
Room Number	Description
Room 106	Pump Room
Room 103/104/105	Fluoride Room/Vestibule/Janitor
Room 102	Hypochlorite Pumping Room
Room 101	Hypochlorite Storage Room

The Lone Pine Well Building was constructed in 1982, directly adjacent to the existing Chlorine Building. The well and pump building is 19 feet 5 inches by 17 feet 4 inches by approximately 10 feet high with concrete masonry unit (CMU) walls, a wood-framed roof, and an 8-inch-thick, reinforced concrete, slab-on-grade floor. The CMU walls were designed with bond beams and the building has a concrete column in each corner. The roof of the Lone Pine Well Building includes two removable sections, and a steel monorail beam (member size: S10x25.4). The building has single doors on both the east and west walls. The east wall includes a large removable, wood-framed wall section that is plywood with 2-inch by 4-inch blocking, located adjacent to the east door.

The Lone Pine Well Building was remodeled in 2016 at the same time the well column was upgraded. The building is typically unoccupied. The CMU walls are doweled into an 18-inch by 18-inch perimeter concrete footing that connects to an 8-inch-thick floor slab.

The existing Chlorine Building is roughly 48 feet by 30 feet and the date of its original construction is not known. The building was remodeled in 1982 when the Well building was constructed, and again in 2016. The Chlorine Building has a wood-framed roof, wood-framed walls, and exterior metal siding. The building has an S6x12.5 monorail with an electric hoist that was centered over two chlorine tanks, which were removed when the treatment process was upgraded to fluoride. The monorail is supported by three W8x17 beams. The building has a perimeter concrete footing and a 4-inch-thick concrete floor slab.

Photos of the Lone Pine Well facility are provided below.



Seismic Evaluations and Upgrades:

CMU buildings constructed in this era would typically include anchorage of walls to foundations, include partially grouted cells, and may not include bond-beam construction. Modern design codes and design approaches would typically provide full cell grouting, bond beams at top and bottom of wall, over openings and at 48" (or closer) on center (or horizontal joint reinforcing).

The removable wall section of the well and Pump Room may need bracing. This is because the large opening in the east side of this CMU wall may not have adequate capacity to resist lateral loads. At the Chlorine Building, it will need to be confirmed that the building frame has seismic tie-downs to the concrete foundation.

Piping connections, and anchorage for heaters, tanks and other equipment should be checked for lateral stability and bracing, but are likely up to code since the equipment in both buildings was upgraded to 2012 International Building Code requirements in 2016.

Based on age, and the critical need for reliable operation, electrical facilities should be considered for upgrade during the planning period including replacement Motor Control Center, Panel Board,

Distribution Transform, and Soft Starter. Vendor quotes for these elements were obtained and an allowance estimated for construction. A detailed electrical predesign is recommended to confirm condition and intended scope.

2.1.2 Jordan Street Well

The Jordan Street Well site consists of two buildings. The rooms are listed in Table 2.

Table 2. Jordan Street Well Facility Rooms

Room Number*	Description
Room 100	Pump Room
Room 200	Chlorination Room
Room 210	Safety Shower

*Number assigned for this study.

No design or as-built drawings were available for review of this facility. Both buildings have CMU walls with concrete slab floors and wood-framed roofs, and the openings in the CMU walls are relatively small. The Pump Room has a large removable roof section, required for pulling the pump and motor from the facility. It is likely that the CMU walls are doweled into a concrete foundation, but this should be verified if possible. A pachometer (a hand-held electronic instrument used to detect reinforcing bars) can be used to verify that the CMU walls have bond beams, vertical reinforcement at openings, pier and column reinforcement.

The lights are wall mounted (due to removable ceiling and roof at the Pump Room), and the electrical equipment is wall or floor mounted.

Photos of the facility are provided below.

Seismic Evaluations and Upgrades:

CMU buildings constructed in this era would typically include anchorage of walls to foundations, include partially grouted cells, and may not include bond-beam construction. Modern design codes and design approaches would typically provide full cell grouting, bond beams at top and bottom of wall, over openings and at 48" (or closer) on center (or horizontal joint reinforcing).

Check anchorage and lateral bracing for equipment and piping. Using a pachometer, verify that CMU walls have bond beams, vertical reinforcement at openings, and pier and column reinforcement.

Based on age, and the critical need for reliable operation, electrical facilities should be considered for upgrade during the planning period including new service rated disconnect, replacement Motor Control

Center, and Soft Starter. Vendor quotes for these elements were obtained and an allowance estimated for construction. A detailed electrical predesign is recommended to confirm condition and intended scope.

2.1.3 Marks Well

The Marks Well site includes two wood-framed buildings with metal roofing and siding and slab-on-grade concrete floors. No shop or design drawings were available for review. The rooms are listed in Table 3.

Table 3. Marks Well Facility Rooms

Room Number*	Description
Room 100	Pump Room
Room 210	Hypochlorite Pumping Room
Room 220	Hypochlorite Storage

*Room number assigned for this study.

Wood-framed construction typically performs fairly well in a seismic event. The equipment should be checked to ensure it has adequate lateral bracing and is properly tied to the concrete foundation.
The lights are suspended from the ceiling, and the electrical equipment is wall mounted.
A small, lined pond is located across Skyline Road to the south, but no structures there exist.

The proximity of the structures to Skyline Road represent a risk of potential and substantial damage from a down-hill moving vehicle on Skyline Road.

Photos of the Marks Well facilities are provided below.

Seismic Evaluations and Upgrades:

Wood and metal frame buildings constructed in this era would typically include anchorage of walls to foundations, Modern design codes would provide prescriptive design requirements, or custom designs including seismic bracing.

Check anchorage and lateral bracing for equipment and piping. Add seismic straps for building frame to concrete foundation.

Based on age, and the critical need for reliable operation, electrical facilities should be considered for upgrade during the planning period including new service rated disconnect, replacement Motor Control Center, low voltage transformer, panelboard and Soft Starter. Vendor quotes for these elements were obtained and an allowance estimated for construction. A detailed electrical predesign is recommended to confirm condition and intended scope.

2.2 Booster Pump Stations

2.2.1 Intermediate Pump Station

The Intermediate Booster Pump Station was constructed in 1982 and is a CMU building with a wood-framed roof. The pump station is located near the Intermediate Reservoir. A single monorail is located above the two installed pumps. Structural drawings were not available for review.

The lights are mounted directly to the ceiling, and the electrical equipment is adjacent to the CMU walls. Lateral bracing for piping and equipment should be checked to verify adequate support for anticipated seismic forces. Walls should be checked to confirm sufficient shear capacity. A pachometer can be used to verify that the CMU walls have bond beams, vertical reinforcement at openings, and pier reinforcement.

Photos of the Intermediate Pump Station are provided below.

Seismic Evaluations and Upgrades:

CMU buildings constructed in this era would typically include anchorage of walls to foundations, include partially grouted cells, and may not include bond-beam construction. Modern design codes and design approaches would typically provide full cell grouting, bond beams at top and bottom of wall, over openings and at 48" (or closer) on center (or horizontal joint reinforcing).

Check anchorage and lateral bracing for equipment and piping. Using a pachometer, verify that CMU walls have bond beams, vertical reinforcement at openings, and pier and column reinforcement.

2.2.2 Garrison Pump Station

The Garrison Pump Station was constructed in 1983 and is adjacent to the Garrison Reservoir. The pump station building is 19 feet 4 inches by 23 feet 4 inches by approximately 10 feet high with CMU walls, a wood-framed roof, and an 8-inch-thick, reinforced concrete, slab-on-grade floor. The building has a 2-foot-6-inch by 8-foot-0-inch meal roof hatch located over the pumps, and the east wall includes a double door. The CMU walls were designed with horizontal bond beams and vertical reinforcement at 32 inches on center, including reinforcement at the building corners, and on each side of the door.

Lateral bracing for piping and equipment should be checked to verify adequate support for anticipated seismic forces. The wall with the double-door should be evaluated to confirm that it has sufficient shear capacity. Equipment mounted to the outside walls may also need additional bracing.

Photos of the Garrison Pump Station are provided below.

Seismic Evaluations and Upgrades:

CMU buildings constructed in this era would typically include anchorage of walls to foundations, include partially grouted cells, and may not include bond-beam construction. Modern design codes and design approaches would typically provide full cell grouting, bond beams at top and bottom of wall, over openings and at 48" (or closer) on center (or horizontal joint reinforcing).

Check anchorage and lateral bracing for equipment and piping. Evaluate CMU wall with double-door for adequate shear capacity.

2.2.3 Vista Pump Station (at Sorosis Site)

Three structures were evaluated to the Sorosis Reservoir site. The rooms at this facility are listed in Table 4.

Table 4. Vista Pump Station Rooms

Room Number*	Description
Room 100	Vista Pump Station
Room 200	Surge Tank Building
Room 300	Communications Building (Control House from original 1947 rectangular Sorosis No. 1 Reservoir)
Not applicable	Telecommunications Antennae Pole

*Room number assigned for this study.

Vista Pump Station is adjacent to the 3 million gallon (MG) American Water Works Association (AWWA) D100 steel Sorosis Reservoir No. 2, which was designed in 1953. The pump station building was built in approximately 2012 based on record drawings.. The building has CMU walls and a metal-framed roof, and a monorail that extends through the door on one side of the building. The monorail is laterally braced by the steel roof beams. Existing equipment, lights, transformers and tanks should be checked to ensure that they are properly braced for lateral loads.

A surge tank is located in a separate structure, which appears to be constructed of wood-framed walls and roof.

A legacy concrete structure houses safety and public works telecommunication equipment. The building is a combination of brick and concrete with a flat concrete roof. No design drawings are available for review and it is not known if the building could be strengthened to meet current seismic codes in a cost effective manner. Telecommunications antennae are mounted to a wood pole approximately 25 feet tall. The pole appears to be in good condition.

A small wood storage shed adjacent and to the south to the Communication Building was not evaluated.

Photos of the Vista Pump Station facilities are provided below.

Seismic Evaluations and Upgrades:

CMU buildings constructed in this era would typically include anchorage of walls to foundations, include partially grouted cells, and may not include bond-beam construction. Modern design codes and design approaches would typically provide full cell grouting, bond beams at top and bottom of wall, over openings and at 48" (or closer) on center (or horizontal joint reinforcing).

Check anchorage and lateral bracing for equipment and piping. Using a pachometer, verify that CMU walls have bond beams, vertical reinforcement at openings, and pier and column reinforcement.

2.3 Reservoirs

No new analyses of reservoirs were conducted during this master plan update, but a summary of a recent prior study is summarized herein. In 2014, a seismic assessment of four of the City's AWWA D100 carbon steel reservoirs was conducted, including:

- Garrison Reservoir (6 MG)
- Sorosis Reservoir (3 MG)
- Intermediate Reservoir (1 MG)
- Columbia View Reservoir (3 MG)

Vista Reservoir had recently been built at the time and was not evaluated as part of the study. The study provided similar recommendations to mitigate seismic damage for all four tanks. Some of these repairs have been completed, others underway, and others remain to be performed. These include:

- Lowering the overflow weir height to provide adequate freeboard for seismic sloshing.
- Not leaving the tanks empty if wind gusts exceeding 60 mph are expected.
- Installing additional support brackets on the interior of the tank shell to support the overflow pipes.
- Providing flexible movement joints for buried pipe connections.
- Replacing damaged grout beneath tank base plates below the tank shell, and above the concrete ringwall.

2.3.1 Garrison Reservoir

The Garrison Reservoir is a 6 MG AWWA D100 carbon steel tank fabricated in 1983. The reservoir has a 140-foot diameter and includes two 24-inch-diameter manways, an outside ladder, inside ladder and roof hatch. The overflow weir is 52 feet 0 inches from the floor plate, providing only 1 foot 0 inches of freeboard according to the design drawings provided by CRS Group Engineers.

The tank is self-anchored and the tank shell is supported by a 7-foot-0-inch-deep by 2-foot-0-inch-wide concrete ringwall.

Photos of the Garrison Reservoir are provided below.

2.3.2 Sorosis Reservoir

Sorosis Reservoir No. 1 has been abandoned. Sorosis Reservoir No. 2 is now simply referred to as "Sorosis Reservoir." Sorosis Reservoir was constructed in 1954 and is a 3 MG tank. It has a diameter of 133 feet, shell height of 28.75 feet, and is considered "self-anchored" (anchor chairs and anchor bolts are not required to resist overturning forces). Seismic upgrades were completed in 2017, in conjunction with a tank repainting project. The upgrades included lowering the height of the tank overflow, adding pipe supports for the overflow pipe, replacing damaged grout above the ringwall, and rotating the inlet pipe so that water is directed toward the tank center. The City also installed flexible joints on the inlet and outlet

pipes. Corrosion damage to the roof structure, which is of bolted construction, was discovered during blasting in preparation for repainting, and minor interim repairs were completed in 2020. Additional repairs were performed in 2024 to repair and restore structural capacity of the roof members and supports.

Photos of the Sorosis Reservoir are provided below.

2.3.3 Intermediate Reservoir

The Intermediate Reservoir is a 1 MG AWWA D100 steel tank fabricated in 1982. The reservoir has a shell height of 28 feet, a diameter of 78 feet, and two manways. A 12-inch-diameter overflow weir is set 12 inches below the top of the tank shell. The tank has a 30-inch square roof hatch, and exterior ladder with a safety cage. The overflow, inlet, and outlet pipes enter the tank through the tank floor. The tank foundation is an 18-inch-wide concrete ringwall, and the tank floor plate is underlain by 6 inches of oiled sand. The piping inside the tank is steel, which transitions to ductile iron below grade, outside of the tank footprint.

In addition to the seismic upgrades listed in Section 2.3, the 2014 Seismic Assessment report recommended removing tank anchor straps. The straps are 4-inch-wide steel plate, welded to the tank shell and embedded into the concrete ringwall at 12 feet 0 inch on center around the reservoir circumference. The straps are not adequate to serve as mechanically anchoring the tank and their embedment depth is unknown. An analysis for overturning showed that the tank would not uplift during a seismic event, and therefore the tank is considered to be self-anchored. Since the tank is not recommended to be left empty if the wind speed exceeds 60 mph, any chance of sliding is mitigated.

Photos of the Intermediate Reservoir are provided below.

2.3.4 Columbia View Reservoir

The Columbia View Reservoir is a 3 MG AWWA D100 steel tank fabricated in 1980. This site was not visited in the January 2023 site visit due to muddy access roads. The reservoir has a shell height of 31.2 feet, a diameter of 128 feet, and two, 36-inch-diameter manways. A 1-foot-0-inch-diameter overflow weir is set 3 feet 6 inches below the top of the tank shell based on improvements completed in 2017. The tank has two 30-inch square roof hatches, and an exterior ladder with a safety cage. The overflow, inlet, and outlet pipes enter the tank through the tank floor. The tank foundation is a concrete ringwall, and the tank floor plate is underlain by 6 inches of oiled sand. The piping inside the tank is steel, which transitions to ductile iron below grade, outside of the tank footprint. A control vault and CMU chlorination building are located at the same site.

Seismic upgrades were completed in 2017, in conjunction with a tank repainting project. The upgrades included lowering the height of the tank overflow, adding pipe supports for the overflow pipe, and replacing damaged grout above the ringwall. An analysis for overturning showed that the tank would not uplift during a seismic event, and therefore the tank is considered to be self-anchored. Since the tank is not recommended to be left empty if the wind speed exceeds 60 mph, any chance of sliding is mitigated.

Photos of the Columbia View Reservoir are provided below.

2.3.5 Vista Reservoir (named "Terminal Reservoir" on construction drawings)

Vista Reservoir is a 2.7 MG AWWA D100 steel tank fabricated in 2012. This site was not visited in the January 2023 site visit. The reservoir has a shell height of 40.0 feet, a diameter of 116 feet, two, 30-inch-diameter manways and a flush cleanout flanged opening. A 24-inch diameter overflow weir is set 4 feet 0 inch below the top of the tank shell and overflows into a 12-inch-diameter overflow pipe. The tank has one 39-inch square roof hatch, and an exterior ladder with a safety cage. The overflow, inlet/outlet pipes enter the tank through the tank floor. The tank foundation is a concrete ringwall, and the tank floor plate is underlain by 3 inches of asphalt over 6 inches of crushed rock. The piping inside the tank is steel, which transitions to ductile iron below grade, outside of the tank footprint.

The 2014 Seismic Assessment did not include Vista Reservoir as it had just been constructed recently.

2.4 Crow Dam Previous Studies and Recommendations

In 1996 the City performed seismic hazard evaluation, stability analysis, flood studies and spillway evaluation, dam break analysis, and dam raise feasibility evaluation for Crow Dam. Stability analyses indicated that the existing and raised dam have adequate static stability, including during rapid drawdown. The static and rapid drawdown stability analyses, though 27 years old, followed standards that are similar to current standards, and the conclusion of adequate stability is unlikely to change.

The seismic stability analyses indicated that the existing and raised dam would experience minor deformations, which would likely not cause severe damage to the dam. However, there have been updates to evaluating the seismic hazard in the region since 1996, including updates to the knowledge of the regional faults and the Cascadia Subduction Zone as well as the methods of analyses to evaluate seismic stability. A cursory review indicates that ground motions from the 1996 evaluation are similar to those that would currently be used, though the methods of analyses to evaluate deformations are outdated.

Flood studies performed indicate that the existing spillway can convey a 1,000 year flood event, and that the dam could overtop during a probable maximum flood with severe damage likely. Dam break analysis identified potential inundation of a "sudden dam failure on downstream developments." Typical spillway design considers the probable maximum flood (PMF); the study indicated that the 1,000 year flood was approximately 16% of the PMF. Though there have been updates to flood studies, it is unlikely that this level of exceedance would be improved to be closer to the PMF. Recommendations from the evaluation included:

- Construct spillway improvements even without a dam raise to bring the spillway capacity to 50% of the PMF.
- Spillway improvements to be considered in a project that raised the dam, with the spillway to pass 50 to 100% of the PMF.

- Prepare Emergency Action Plan (EAP).
- Perform dam inspection after all major natural events (e.g., earthquake, flood).
- Provide of additional topographic mapping to inform reservoir storage volumes under a dam raise.
- Perform Intake slide gate repair/replacement.

It is recommended that the seismic and flood studies be updated to be consistent with current practice. These studies should be performed using a phased approach, where initial analyses are conducted as a screening exercise to confirm adequate or unacceptable performance, and document data needs for more in-depth analyses should it be determined that the dam has an unacceptable performance. The initial screening level analyses are estimated to cost approximately $150,000 to $200,000, assuming the work includes a desktop study and site visit, without additional field data collection (e.g., geotechnical borings). The second phase cost will depend on the conclusions of the first phase evaluation, and are therefore not provided.

If an EAP has not been developed, it is recommended that this be developed considering that the dam is classified as high hazard. It is estimated that developing an EAP would cost approximately $150,000 to $200,000, depending on the applicability of current flood modeling and emergency response planning.

It is understood that the intake slide gate has been repaired/replaced. Maintaining operable conditions is important to allow for safe inspection and operation of the dam.

Construction costs estimates from the 1996 study for a dam raise, and modifications to the spillway are not considered or updated here. Spillway modification without raising the dam was estimated at $2 million in 1996 dollars, and a dam raise of 35 feet was estimated as $6.9 million in 1996 dollars. It is likely that construction costs would significantly exceed even escalated estimates, because of environmental and permitting requirements and conditions. Updated estimates for these facilities is beyond the scope of this study.

Photos of Crow Dam and Reservoir are provided below.

3. Recommendations for Maintenance Activities

Annual inspections of building envelopes is good practice for maintaining facilities in good condition. Following significant snow/ice/wind events, additional inspections should also be performed. The following inspection activities are recommended:

- Metal siding – inspect for corrosion, water intrusion, and failure of external fasteners.
- Wood frame buildings – inspect for water damage, loose fasteners.

- Insulation – where visible, inspect for deterioration and damage.
- Doors and windows – inspect for proper function, and damage.
- Hardware – inspect for proper function and corrosion.
- Sealants (windows, ducts, doors) – inspect for proper placement, function, and condition.
- Heating, ventilation, and air conditioning (HVAC) – inspect for proper function.

Capital improvements are recommended to improve resilience against wildfire. Specific improvements are recommended as follows:

- Provide 1/8-inch metal intake screens at all HVAC intakes and passive vents to prevent embers from entering building, and to prevent pest intrusion.
- Roofing materials: Replace all roofs with Class A ASTM E108 or UL 790 materials and systems.
- Exterior wall covering (siding) replacement: Replace combustible siding and trim with noncombustible siding and trim (cement fiber board).
- Soffits and eves. Enclose soffits with noncombustible materials.
- Windows and Skylights. Best practices include retrofit of existing windows with tempered, multi-layered, or fire resistant rated glass to prevent ember intrusion if glass would otherwise break when exposed to fire.
- Walking surfaces: All surfaces are noncombustible. No work recommended.
- Gutters: provide gutter guards to prevent accumulation of leaves, needles, and debris.
- Painting: Cement fiber board products are often factory painted. Repainting as an asset management activity every 15 to 20 years is a reasonable duration for planning purposes.

Planning and Design:

These proposed improvements are largely architectural and so the City should plan to engage a qualified architect (that would engage a structural engineer as required) to evaluate each site and develop site-specific designs to address these recommendations. The budgets developed below assume all design and construction work is performed in a single professional services contract. Breaking the project across multiple years will cost more due to reduction in efficiencies. The City could still decide to prioritize improvements if required by budget constraints.

Prioritization and timing of improvements

Completion of recommendations from the 2014 reservoir seismic improvement study are a high priority and should be implemented as soon as practical, and early in the first 5 years of the CIP.

Pump station and well architectural improvements are mostly based on good practices for resilient facilities and specifically intended to reduce risk of damage due to wildfire. The City may be eligible for grant funding to address some or all of these resilience based needs, so it is recommended to investigate and apply for such funding early in the 20 year CIP, and proceed with immediate implementation if grant funding is available. Otherwise, it is recommended to start planning and design in the first 5 years of the CIP, and implement in accordance with other priorities.

Electrical recommendations at pump stations and wells should be reviewed by the City's contract electrician for endorsement. These electrical improvements may also be considered for improved resilience if equipment is at end of service life, and should be included in any applications for grants based on utility resilience. Equipment is not necessarily in need of replacement because it's old – for example the original well pump motors that were reportedly recently re-wound should have a long service life and may be of higher quality and durability than newer motors if they are regularly tested in accordance with

industry standards. Electrical sub-components (such as relays, and switches) are relatively low cost and spare parts are easy to maintain in supply. The City should review and update its spare parts inventory for critical spares across all facilities and equipment.

The Crow Dam seismic and flood studies should be performed within the 5 year CIP to set the basis for future improvements. The EAP should be completed, if not already complete.

4. Recommendations for Future Seismic Evaluation, Structural Rehabilitation and Other Improvements

Recommendations for future seismic evaluation, structural rehabilitation, and other improvements are shown in Table 5 with cost estimates.

Table 5. Recommended Studies or Improvements Cost Estimates

Item	Description of Additional Study or Improvements	Construction Cost*
Buildings- Wells		
Lone Pine	Planning and design Construction	$127,000 $470,000
Jordan	Planning and design Construction	$94,000 $349,000
Marks	Planning and design Construction	$60,000 $224,000
Buildings-Booster Pump Stations		
Intermediate	Planning and design Construction	$27,000 $100,000
Garrison	Planning and design Construction	$51,000 $188,000
Vista	Planning and design Construction	$23,000 $84,000
	Subtotal- Buildings	$1,797,000
Reservoirs		
Garrison	Planning and design Construction	$66,000 $243,000
Intermediate	Planning and design Construction	$56,000 $206,000
Columbia View	Planning and design Construction	$43,000 $160,000
Sorosis	Planning and design Construction	$0 $0
Vista	Planning and design Construction	$0 $0
	Subtotal – Reservoirs	$774,000
Crow Dam		
	Update seismic evaluation Prepare/update Emergency Action Plan	$225,000 $200,000
	Subtotal – Crow Dam	$425,000

*Association for the Advancement of Cost Estimating Class 5 planning level estimates with an accuracy range of +100%/-50%.

Attachment 1
2014 Reservoir Seismic Assessment (CH2M, 2014)

Final Report

Steel Tank Seismic Evaluation

Prepared for

The Dalles, Oregon

December 2014

Prepared by

CH2MHILL®

1100 NE Circle Blvd.
Suite 300
Corvallis, Or 97330

Final Report

Steel Tank Seismic Evaluation

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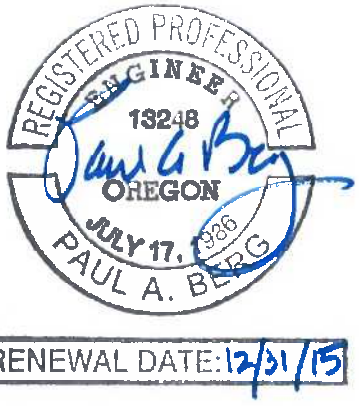

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Executive Summary

Introduction

The project consisted of a seismic condition assessment of four of the City's drinking water storage tanks (reservoirs). All four are constructed of welded steel and were designed and built prior to modern seismic design codes. The assessment was conducted using available design drawings and site information, and observations made during a site visit. The four tanks included in this investigation were the following:

- Garrison Reservoir (6 million gallons)
- Sorosis Reservoir (3 million gallons)
- Columbia View Reservoir (3 million gallons)
- Intermediate Reservoir (1 million gallons)

Summary of Findings

The findings for the four tanks were similar. It was concluded that neither ringwall improvements nor the addition of anchor chairs are necessary to address seismic stability concerns. However, to improve the likelihood of the tanks remaining in service following an earthquake, the following mitigation measures are recommended:

- Consider reducing the maximum operating water levels in the tanks to minimize the risk of damage and failures caused by seismic slosh waves. This item warrants further discussion with the City as it reduces the City's available storage volume. Lowering the maximum operating level in a tank represents a trade-off between storing a greater volume of water, which provides more supply during emergencies, and the risk of incurring damage and possibly losing the service of a reservoir following an earthquake.
- Do not leave the reservoirs empty during high wind times, a mitigation measure that the City has been implementing in recent years.
- For the Columbia View and Intermediate Reservoirs, remove the existing anchor straps and repair the foundations. The removal of the anchor straps will reduce the ongoing damage to the concrete ringwalls from the shallow embedment of the straps.
- Improve the overflow pipe to side wall connections. The breakage of the overflow pipe, especially if it occurred near the floor of a tank, could render the tank unusable following an earthquake.
- Add flexibility to the buried pipe connections outside of the tanks to allow for differential movement between the tanks and the buried piping. Breaks in the inlet/outlet pipes to the tanks would take them out of service until repairs could be made.

Limited geotechnical and structural design data were available for use in the analyses. The above findings and recommendations were based on what CH2M HILL believes are conservative assumptions for geotechnical site conditions.

CH2M HILL's interpretation of the Oregon Structural Specialty code is that site-specific geotechnical investigations are not required for modifying the overflow pipe supports, adding flexibility to the connecting pipelines, and removing the anchor straps. The code chapter on Existing Buildings and Structures states that alterations to existing structures do not trigger a site-specific geotechnical investigation provided that the altered structure is no less conforming to the code than it was prior to the alteration. That would be true for implementing these improvements to the tanks, even if the maximum operating water levels are not lowered.

However, although the intent was to use conservative geotechnical values, the actual conditions may be more or less favorable than the assumed values. CH2M HILL recommends that the City collect additional

geotechnical data to confirm the assumptions for the tanks as part of the final design effort. The collection of additional geotechnical data could be especially valuable if it is found that the conditions are more favorable than assumed and the maximum operating water level does not need to be lowered as much as recommended in this report. The data collection could be as simple as excavating test pits within the vicinity of the foundations to determine whether the foundations are on bedrock or soil.

Seismic Site Class D was assumed for all sites given the minimal project site-specific geotechnical information. If it is confirmed that the foundation(s) are on bedrock, Site Class C could be assumed. Further site work, including collection of site-specific shear wave velocity measurements, would be required to conclude that Site Class B is appropriate.

Project Team

The following CH2M HILL staff were the primary engineers for the project:

Kevin Whittier, Structural Engineer
Nason McCullough, Geotechnical Engineer
Paul Berg, Civil Engineer and Project Manager

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SECTION 1

Analysis Approach

1.1 Site-Specific Geotechnical Information

Limited site-specific geotechnical information was available for the reservoirs. The following geotechnical information was obtained and used for this evaluation:

- **Garrison Reservoir:** no data were available.
- **Sorosis Reservoir:** One boring was advanced to a depth of about 20 feet in the vicinity of the reservoir as part of a 2009 design of a new pump station adjacent to the reservoir.[1] The boring log indicates 6.8 feet of sandy fill underlain by 6.0 feet of silty (native topsoil), underlain by the regional bedrock formation denoted as the Chenoweth Formation, The Dalles geologic group, a weakly cemented volcanoclastic sandstone.
- **Columbia View Reservoir:** Four test holes (borings) were included on the 1978 design drawings. They indicate 1.5 feet of topsoil, underlain by 3.5 to 9.5 feet or more of sandy clay, underlain by sand. The three test holes had a maximum explored depth of 11.0 feet. No engineering data were included on the logs.
- **Intermediate Reservoir**: no data were available.

Only the recent 2009 boring at the Sorosis Reservoir provided subsurface information for the bedrock formation in the area. However, at all the reservoir sites there was indication that the Chenoweth Formation is relatively shallow given the presence of a weakly cemented sandstone in the cut slopes. Figure 1 shows two examples of the sandstone from the October 2014 site visit.

FIGURE 1
Examples of the Sandstone from the October 2014 Site Visit

Shannon & Wilson (2009) reported in their evaluation of the new Sorosis Pump Station that given the weak sandstone encountered in the boring, the site would classify as Site Class C per the 2006 International Building Code (IBC) for seismic site classification.

[1] Shannon & Wilson. 2009. Geo*technical Data and Design Report, New Terminal Reservoir, The Dalles, Oregon*. Submitted to Kennedy/Jenkins Consultants. June 12, 2009.

1.2 Seismic Ground Motions

Seismic ground motions are dependent on the motions at bedrock (or "firm ground") beneath as well as the site-specific soil properties. The bedrock motions are based on regional tectonic features, with the ground motions largely dependent on the magnitude and distance of probable earthquake sources (e.g., from active seismic faults, volcanic activity, or tectonic plate boundaries). The bedrock motions can be determined from site-specific hazard studies or the results or the nationwide seismic hazard mapping performed by the United States Geological Survey (USGS). For this preliminary evaluation, the 2008 USGS[2] data were used, which is the input for the current revision of the International Building Code (2012 IBC)[3] used by the Oregon Structural Specialty Code (2014 OSSC).[4] The bedrock ground motion parameters for short-period motions (S_S) and long-period motions (S_1) were estimated for each reservoir site and are included in Table 1.

TABLE 1
Bedrock Ground Motions Parameters (per 2010 USGS)

Parameter	Garrison	Sorosis	Intermediate	Columbia View
S_S	0.49	0.49	0.48	0.48
S_1	0.22	0.22	0.22	0.22

To determine the ground surface motions for the structural evaluation and assessment of geotechnical seismic hazards, the effect of the soil column needs to be considered. This involves using either site-specific site-response analyses or simplified coefficient-based methods. For structures governed by the IBC, the simplified site-response can be determined using Site Class coefficients that are based on simplified site properties. The IBC Site Classes A through F are defined as follows:

- **Site Class A**: Hard rock (shear wave velocity measurement of 5,000 feet per second or larger)
- **Site Class B**: Rock (shear wave velocity measurement of 2,500 to 5,000 feet per second)
- **Site Class C**: Very dense soil and soft rock (foundation classified as bedrock, or measured shear wave velocity of 1,200 to 2,500 feet per second)
- **Site Class D**: Stiff soil (default class without site-specific information; shear wave velocity of 600 to 1,200 feet per second)
- **Site Class E**: Soft clay soil (shear wave velocity of less than 600 feet per second)
- **Site Class F**: Soils requiring site response analysis

Based on the 2009 Shannon & Wilson report and site observations, it is anticipated that all four reservoirs would likely classify as Site Class C, although they may alternatively classify as Site Class D (poorer soil conditions than Site Class C) or B (better soil conditions than Site Class C) depending on the depth to the bedrock formation, and the site-specific stiffness of the sandstone bedrock and overlying soil. Note that where soil properties are not known in sufficient detail to determine site class, the IBC/OSSC states that Site Class D shall be used unless the Building Official or available geotechnical data determines Site Class E or F soils are present at the site.

Given the uncertainty about whether the foundations are founded on bedrock or not, Site Class D was used for the evaluation of all reservoirs. Using Site Class D is relatively conservative because it is likely that the

[2] Peterson et al. 2008. *Documentation for the 2008 Update of the United States National Seismic Hazard Maps.* United States Geological Survey (USGS). Open File Report 2008-1128.

[3] International Code Council. 2012. *2012 International Building Code.*

[4] State of Oregon. 2014. *Oregon Structural Specialty Code (OSSC).*

reservoirs would classify as Site Class C if the foundations are confirmed to be founded on the sandstone bedrock, or possibly Site Class B if the shear wave velocity is measured to be 2,500 feet per second or higher (e.g., the sandstone is very dense or the reservoir is founded on basalt, which may be the case for the Intermediate Reservoir). Note that Site Class B can only be used if shear wave velocity measurements are collected. Site Class C can be used if it is determined that the foundation is on bedrock (either sandstone or basalt).

Test pits could be excavated with a backhoe or trackhoe from the City, with observations by a geotechnical engineer to log the test pits and confirm the conditions. Shear wave velocity measurements would be collected by a specialty firm, with costs typically around $5,000 per reservoir location, and should include observation and direction by a geotechnical engineer.

The ground surface design seismic values for the structural evaluation are summarized in Table 2 for Site Classes B, C, and D. Note that given the relatively close proximity of the reservoirs to one another, the values are very similar for the four reservoirs.

TABLE 2
Ground Surface Ground Motions Parameters (per 2012 IBC)

Site Class	Parameter	Garrison	Sorosis	Intermediate	Columbia View
B	F_a	1.00	1.00	1.00	1.00
	F_v	1.00	1.00	1.00	1.00
	S_{MS}	0.49	0.49	0.48	0.48
	S_{M1}	0.22	0.22	0.22	0.22
	S_{DS}	0.33	0.32	0.32	0.32
	S_{D1}	0.15	0.15	0.15	0.15
C	F_a	1.20	1.20	1.20	1.20
	F_v	1.58	1.58	1.58	1.58
	S_{MS}	0.59	0.58	0.57	0.57
	S_{M1}	0.35	0.35	0.34	0.34
	S_{DS}	0.39	0.39	0.38	0.38
	S_{D1}	0.23	0.23	0.23	0.23
D	F_a	1.41	1.41	1.42	1.42
	F_v	1.96	1.96	1.97	1.97
	S_{MS}	0.69	0.69	0.68	0.68
	S_{M1}	0.44	0.43	0.43	0.43
	S_{DS}	0.46	0.46	0.45	0.45
	S_{D1}	0.29	0.29	0.29	0.28

For the purpose of this analysis it was assumed the sites would be classified as Site Class D. However, additional geotechnical investigation may determine that Site Class B or C is more applicable.

1.3 Other Geotechnical Seismic Hazards

In addition to the ground shaking, other geotechnical seismic hazards are to be considered in a seismic hazard evaluation, including fault rupture, liquefaction, and seismic slope instability. There are no known faults that cross within the vicinity of the reservoir sites. The probability of an unknown fault rupturing at a reservoir is considered minimal. The potential for liquefaction is considered minimal for all four reservoir sites, given that liquefaction only occurs in saturated soils and the groundwater table for all four reservoirs is noted to be relatively deep. The potential for slope instability is based on the steepness of adjacent slopes, as well as the strength of the slope material. The potential for slope instability is discussed for each reservoir.

1.4 Structural Design Codes and Assumptions

The nationally accepted design standard for the design and construction of welded steel water storage tanks is American Water Works Association (AWWA) D100-11 Welded Carbon Steel Tanks for Water Storage. The seismic evaluation of the tanks was performed in accordance with the AWWA D100-11 standard, the OSSC, and the 2012 IBC, with the following assumptions:

- As noted previously, the site class is intended to account for the effect of local soil conditions on the ground motion. Since the soil properties are not known in sufficient detail, the analysis was performed assuming Site Class D.
- The IBC requires that buildings and other structures be classified based on risk to human life, health, and welfare associated with their damage or failure by nature of their occupancy or use. For this analysis, the tanks were classified as Risk Category IV and Seismic Use Group III since the tanks provide direct services to facilities that are deemed essential for post-earthquake recovery and are essential to the life, health, and safety of the public, including post-earthquake fire suppression.

SECTION 2

Garrison Reservoir

2.1 Tank Information

Year Constructed:	1983
Volume:	6 million gallons
Diameter:	140 feet
Height:	53 feet
Water Depth:	52 feet
Tank Anchorage:	Self-anchored (no anchors from tank shell to the foundation)

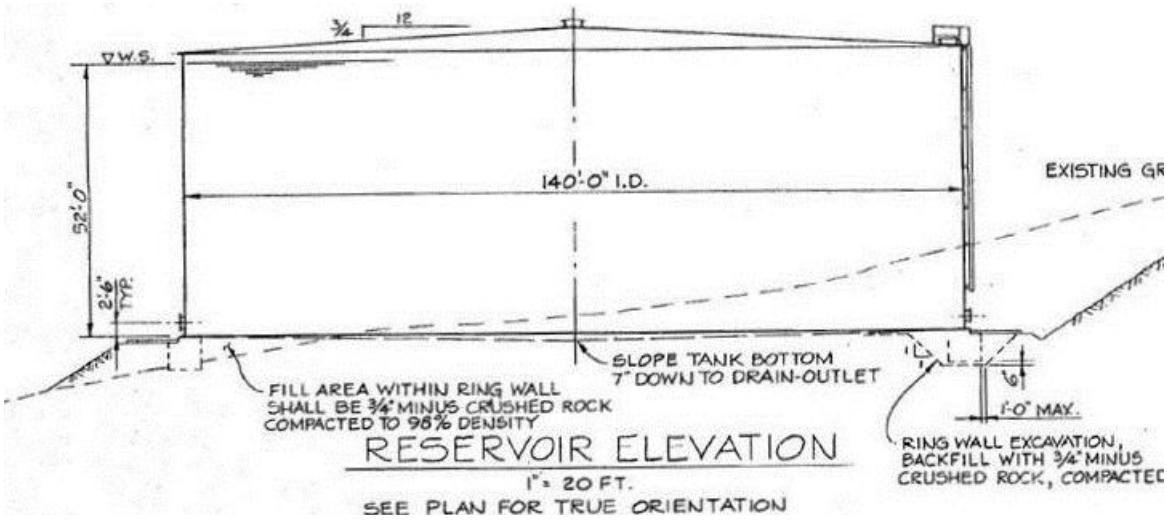

FIGURE 2
Garrison Reservoir Cross Section

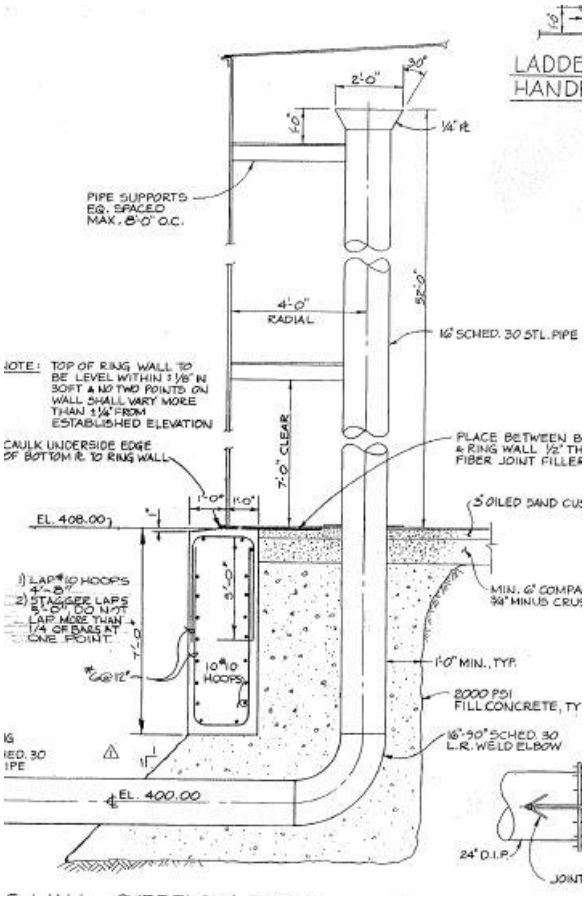

FIGURE 3
Garrison Reservoir Overflow and Ringwall Footing

2.2 Results of Analysis Based on Seismic Risk

2.2.1 General

The following information was available and was used in the analysis:

- Original design drawings which included
  - Tank geometry
  - Foundation design
- Original tank fabrication (shop) drawings which included
  - Tank shell, roof plate and floor plate thickness
  - General fabrication details

Based on the information shown in the shop drawings, the bottom two courses of the tank are undersized for hydrostatic loads by 0.05 inches thickness, per the requirements of AWWA D100-11. This is not significant enough to require modifications. The slight deficiency is eliminated if the water depth is lowered to address the seismic slosh requirements noted later in this report. However, even if the operating level is not lowered, the slight deficiency in wall thickness does not warrant mitigation.

2.2.2 Foundation Conditions

The native soil visible in the cut-slope adjacent to the tank indicated sandy soils with intact weakly cemented sandstone, possibly the Chenoweth Formation. Based on the deep ring-wall footings for the reservoir, it is likely that the reservoir foundation is on, or close to, the sandstone bedrock formation. However, none of the current documents indicate that the foundations are on bedrock, and therefore Site Class D was assumed. Given the presence of the sandstone in the uphill cut slope, and no evidence of current slope instability, seismic slope instability is considered a minimal hazard for this reservoir.

2.2.3 Overturning

Tank stability was checked using AWWA D100-11 equation 13-36 which calculates the overturning ratio J. The value of the overturning ratio was then compared against the following AWWA criteria for tank stability:

- $J < 0.785$, No shell uplift because of overturning, tank is adequate as self-anchored
- $0.785 < J < 1.54$, Shell uplift occurs, but the tank is stable provided shell compression requirements are satisfied
- $J > 1.54$, Tank is not stable as self-anchored, anchor bolts are required

Assuming the site is classified as Site Class D, the overturning ratio J for Garrison Reservoir is 1.108. Based on the criteria noted above, in a design seismic event the tank will experience some uplift, however the tank is stable under seismic loads and does not require anchor bolts. Since shell uplift occurs, there is an additional check required to confirm shell compression does not exceed the allowable compression. For Site Class D, the maximum shell compression stress under the design seismic event is 926 psi which is less than the allowable shell compression stress of 2,301 psi.

It is possible that a site specific geotechnical analysis would determine the site could be classified as Site Class B or C. The overturning ratios for Site Classes B, C and D are presented in Table 3.

TABLE 3
Garrison Reservoir Tank Stability

Seismic Site Class	Overturning Ratio J	Tank Stability	Shell Compression Requirements Satisfied
B	0.758	No shell uplift because of overturning, tank is self-anchored	N/A
C	0.935	Shell uplift, but the tank is stable provided shell compression requirements are satisfied	Yes
D	1.108	Shell uplift, but the tank is stable provided shell compression requirements are satisfied.	Yes

2.2.4 Slosh Height

There is currently 1.5 feet of freeboard from the top of the tank overflow to the underside of the roof structure. Assuming Site Class D, the design slosh wave height is 4.2 feet. It would be necessary to reduce the water depth by approximately 3 feet to protect against possible slosh damage to the roof. However, it is possible that a site specific geotechnical analysis would determine the site could be classified as Site Class B or C thereby lowering the expected slosh wave height. The slosh wave height for each seismic site class is presented in Table 4.

TABLE 4
Garrison Reservoir Slosh Wave Height

Seismic Site Class	Slosh Wave Height (feet)	Reduction Required to Water Depth (feet)	Corresponding Decrease in Volume (gallons)
B	2.1	1.1	127,000
C	3.4	2.4	276,000
D	4.2	3.2	368,000

2.2.5 Pipe Connections

AWWA D100 requires the design of piping connected to the tank take into consideration the potential movement of the connection points during earthquakes and requires the connections to provide sufficient flexibility to avoid the release of the tank contents because of failure of the piping system. The requirements for self-anchored tanks are presented in Table 5. Based on the information available in the design drawings, none of the piping connections at Garrison Reservoir allow the movement required by these provisions.

TABLE 5
Garrison Reservoir Minimum Design Displacements for Piping Attachments (AWWA D100-11 Table 30)

Condition	Design Displacement (inches)
Upward vertical displacement relative to support or foundation when J > 0.785	4.0
Downward vertical displacement relative to support or foundation when the tank is supported by a ringwall or mat foundation	0.5
Horizontal displacement (radial and tangential) relative to support or foundation	2.0

The design drawings show overflow pipe supports located at a maximum 8 feet on center. However, the overflow pipe supports are not detailed in the steel shop drawings so it was not possible to determine if the existing overflow pipe supports are adequate for the design seismic sloshing loads.

2.3 Recommendations to Mitigate Seismic Risks

CH2M HILL recommends the following actions to reduce seismic risks for the Garrison Reservoir:

- Reduce maximum depth of water storage (either by lowering overflow rim level or adjusting SCADA to limit maximum water surface to a lower level).
- Do not leave the reservoir empty during high wind events (when wind gusts over 60 miles per hour are anticipated).
- Improve the supports for the overflow pipe to the tank wall.
- Install movement joints on buried pipe connections located just outside of the ringwall.

It may be possible to reduce the seismic loading for design if site-specific information is collected that indicates Site Class C or B may be used. Site Class C could be confirmed if the foundation is founded on bedrock; Site Class B would require shear wave velocity measurements of 2,500 feet per second or larger.

2.4 General Observations

This scope of this study did not include a comprehensive condition assessment of the reservoirs. However, during the site visit, various items were observed that should be further investigated and repaired. The following is a brief summary of those items which were observed.

2.4.1 Base of Tank Shell at the Concrete Foundation

The grout at the base of the tank has eroded in some locations (see Figure 4). It appeared the original cementitious grout that was installed was repaired with flexible sealant at various locations. It is recommended that the flexible sealant be removed and the base ring grout be repaired to prevent water from migrating under the tank floor. Water under the floor could result in corrosion or freeze thaw damage from ice.

FIGURE 4
Garrison Reservoir Base of Tank Shell at Foundation

2.4.2 Interior Paint

The interior of the reservoir was only observed through the roof hatch. From this limited view it was evident that the interior paint is failing and leading to corrosion (see Figures 5 and 6).

FIGURE 5
Garrison Reservoir Overflow

FIGURE 6
Garrison Reservoir Underside of Roof Plate (looking through roof hatch)

SECTION 3

Sorosis Reservoir

3.1 Tank Information

Year Constructed:	1954
Volume:	3 million gallons
Diameter:	133 feet
Height:	28.75 feet
Water Depth:	28.00 feet
Tank Anchorage:	Self-anchored (no anchors from tank shell to the foundation)

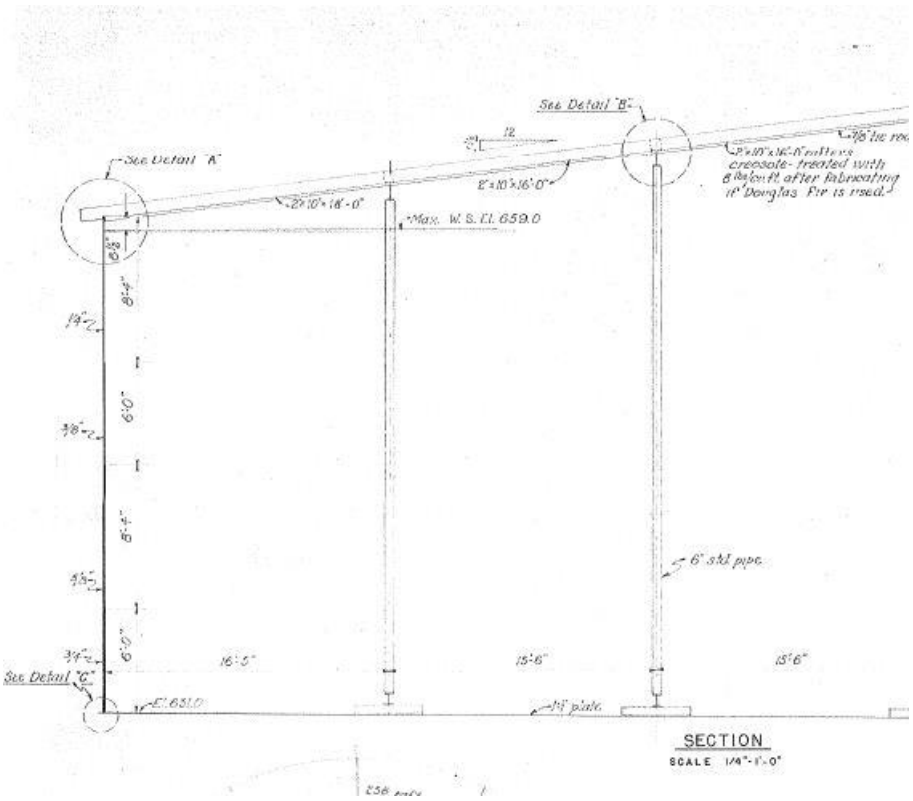

FIGURE 7
Sorosis Reservoir Cross Section

3.2 Results of Analysis Based on Seismic Risk

3.2.1 General

The following information was available and used in the analysis:

- Original design drawings which included the following
  - Tank geometry
  - Shell and floor plate thickness
  - Foundation design

Based on the information shown in the original design drawings, the original roof was constructed from wood rafters and 1-inch shiplap roof decking, which was covered by composition roofing. It is unknown if the tank was constructed as shown in the design drawings and the wood roof was later replaced with a steel roof or if the roof shown on the drawings was replaced by a steel roof in the original construction.

The perimeter foundation shown in the original design drawings is a 5 foot wide by 6 inch thick ringwall footing. This is an unconventional foundation as tanks of this size are typically constructed on deeper ring walls; however no foundation distress was observed during the site visit.

3.2.2 Foundation Conditions

The native soil visible in the cut-slope adjacent to the tank indicated sandy soils with intact weakly cemented sandstone, possibly the Chenoweth Formation. This is confirmed with the single boring obtained in 2009 by Shannon & Wilson for the new pump station on the opposite side of the reservoir from the visible cut slope. It is unclear if the relatively shallow tank foundation is founded on the sandstone or fill soil; therefore, Site Class D was assumed for these analyses.

Given the presence of the sandstone in the uphill cut slope, and no evidence of current slope instability, seismic slope instability is considered a minimal hazard for this reservoir. There may be some localized rock-fall and/or slope instability because of the very steep cut slope (almost vertical) on the uphill side of the reservoir. However, it is unlikely that instability of this cut slope would damage the reservoir; it is likely to only hinder access around the reservoir until the debris is removed.

3.2.3 Overturning

Tank stability was checked using AWWA D100-11 equation 13-36 which calculates the overturning ratio J. The value of the overturning ratio was then compared against the following AWWA criteria for tank stability:

- J < 0.785, No shell uplift because of overturning, tank is adequate as self-anchored
- 0.785 < J < 1.54, Shell uplift occurs, but the tank is stable provided shell compression requirements are satisfied
- J > 1.54, Tank is not stable as self-anchored, anchor bolts are required

Assuming the site is classified as Site Class D, the overturning ratio J for Sorosis Reservoir is 0.370. Based on the criteria noted above, in a design seismic event the tank will not experience uplift, is stable under seismic loads and does not require anchor bolts.

It is possible that a site specific geotechnical analysis would determine the site could be classified as Site Class B or C. The overturning ratios for Site Classes B, C, and D are presented in Table 6.

TABLE 6
Sorosis Reservoir Tank Stability

Seismic Site Class	Overturning Ratio J	Tank Stability	Shell Compression Requirements Satisfied
B	0.243	No shell uplift because of overturning, tank is self-anchored	N/A
C	0.310	No shell uplift because of overturning, tank is self-anchored	N/A
D	0.370	No shell uplift because of overturning, tank is self-anchored	N/A

3.2.4 Slosh Height

There is currently 8.5 inches of freeboard from the top of the tank overflow to the underside of the roof structure. Assuming Site Class D, the design slosh wave height is 3.5 feet. It would be necessary to reduce the water depth by 2.8 feet to protect against damage to the roof from a slosh wave. It is possible that a site specific geotechnical analysis would determine the site could be classified as Site Class B or C thereby lowering the expected slosh wave height. The slosh wave height for each seismic site class is presented in Table 7.

TABLE 7
Sorosis Reservoir Slosh Wave Height

Seismic Site Class	Slosh Wave Height (feet)	Reduction Required to Overflow (feet)	Corresponding Decrease in Volume (gallons)
B	1.8	1.1	113,000
C	2.8	2.1	222,000
D	3.5	2.8	292,000

3.2.5 Pipe Connections

AWWA D100 requires the design of piping connected to the tank take into consideration the potential movement of the connection points during earthquakes and requires the connections to provide sufficient flexibility to avoid the release of the tank contents because of failure of the piping system. The requirements for self-anchored tanks are presented in Table 8. Based on the information available in the design drawings none of the piping connections at Sorosis Reservoir allow the movement required by these provisions.

TABLE 8
Sorosis Reservoir Minimum Design Displacements for Piping Attachments (AWWA D100-11 Table 30)

Condition	Design Displacement (Inches)
Upward vertical displacement relative to support or foundation when J< 0.785	1.0
Downward vertical displacement relative to support or foundation when the tank is supported by a ringwall or mat foundation	0.5
Horizontal displacement (radial and tangential) relative to support or foundation	2.0

The overflow pipe supports are not detailed in the design drawings so it was not possible to determine if the existing overflow pipe supports are adequate for the design seismic sloshing loads.

3.3 Recommendations to Mitigate Seismic Risks

CH2M HILL recommends the following actions to reduce seismic risks for the Sorosis Reservoir:

- Reduce maximum depth of water storage (either by lowering overflow rim level or adjusting SCADA to limit maximum water surface to a lower level)
- Do not leave the reservoir empty during high wind events (when wind gusts over 60 miles per hour are anticipated).
- Improve the supports for the overflow pipe to the tank wall
- Install movement joints on buried pipe connections located just outside of ringwall

It may be possible to reduce the seismic loading for design if site-specific information is collected that indicates Site Class C or B may be used. Site Class C could be confirmed if the foundation is founded on bedrock; Site Class B would require shear wave velocity measurements of 2,500 feet per second or larger.

3.4 General Observations

This scope of this study did not include a comprehensive condition assessment of the reservoirs. However, during the site visit, various items were observed that should be further investigated and repaired. The following is a brief summary of those items which were observed.

3.4.1 Base of Tank Shell at the Concrete Foundation

In some places the grout at the base of the tank has eroded (see Figure 8 below). In some places it appeared the original cementitious grout that was installed was repaired with flexible sealant. It is recommended that the flexible sealant be removed and the base ring grout be repaired to prevent water from migrating under the tank floor. Water under the floor could result in corrosion or freeze thaw damage from ice.

FIGURE 8
Sorosis Reservoir Base of Tank Shell at Foundation

3.4.2 Interior Paint

The interior of the reservoir was only observed through the roof hatch. However, from this limited view it is evident that the interior paint is failing and leading to corrosion (See Figures 9 and 10).

FIGURE 9
Sorosis Reservoir Roof Beam and Roof Plate (looking through roof hatch)

FIGURE 10
Sorosis Reservoir Roof Beam and Roof Plate (looking through roof hatch)

SECTION 4

Columbia View Reservoir

4.1 Tank Information

Year Constructed:	1980
Volume:	3 million gallons
Diameter:	128 feet
Height:	31 feet
Tank Anchorage:	Self-anchored (no structural anchors from tank shell to the foundation)*

* The existing straps (located at approximately 20 feet on center around the circumference of the tank) that are welded to the tank and embedded into the concrete ringwall are not adequate for the tank to be designated as a mechanically anchored tank.

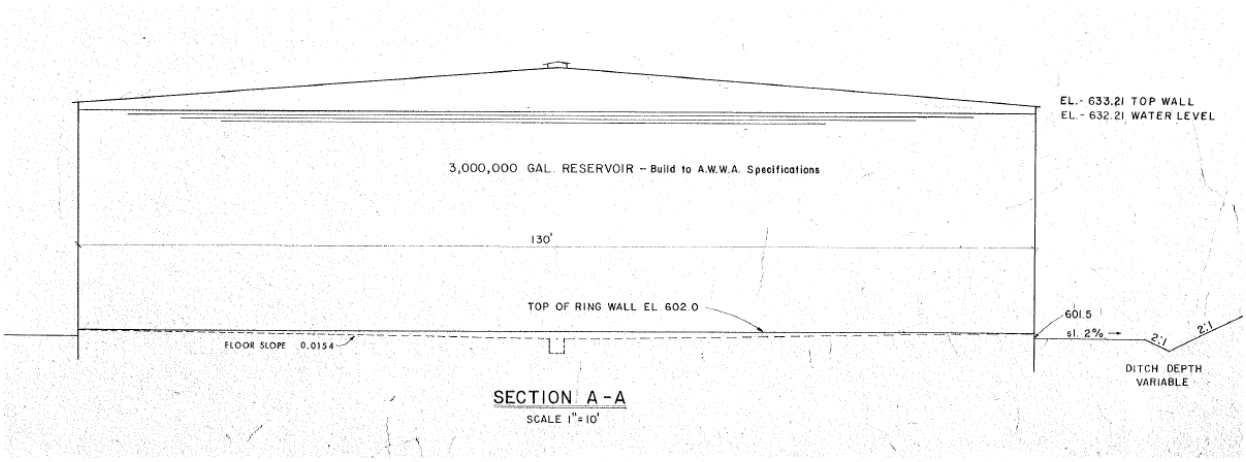

FIGURE 11
Columbia Reservoir Cross Section

4.2 Results of Analysis Based on Seismic Risk

4.2.1 General

The following information was available and used in the analysis:

- Original design drawings which included the following
  - Tank geometry
  - Schematic details for piping and other tank appurtenances
  - Schematic ringwall foundation design

The information in the design drawings does not provide any information on the thickness of the wall, floor or roof plates. The following assumptions were used for the purpose of this analysis:

- Shell wall thickness
  - Top two courses are ¼ inch thick
  - The bottom two courses are the thickness required to resist hydrostatic loads
- Floor plate thickness
  - ¼ inch

Although the original drawings do not show any details for a connection between the tank and the foundation, anchor straps are located at approximately 20 feet on center around the circumference of the tank. The straps are 4-inch wide steel plates that are welded to the tank shell and are embedded into the concrete foundation. Since no details were available for this connection it is unknown how deep the straps are embedded in the concrete. The concrete around the straps has spalled in multiple locations (see Figure 13). As noted in the following section, the tank meets the current code requirements for a self-anchored tank so the purpose of these straps is not known. Further investigation would be necessary to determine if the spalling is because of thermal expansion of an empty tank, or if the spalling is because of movement of an empty tank because of wind loads. It is likely that simply repairing the spalled concrete around the straps would eventually result in the repairs spalling in the same manner.

4.2.2 Foundation Conditions

The native soil visible in the cut-slope adjacent to the tank indicated sandy soils with intact weakly cemented sandstone, possibly the Chenoweth Formation. However, four test holes (borings) were included on the 1978 design drawings that indicate 1.5 feet of topsoil, underlain by 3.5 to 9.5 feet or more of sandy clay, underlain by sand. Given this information and the fact that the reservoir is located on the top of the plateau,

it is uncertain if the reservoir is founded on the sandstone or the predominant sandy soils observed at the surface surrounding the reservoir; therefore the analyses assumed Site Class D.

The seismic slope instability is considered a minimal hazard for this reservoir because of the presence of the sandstone in the uphill cut slope, no evidence of current slope instability, and the very flat adjacent slopes.

4.2.3 Overturning

Tank stability was calculated using AWWA D100-11 equation 13-36 which calculates the overturning ratio J. The value of the overturning ratio was then compared against the following AWWA criteria for tank stability:

- J < 0.785, No shell uplift because of overturning, tank is adequate as self-anchored
- 0.785 < J < 1.54, Shell uplift occurs, but the tank is stable provided shell compression requirements are satisfied
- J > 1.54, Tank is not stable as self-anchored, anchor bolts are required

Assuming Site Class D, the overturning ratio J for Columbia View Reservoir is 0.459. Based on the criteria noted above, in a design seismic event the tank will not experience uplift, is stable under seismic loads, and does not require anchor bolts.

It is possible that a site specific geotechnical analysis would determine the site could be classified as Site Class B or C. The overturning ratios for Site Classes B, C, and D are presented in Table 9.

TABLE 9
Columbia View Reservoir Tank Stability

Seismic Site Class	Overturning Ratio J	Tank Stability	Shell Compression Requirements Satisfied
B	0.302	No shell uplift because of overturning, tank is self-anchored	N/A
C	0.383	No shell uplift because of overturning, tank is self-anchored	N/A
D	0.459	No shell uplift because of overturning, tank is self-anchored	N/A

4.2.4 Slosh Height

There is currently 1 foot of freeboard from the top of the tank overflow to the underside of the roof structure. Assuming Site Class D, the design slosh wave height is 3.5 feet. It would be necessary to reduce the water depth by 2.5 feet to protect against damage to the roof from a slosh wave. However, as discussed previously it is possible that a site specific geotechnical analysis would determine the site could be classified as Site Class B or C thereby lowering the expected slosh wave height. The slosh wave height for each seismic site class is presented in Table 10.

TABLE 10
Columbia View Reservoir Slosh Wave Height

Seismic Site Class	Slosh Wave Height (feet)	Reduction Required to Overflow (feet)	Corresponding Decrease in Volume (gallons)
B	1.8	0.8	79,000
C	2.9	1.9	184,000
D	3.5	2.5	252,000

4.2.5 Pipe Connections

AWWA D100 requires the design of piping connected to the tank take into consideration the potential movement of the connection points during earthquakes and requires the connections to provide sufficient flexibility to avoid the release of the tank contents because of failure of the piping system. The requirements for self-anchored tanks are presented in Table 11. Based on the information available in the design drawings none of the piping connections at Columbia View Reservoir allow the movement required by these provisions.

TABLE 11
Columbia View Reservoir Minimum Design Displacements for Piping Attachments (AWWA D100-11 Table 30)

Condition	Design Displacement (Inches)
Upward vertical displacement relative to support or foundation when J< 0.785	1.0
Downward vertical displacement relative to support or foundation when the tank is supported by a ringwall or mat foundation	0.5
Horizontal displacement (radial and tangential) relative to support or foundation	2.0

The original drawings include a detail for bracing the overflow pipe from the tank shell; however the drawings do not provide the spacing of the pipe support so it was not possible to determine if the existing overflow pipe supports are adequate for the design seismic sloshing loads.

4.3 Recommendations to Mitigate Seismic Risks

CH2M HILL recommends the following actions to reduce seismic risks for the Columbia View Reservoir:

- Reduce maximum depth of water storage (either by lowering overflow rim level or adjusting SCADA to limit maximum water surface to a lower level).
- Do not leave the reservoir empty during high wind events (when wind gusts over 60 miles per hour are anticipated).
- Improve the supports for the overflow pipe to the tank wall.
- Install movement joints on buried pipe connections located just outside of ringwall.
- Remove the existing straps (located at approximately 20 feet on center around the circumference of the tank) that are welded to the tank and embedded into the concrete ringwall and repair the existing foundation.

It may be possible to reduce the seismic loading for design if site-specific information is collected that indicates Site Class C or B may be used. Site Class C could be confirmed if the foundation is founded on bedrock; Site Class B would require shear wave velocity measurements of 2,500 feet per second or larger.

4.4 General Observations

This scope of this study did not include a comprehensive condition assessment of the reservoirs. However, during the site visit various items were observed that should be further investigated and repaired. The following is a brief summary of those items which were observed.

4.4.1 Base of Tank Shell at the Concrete Foundation

In some places the grout at the base of the tank has eroded (see Figure 12). It is recommended that the base ring grout be repaired to prevent water from migrating under the tank floor. Water under the floor could result in corrosion or freeze thaw damage from ice.

FIGURE 12
Columbia View Reservoir Base of Tank Shell at Foundation

At multiple locations the concrete around the existing anchors has spalled. In some cases the spalling has exposed the concrete reinforcing. It is recommended that the spalled concrete be repaired to prevent corrosion of the reinforcing and further damage to the concrete foundation. In additon, to prevent future spalling it is recommended that the tank not be left empty.

FIGURE 13
Columbia View Reservoir Base of Tank Anchors

4.4.2 Interior Paint

The interior of the reservoir was only observed through the roof hatch. From this limited view it is evident that the interior paint is beginning to fail leading to some corrosion (See Figures 14 and 15).

FIGURE 14
Columbia View Reservoir Roof Beam and Roof Plate (looking through roof hatch)

FIGURE 15
Columbia View Reservoir Roof Beam and Roof Plate (looking through roof hatch)

SECTION 5

Intermediate Reservoir

5.1 Tank Information

Year Constructed:	1982
Volume:	1 million gallons
Diameter:	78 feet
Height:	28 feet
Tank Anchorage:	Self-anchored (no structural anchors from steel shell to the foundation)*

* The existing straps (located at approximately 12 feet on center around the circumference of the tank) that are welded to the tank and embedded into the concrete ringwall are not adequate for the tank to be designated as a mechanically anchored tank.

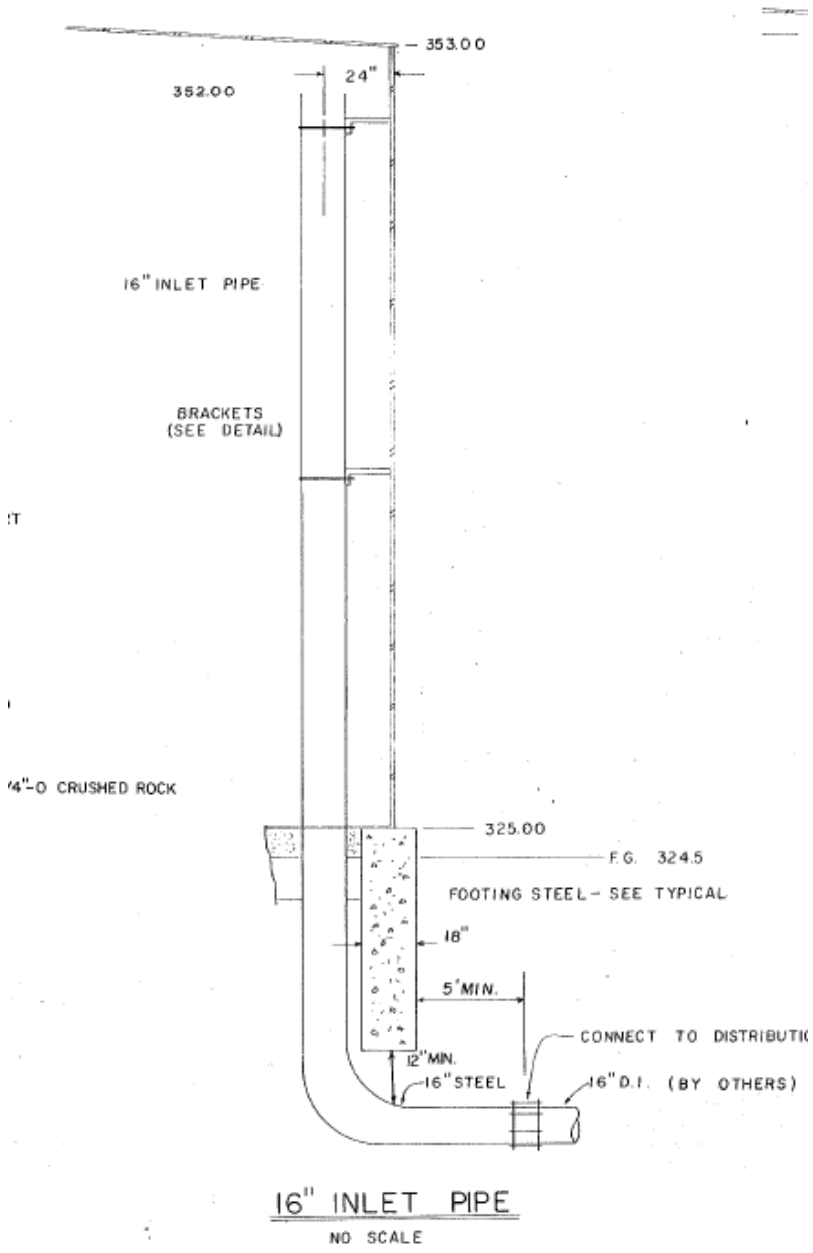

FIGURE 16
Intermediate Reservoir Cross Section

5.2 Results of Analysis Based on Seismic Risk

5.2.1 General

The following information was available and used in the analysis:

- Original design drawings which included the following
  - Tank geometry
  - Schematic details for piping and other tank appurtenances
  - Schematic ringwall foundation design

The information in the design drawings does not provide any information on the thickness of the wall, floor or roof plates. The following assumptions were used for the purpose of this analysis:

- Shell wall thickness
  - Top two courses are ¼ inch thick
  - The bottom two courses are the thickness required to resist hydrostatic loads
- Floor plate thickness
  - ¼ inch

The original drawings do not show any details for a connection between the tank and the foundation. However, anchor straps are located at approximately 12 feet on center around the circumference of the tank. The straps are 4" wide steel plates that are welded to the tank shell and are embedded into the concrete foundation. Since no details are available for this connection it is unknown how deep the straps are embedded in the concrete. As noted in the following section, the tank meets the current code requirements for a self-anchored tank so the purpose of these straps is not known.

5.2.2 Foundation Conditions

The native soil visible in the cut-slope adjacent to the tank indicated sandy soils with intact weakly cemented sandstone, possibly the Chenoweth Formation. However, the reservoir is located in between basalt flow formations, and it is uncertain if the reservoir is founded on soil, sandstone, or basalt. Given the uncertainty with the foundation, Site Class D was assumed for these analyses.

Given the presence of the sandstone in the uphill cut slope and no evidence of current slope instability, seismic slope instability is considered a minimal hazard for this reservoir. There may be some localized rock-fall and/or slope instability because of the very steep slope (almost vertical) on the uphill and downhill sides of the reservoir. Given the height of the uphill slope, and the site of the basalt boulders that could be generated, it is possible that a rock fall could damage the reservoir.

5.2.3 Overturning

Tank stability was calculated using AWWA D100-11 equation 13-36 which calculates the overturning ratio J. The value of the overturning ratio was then compared against the following AWWA criteria for tank stability:

- $J < 0.785$, No shell uplift because of overturning, tank is adequate as self-anchored
- $0.785 < J < 1.54$, Shell uplift occurs, but the tank is stable provided shell compression requirements are satisfied
- $J > 1.54$, Tank is not stable as self-anchored, anchor bolts are required

Assuming Site Class D, the overturning ratio J for Intermediate Reservoir is 0.536. Based on the criteria noted above, in a design seismic event the tank will not experience uplift, is stable under seismic loads, and does not require anchor bolts

It is possible that a site specific geotechnical analysis would determine the site could be classified as Site Class B or C. The overturning ratios for Site Classes B, C, and D are presented in Table 12.

TABLE 12
Intermediate Reservoir Tank Stability

Seismic Site Class	Overturning Ratio J	Tank Stability	Shell Compression Requirements Satisfied
B	0.355	No shell uplift because of overturning, tank is self-anchored	N/A
C	0.448	No shell uplift because of overturning, tank is self-anchored	N/A
D	0.536	No shell uplift because of overturning, tank is self-anchored	N/A

5.2.4 Slosh Height

There is currently 1 foot of freeboard from the top of the tank overflow to the underside of the roof structure. Assuming Site Class D, the design slosh wave height is 3 feet. It would be necessary to reduce the water depth by 2 feet to protect against damage to the roof from a slosh wave. It is possible that a site specific geotechnical analysis would determine the site could be classified as Site Class B or C thereby lowering the expected slosh wave height, thereby reducing the slosh wave height. The slosh wave height for each seismic site class is presented in Table 13.

TABLE 13
Intermediate Reservoir Slosh Wave Height

Seismic Site Class	Slosh Wave Height (feet)	Reduction Required to Overflow (feet)	Corresponding Decrease in Volume (gallons)
B	1.55	0.6	21,000
C	2.5	1.5	55,000
D	3.0	2.0	77,000

5.2.5 Piping Connections

AWWA D100 requires the design of piping connected to the tank take into consideration the potential movement of the connection points during earthquakes and requires the connections to provide sufficient flexibility to avoid the release of the tank contents because of failure of the piping system. The requirements for self-anchored tanks are presented in Table 14. Based on the information available in the design drawings none of the piping connections at Intermediate Reservoir allow the movement required by these provisions.

TABLE 14
Intermediate Reservoir Minimum Design Displacements for Piping Attachments (AWWA D100-11 Table 30)

Condition	Design Displacement (inches)
Upward vertical displacement relative to support or foundation when J< 0.785	1.0
Downward vertical displacement relative to support or foundation when the tank is supported by a ringwall or mat foundation	0.5
Horizontal displacement (radial and tangential) relative to support or foundation	2.0

The original drawings include a detail for bracing the overflow pipe from the tank shell; however the drawings do not provide the spacing of the pipe support so it was not possible to determine if the existing overflow pipe supports are adequate for the design seismic sloshing loads.

5.3 Recommendations to Mitigate Seismic Risks

CH2M HILL recommends the following actions to reduce seismic risks for the Intermediate Reservoir:

- Reduce maximum depth of water storage (either by lowering overflow rim level or adjusting SCADA to limit maximum water surface to a lower level).
- Do not leave the reservoir empty during high wind events (when wind gusts over 60 miles per hour are anticipated).
- Improve the supports for the overflow pipe to the tank wall.
- Install movement joints on buried pipe connections located just outside of ringwall.
- Remove the existing straps (located at approximately 12 feet on center around the circumference of the tank) that are welded to the tank and embedded into the concrete ringwall and repair the existing foundation.

It may be possible to reduce the seismic loading for design if site-specific information is collected that indicates Site Class C or B may be used. Site Class C could be confirmed if the foundation is founded on bedrock; Site Class B would require shear wave velocity measurements of 2,500 feet per second or larger.

5.4 General Observations

This scope of this study did not include a comprehensive condition assessment of the reservoirs. However, during the site visit various items were observed that should be further investigated and repaired. The following is a brief summary of those items which were observed.

5.4.1 Interior Paint

The interior of the reservoir was only observed through the roof hatch. However, from this limited view it is evident that the interior paint is beginning to fail leading to some corrosion (See Figures 17 and 18).

FIGURE 17
Intermediate Reservoir Roof Beam and Roof Plate (looking through roof hatch)

FIGURE 18
Intermediate Reservoir Roof Beam and Roof Plate (looking through roof hatch)

Jacobs

Technical Memorandum

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Subject	**Task 5.6 SCADA/Telemetry Evaluation**
Project Name	City of The Dalles Water Master Plan
City Project Number	2022-005
Jacobs Project Number	D3718900
To	Dave Anderson/City of the Dalles
From	Jeff Kanyuch/Jacobs
Reviewed by	Brady Fuller/Jacobs
Date	July 19, 2024

1. Introduction

The City of The Dalles operates its municipal water system using automated systems to perform essential monitoring and control functions. The system includes a Supervisory Control and Data Acquisition (SCADA) system that has reached end of useful life and requires upgrades to current technology and incorporation of certain security features which have become recommended in the industry since the last generation of upgrades were performed over 20 years ago.

This memorandum provides a brief description of work currently underway and work required to provide an upgraded and secure SCADA system.

This memo generally describes SCADA improvements into categories:

1) Wicks Water Treatment Plant (Phase 1)
2) Distribution System (Phase 2)

1.1 Wick Water Treatment Plant (WTP) SCADA Facilities

Wicks WTP treats surface water from South Fork Mill Creek and is the only surface water supply used by the City. Groundwater wells supplement the surface water supply. The City has prioritized SCADA system improvements at Wicks WTP, and the following improvements are recommended and underway. It should be noted that SCADA improvements at Wicks WTP have been deferred by the City for several years beyond the normal useful life of these systems, with interest in avoiding stranded investments when new or upgraded WTP facilities are constructed. However need for continued, reliable, and resilient control system equipment remains and the system replacement should not be further deferred. It is essential to implement these recommended improvements even if they will eventually be demolished or abandoned as the proposed WTP improvements will take several years to implement. Further delays in implementation substantially increase the risk of failures, and replacement equipment is no longer commercially available from suppliers, and instead only available as used equipment on the secondary market.

Phase 1 – Wicks WTP SCADA System Improvements.

1) **PLC Hardware replacement**. The driver for this project element is due to the existing PLCs platform becoming obsolete. Allen Bradley PLC 5 and Allen Bradley SLC hardware is currently in use. These platforms and related spare parts are no longer manufactured and have been replaced by Allen Bradley. The PLC5 model has been replaced with ControlLogix, and the SLC model has been replaced with CompactLogix. PLC code that runs on the PLC hardware must be migrated to more modern programming language.
2) **PLC human machine interface (HMI) software upgrade and replacement.** Currently the Wicks WTP PLCs are using Wonderware Intouch HMI software. The HMI software is custom programmed to prepare visible control "screens" which depict processes and equipment, and operating conditions. Within the water industry, many owners are migrating to Inductive Automation Ignition HMI software due to lower license costs and lower long term support costs.
3) **Development of High Performance HMI graphics**. Within the water industry, simple graphics have been demonstrated to be very effective and easier to understand than the historical "cartoon" style process graphics with color and movement and visual detail that doesn't support current process understanding.
4) **SCADA historian and automated reporting tool.** Process operating data is typically recorded and saved to support compliance record keeping and good practice for operation. The software tool that saves data and from which historical reports can be prepared, is no longer functional. The existing Wonderware historian tool will be replaced with Inductive Automation Ignition Historian and XLReporter will be implemented to generate automatic reports.
5) **Operational Technology (OT) System Improvements:**
    a) The existing communications connection from the Wicks WTP to City Shops uses a T1 phone line that has been unreliable for SCADA communications. A satellite-based high speed internet connection will be evaluated as part of Phase 1 and will be implemented to provide more reliable SCADA communications between the Wicks WTP and City Shops and provide remote access capabilities for offsite SCADA support.
    b) **Network and computer hardware replacement.** Current Wicks WTP network and computer hardware equipment, required to operate the SCADA system, is over 20 years old and requires replacement based on condition and software versions. New SCADA Servers and workstations will be provided to host the Inductive Automation Ignition software. A demilitarized zone (DMZ) server will be provided to facilitate secure remote access for offsite SCADA system access. Security risks and system resilience will benefit from improvements.
    c) **Network and hardware component physical configuration**. The configuration for replacement will be per current industry standards and in support of appropriate redundancy, access, maintenance requirements and operational efficiency. High availability (HA) firewalls will be installed to provide secure remote access and secure network connections between different SCADA and business networks.
6) The following existing PLC's and related hardware are included in the proposed upgrade
    a) **Wicks WTP Main PLC:** The existing PLC system uses a pair of Allen Bradley PLC5 with multiple remote I/O racks using "bluehose" connections to the chemical building and clearwell vault. The Allen Bradley PLC5s and remote I/O racks will be replaced with a ControlLogix PLC and remote I/O connected via singlemode fiber.
    b) **Wick WTP raw water intake fish screen PLC:** Allen Bradley MicroLogix. Replace with CompactLogix and connect to plant SCADA either with radio or new fiberoptic network extension.
    c) **Crow Creek Dam Allen Bradley PLC:** Existing Allen Bradley SLC was replaced with a CompactLogix PLC by City Staff. The CompactLogix PLC will be replaced with a new series of

CompactLogix PLC in order to meet the updated City PLC standards. Both the historic and recent replacement have been powered by solar panel at this remote site. The system is used to monitor reservoir level and outflow flow. The CompactLogix unit panel needs to be configured to conform to standardized configuration. The existing 900 MHz radio link back to Wicks WTP will be retained. The existing panel uses serial connection from the 900 MHz radio which is old technology and the new system will be configured with ethernet connection.

d) **City Public Works Shops PLC:** This facility is physically near the geographic center of the distribution system. The existing PLC is Allen Bradley PLC5 and will remain online during Phase 1. Redundant firewalls and a managed network switch are being added and modified with ongoing development project for the Riverview sewer pump station and Riverside Water Facility in the port area.

7) City Shops Network and Computer Hardware:

   a) The existing computers have remaining useful life and will not be replaced as part of the Wicks WTP SCADA Improvement project.

   b) A new SCADA server will be installed at City Shops as part of Phase1 to provide redundancy for the SCADA server at the Wicks WTP. A local thin client workstation will be provided to allow operators the ability to monitor and control, based on user access level control, process equipment located at the Wicks WTP.

   c) Distribution system operators have operational needs to monitor conditions at Wick WTP, and so a new, separate HMI at City Shops will be stood up on an interim basis until further distribution system PLC replacements are completed.

8) Design, Construction and Startup Approach

   a) Planning and engineering are underway in early 2024.

   b) Programming of new PLCs and HMI software will then be performed. "Factory demonstration testing" will be performed by the Engineer in presence of City representatives to confirm that the software provides and demonstrates intended functions.

   c) Material and equipment procurement will be performed, either by City or on behalf of City by City's consultant.

   d) Certain electrical and controls work requires work by a licensed electrician. The City will hire an electrician to install the equipment per the design. The City's consultant performing programming and startup services will implement a startup and testing protocol to record and demonstrate proper function and performance.

9) Schedule

   a) All new facilities are intended to be operational by late 2025.

10) Capital Costs

See Table 1 at end of memorandum.

1.2 Distribution System SCADA Facilities

The City of The Dalles Distribution System SCADA facilities includes about 30 different sites with SCADA and control system elements and includes facilities for drinking water, sewer collection, and dewatering wells for slope stabilization and landslide risk mitigation on steep slopes south of downtown. This system is separate from SCADA systems at the Wastewater Treatment Plant (WWTP).

Phase 2 – Distribution System SCADA System Improvements.

1) **PLC Hardware replacement.** The driver for this project element is due to the existing PLCs platform becoming obsolete. At drinking water reservoirs, wells, and booster pump stations, the Allen Bradley Micrologix PLC hardware is currently in use, and the system dates from the 2000's. The Micrologix platform and related equipment are near end of useful life and not supported by the manufacturer. At the City shops, a pair of Allen Bradley PLC5 processors control polling of the radio system. The Allen Bradley PLC5 hardware is obsolete. For both platforms, the PLC code that runs on the PLC hardware must be migrated to more modern programming language.
2) **Panel Replacement.** The existing PLC panels for each of the sites will be evaluated to determine if an entire new panel will be required based on site evaluation as part of the Phase 2 scope definition effort.
3) **PLC human machine interface (HMI) software upgrade and replacement**. Similar to the Wicks WTP, the HMI software is proposed to be upgraded from Wonderware Intouch to Inductive Automation Ignition.
4) **Development of High Performance HMI graphics.** Similar to Wicks WTP, HMI graphics will be updated to confirm to modern high performance graphics standards.
5) **SCADA historian and automated reporting tool.** The Inductive Automation Ignition Historian and XLReporter that will be provided in Phase 1 will be configured to provide additional historical data and automated reporting for the distribution facilities.
6) **Alarm Notification.** The existing alarm notification system for the distribution facilities uses a WIN911 system for alarm notification based on alarms generated by the SCADA system. The Inductive Automation Ignition Alarming system will provided as part of the Phase 2 scope for primary alarm notification. The existing WIN911 system can be retained and recommended to be used in the event of the Ignition alarm system failure.
7) **Operational Technology (OT) System Improvements:**
    a) Radio communications upgrades. Due to the distributed nature of the distribution system facilities (and other public works facilities like collection system and dewatering well equipment) supported by this SCADA system, radio communication has historically been used to provide monitoring and control of remote facilities. The radio communication equipment is current FCC licensed 900 MHz frequency with serial connections to PLC hardware. This project will upgrade to Ethernet based radio technology. Some of the existing radio equipment is obsolete (including master radio at City Shops) and spare parts are only available on the second hand market.

       The PLC at City Shops communicate with each remote station 1 at a time, in series. A 100 ft radio repeater tower at the Airport across the Columbia River in Dallesport, Washington is integral to maintaining system wide communications. One important challenge during the Phase 2 work will be to identify alternatives and recommend a best approach to upgrade and replace the existing system (for example, using line of sight radio, or mesh network system). For basis of planning and

cost estimating, the replacement is proposed to be in-kind but with update of PLC, and radio communications hardware. Security upgrades are also required to reduce risk of malevolent threats.

Finally, the existing radio network has been identified to have reached, or nearly reached, its limit in station addressing. The project will determine how additional stations may be brought into the network to prevent capacity limits based on station address count.

b) Network and hardware component physical configuration. Similar to Wicks WTP system, the distribution system network and hardware will be per current industry standards and in support of appropriate redundancy, access, maintenance requirements and operational efficiency.

c) Network and computer hardware replacement. The only computer network and hardware for the distribution system is located at the City Shops. As noted above, the Phase 1 project will include a new SCADA server and thin client workstation. Phase 2 will use the new SCADA server and thin client workstation to integrate the distribution system facilities. The existing Wonderware workstations will then be replaced with modern and current technology. Security risks and system resilience will benefit from improvements.

8) Design, Construction and Startup Approach

a) Planning and engineering are proposed to be performed in early 2025.

b) Programming of new PLCs and HMI software will then be performed. "Factory demonstration testing" will be performed by Engineer in presence of City representatives to confirm that the software provides and demonstrates intended functions.

c) Material and equipment procurement will be performed, either by City or on behalf of City by City's consultant.

d) Certain electrical and controls work requires work by a licensed electrician. The City will hire an electrician to install the equipment per the design. The City's consultant performing programming and startup services will implement a startup and testing protocol to record and demonstrate proper function and performance.

9) Schedule

a) All new facilities re intended to be operational by late 2027.

10) Capital Costs

See Table 1 at end of memorandum.

Table 1. Recommended Improvements Cost Estimates

Item	Description of Additional Study or Improvements	Construction Cost*
Phase 1 – Wicks Water Treatment Plant		
	Planning and Design, Programming, Testing and Design	$1,370,000
	Materials, Construction	$630,000
	Subtotal	$2,000,000
Phase 2 – Distribution System		
	Planning and Design, Programming, Testing	$2,000,000
	Materials, Construction	$1,129,000
	Subtotal	$3,290000

**Association for the Advancement of Cost Estimating Class 5 planning level estimates with an accuracy range of +100%/-50%.*

Attachment 1
Cost Backup

The Dalles
Distribution SCADA Upgrade
Order of Magnitude Budgetary Estimate (AACE Class 5 Estimate)

Engineering	**$1,433,672**	
Project Management (5 years)	$123,000	6 hrs / month for 60 months
Design / SDC		
Concept Design Allowance	$91,520	16 hrs, 26 sites @ $220/hr
Final Design Allowance	$91,520	16 hrs, 26 sites @ $220/hr
Engineering SDC		
SDC / Construction Support	$68,640	12 hrs, 26 sites @ $220/hr
Electrical Contractor Procurement Support	$8,800	40 hrs @ $220/hr
Material Procurement Labor	$13,200	60 hrs @ $220/hr
SCADA Software		
SW Planning (Loop Descriptions / Workshops)	$112,000	80% of LOE on Wicks SCADA Upgrade
SW Programming for Remote Stations	$481,712	476 I/O @ 4.6 hrs/point, $220/hour
SW Field Testing for Remote Stations	$101,520	16 hours per station, 26 stations + $10k expenses
SW Programming for Radio Master	$66,000	Allowance - 200 hours PLC, 100 hours HMI @ $220/hour
Radio Comm's Configuration and Field Testing	$47,760	8 hours per station, 26 stations + $2k expenses
Configure Historian, Reporting, Alarm Dialer	$23,000	Allowance
OT Systems		
Configuration	$45,000	Based on 50% of LOE on Wicks SCADA Upgrade
Deployment	$45,000	Based on 50% of LOE on Wicks SCADA Upgrade
Record Drawings	$20,000	Allowance
Travel Expenses - SCADA Field Testing	$84,000	Allowance - $2,000 per station x 26 stations * 1.5 people
Travel Expenses - OT	$6,000	Allowance - $6,000
Travel Expenses - Radio System Testing	$5,000	Allowance - $5,000

Construction Allowance	**$154,160**	
Panel Work	$108,160	2 ppl, 16 hrs per panel @ $130 / hour for each of 26 panels
Other Misc Electrical (OT, cabling, etc)	$26,000	10% of Panel Work
Miscellaneous EE Materials Allowance	$20,000	Allowance, same amount as line above

Materials	**$746,450**	
SCADA Hardware (PLC) - Remote Stations & Shops	$308,200	Northcoast 2/7/24 budgetary quote + 15% markup
SCADA Software (HMI) - Shops	$25,000	Ciaran 6/1/23 ballpark
New Panel Material Alowance	$104,000	26 Stations @ $4000 each
New Radios	$55,050	26 Stations @ $2000/radio + $50 programming cable
OT Hardware - 5 Year Server Replacement at Shops	$100,000	Replacement of servers installed in Phase 1 due to server lifespan (5 yrs).
UPS Replacement Allowance	$31,200	26 Stations @ $1200 per panel
OT Hardware - Remote Stations	$91,000	$3,500 allowance per site, 26 sites
OT Hardware - Shops	$7,000	2 HMI workstations, 2 core switches
OT Software - Shops	$25,000	Allowance

MATERIAL SHIPPING ALLOWANCE:	$22,394	3%
GENERAL CONDITIONS:	$90,061	10%
SUBTOTAL:	$2,334,282	
ESCALATION (to 2028 midpoint):	$344,360	15%
CONTINGENCY:	$583,571	25%
TOTAL:	**$3,262,213**	

The Dalles
Wicks WTP SCADA Upgrade - Phase 1
Order of Magnitude Budgetary Estimate (AACE Class 5 Estimate)
6/18/2024

		Additional Items	
Engineering - Per Contract Scope of Work and LOE	**$1,035,691**	**$40,000**	**Comments**
Project Management (2 years)	$76,440		Per Orignal Contract LOE
Project Definition			Per Orignal Contract LOE
Project KOF Meeting and Site Evaluation	$16,909		
Existing PLC Panel Evaluation	$13,506		
Feasibility Assessment for Connecting the Fish Screen PLC to the Plant SCADA System	$2,713		
Project Planning Workshops	$11,502		
Project Definition Report	$20,980		
Engineering Design			
Tehnical Design Package	$109,200		Per Orignal Contract LOE
Existing Operator Room Upgrades		**$4,000**	**Additional Drawings Required**
Existing Computer Enclosure Demo/Removal		**$4,000**	**Additional Drawings Required**
Existing Microfloc Control Panel Demo/Removal		**$4,000**	**Additional Drawings Required**
Filter Builiding Conduit and Wiring		**$5,000**	**Additional Drawings Required**
Chemical Builiding Conduit and Wiring		**$5,000**	**Additional Drawings Required**
Wicks Well PLC Drawings		**$5,000**	**Additional Drawings Required**
Supplements to Support City's Selection of Electrical Contractor	$2,713		Per Orignal Contract LOE
Price Quotations for Major Materials	$4,358		Per Orignal Contract LOE
SCADA Software			Per Orignal Contract LOE
SW Planning (Loop Descriptions / Workshops)	$75,910		
SW Programming	$223,176		
Configure Historian and Reporting	$83,626		
SW Field Testing	$121,107		
OT Systems			Per Orignal Contract LOE
Configuration	$91,116		
Additional Configuration		**$8,000**	**Additional Server and Network Equiment**
Deployment	$21,947		
Additional Deployment		**$5,000**	**Additional Server and Network Equiment**
OT Record Documentation	$8,632		
Post Development Support	$12,373		
Engineering Construction Support	$79,887		Per Orignal Contract LOE
Material Procurement Support	$11,482		Per Orignal Contract LOE
Owner Managed Contingency	$10,253		Per Orignal Contract LOE
Expenses	$37,865		Per Orignal Contract LOE

Construction Allowance	**$82,400**	**$36,660**	
Panel Work	$31,200		2 ppl, 40 hrs per panel @ $130 / hour for each of 3 panels
Existing Operator Room Upgrades		**$10,400**	2 ppl, 40 hrs @ $130 / hour
Existing Computer Enclosure Demo/Removal		**$2,100**	2 ppl, 8 hrs per panel @ $130 / hour
Existing Microfloc Control Panel Demo/Removal		**$4,160**	2 ppl, 16 hrs per panel @ $130 / hour
Other Misc Electrical (OT, cabling, etc)	$31,200		Allowance, same amount as Panel Work
Miscellaneous EE Materials Allowance	$20,000		Allowance
EE Materials for Conduit Runs to connect Chemical Pumps		**$20,000**	Allowance

Materials	**$264,323**	**$119,116**	
PLC HW			
Wicks PLCs	$95,614		
Fish Screen PLC	$9,586		
Crow Dam PLC	$9,735		
Raw Water Well PLC		**$35,000**	**Not included in orginal LOE**
Wicks PLC 24VDC Power Supplies	$4,249		
Remote PLC 24VDC Power Supplies	$4,249		
PLC UPS		**$8,100**	**Three 1.5kVA UPS**
HMI SW			
Ignition HMI Platform	$26,490		
Ignition HMI Platform - Redundancy		**$13,300**	**Not included in orginal LOE**
FactoryTalk AssetCentre		**$15,000**	**Not included in orginal LOE**
OT Hardware - Wicks			
Server Enclosure		**$1,600**	**42U Freestanding Server/Network Enclosure**
Rack Mounted Fiber Patch Panel		**$1,316**	Rack Mount, 2U Patch Panel with Fiber Inserts
Server	$16,000		1 Dell Server
Thin Clients	$3,000		Two Thin Client Dell Workstation
Panel Mounted Industrial Computer		**$7,500**	**Panel PC mounted within Wall Mount Stainless Steel Enclosure**
Firewalls	$5,874		
Managed Network Switches	$2,400		(1 ISP Switch, 2 SCADA Switches)
Managed DIN Rail Mounted Network Switches	$7,228		(3 SCADA Switches)
Radios			
Rackmount Server Enclosure UPS		**$4,500**	**One 3KVA UPS**
Starlink Connection		**$800**	
OT Software - Wicks	$20,000		Allowance
OT Hardware - Shops	$5,000		1 Dell server, 2 HMI workstations, 1 firewall, 1 NAS, 2 core switches
Server		**$16,000**	**Not included in orginal LOE**
DMZ Server		**$16,000**	**Not included in orginal LOE**
Managed Network Switches	$2,400		(1 ISP Switch, 2 SCADA Switches)
OT Software - Shops	$20,000		Allowance
PLC Spares	$32,497		

SUBTOTAL:	$1,382,414	**$195,776**	
ESCALATION:	$69,121	**$9,789**	5%
CONTINGENCY:	$276,483	**$39,155**	20%
ADDITONAL PM TIME ALLOWANCE:		**$24,472**	
ORIGINAL TOTAL:	**$1,728,017**	**$269,192**	10%

TOTAL:	**$1,997,209**

Jacobs

Technical Memorandum

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Subject	**Task 5.8 Renewable Energy Evaluation**
Project Name	City of The Dalles Water Master Plan
City Project Number	2022-005
Jacobs Project Number	D3718900
To	Dave Anderson/City of the Dalles
From	YunJi Choi/Jacobs
Reviewed by	Brady Fuller/Jacobs
Date	Updated December 11, 2024

EXP. 12/31/2025

1. Introduction

This memorandum examines potential renewable energy generation (in-conduit hydropower) within The Dalles municipal water system. In-conduit hydropower has a very low environmental impact and therefore permitting for these facilities is very straightforward with limited permitting requirements, compared to conventional hydropower facilities (like dams on rivers) with which the public may be more familiar. The evaluation presented in this memo should be considered a screening-level evaluation, and more detailed analyses are warranted to confirm financial feasibility. The water master plan scope intended that energy recovery would be evaluated for both a new finished water transmission pipeline from Wicks Water Treatment Plant into town, and down-hole aquifer storage and recover (ASR) wells. The scope also assumed that other hydropower feasibility would be studied under a future feasibility study, and that potential opportunities to integrate hydropower into planned CIP projects will be identified.

The feasibility and cost effectiveness of hydropower generation at Garrison Reservoir at the downstream end of the new finished water transmission main is evaluated herein. The finished water transmission main also branches to Sorosis Reservoir but the available net head is much smaller on the Sorosis Branch (the "High Line") than the pipeline to Garrison, so only the Garrison site was evaluated.

The initial ASR well is already in construction and limited information was available regarding system configuration. A cursory evaluation of down-hole hydropower is provided.

2. Energy Potential and Economic Analysis

From experience, it is understood that the most economic opportunities for energy recovery from in-conduit hydropower occur where steady flow can be sustained for most of the calendar year, and where this steady flow exists with similar differential head conditions. Further, in-conduit hydropower can often be most economic at a site that already has existing electrical load that can be offset by energy recovery. Two potential applications of in-conduit hydropower are evaluated herein.

- Garrison Reservoir site
- Aquifer Storage and Recovery Well sites

2.1 Garrison Reservoir

In the case of Garrison Reservoir site, the pump station exerts significant annual power demand, as well be described below.

Applications for in-conduit hydropower often occur at the location of existing pressure reducing valves, and any in-conduit hydropower facility must provide for one or more such bypass valves to sustain water operations when the turbine/generator goes offline (either for planned outages, or during unplanned grid disruptions). For sites like Garrison where potentially summer seasonal water demands could be higher than winter seasonal demands, the installation of two parallel turbines could make sense with the single turbine operating during lower flow periods. The City's plans for implementing ASR are expected to increase wintertime water demand so projections of flow conditions will continue to be an important aspect of planning for any in-conduit hydropower facility.

The available flow and head at Garrison Reservoir inlet were provided by Consor on June 4, 2024, based on the updated hydraulic model of the water system. The available Flow verses Head curve is shown in Figure 1.

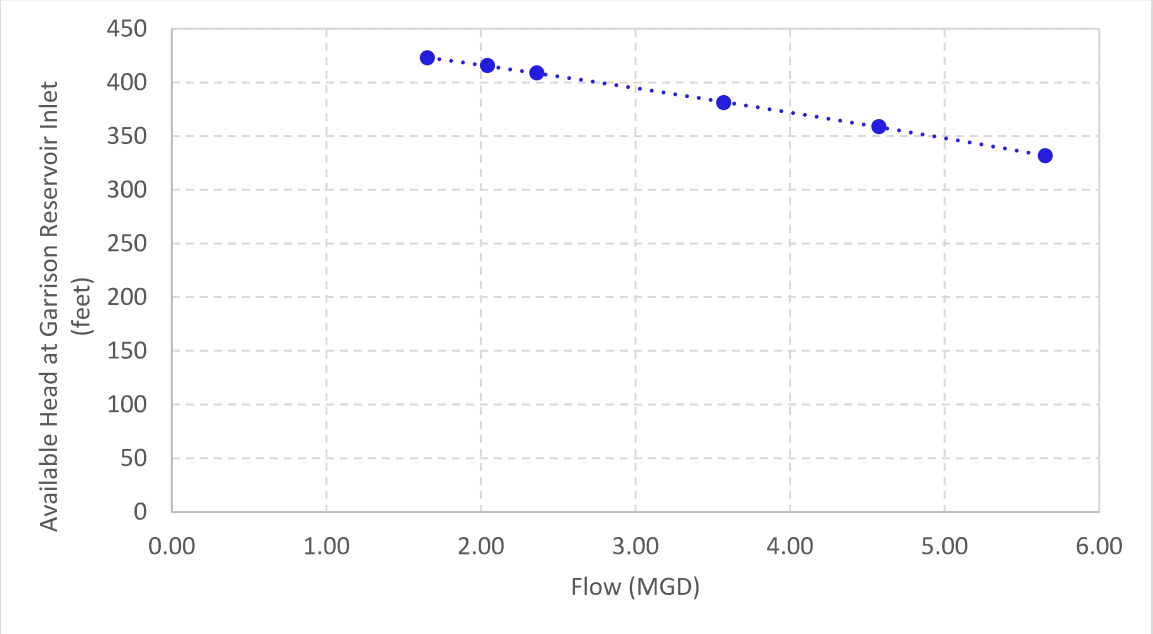


Figure 1. Available Flow vs. Head at Garrison Reservoir Inlet

Power output from an in-conduit hydropower turbine, regardless of size or type, is proportional to flow through the turbine and the headloss (or differential pressure) across the turbine. In principle, low-head/high-flow and high-head/low-flow conditions offer the same power and energy potential. The power formula for a hydraulic turbine generator is as follows:

$$THP = \frac{Q \times H}{8.8}$$

$THP = Theoretical\ Horse\ Power\ (Horse\ Power, HP)$
$Q = Flow\ rate\ (cubic\ foot\ per\ second, cfs)$
$H = Available\ head\ (ft)$

(US Bureau of Reclamation, 2005)

For the evaluation purposes, the following list of assumptions were made:

- Combined efficiency of the turbine and generator is 85%.

- 3 million gallons per day (MGD) in October to April and 6 MGD in May to September is available continuously for hydropower generation.
- Hydropower generation is continuous throughout the year.
- Rate of power is assumed to be $0.08/kilowatt-hour for power generation benefits calculation.
- Net Energy Metering (NEM) agreement with local electric utility will offset the total energy use across 16-meter locations in 2022 listed in "WD Power Usage 2022.xlsx" shared on May 17, 2024, as an email attachment. The total annual energy use was 1,022,716 kwh.
- Excess power generation (that is, power generated that exceeds annual demand at the site) is not sold back to the electric utility. This assumption was made because NEM interconnection agreements often require the generator to forfeit any excess annual production. This is not the only interconnection and payment arrangement but it is conservative for financial projections.
- A previous feasibility study for another Oregon water utility completed by Jacobs in 2023 was referenced to estimate the Capital cost at Garrison Reservoir. The estimate was scaled based on power production capacity (i.e. generator size). The estimated opinion of probable construction cost is $2,120,000 and an additional 30% markup engineering, legal, and administration costs.
- Previous feasibility study carried out by Jacobs in 2023 was referenced to estimate the Operation and Maintenance cost (O&M).
- All benefit calculations and cost calculations use simple present value and depreciation is not included.
- The proposed system assumes that the grid must be operational to allow power generation. Specific electrical equipment is required to operate generation systems in "island mode" while disconnected from the grid. This can be an important resilience feature which should be evaluated in the In-Conduit Hydropower Feasibility Study recommended in this memo.
- The planned facility would be subject to a facility charge of $105/month according to the Northern Wasco County Tariff Rate Schedule 803 (Northern Wasco County People's Utility District, 2024).

The estimated total power generation is 1,383,642 kwh over a one-year period which is 135% of recorded power use in 2022. The energy potential at Garrison Reservoir is estimated to exceed the total power use in 2022. Table 1 presents the cost-benefit ratio of hydropower generation potential at Garrison Reservoir based on the estimated hydropower generation benefit, capital cost, and O&M cost under 20- and 50-year operation periods.

Table 1. Capital Cost Estimates

	20 Year	50 Year
Hydropower Generation Benefit		
The Dalles Total Energy Use in 2022 (kwh)	1,022,716	1,022,716
Energy production estimate over continuous 1 year (kwh)	1,383,642	1,383,642
Annual benefit rate (per kwh)	$ 0.08	$ 0.08
Annual benefit	$ 81,817	$ 81,817
Capital cost		
Opinion of Probable Construction Costs	$ 2,120,000	$ 2,120,000
Engineering, Legal, and Admin (30%)	$ 636,000	$ 636,000
O&M cost		
O&M Daily operation, staff, $70/hr, 1hr/day/year, 365 days	$ 25,550	$ 25,550
O&M Yearly maintenance, manager, $90/hr, 80hr/year	$ 7,200	$ 7,200
O&M Consulting, third party (per yr)	$ 2,000	$ 2,000
Schedule 803 Facilities charge $105/month (per yr)	$ 1,260	$ 1,260
O&M Inhouse, one-time, off-site education, 3 people (one time)	$ 7,500	$ 7,500
O&M Startup, commissioning, and training by Manufacturer	$ 20,000	$ 20,000
Operational period (yrs)	20	50
Cost-Benefit Analysis		
Total Cost (present value, rounded)	$ 3,500,000	$ 4,580,000
Total benefit over operation period (use off set, no excess sale)	$ 1,640,000	$ 4,090,000
Net benefit	$ (1,860,000)	$ (490,000)
Simple payback period (yrs)	60.8	60.8
(Sum of benefits at present value)/(cost for implementation)	0.47	0.89

2.2 Aquifer Storage and Recovery Well sites

ASR down-hole in-conduit hydropower is created by essentially running the production well pump in reverse, generating energy from the differential head and flow between the pressure zone and the groundwater level in the well.

Consideration of down-hole in-conduit hydropower at one or more of the City's proposed aquifer storage and recovery wells was evaluated based on available cursory information that could be more fully evaluated in a future feasibility study. This analysis assumes Riverside Well #1 is considered for down-hole hydropower. Well #2 is also capable of the same configuration but values listed below are for a single well.

The assumptions used for the power production estimate and potential benefit calculations are listed below:

- The available net head for hydropower generation is 220 ft.
- The available incoming flowrate which is assumed to be 75 % of the typical well production rate as is typical in ASR flowrate applications.
- Combined efficiency of ASR hydropower operation is 75%.
- The previously presented power formula for a hydraulic turbine generator is applicable to ASR hydropower generation.

- Rate of power is assumed to be $0.08/kilowatt-hour for power generation benefits calculation.
- A Net Energy Metering (NEM) agreement with the local electric utility will be established and all power generated will result in benefit. Excess power generation (that is, power generated that exceeds annual demand at the site) is not sold back to the electric utility. This assumption was made because NEM interconnection agreements often require the generator to forfeit any excess annual production. This is not the only available interconnection and payment arrangement, but it is conservative for financial projections and most likely for the ASR sites. The planned facility would be subject to a facility charge of $105/month according to the Northern Wasco County Tariff Rate Schedule 803 (Northern Wasco County Peoples Utility District, 2024).
- The planned facility O&M efforts are not expected to materially increase, and will rely on existing staffing arrangements. For this reason, ASR hydropower operation is assumed to not incur incremental additional O&M cost.
- The anticipated power use at Riverside Well #1 is two times the Jordan Well energy use, per judgment provided by City staff. Accordingly, annual power use at Riverside Well #1 was based on 2x the power used at Jordan Well per data provide by the City. The total energy use at Jordan Well was 68,240 kwh in 2022. The anticipated energy use at Riverside Well #1 is 136,480 kwh.
- All benefit calculations and cost calculations use simple present value and depreciation is not included.

The estimated total power generation is 90,838 kwh for 90-day per year operation and 181,677 kwh for 180-day per year operation. The 90-day per year operation is estimated to produce energy below the anticipated annual energy use at Riverside Well #1 and 180-day per year operation is estimated to produce energy that exceeds the anticipated annual energy use at Riverside Well #1. Table 2 presents the cost-benefit ratio of hydropower generation potential at Riverside Well #1 based on the estimated hydropower generation benefit, capital cost, and O&M cost under 20- and 50-year operation periods. The analysis applies to one ASR hydropower facility. From planning information provided, it seems likely that 90 days per year may be a likely ASR operation scheme.

Table 2. Down-hole In-Conduit hydropower production estimate

	90 day / year operation		180 day / year operation	
	20 Year	50 Year	20 Year	50 Year
Hydropower Generation Benefit				
Riverside Energy Use in 2022 (kwh)	136,480	136,480	136,480	136,480
Energy production estimate 90 or 180 day per year operation (kwh)	90,838	90,838	181,677	181,677
Annual benefit rate (per kwh)	$ 0.08	$ 0.08	$ 0.08	$ 0.08
Annual benefit	$ 7,267	$ 7,267	$ 10,918	$ 10,918
Capital cost				
Opinion of Probable Construction Costs	$ 48,000	$ 48,000	$ 48,000	$ 48,000
O&M cost				
Schedule 803 Facilities charge $105/month (per yr)	$ 1,260	$ 1,260	$ 1,260	$ 1,260
Operational period (yrs)	20	50	20	50
Cost-Benefit Analysis				
Total Cost (present value, rounded)	$ 70,000	$ 110,000	$ 70,000	$ 110,000
Total benefit over operation period (no excess sale)	$ 150,000	$ 360,000	$ 220,000	$ 550,000
Net benefit	$ 80,000	$ 250,000	$ 150,000	$ 440,000
Simple payback period (yrs)	8.0	8.0	5.0	5.0
(Sum of benefits at present value)/(cost for implementation)	2.08	3.30	3.12	4.96

From review of existing Riverside Well #1 documentation and other consultant experience with ASR well implementation, to be conservative some relatively minor capital costs should be anticipated to realize implementation. Detailed review of the existing equipment was not performed. The listed opinion of probable construction cost total of $ 48,000 presented in Table 2 above includes the following list of items:

- Electrical equipment and installation allowance $ 28,000
- Relay programming $ 5,000
- SCADA/PLC programming $ 15,000

The City has constructed one ASR well site, and is considering others. At the time of this evaluation, detailed layouts of the existing site and proposed sites were not available to the project team. In addition to electrical and mechanical infrastructure required for ASR well operation, the following additional analyses, agreements, and infrastructure would be required to realize effective energy recovery:

- Well pump/motor, and shafting must be designed for full operation in both directions (bearings, couplings)
- Instrumentation and controls integrated for monitoring and control.
- Hydraulic transient analysis performed and any mitigating measures provided.
- Net metering arrangements made with power utility. The utility will provide an appropriate bi-directional meter.
- Confirm electrical equipment is complete and suitable for intended use including inverters, switches, regenerative variable frequency drive equipment, grounding, controls and regulator.

3. Conclusion

3.1 Garrison Reservoir Site

The Garrison Reservoir has the hydropower generation potential to offset the city's power use at the Garrison site. The estimated benefit-cost ratio of a 20-year operation is 0.47 and a 50-year operation is 0.89. These show that assuming Net Energy Metering, and without incentives, construction of in-conduit hydropower requires long pay back periods.

The development of energy recovery at the Garrison site is closely linked to the design and operating conditions of the proposed new finished water transmission main(s) from Wicks WTP into town. The additional conceptual and preliminary design of such energy recovery facilities should be performed as part of early planning for the new finished water transmission mains.

3.2 Aquifer Storage and Recovery Well sites

ASR sites have hydropower generation potential to offset a portion of the city's power use at each ASR site. Unlike the Garrison site, the Riverside Well #1 site has payback period as short as 10 years, and could be even more favorable if all electrical equipment is confirmed to be ready for implementation. Benefits are limited however because the system would only operate seasonally.

3.3 General

Federal government tax benefits (which can be sold by the City to third parties with tax liability) and various economic incentive opportunities are available to supplement the planning, design, construction costs and maximize the hydropower generation benefit. Certification of in-conduit hydropower under certain industry programs (such as the Low Impact Hydropower Institute – LIHI) can increase the value of power generated if it is sold to third parties that are willing to pay for such credentialed generation. Other renewable energy "credits" can be accrued by the City and sold on the market to gain additional revenue. Incentives for both capital and generation sales exist, and State and Federal programs are nearly always bringing new potential incentives to the market.

An in-conduit hydropower feasibility study that further evaluates the hydropower potential at finished water transmission pipelines and down-hole hydropower at ASR wells is recommended. The estimated consulting cost of such effort is highly variable based on actual project needs, but for an evaluation as described herein a consulting budget of $100,000 is a reasonable plan, with some of that cost potentially paid by a third party such as the power utility. Evaluation of potential recovery at ASR wells can efficiently be performed during early planning efforts on the finished water transmission mains, if other in-conduit hydropower evaluations are performed.

4. References

Consor, "WD Power usage 2022.xlsx", email attachment, 5/17/2024

Consor, "HGL_Profile-Head_Available_at_Garrison.xlsx", email attachment, 6/4/2024

Northern Wasco County Peoples Utility District, "Tariff-Rate-Schedule-effective-July-2-2024", July 2024

US Bureau of Reclamation, "Reclamation Managing Water in the West – Hydroelectric Power", July 2005

APPENDIX D
WICKS WTP EXPANSION
ALTERNATIVES ANALYSIS

consor

The Dalles Wicks Water Treatment Plant (WTP) Expansion Alternatives Analysis

Date: November 18, 2024
Project name: The Dalles Water System Master Plan
Project no: D3718900
Prepared by: Tyler Kurtz, P.E.
Reviewed by: Enoch Nicholson, P.E.
Brady Fuller, P.E.

Exp. 12/31/2024

1. Introduction

The Wicks Water Treatment Plant (WTP) has served the City of The Dalles for nearly 75 years since its construction in 1950. Currently, the facility provides water to over 13,000 people with a rated capacity of 5.6 MGD. The original construction included flash mix, flocculation, sedimentation, filtration, and chlorination treatment processes. The facility has been expanded and improved over the years, with significant additions including the following:

- 1967: Construction of the alum room, a second washwater tank, and the intake screen
- 1973: Tube settlers installed in basins
- 1982: Clearwell 1 constructed
- 1985: Polymer room constructed
- 1990: Carbon building constructed
- 1991: Solids drying beds constructed
- 2003: Fish screen and fish ladder constructed
- 2008: Clearwell 2 constructed

Despite the facility being well maintained, much of the concrete and equipment on site are nearing the end of their useful lives. Coupled with a growing population and increased water demand from the community, the City is faced with either upgrading and expanding the existing facility or constructing a new, larger facility on the same property where the existing Wicks WTP is currently located.

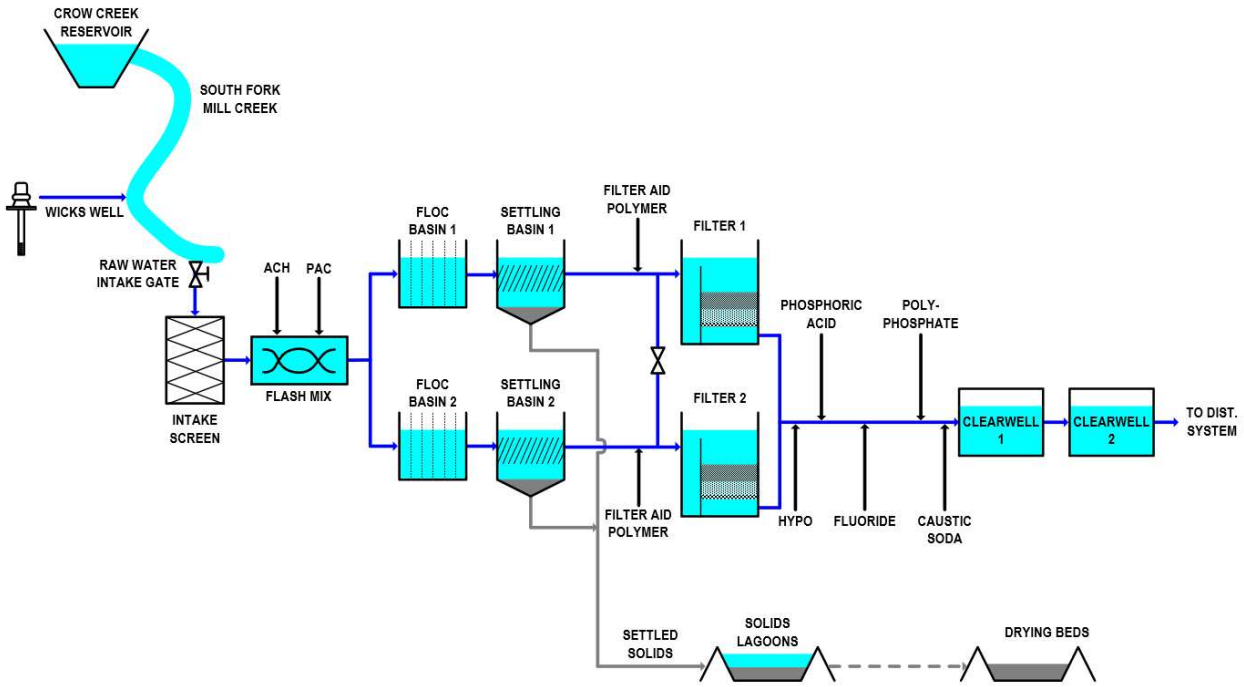
1.1 Existing Treatment Process

Wicks WTP is fed by watersheds that extend from Hood River County into Wasco County. The main tributaries are Crow Creek, Alder Creek, and South Fork Mill Creek (which receives water diverted from Dog River) which combine in Crow Creek Reservoir. Wicks WTP draws water from South Fork Mill Creek, approximately nine miles below the Crow Creek Reservoir. On average, the facility produces about 80% of the City's annual water supply, with the remainder coming from multiple groundwater wells that the City operates in town.

The intake at Wicks WTP diverts water by gravity at a low head dam structure with flashboards; the water then passes through a fish screen before being conveyed to the flash mix basin at the head of the facility. The flash mix basin utilizes a jet injector to disperse the aluminum chlorohydrate (ACH) that is used for coagulation upstream of the hydraulically mixed flocculation basins. The sedimentation basins utilize tube settlers and are covered with hollow-core prestressed concrete slabs to prevent icing of open basins and UV degradation of the plastic tube settlers. Two trains of flocculation and sedimentation are located

upstream of the filters, and two dual-media filters are located ahead of the two clearwells. A process flow diagram of the existing WTP is presented in Figure 1.

Figure 1. Process Flow Diagram of Wicks WTP



1.2 Raw Water Quality

Raw water data dating back to 2019 was reviewed. Total organic carbon (TOC) data was pulled from Oregon Health Authority's (OHA's) Drinking Water Data Online Portal, dating back to 2007. Raw water entering the facility generally has low turbidity, TOC, and alkalinity, with higher turbidity regularly recorded from January through April due to increased precipitation during these months. In the winter, groundwater is occasionally pumped from Wicks Well into South Fork Mill Creek to supplement flows and raise the stream temperature slightly and prevent freezing issues at the intake screens. Raw water quality by season is presented in Table 1. Plots of raw water temperature, turbidity, pH, and alkalinity measured at the headworks of the facility are provided in Figure 2 through Figure 5.

Table 1. Average Raw Water Quality by Season at Wicks WTP

Parameter	Spring (Mar-May)	Summer (Jun-Aug)	Fall (Sep-Nov)	Winter (Dec-Feb)	Full Year
Temperature (°C) [1]	7.4	15.2	9.8	4.3	9.4
Turbidity (NTU) [1]	5.41	1.74	1.12	4.44	3.02
pH [1]	7.40	7.49	7.58	7.46	7.47
TOC (mg/L) [2]	2.6	1.6	1.5	2.4	2.1
Alkalinity (mg/L) [1]	32.8	38.2	44.7	46.0	40.3

[1] Data is from 2019-2023, includes 455-460 data points per season.
[2] Data is from 2007-2023, includes 41-49 data points per season.

Figure 2. Daily Temperature Data, Averaged from 2019-2023

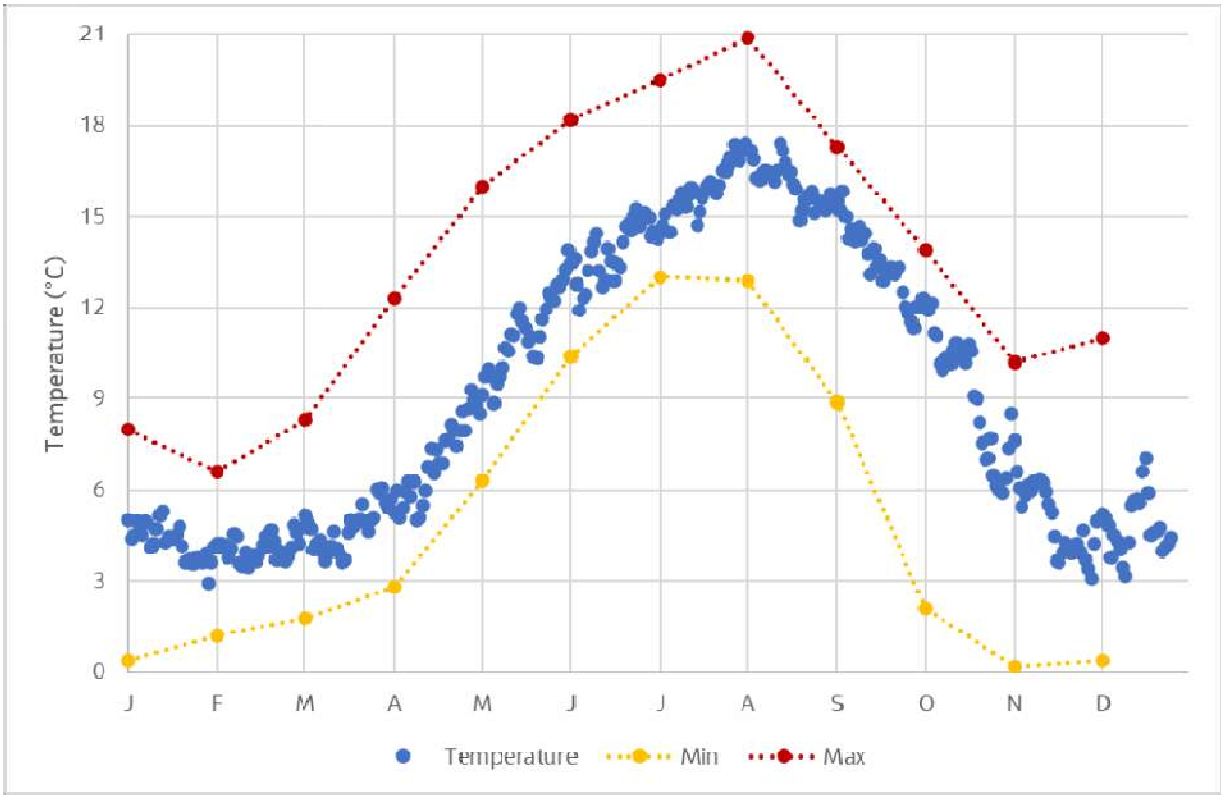


Figure 3. Daily Turbidity Data, Averaged from 2019-2023

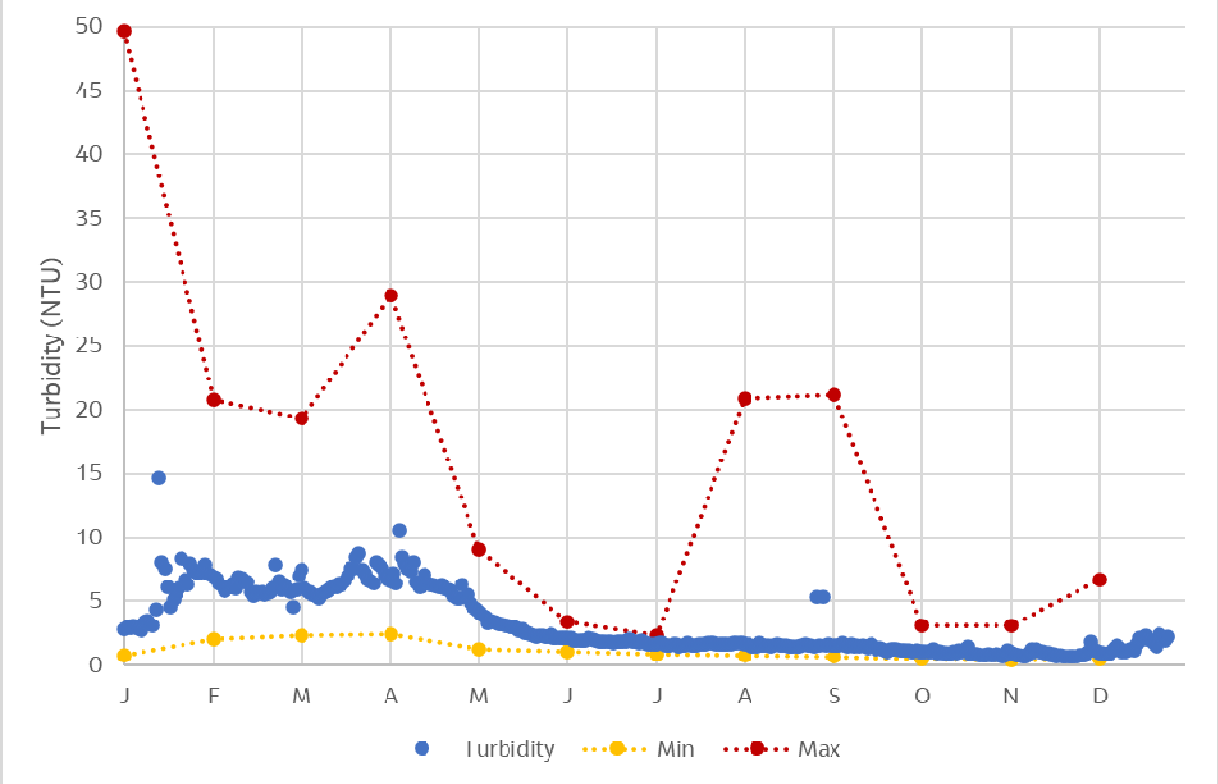


Figure 4. Daily pH Data, Averaged from 2019-2023

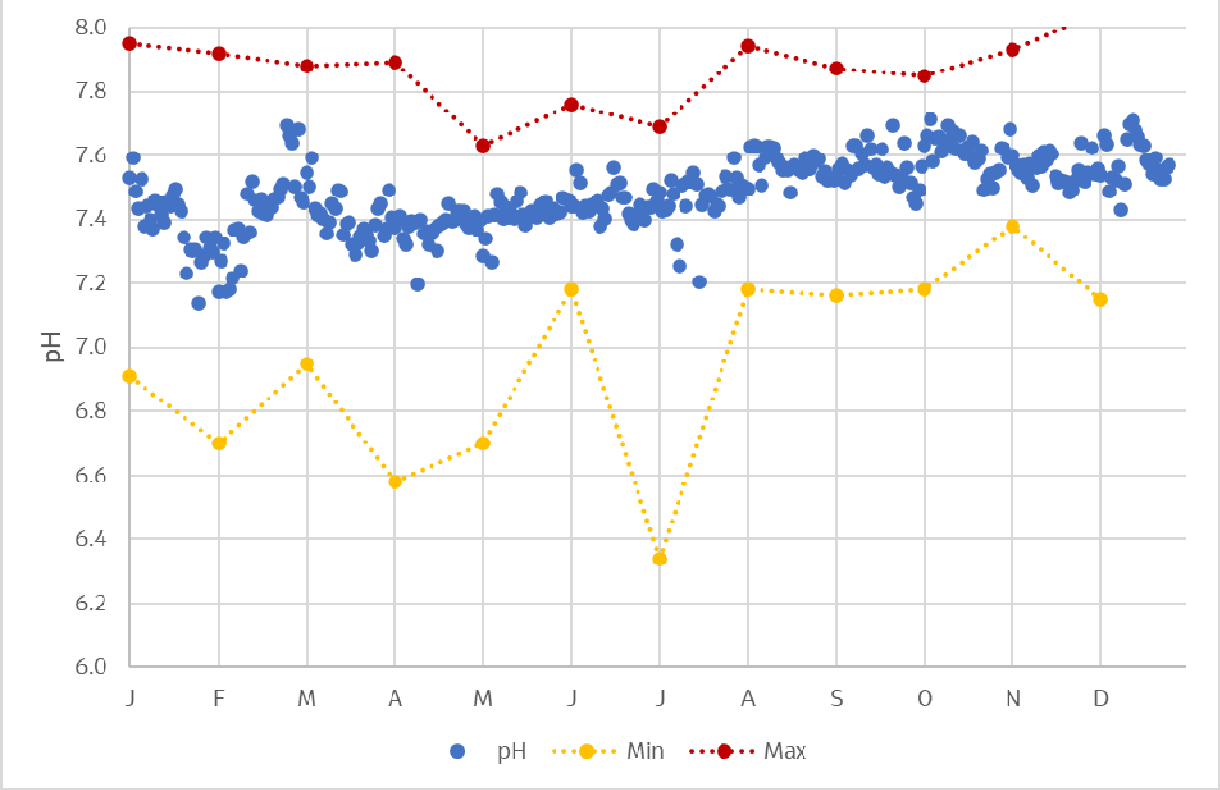
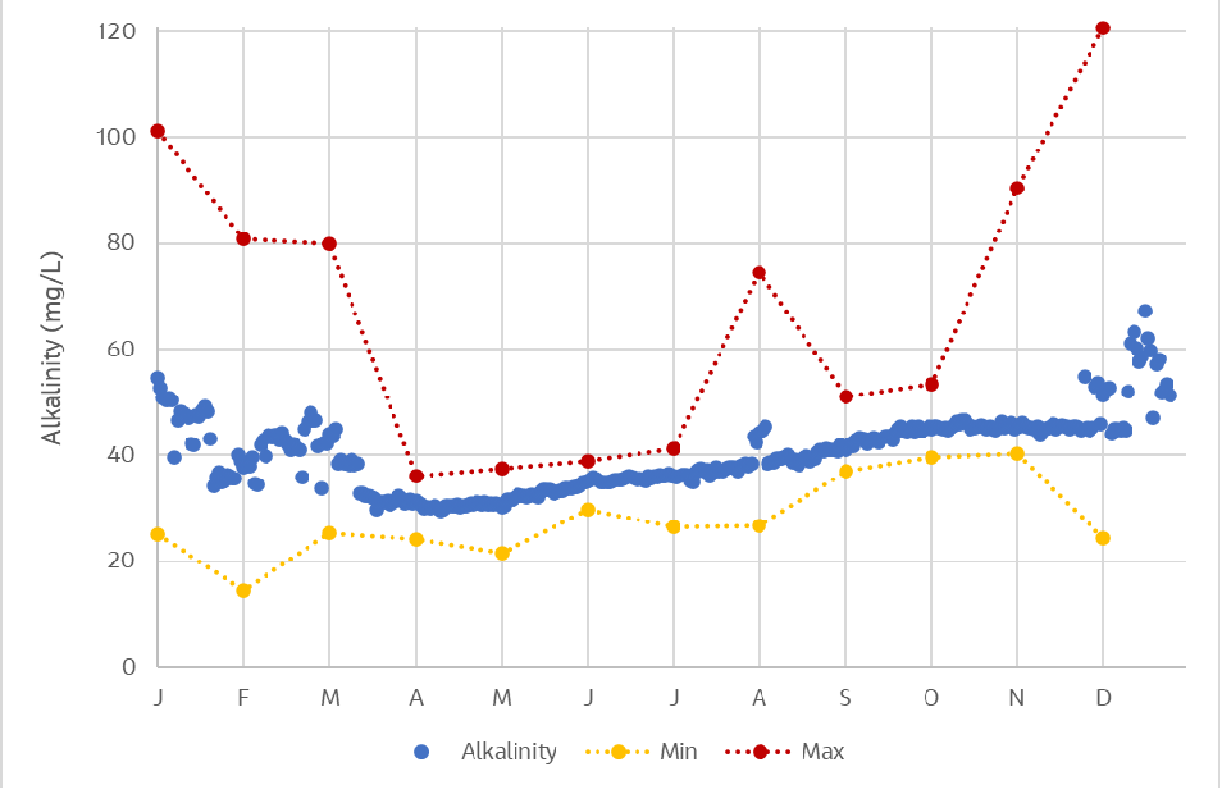


Figure 5. Daily Alkalinity Data, Averaged from 2019-2023



1.3 Regulatory Requirements

The Environmental Protection Agency (EPA) and OHA are the governing regulatory bodies for Wicks WTP. South Fork Mill Creek is a surface water supply and therefore must meet the provisions of the Surface Water Treatment Rule (SWTR) and its successors: the Interim Enhanced Surface Water Treatment Rule (IESWTR), Filter Backwash Rule, Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR), and Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). In addition to meeting federal and state water quality regulations, the City is part of the AWWA Partnership for Safe Water, which establishes stricter performance goals for sedimentation and filtration. Regulatory requirements and AWWA Partnership goals are outlined in Table 2.

Table 2. Regulatory Requirements and AWWA Partnership for Safe Water Performance Goals

Water Quality Requirement/Goal	Regulatory Requirement	AWWA Partnership Performance Goal
Turbidity Criteria		
Clarified Water	Oregon Health Authority optimization goal only	95th percentile < 1.0 NTU for raw waters averaging 10 NTU or less.
Filtration – Combined Filter Effluent	< 0.3 NTU 95% of the time, monthly < 1.0 NTU 100% of the time	95th percentile CFE turbidity < 0.10 NTU, maximum CFE turbidity ≤ 0.30 NTU.
Filtration – Individual Filter Effluent	Optimization goal only	95th percentile IFE turbidity < 0.10 NTU, maximum IFE turbidity ≤ 0.30 NTU.
Filtration Backwash Recovery	None	With filter to waste (FTW): return to service when turbidity <0.10 NTU. Without FTW: maximum backwash recovery period of 15 min to return filter effluent turbidity to <0.10 NTU.
Virus and Protozoa Control		
Giardia Removal/Inactivation	Minimum 3.0-log total, minimum 0.5-log via disinfection	CT values to achieve required inactivation of Giardia and viruses
Cryptosporidium Removal	Minimum 2.0-log total	None
Virus Removal/Inactivation	Minimum 4.0-log total	CT values to achieve required inactivation of Giardia and viruses
Disinfectant Residual		
Total chlorine residual entering distribution system	Minimum 0.2 mg/L	None
Disinfection Byproducts		
Haloacetic Acids (HAA5)	< 60 µg/L annual average	None
Trihalomethanes (TTHM)	< 80 µg/L annual average	None
Corrosion Control		
pH	7.0-8.5	None

1.3.1 Emerging Regulatory Requirements

A review of the status of several potential future regulations was conducted to identify impacts to the WTP if these regulations are finalized. The following discussion highlights the current state of the most critical and relevant regulatory developments for drinking water treatment. The regulatory development that is most likely to impact Wicks WTP is the potential rule regarding cyanotoxins, which is likely to require increased monitoring of the source and finished water when it is implemented. However, it is not expected that this or other rules that are in progress will require modifications to the treatment process.

1.3.1.1 Fifth Unregulated Contaminant Monitoring Rule (UCMR5)

The 1996 Safe Drinking Water Act (SDWA) amendments require that once every five years the EPA issue a new list of no more than 30 unregulated contaminants to be monitored by public water systems (PWSs). The EPA collects data for contaminants that are suspected to be present in drinking water and do not have health-based standards set under the Safe Drinking Water Act (SDWA); it is another iteration of the rulemaking to fill the occurrence data gaps in the Contaminant Candidate List (CCL).

The fifth Unregulated Contaminant Monitoring Rule (UCMR 5) was published in the Federal Register on December 27, 2021. UCMR 5 requires monitoring contaminants between 2023 and 2025 using analytical methods developed by EPA and consensus organizations. This monitoring provides a basis for future regulatory actions to protect public health. The monitoring requirements include 30 compounds including 29 per- and polyfluoroalkyl substances (PFAS) and lithium. Since UCMR 5 monitoring began in 2023, Wicks WTP staff are already familiar with these regulatory requirements. In 2023, no PFAS were detected in any City water sources. Low levels of naturally occurring lithium were found in three well sources, but not South Fork Mill Creek.

On April 10, 2024, the EPA announced the final National Primary Drinking Water Regulation (NPDWR) for six PFAS included in UCMR 5 monitoring. It is possible that more of these compounds become regulated contaminants in the future.

1.3.1.2 Cyanotoxins

The EPA has 10-day health advisories for microcystins and cylindrospermopsin in drinking water, which are non-regulatory values that serve as technical guidance for others. OHA requires specified drinking water systems that use surface water sources susceptible to harmful algae blooms (HABs) to routinely test for cyanotoxins and notify the public about the test results, adopting the health advisory levels put forth by the EPA, as shown in Table 3. The City is currently not on the list of systems required to test for cyanotoxins, though testing is recommended. Per OHA rules, water suppliers will issue a "do not drink" advisory if routine and confirmation samples are over any health advisory level. There are no advisory levels for anatoxin-a or saxitoxins, but OHA should be contacted if they are found in raw or finished water over the course of sampling.

Table 3. Cyanotoxin Advisory Levels

Cyanotoxin	EPA 10-Day Health Advisory / OHA Advisory Levels
Microcystins (Total)	0.3 µg/L for children under 6 years old and vulnerable groups 1.6 µg/L for all age groups
Cylindrospermopsin	0.7 µg/L for children under 6 years old and vulnerable groups 3.0 µg/L for all age groups

Cyanotoxins were included on CCL 3 and CCL 4, and ten different cyanotoxins were sampled for in the monitoring efforts of Fourth Unregulated Contaminant Monitoring Rule (UCMR 4), which was completed in 2020. It is possible that more cyanotoxins receive health advisories or that more stringent regulations are created in the future. Given the historical occurrence of algal blooms on Crow Creek Reservoir and the predicted increase in HAB frequency and magnitude with the impacts of climate change, cyanotoxins could become a concern for the City in the future. Treatment alternatives vary, depending on the cyanotoxin(s) present, but primarily involve oxidation (ozone, chlorine, permanganate, hydroxyl radical, etc.) or physical removal through adsorption (GAC or PAC).

1.3.1.3 Perfluorinated Compounds

On April 10, 2024, the EPA announced the final National Primary Drinking Water Regulation (NPDWR), establishing legally enforceable maximum contaminant levels (MCLs) and non-enforceable maximum contaminant level goals (MCLGs) for six PFAS (Table 4). The rule requires that PWSs must monitor for these PFAS and complete initial monitoring by 2027, followed by ongoing compliance monitoring. Water systems must also provide the public with information on the levels of these PFAS in their drinking water beginning in 2027. If monitoring shows that the MCLs are exceeded in a system's drinking water, then solutions must be implemented by 2029 to reduce PFAS levels. After 2029, PWSs that are in violation of one or more of the MCLs must take action to reduce PFAS levels in their drinking water and notify the public of the violation.

Table 4. MCLGs and MCLs Required by the EPA's PFAS NPDWR

Compound	Final MCLG	Final MCL
PFOA	Zero	4.0 ppt
PFOS	Zero	4.0 ppt
PFHxS	10 ppt	10 ppt
PFNA	10 ppt	10 ppt
HFPO-DA (GenX)	10 ppt	10 ppt
Mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS	1 (unitless) hazard index	1 (unitless) hazard index

Given the nature of the watershed that feeds Wicks WTP and the past sampling showing no PFAS contamination, it is unlikely that Wicks WTP will need to treat for PFAS.

1.3.1.4 Lead and Copper Rule

The original Lead and Copper Rule (LCR) was published by the EPA in 1991, though it has been revised in 2000, 2004, 2007, and most recently in 2021. Additionally, the EPA published the proposed Lead and Copper Rule Improvements (LCRI) in December 2023, building upon the Lead and Copper Rule Revisions (LCRR) promulgated in 2021, which includes the following improvements:

- Locating legacy lead pipes and achieving 100% lead pipe replacement within 10 years
- Improving tap sampling
- Lowering the lead action level
- Strengthening protections to reduce exposure

The City has no known lead service lines and has reduced sampling requirements due to previous sampling results. Furthermore, the addition of phosphates and pH control at Wicks WTP means the City is

well positioned to avoid any lead and copper concerns, as the impacts of this regulatory development are primarily in the operation and maintenance of the distribution system.

1.4 Future Demand Assumptions

Future water demands were provided to Jacobs by Consor and are summarized in Chapters 2 and 4 of the Water System Master Plan Update. The proposed WTP expansion will be designed to maximize the beneficial use of the City's surface water sources through 2074. WTP expansion capacity should be refined as part of predesign and informed by any additional supply analysis and testing completed at that time.

2. Treatment Assessment

The existing treatment process was evaluated during three different assessments: the filter assessment, condition assessment, and capacity assessment. These were performed to provide WTP staff with operational recommendations, as well as to gather information that would be relevant for comparing expansion alternatives to complete replacement alternatives.

2.1 Filter Assessment

An assessment of the existing filters was conducted in April 2023 (Attachment A). The filters were analyzed in multiple ways, following guidance provided in *Filter Evaluation Procedures for Granular Media, Second Edition* (Nix and Taylor 2018). First, filter run data was collected before the filters were drained and the media depth was measured. Filter media samples were collected before and after backwashing to conduct sieve and floc retention analyses. A backwash was performed to monitor bed expansion, backwash flow, and profile backwash turbidity.

Through this assessment, it was determined that the anthracite depth in both filters was 6" to 8" less than the design depth of 26". Additionally, a layer of fines was resting on top of the media, up to 2" in depth, which was collecting a large portion of solids and contributing to premature headloss increases. Following the filter assessment, all of the anthracite within the filters was replaced. The backwash sequence was effectively cleaning the media, but was potentially "overcleaning" the filters, leading to extended filter maturation and the production of fines through excessive surface washing.

2.2 Condition Assessment

A limited condition assessment was performed in April 2023 to evaluate the current condition of the treatment plant. This assessment included preparing an inventory of facilities, unit processes, and equipment at the WTP. All observed items were evaluated to determine their condition and identify any defects. The primary goal of this assessment was gathering information to determine which facilities and equipment will need to be either repaired or replaced in future capital improvements should the existing WTP be left in operation for the coming decades. The following facilities were evaluated during the assessment:

- Wicks Well
- Intake Structure
- Headworks
- Flocculation and Sedimentation
- Filters
- Sludge Lagoons and Drying Beds
- Clearwells
- Chemical Facilities

- Offices and Ancillary Buildings

The condition assessment identified a multitude of defects throughout the facility. However, whether the facility is expanded or replaced, many of these would no longer be necessary as they are associated with infrastructure that would be replaced in either alternative (i.e., admin spaces, chemical buildings, etc.). Other defects, such as the replacement of the existing sodium hypochlorite tanks and some finished water sensors, would be addressed during expansion but present immediate concerns to the continued operation of the facility while WTP construction is underway. Those items were included as early projects in the phasing of the proposed alternative. Of primary concern were safety deficiencies throughout the facility, lack of SCADA connectivity with the facility's intake and chemical systems, exposed supports and paste loss in the concrete basins, the structural integrity of the hollow core sed basin covers, the age of filter gallery piping, and the condition of the wash water tanks.

Whether the facility is expanded or fully replaced also factors into which defects are addressed. With a full replacement, many improvements to the existing treatment process are not worth pursuing, as they were not identified as posing immediate risks to health and safety. With expansion and continued use of the existing facility, many costly improvements to the existing treatment process would be recommended, including secure and remote SCADA integration, full replacement of the tube settlers, and replacement of all filter gallery piping. Existing infrastructure that was assumed to have continued use with a new facility are the Wicks Well, raw water intake, washwater tanks (after replacement), and clearwells.

The total costs associated with the expansion and replacement alternatives are summarized in Table 5. A full list of deficiencies is included in Attachment B.

Table 5. Total Costs to Address Identified Defects in Expansion and Replacement Scenarios

Facility/Area	Wicks WTP Expansion Alternative	Wicks WTP Replacement Alternative
Wicks Well	$215,000	$215,000
Intake	$489,000	$489,000
Headworks/Flash Mix	$1,094,000	-
Flocculation/Sedimentation	$1,652,000	$1,621,000
Filter Facility	$590,000	-
Washwater Tanks	$1,131,000	$1,131,000
Clearwells	$2,159,000	$2,159,000
Chemical and Ancillary Buildings	$60,000	$60,000
Total	**$7,390,000**	**$5,675,000**

2.3 Capacity Assessment

As part of the overall Water Master Plan in which the WTP evaluation was performed, a potential option to meet future water system demand is to treat water at Wicks WTP during the winter at flow rates higher than consumptive demand and store it via aquifer storage and recovery (ASR). The City is currently constructing its first ASR well. Currently, the winter water demand is well below the treatment capacity of the existing Wicks WTP, but given the projections for additional winter demand, the winter capacity of Wicks needed to be determined.

To determine the winter capacity of the existing facility, two capacity assessments were performed during the winter of 2023-2024. The capacity assessments captured raw water conditions that were somewhat typical for winter in The Dalles, with a few caveats. During both capacity assessments, water temperatures were slightly above average for the month of the test. These warmer temperatures may have yielded better performance than what could be typically expected during winter, as colder temperatures will suppress sedimentation and filter performance, leading to shorter filter run times. Turbidity was also above average during both assessments, particularly in the second capacity assessment.

Based on the observations from the first capacity assessment, the Wicks WTP was physically capable of an instantaneous capacity of at least 4.4 MGD during the conditions assessed in December 2023. However, flows between 4.4 and 5.0 MGD were not tested due to time constraints. The results of the second capacity assessment suggested that an instantaneous capacity of 4.8 MGD was feasible during winter conditions with above average temperatures and turbidities. When the flow was set to 2.4 MGD through one flocculation-sedimentation-filter train, no particle breakthrough was observed and a unit filter run volume (UFRV) of 5,000 gal/sf was nearly achieved, almost meeting the UFRV goal of the facility.

Based on both capacity tests, the net filtration capacity during average winter conditions could reach 4.8 MGD (excluding storm events with greater suspended solids and turbidity in the raw water, which would significantly reduce capacity). Assuming a UFRV of 4,000 gal/sf, a net production capacity of 4.1 MGD would be achieved with both filters online (Attachment C).

3. Treatment Alternatives

Treatment alternatives for the future of Wicks WTP were evaluated using a multi-step process that included an alternative prescreening workshop with City staff, multi-objective decision analysis (MODA), and an alternatives assessment workshop with City staff. During the prescreening workshop, the target treatment capacity was established (Section 3.1), undesirable alternatives were removed during prescreening (Section 3.2), and two alternatives were selected to move forward to a full alternatives analysis under expansion and replacement scenarios (Section 3.3). During the alternatives assessment workshop, Jacobs presented proposed ancillary facilities to the new WTP (Section 3.4), siting and phasing assumptions which apply to all alternatives (Sections 3.5 and 3.6), as well as preliminary layouts and costs for the two selected alternatives (Sections 3.7 and 3.8). A greater discussion of the full evaluation of alternatives is presented in Section 6.

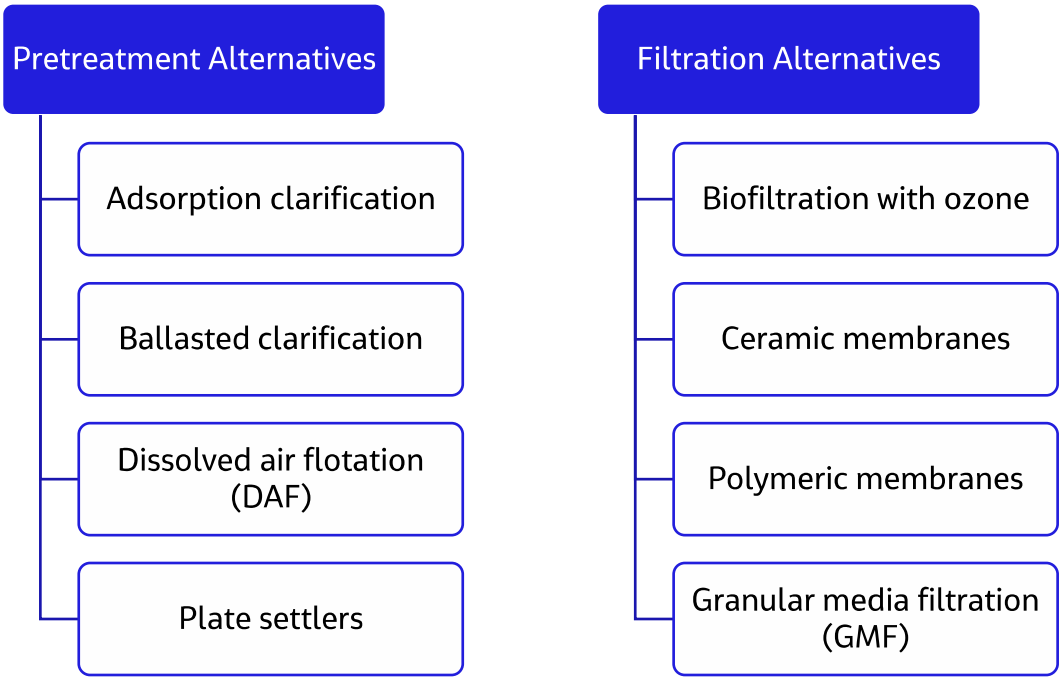
3.1 Target Treatment Capacity

Based on the future water demands provided to Jacobs by Consor (summarized in Chapters 2 and 4 of the Water System Master Plan Update), a target production capacity of 9 MGD was proposed. Conservative water production losses of 5% were assumed to cover potential deviations from the norm, bringing the required treatment capacity of the facility up to 9.5 MGD. This number should be refined during predesign.

3.2 Prescreening

Jacobs, Consor, and City staff met on February 8, 2024, to conduct a screening workshop and review possible alternatives to expanding the Wicks WTP. The alternatives shown in Figure 6 were considered.

Figure 6. The Pretreatment and Filtration Alternatives That Were Considered During Prescreening



The alternatives listed in Table 6 were removed from consideration due to the reasons provided in the table. The remaining alternatives were assigned scores for various criteria (Table 7) before two combinations were selected to move forward with a full alternatives analysis: DAF with GMF and plate settlers with GMF. These were selected as they were viewed as cost effective solutions that could effectively treat the low-turbidity raw water that is typically seen at Wicks WTP. While polymeric membranes scored well overall, they were not selected due to operator concerns about the disposal of membrane cleaning waste streams, since there is no sewer connection on site.

Table 6. Prescreened Treatment Process Alternatives

Alternative	Primary Reason(s) for Exclusion
Adsorption clarification	Unlikely to meet AWWA Partnership for Safe Water Goals.
Ballasted clarification	Not ideal for low turbidity (<20 NTU) water which occurs 99.7% percent of the time.
Clarification with membranes	Unnecessary, given the low turbidity water. Concern over handling of membrane cleaning waste streams, given no existing connection to municipal sewer at the remote WTP site.
Ceramic membranes	More costly than polymeric membranes. More complex operation could lead to staffing concerns. Concern over handling of membrane cleaning waste streams, given no existing connection to municipal sewer.
Biological filtration with ozone	Significant increase to operation and maintenance costs for minimal return, as there is no obvious ozone driver (such as taste and odor concerns or cyanotoxins). Future ozone treatment should be considered in site layout and hydraulic planning.

Table 7. Scores Assigned to the Remaining Alternatives After Prescreening

Performance Criteria	Expansion with GMF	Expansion with Membranes	Plate Settlers with GMF	DAF with GMF	Polymeric Membranes
Microbial Removal and Turbidity Reduction	3	4	4	4	5
DBP Precursor Removal	4	3	4	4	3
Ability to Mitigate Future Taste, Odor, and Cyanotoxin Concerns	3	2	3	4	2
Winter Capacity	3	3	3	4	3
Footprint	2	4	2	3	4
Solids Production	3	4	3	4	5
Solids Disposal	3	1	3	4	1
Chemical Use	3	1	3	4	2
Level of Automation	2	3	3	4	5
Ease of Operation	3	2	3	4	5
Maintenance Requirements	2	1	4	3	2
Capital Cost	$$	$$$	$$$$	$$$$	$$$$
Operating Cost	$$	$$$	$$	$$$	$$$$

3.3 Expansion vs Replacement

With the two alternatives selected in the prescreening workshop, the decision was also made to evaluate both alternatives under two different scenarios: 1) expansion of Wicks WTP and 2) full replacement of Wicks WTP. Given the results of the condition assessment and structural evaluation, it is estimated that the existing facility could continue to be used for an additional 15-25 years with the identified improvements.

The primary concern with expanding the facility develops when this useful period expires and the existing WTP needs to be replaced. With the existing Wicks WTP and the expansion on site, it becomes essentially impossible to construct a replacement facility in the remaining available footprint while maintaining the new increased capacity. As seen in Figure 7, the only remaining space for expansion would be the existing lagoons, unless the land that used to be a Boy Scout Camp (discussed further in Section 3.5) was considered; either option would prove costly. Additionally, the planning, design, and construction of the replacement facility would likely need to begin shortly after the construction of the expansion. For these reasons, the full replacement of Wicks WTP was identified as the only viable alternative.

Figure 7. Layout for a Conceptual 6 MGD DAF Facility Expansion on Site, Demonstrating the Limited Space That Would be Left for Expansion

3.4 Resiliency Considerations

Potential threats to water quality in The Dalles include the presence of MIB, geosmin, and cyanotoxins in Crow Creek Reservoir, as well as fires within the watershed. The City has had occasional instances of taste and order concerns due to the presence of MIB and geosmin, but cyanotoxins have not been detected in Crow Creek Reservoir. Fires impacted the watershed in 1967, 2003, and 2013, with raw water turbidity exceeding 1,000 NTU during these events, though the spike in turbidity was reportedly brief.

Post wildfire, the ability of the proposed alternatives to provide adequate treatment would vary. Ash can become a concern shortly after a fire occurs, though both treatment alternatives could remove ash from water. Increases in sediment loads, DOC, nitrate, and manganese have been reported after wildfires (Murphy et al. 2015) and could prove more difficult. The plate settlers would handle greater sediment loads (i.e., turbidity) better than DAF would, as at high enough turbidities (>100 NTU) the DAF system may need to be taken offline. Increased DOC concentrations may result in greater coagulant demand but could be addressed by either treatment alternative. The presence of nitrate or manganese would prove difficult to treat for either alternative, as nitrate is most commonly removed by ion exchange or reverse osmosis, and manganese treatment typically consists of chemical oxidation (potassium permanganate or chlorine) or sorption through manganese oxide coatings on filter media.

The current Wicks WTP has a PAC system to address these concerns, though it is rarely used. A PAC system was not included in the expansion alternatives but could be added in during detailed design if the City desired increased resiliency to the aforementioned threats to water quality. PAC could be continued to be used if the plate settler alternative was selected, but if DAF is selected then superfine PAC would be required to allow for removal in the DAF basin.

3.5 Ancillary Facilities

Four ancillary facilities were included in the layouts developed for the alternatives analysis:

- Admin Facility

- Backwash Supply Pump Station
- Finished Water Chemical Building
- Treatment Chemical Building

As noted during the condition assessment, many of the ancillary buildings on site require upgrades or replacement to achieve the target lifespan of the facility of at least 15-20 more years. Given their age, condition, and proximity to preferred construction areas, it was assumed that the following facilities would be demolished to provide sufficient room to construct the new WTP:

- Conference Room
- Covered Storage Area
- Generator Building
- Maintenance Shed
- Plumbing Building
- Wicks House

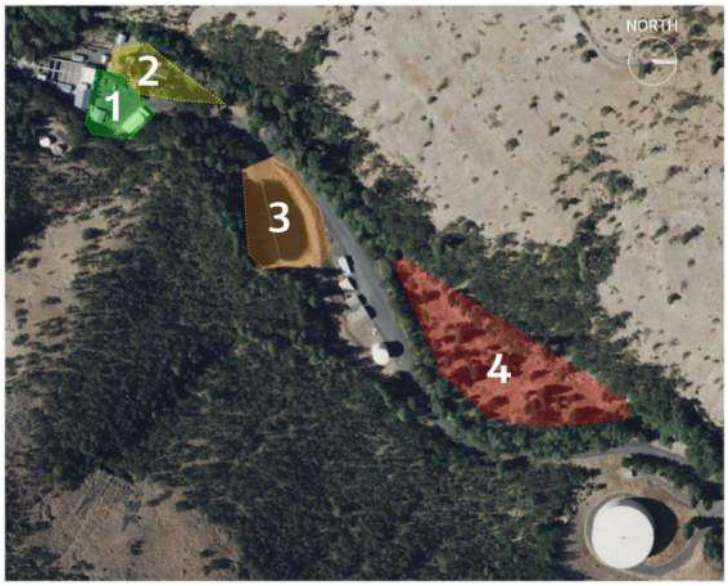
Except for the Wicks House, space to provide the functions of these facilities was included in the sizing of the proposed admin building.

The chemicals needed at the future WTP were divided into two buildings due to space constraints and were separated based on dosing location. The Finished Water Chemical Building contains the equipment associated with the fluoride, caustic soda, polyphosphate, phosphoric acid, and on-site sodium hypochlorite generation systems, while the Treatment Chemical Building contains the equipment associated with the coagulant and filter aid polymer systems.

3.6 Siting Assumptions

Siting assumptions were made for the basis of the WTP evaluation to provide a more accurate cost estimate. Four locations were considered as the most probable areas for the construction of a new WTP (Figure 8):

Figure 8. The Four Siting Alternatives That Were Considered



1. Wicks Parking Lot: The asphalt paved area in front of Wicks WTP. It currently includes 11 parking spots, the conference room, and maintenance shed.

2. Wicks House: The area where the lead operator's residence currently sits, just north of Wicks WTP.

3. Solids Lagoons: The area where the solids lagoons are currently located. The elevation here is approximately 20' lower than the existing WTP and would result in the need for filter effluent pumping and an additional clearwell.

4. Former Boy Scout Camp: The tree-lined area situated west of South Fork Mill Creek.

The Wicks parking lot was selected as the most preferable alternative out of the four. Similar hydraulics to the existing WTP could likely be achieved through the facility since it sits at roughly the same elevation as the existing facility, allowing for the continued gravity feed into the existing clearwells. Additionally, it avoids the need to move the solids lagoons or have construction directly adjacent to South Fork Mill Creek, which was anticipated to increase permitting complexity.

These assumptions form the basis of the costs presented in this report. A more detailed siting evaluation considering the impacts of the location of the WTP expansion will need to be performed before a preferred WTP location and layout can be finalized. The location of a new septic system will need to be considered during the siting evaluation, as the existing WTP's septic system and leach field sits below the parking lot. Additionally, the logistics of continuing ACH deliveries during and after construction would need to be evaluated.

3.7 Phasing Assumptions

Like the preliminary siting assumptions, phasing assumptions were made to provide a more accurate cost estimate. The phasing assumptions were the same for both alternatives, with construction of the new WTP being divided into three phases. Table 8 details the projects that were assumed to be included in each phase. Figure 9 shows the existing Wicks WTP. Figure 9 through Figure 15 show Phases 1A-3A of proposed WTP construction, which are applicable to all treatment alternatives.

The existing plastic tube settlers are at risk of imminent failure. Costs for replacement stainless steel plate settlers were included in CIP Project 1. These costs could be eliminated if WTP construction was expedited and expected to be completed in 7 years or less, as the City could elect to not remove the sedimentation basin covers and leave the existing tube settlers in operation.

Table 8. Projects and associated descriptions for each phase

CIP Project	WTP Construction Phase	Description	Notes/Assumptions
1	Short-Term Improvements	Make necessary improvements to the existing WTP	Replacement of existing pH analyzer, sodium hypochlorite tanks, and track vac air compressor. Demolition of sedimentation basin covers, repair of sedimentation basin walls, and replacement of tube settlers with stainless steel plate settlers is also included, but would be optional dependent on timeline.
2	Planning Studies	Pilot study	Pilot of water treatment process for one year.
	Planning Studies	Survey, geotechnical, and siting evaluation studies	Studies to confirm preferred WTP location, establish existing grade, and identify structural/geotechnical needs.
	Planning Studies	Environmental studies	Studies looking at land use, floodplain, wetlands, endangered species, waterway impacts, and/or cultural resources.
3	1A	Make necessary improvements to the existing WTP	Replacement of CW1 and improvements to washwater tanks.
	1A	Reroute the electrical feed to the existing facility and install a temporary generator onsite for the existing WTP	New access road will need to be routed through area where the generator building is currently located due to excavation extents of WTP construction. New backup generator will be sized during detailed design.
	1B	Demolition of the covered storage area, plumbing building, Wicks House, and generator building	Required to clear space for construction of new access road and admin building. Replacement of these facilities will be included in new Admin Building in Phase 3 (except Wicks House).
	1C	Reroute the existing 12" backwash supply (BWS) and 30" filtered water (FW) lines, and construct residuals piping.	BWS and FW rerouted to avoid conflict with future Finished Water Chemical Building, Admin Building, and WTP construction.

CIP Project	WTP Construction Phase	Description	Notes/Assumptions
4	2A	Construct a new finished water chemical building that stores fluoride, caustic soda, polyphosphate, phosphoric acid, and on-site sodium hypochlorite generation storage and equipment	Constructed in Phase 2 so that the existing hypo and caustic buildings can be demolished in Phase 3 to make space for new Admin Building.
	2A	Construct a new backwash supply pump station	Constructed in Phase 2 so that the existing hypo and caustic buildings can be demolished in Phase 3 to make space for new Admin Building.
	2A	Demolition of the caustic soda and sodium hypochlorite buildings	Required to clear space for future admin building construction.
	2B	Construct a new admin building	Includes a maintenance area, two water quality labs, breakroom, bathrooms/locker rooms, conference room, plant manager office, and operator cubicles.
5	3A	Make necessary improvements to the existing WTP	Improvements to Wicks Well and Intake areas.
	3A	Construct a new 24" raw water pipeline, connecting the existing intake and fish screen to the new WTP	Assumes continued use of the existing intake structure, which has a capacity of 10 MGD.
	3A	Demolition of the conference room and maintenance shed	Required to clear space for future WTP construction.
	3B	Construct a new treatment chemical building	Contains coagulant and filter aid polymer.
	3B	Construct the new WTP	None.
	3B	Construct residuals handling facilities	Residuals handling alternatives discussed in Section 4.

Figure 9. The Existing Wicks WTP

Figure 10. Phase 1A of Wicks WTP Construction

Figure 11. Phase 1B of Wicks WTP Construction

Figure 12. Phase 1C of Wicks WTP Construction

Figure 13. Phase 2A of Wicks WTP Construction

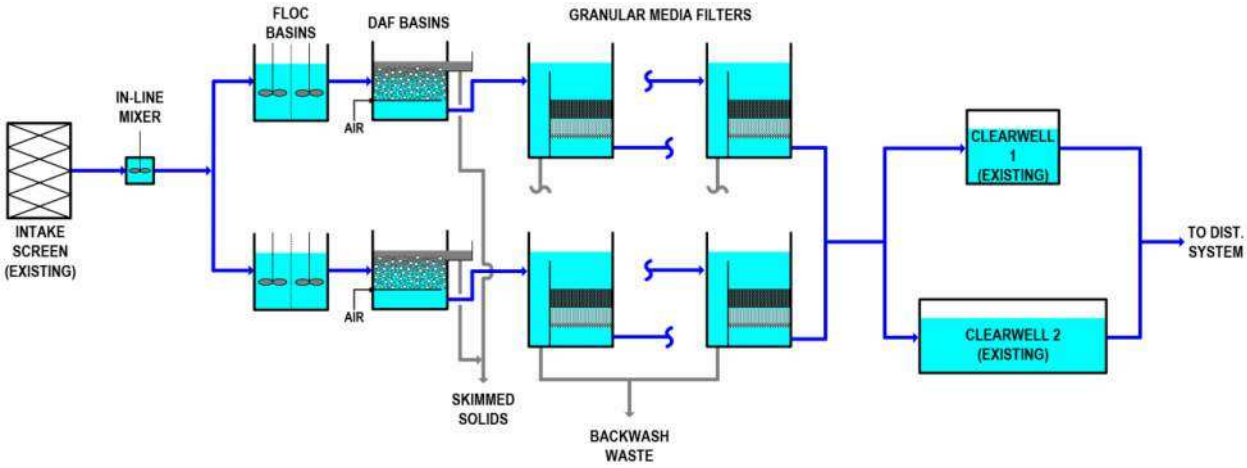
Figure 14. Phase 2B of Wicks WTP Construction

Figure 15. Phase 3A of Wicks WTP Construction

3.8 WTP Alternative A: Dissolved Air Flotation with Granular Media Filtration

Dissolved air flotation is a treatment process that utilizes air saturated, recycled water to produce micro-bubbles that float flocculated solids to the surface of a basin where they can then be skimmed or hydraulically floated to be removed. DAF is known to be effective at treating low turbidity water and water that is impacted by algal blooms. Ahead of the DAF basin, pin floc formation is ideal. To form this pin floc, an in-line rapid mixer upstream of two-stage flocculation with vertical turbine flocculators is proposed. Additional equipment required to operate DAF basins includes recycle pumps, air compressors, air vessels, air spargers, and skimmers. After DAF, water would be filtered by dual media filters. A process flow diagram for Alternative A is included in Figure 16.

Figure 16. Process Flow Diagram for Alternative A



There are a couple of advantages of using DAF over sedimentation with plate settlers. The footprint for DAF basins is much smaller than that required for sedimentation basins, although this is slightly offset by the equipment room required for the recycle pumps and air saturator systems. Since pin floc is all that is needed (versus the larger floc required for plate settlers to be effective), coagulant demand is lower, subsequently reducing solids production. Similarly, since flocculation requires less optimization with DAF, there is greater potential for automation and ease of operation when compared with plate settlers. Perhaps the most significant difference is the greater winter capacity of DAF, since its performance is not as impacted by lower raw water temperatures and cold-water viscosity.

High-turbidity events (>30 NTU) would prove problematic for DAF treatment, with raw water over 70 NTU potentially requiring the plant be taken offline. Thankfully, these events are rare, with raw turbidity only exceeding 30 NTU on five days between 2018 and 2022, and 70 NTU only being exceeded once in that time. During low-flow conditions, such as those typically seen in winter, a couple of considerations would need to be made for the DAF treatment process. Even with one train offline, there would be increased hydraulic retention time in the floc basins, which could produce floc that settles out of solution ahead of the DAF basin. The flocculation treatment process may require closer monitoring during these months to ensure that floc is remaining suspended and is not growing too large. Additionally, DAF recycle pumps would need to be sized to handle the turndown, otherwise a smaller jockey pump may be needed.

Preliminary design criteria for the DAF treatment train are presented in Table 9. Figure 17 provides a preliminary site plan for the DAF facility.

Table 9. Preliminary Design Criteria for Alternative A

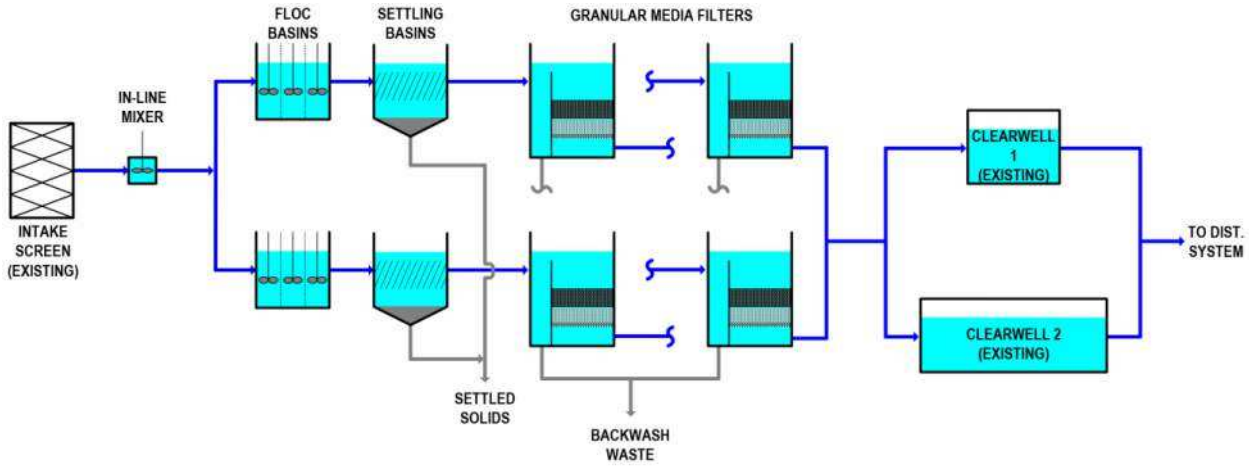
Criterion	Value
Rapid Mix	
Type	In-Line Rapid Mixer
Number of Trains	2
G Value	2,000 s-1
Detention Time	< 15 s
Flocculation	
Type	Vertical Turbine
Number of Trains	2
G Value	60 s-1 / 40 s-1
Detention Time	20 min (10 min per stage)
Dissolved Air Flotation	
Type	High-Rate DAF
Number of Trains	2
Flotation Zone Surface Loading Rate	10 gpm/sf
Filtration	
Type	Dual Media Filters
Top Media	Anthracite
Top Media Depth	60 in
Bottom Media	Sand
Bottom Media Depth	12 in
Filter Hydraulic Loading Rate	8.0 gpm/sf
Number of Filters	3 duty, 1 redundant

Figure 17. Preliminary Site Plan for a 9.5 MGD DAF WTP (Alternative A)

3.9 WTP Alternative B: Plate Settlers with Granular Media Filtration

A sedimentation basin with plate settlers operates under the same principle as the existing tube settlers – the vertical settling distance required for flocculated solids to travel is reduced by forcing water to flow through a narrow path, just between plates rather than through tubes. The proposed plate settlers are made using stainless steel to provide durability and allow for easier maintenance, compared to the existing plastic tube settlers that are susceptible to degradation through UV exposure and chemical attack. A hoseless sludge collector would be installed beneath the plate settlers to periodically capture settled solids. A process flow diagram for Alternative B is included in Figure 18.

Figure 18. Process Flow Diagram for Alternative B



Like the DAF alternative, an in-line rapid mixer and vertical turbine flocculators are utilized upstream of the sedimentation basin. However, three stages of flocculation would be required to achieve the larger floc formation required for proper settling, compared with the two needed upstream of DAF. A greater coagulant dose is also anticipated to be necessary to achieve larger floc formation. Downstream of the sedimentation basin, the filters are sized the same as the DAF alternative.

The use of plate settlers does not have many advantages over DAF. As discussed in Section 3.7, DAF has superior footprint, winter capacity, chemical use, level of automation, ease of operation, solids production, and algae removal. However, since less equipment is used, maintenance requirements are less with plate settlers. Plate settlers are also better suited to handle high-turbidity events, though those are relatively rare at Wicks WTP. The low turbidity, cold water (<20 NTU & <10° C) that is typically seen at Wicks WTP requires well-optimized coagulation and flocculation to most effectively use plate settlers and meet AWWA Partnership Performance Goals, as the City's WTP staff are aware. Construction costs and O&M costs are also expected to be lower, as will be discussed in Section 6.1.

Preliminary design criteria for the plate settler treatment train are presented in Table 10. Figure 19 provides a preliminary site plan for the plate settler facility.

Table 10. Preliminary Design Criteria for Alternative B

Criterion	Value
Rapid Mix	
Type	In-Line Rapid Mixer
Number of Trains	2
G Value	2,000 s^{-1}
Detention Time	< 15 s
Flocculation	
Type	Vertical Turbine
Number of Trains	2
G Value	60 s^{-1} / 40 s^{-1} / 20 s^{-1}
Detention Time	30 min (10 min per stage)
Sedimentation	
Type	Plate Settlers
Number of Trains	2
Plate Loading Rate	0.30 gpm/sf
Filtration	
Type	Dual Media Filters
Top Media	Anthracite
Top Media Depth	60 in
Bottom Media	Sand
Bottom Media Depth	12 in
Filter Hydraulic Loading Rate	8.0 gpm/sf
Number of Filters	3 duty, 1 redundant

Figure 19. Preliminary Site Plan for a 9.5 MGD Plate Settler WTP (Alternative B)

4. Residuals Handling Alternatives

Wicks WTP's current residuals handling consists of two solids lagoons where all process drains, settled solids, backwash waste (BWW), and FTW flows are sent. Each pond has a footprint of approximately 13,300 sf and can hold approximately 400,000 gallons at a maximum depth of 4.5 feet. Decant from the ponds is discharged to South Fork Mill Creek, which leads to the total maximum daily load (TMDL) excess thermal load exceedances that the City currently faces, as the temperature in the lagoons is greater than that seen in the creek.

Residuals concentrations and quantities produced by DAF would depend on how the floated solids are removed. The two options for floated solids removal are mechanical skimming and hydraulic float removal. Mechanical skimming creates residuals with higher solids content (1-3%) at the expense of additional mechanical equipment to maintain. Alternatively, hydraulic float removal would produce solids at 0.2-0.5% at the expense of additional wastewater produced.

Residuals concentrations produced by a new plate settler facility would be similar to those seen in the existing facility. Solids content in the settled solids would likely range from 0.25-0.50% but could be greater during high solids loading conditions.

Only one alternative was removed from consideration during prescreening – sending residuals flows to the municipal sewer system. This alternative was eliminated since the WTP is on a septic system and approximately seven miles of sewer main would need to be installed to connect to the City's sewer system. For the remaining alternatives considered, it was assumed that a recycle pump station would be present, sending flows up to 10% of the incoming raw water flow back to the front of the WTP and eliminating the discharge back to South Fork Mill Creek. Three residuals handling improvement alternatives were considered:

1. Backwash equalization (EQ) basin with no backwash clarification upstream of engineered drying beds (EDBs)
2. Backwash EQ basin with a separate clarification basin utilizing lamella plate clarifiers upstream of EDBs
3. Backwash EQ basin with a separate clarification basin utilizing lamella plate clarifiers upstream of gravity thickeners and mechanical dewatering

4.1 Residuals Alternative A: Engineered Drying Beds with No Backwash Clarification

In this alternative, backwash flows would be directed to a backwash EQ basin, before being sent to the EDBs. Float from the DAF basins would be sent directly to the EDBs in a separate pipe for operational flexibility. The engineered drying beds would include an underdrain system beneath a sand layer to allow for solids retention during draining, as well as a decant weir. Decant and/or filtrate from the EDBs would be sent to a recycle pump station where it would be recycled to the head of the facility or another drying bed. Regulations allow for this to be up to 10% of total plant flow. Dried solids would be hauled away and disposed of offsite (Figure 20). The design criteria are summarized in Table 15.

While this alternative avoids construction costs associated with BW clarifiers and a second recycle pump station, these savings are mostly offset by the need to run two pipes down to the EDBs (BWW/FTW and clarification solids) rather than just one. Additionally, the performance of the EDBs would be worsened since the solids content of the BWW and FTW streams would be lower with no upstream clarification of these flows.

Figure 20. Process Flow Diagram for Residuals Handling Alternative A

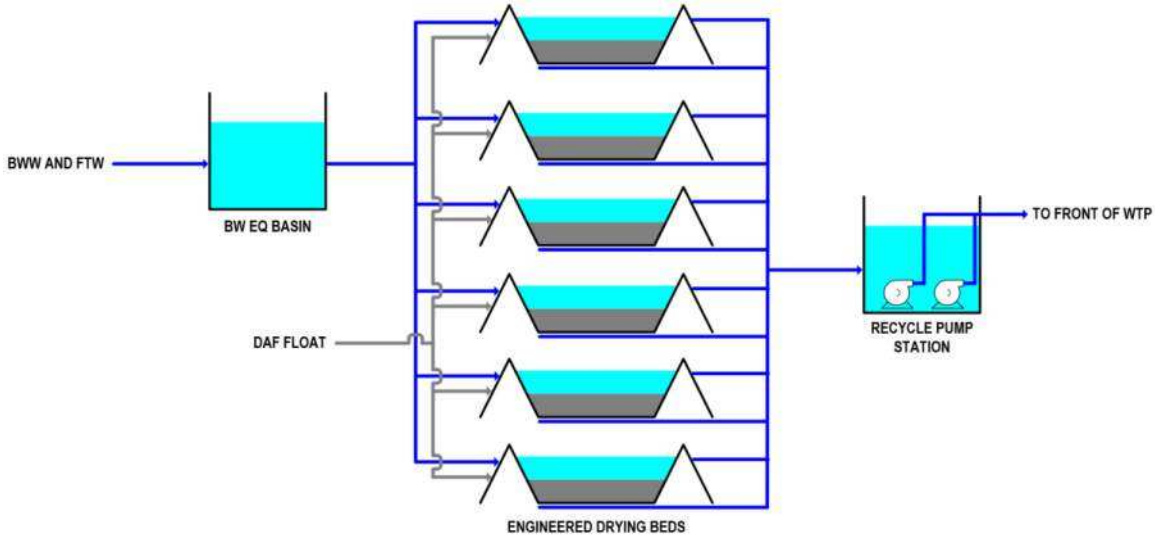


Table 11. Preliminary Design Criteria for Residuals Alternative A

Criterion	Value
Backwash Equalization Basin	
Number of Backwashes Stored	2
Backwash Volume	82,500 gal
Basin Volume	165,000 gal
Basin Dimensions (L x W x H)	54 ft x 27 ft x 17 ft
Engineered Drying Beds	
Number	6
Dry Solids Loading Rate	14 lb/sf/yr
Wet Tons of Sludge per Year	426 tons/yr
Daily Sludge Flow to Beds	7,500 gpd
Total Drying Bed Area	24,300 sf (0.56 ac)
Recycle Pump Station	
Number of Pumps	2 (1+1)
Type	Submersible
Pump Capacity, Each	110 gpm

4.2 Residuals Alternative B: Engineered Drying Beds with Backwash Clarification

In this alternative, backwash flows would be directed to a backwash EQ basin, before being sent to a packaged backwash clarifier. Settled solids would be collected and combined with float from the DAF basins before being sent to the EDBs. The engineered drying beds would include an underdrain system

beneath a sand layer to allow for solids retention during draining, as well as a decant weir. Clarified backwash water would be recycled to the front of the facility, along with decant and/or filtrate from the EDBs, up to 10% of total plant flow. Dried solids would be hauled away and disposed of offsite (Figure 21).

The addition of a backwash clarifier has the benefit of allowing for one pipe to be run to the EDBs, where both DAF float and BW clarifier solids can be sent. EDB performance would also be optimized since the solids content of the flows that they would accept would be greater.

Figure 21. Process Flow Diagram for Residuals Handling Alternative B

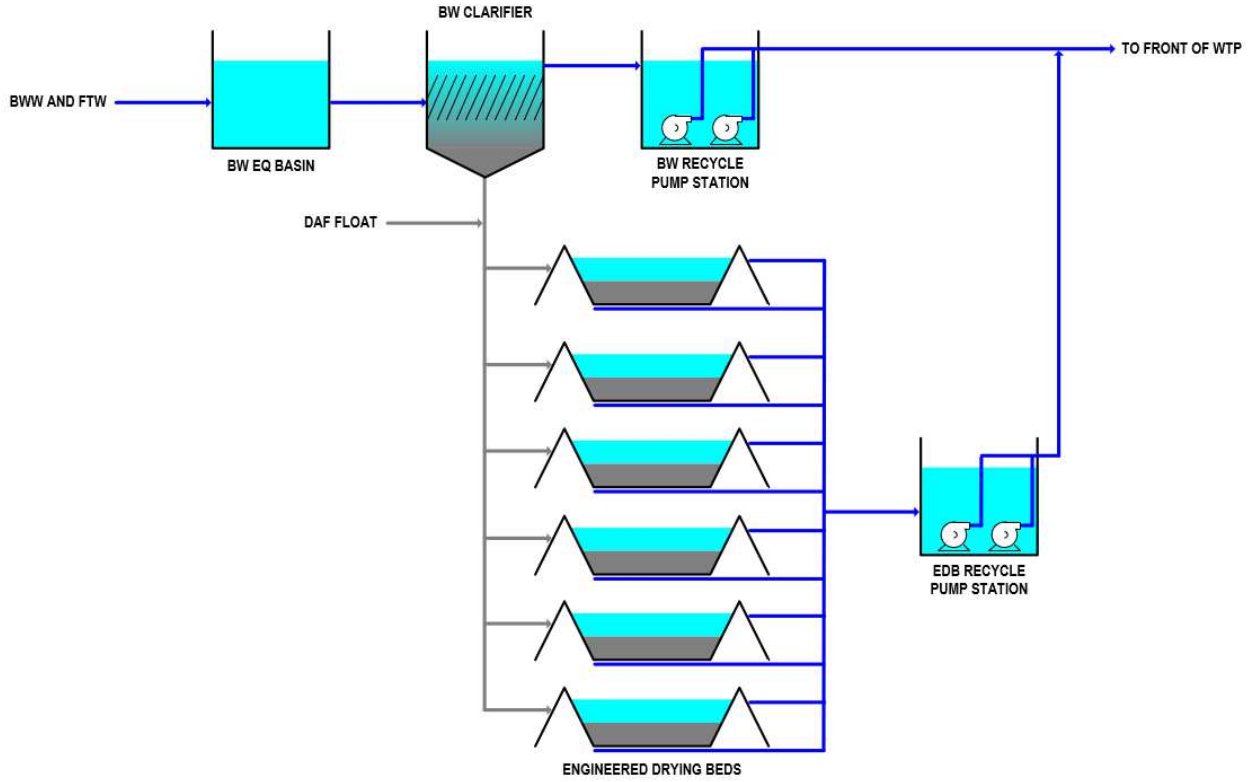


Table 12. Preliminary Design Criteria for Residuals Alternative B

Criterion	Value
Backwash Equalization Basin	
Number of Backwashes Stored	2
Backwash Volume	82,500 gal
Basin Volume	165,000 gal
Basin Dimensions (L x W x H)	54 ft x 27 ft x 17 ft
Backwash Clarifier	
Type	Packaged Tank – Lamella Plates
Flow	230 gpm
Tank Dimensions (L x W x H)	20 ft x 8 ft x 10 ft
Plate Loading Rate	0.35 gpm/sf @ 90% efficiency factor

Criterion	Value
Backwash Recycle Pump Station	
Number of Pumps	2 (1+1)
Type	Submersible
Pump Capacity, Each	115 gpm
Engineered Drying Beds	
Number	6
Dry Solids Loading Rate	14 lb/sf/yr
Wet Tons of Sludge per Year	426 tons/yr
Daily Sludge Flow to Beds	7,500 gpd
Total Drying Bed Area	24,300 sf (0.56 ac)
Recycle Pump Station	
Number of Pumps	2 (1+1)
Type	Submersible
Pump Capacity, Each	20 gpm

4.3 Residuals Alternative C: Mechanical Dewatering

In this alternative, backwash flows would be directed to a backwash EQ basin, before being sent to a packaged backwash clarifier. Settled solids would be collected and combined with float from the DAF basins before being sent to a gravity thickener. The solids would thicken in this basin through additional settling time and the addition of polymer. Thickened solids would be fed to mechanical dewatering equipment (e.g., centrifuges or screw presses), where the solids would be dewatered and collected in a roll-off dumpster before being hauled offsite. Centrate/pressate from the mechanical dewatering equipment and decant from the gravity thickener would be collected in a pump station and recycled to the front of the facility (Figure 22).

The use of mechanical dewatering would require much more operator attention than EDBs. It is anticipated that the centrifuges or screw presses would need to be operated twice a week for 8 hours, with some supervision required at times during their operation. One or two polymers would need to be dosed in the gravity thickeners, leading to increased chemical costs. Finally, there would be additional equipment to maintain, including gravity thickener drives, thickened sludge pumps, centrifuges/screw presses, chemical pumps, and more, increasing maintenance needs and O&M costs.

Figure 22. Process Flow Diagram for Residuals Handling Alternative C

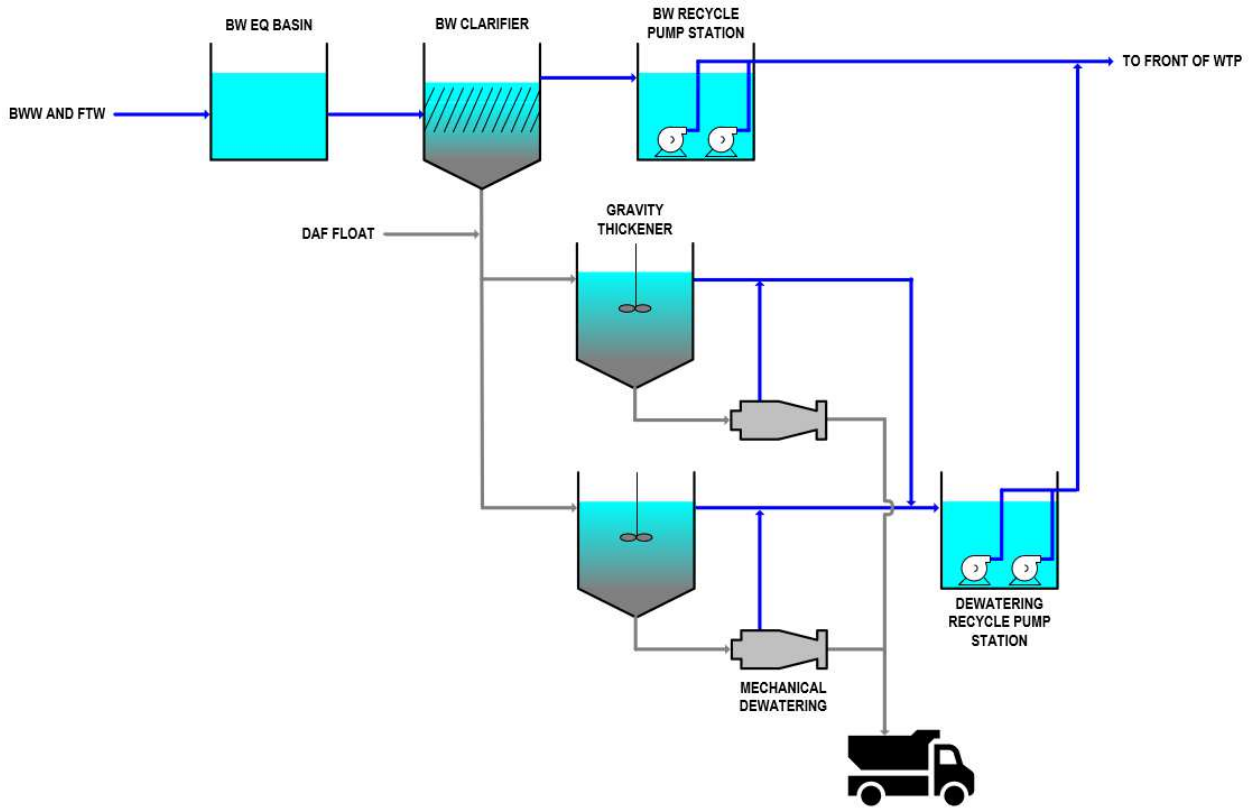


Table 13. Preliminary Design Criteria for Residuals Alternative C

Criterion	Value
Backwash Equalization Basin	
Number of Backwashes Stored	2
Backwash Volume	82,500 gal
Basin Volume	165,000 gal
Basin Dimensions (L x W x H)	54 ft x 27 ft x 17 ft
Backwash Clarifier	
Type	Packaged Tank – Lamella Plates
Flow	230 gpm
Tank Dimensions (L x W x H)	20 ft x 8 ft x 10 ft
Plate Loading Rate	0.35 gpm/sf
Backwash Recycle Pump Station	
Number of Pumps	2 (1+1)
Type	Submersible
Pump Capacity, Each	115 gpm

Criterion	Value
Gravity Thickener	
Number of Basins	2
Basin Dimensions (D x H)	23 ft x 27 ft
Hydraulic Loading Rate	300 gpd/sf
Solids Loading Rate	10 lb/d/sf
Thickened Sludge Pump Station	
Type	Progressive Cavity
Number of Sludge Pumps	2 (1+1)
Sludge Pump Capacity, Each	20 gpm
Mechanical Dewatering	
Type	Centrifuge or Screw Press
Number	2
Sludge Flow, Dry Solids	410 lb/hr
Sludge Flow, Wet Solids	40 gpm
Recycle Pump Station	
Number of Pumps	2 (1+1)
Type	Submersible
Pump Capacity, Each	20 gpm

4.4 Residuals Alternative Evaluation

Cost estimates were prepared to compare the proposed alternatives using Jacobs' Replica™ Parametric Design and budgetary quotes from equipment manufacturers for centrifuges, screw presses, and packaged plate settler systems. These costs are summarized in Table 14. Mechanical dewatering was subsequently removed from consideration due to its cost and increased O&M demands. Since the addition of backwash clarification adds minimal cost but would significantly improve the performance of the residuals handling system, Alternative B was selected as the preferred residuals handling approach.

Table 14. Total Costs for Each Residuals Handling Alternative

Component/ Facility	Alternative A: EDBs, No BW Clarification	Alternative B: EDBs, BW Clarification	Alternative C: Mechanical Dewatering
BW EQ Basin	$1,295,000	$1,295,000	$1,295,000
BW Clarifier and Recycle PS	-	$889,000	$889,000
Engineered Drying Beds	$1,267,000	$1,267,000	-
Gravity Thickener	-	-	$1,443,000
Centrifuge/Screw Press	-	-	$5,109,000

Component/ Facility	Alternative A: EDBs, No BW Clarification	Alternative B: EDBs, BW Clarification	Alternative C: Mechanical Dewatering
Centrate/Pressate/Decant Recycle PS	$532,000	$532,000	$532,000
Yard Piping	$3,182,000	$2,335,000	$2,335,000
Total	$6,276,000	$6,318,000	$11,603,000

5. TMDL Compliance

The City has seasonal excess thermal loads that put them out of compliance with their waste load allocation established in the Middle Columbia-Hood (Miles Creeks) Subbasin TMDL (2008). This issue is a result of the current Wicks WTP residuals handling process, where settled solids and BWW is sent to two lagoons where solids can settle out before the liquid stream is discharged to South Fork Mill Creek. Since the lagoons are shallow, the water heats up to be warmer than the Creek, and the thermal loads associated with the discharge volume of this warmer water exceed the thermal load allocation for Wicks WTP.

Jacobs' scope included identifying the seasonal excess thermal loads and assessing potential mitigation measures, including riparian restoration, backwash recirculation, cooling tower(s), and hyporheic discharge. This analysis is discussed further in Attachment D. However, over the course of the WTP alternatives analysis, it became clear that backwash recirculation is essential to meet future water demands of the City, since the flows in South Fork Mill Creek are expected to limit the amount of water that can be fed to Wicks WTP in the future. As a result of this, zero liquid discharge (ZLD), or as close to ZLD as possible, will be essential for the City to fully utilize their water rights, which will be achieved with recycle pump stations in the residuals handling system as described in Section 4.

6. Evaluation of Alternatives

6.1 Capital and Operating Costs

Using guidelines provided by The Association for the Advancement of Cost Engineering (AACE), a Class 5 cost estimate was prepared. This level of cost estimate is for a project that is 0-2% complete for the purpose of concept screening. Given this level of cost estimate, the expected accuracy range on the low end is between -20% to -50% and between +30% to +100% on the high end. Costs were escalated to the estimated midpoint of construction, based upon economic data from Global Insight, Inc. and the United States Bureau of Labor Statistics and ENR indices.

The final costs of the project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimate presented herein. Project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

Jacobs' estimate is based on material, equipment, and labor pricing as of May 2024 and uses conceptual and stochastic costs and detailed items using separate labor, material, and equipment costs. The estimate uses parametric costs where design information or details are insufficient to allow a detailed item method. At this level of estimate, AACE recommends adding a 30 percent budgeting contingency when considering funding needs. 20-year life cycle costs for each WTP alternative are summarized in Table 15, broken down

by project phase and O&M costs. A detailed breakdown of these cost estimates is included in Attachment E.

Table 15. Capital, O&M, and 20-Year Life Cycle Costs Associated with Each WTP Alternative

CIP Project	WTP Construction Phase	DAF	Plate Settlers
1	Short-Term Improvements	$1,675,000*	$1,675,000*
2	Planning Studies	$2,200,000	$2,200,000
3	1A	$3,973,000	$3,973,000
	1B	$1,017,000	$1,017,000
	1C	$5,750,000	$5,750,000
4	2A	$9,272,000	$9,272,000
	2B	$6,557,000	$6,557,000
5	3A	$2,836,000	$2,836,000
	3B	$55,330,000	$52,506,000
Subtotal	Capital Costs	$88,610,000	$85,786,000
O&M	20-Year O&M Costs	$23,943,000	$22,772,000
Total	20-Year Life Cycle Costs	$112,553,000	$108,558,000

*Includes $1,607,000 for existing sedimentation basin upgrades described in Section 3.7. May not be required if WTP replacement is expedited.

6.2 Multi-Objective Decision Analysis

To evaluate the alternatives as objectively as possible with the City's priorities in mind, multi-objective decision analysis (MODA) was utilized. MODA is a quantitative technique that aids in the evaluation of alternatives where multiple objectives or evaluation criteria warrant consideration.

6.2.1 Evaluation Criteria

Evaluation criteria between three categories were developed with input from a diverse group of City staff. These criteria are presented in Table 16.

Table 16. Evaluation Criteria Used in MODA

Category	Evaluation Criteria
Construction	Footprint
	Constructability
	Expansion complexity
Operation	Winter capacity
	Chemical use
	Level of automation
	Ease of operation
	Maintenance requirements

Category	Evaluation Criteria
	Solids production
Water Quality	Microbial removal and turbidity reduction
	Ability to mitigate future taste and odor (T&O) and cyanotoxin concerns

6.2.2 Measurement Scales

Measurement scales are required to determine how well alternatives perform against the evaluation criteria. Scales may be quantitative or qualitative, depending on the objective and the availability of data. The measurement scales developed for this evaluation are presented in Table 17.

Table 17. Measurement Scales for the Evaluation Criteria Used in MODA

Decision Criteria	Worst Outcome	Best Outcome
Construction		
Footprint	Final WTP takes up 18,000+ SF	Final WTP takes up less than 10,000 SF.
Constructability	Approach has many challenging constructability issues exist that have the potential to negatively affect construction cost or schedule (e.g., geotechnical, existing plant infrastructure, open cut construction)	Approach has few challenging issues that could negatively affect construction costs or schedule.
Expansion complexity	Expansion likely requires building over solids lagoons or the former Boy Scout camp	Expansion can be achieved in footprint of existing WTP.
Operation		
Winter capacity	Winter capacity as a percentage of max WTP capacity is approximately 60%	Winter capacity as a percentage of max WTP capacity is approximately 80%
Chemical use	Chemical use and doses are similar to existing	Chemical use and doses are lower than existing
Level of automation	Treatment process requires large amounts of manual automation and regular jar testing	Treatment process can be fully automated and requires minimal jar testing
Ease of operation	Approach results in highly complex operational requirements for WTP	Approach results in relatively simple operational requirements for WTP
Maintenance requirements	System maintenance requirements are complex and challenging requiring new, high levels of skill and training	System maintenance requirements not likely to require skill, challenges, or training beyond that required today
Solids production	Treatment process increases solids production compared to existing	Treatment process decreases solids production compared to existing

Decision Criteria	Worst Outcome	Best Outcome
Production Efficiency	WTP is 90% water efficient	WTP is 97% water efficient
Water Quality		
Microbial removal and turbidity reduction	Treatment process meets all regulatory criteria but does not meet some Partnership for Safe Water targets	Treatment process meets all regulatory criteria and Partnership for Safe Water goals
Ability to mitigate future taste and odor and cyanotoxin concerns	Treatment process is not particularly adaptable; future taste and odor and cyanotoxin presence would result in substantial investment need	Treatment process is highly adaptable; future taste and odor and cyanotoxin presence could be addressed with little investment need

6.2.3 Scoring Alternatives

Scoring alternatives is the process by which the measurement scales are applied to the alternatives. The alternatives were initially scored by Jacobs engineering staff and then reviewed and adjusted by the City and consultant project team. A scoring scale of 1 to 5 was implemented for each evaluation criterion except operating footprint (measured in square footage), winter capacity (measured as a percent of max WTP capacity), and production efficiency (measured as the percent of water not lost through treatment). For the 1-5 scale, the worst outcome is given a score of 1 and the best outcome a score of 5. The scores for each alternative are included in Table F-1 in Attachment F.

6.2.4 Relative Value Weights

Evaluation criteria vary in their importance, which needs to be accounted for when deciding the relative merits of different alternatives. Thus, relative value weights are assigned to each criterion that represent the importance of each criterion for decision making. For this evaluation, weights were assigned by each member of the City's project team and discussed in a workshop. All of the assigned weights provided by City staff resulted in the same alternative being selected as the preferred option. The consensus set of weights for the evaluation criteria are presented in Table F-2 in Attachment F.

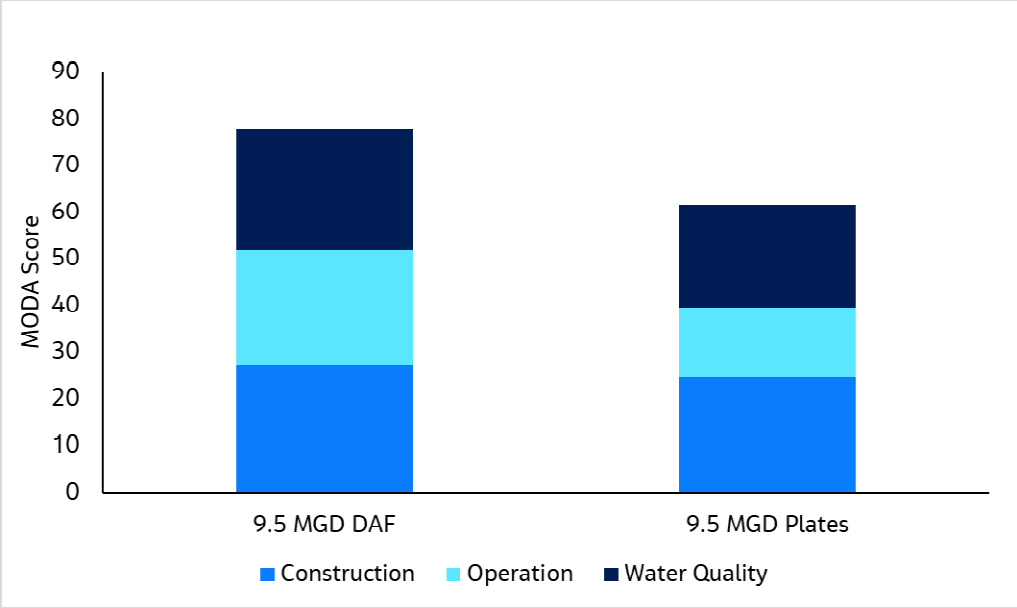
6.2.5 Results

The total value score of each alternative was calculated in a weighted average. In MODA, the raw scores shown in Table 18 are arithmetically transformed, based on the measurement scales presented in Table 17, to allow for an equal comparison between criteria with different measurement scales. The normalized scores were multiplied by the weights presented in Table F-2 and summed for each alternative. Resulting MODA scores for the consensus weights are presented in Table 18 and Figure 23. A greater score denotes the alternative with the best overall outcomes.

Table 18. MODA Results for Treatment Plant Alternatives (Higher Values Equate to a Better Outcome)

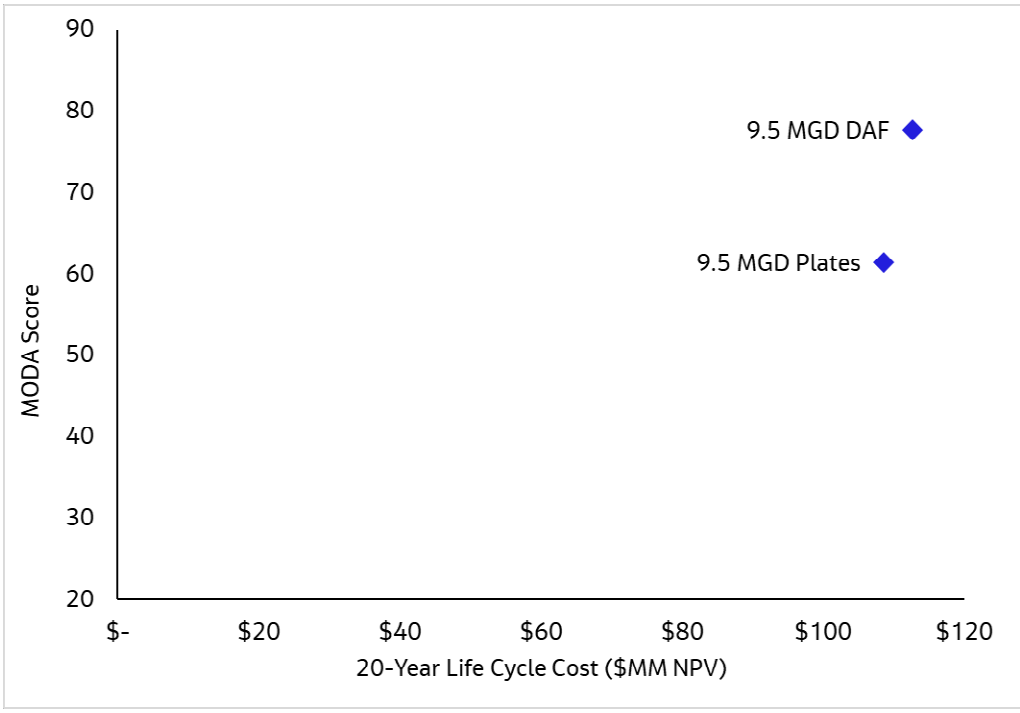
Evaluation Criterion	DAF with GMF	Plate Settlers with GMF
Construction	27.1	24.6
Operation	24.7	14.9
Water Quality	26.0	22.0
Total	77.8	61.5

Figure 23. MODA Results for Treatment Plant Alternatives



As shown in Figure 23, DAF with GMF scored the highest between the two alternatives. DAF outperformed plate settlers in all three evaluation categories, though construction and water quality scores were similar between both alternatives. Operation is where DAF scored considerably higher than plate settlers, due to its greater winter capacity, lower chemical use, higher degree of automation, less stringent floc formation requirements, and lower solids production. While DAF is the more expensive alternative, the estimated cost is only about 4% greater to achieve a more easily operable facility that is better suited for the raw water typically seen in The Dalles (Figure 24).

Figure 24. MODA Value to Cost Comparison



7. Conclusions

Due to the age and condition of the existing facility, a full replacement of the WTP with a new 9.5 MGD facility is recommended. While expanding Wicks WTP may have some short-term cost savings, those savings are lost when the old Wicks WTP requires replacement in 15-25 years. The proposed water treatment process includes DAF with GMF to improve automation and ease of operation, while reducing chemical demands and solids production. The proposed residuals handling process includes a backwash EQ basin, BW clarifier, and EDBs, to help the City fully utilize the water that is sent to Wicks WTP and significantly reduce discharges to South Fork Mill Creek, preventing further issues with TMDL compliance. Figure 25 shows a rendering of the proposed WTP replacement configuration, which will be further refined based on the outcome of future evaluations.

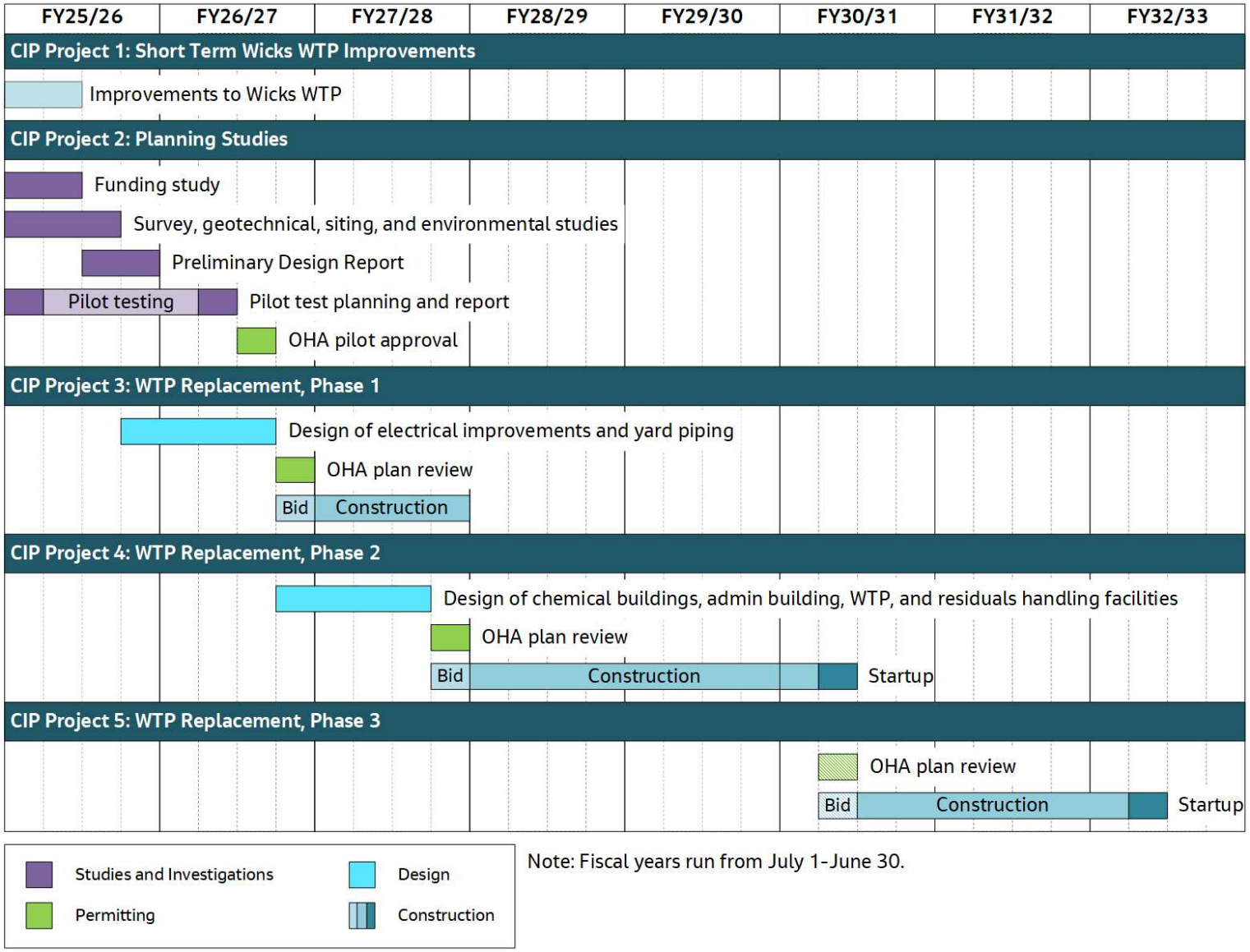
Figure 25. Replacement WTP Rendering

7.1 Implementation

Before Wicks WTP can be replaced, extensive permitting, planning, and design work will need to be undertaken. A proposed schedule of these tasks, based on the phasing outlined in Section 3.6, is provided in Figure 26. Crucially, the first step to replacing Wicks WTP will be to secure funding. However, because the funding schedule is highly dependent on the type of funding pursued, a funding study is proposed to occur at the beginning of the Wicks WTP replacement and the exact funding schedule has been left out of the preliminary schedule of WTP improvement projects. The OHA plan review and bidding of CIP Project 5 is shown hatched, as it is proposed that this project be combined with CIP Project 4 and bid simultaneously to reduce overall project cost.

An alternative timeline was investigated which would expedite construction of the new WTP. If the preliminary studies and design were conducted as quickly as possible, and all construction projects consolidated into one project to allow for overlap between phases, it is believed that the overall construction timeline presented in Figure 26 could be shortened by up to 18 months. The proposed changes would likely be the fastest that the proposed WTP alternative could be constructed.

Figure 26. Preliminary Schedule of WTP Improvement Projects



8. References

Murphy, Sheila F, et al. 2015. "The role of precipitation type, intensity, and spatial distribution in source water quality after wildfire." *Environmental Research Letters*. Vol. 10, No. 8. August.

Nix, Daniel and John Taylor. 2018. *Filter Evaluation Procedures for Granular Media*. Denver, CO: American Water Works Association.

Attachment A
Filter Surveillance Assessment

Wicks WTP Filter Surveillance Assessment

Date: September 13, 2023
Project name: The Dalles Water System Master Plan
Project no: D3718900
Client: City of The Dalles, OR
Prepared by: Talia Assi
Enoch Nicholson, P.E.
Reviewed by: Enoch Nicholson, P.E.

1. Description of Evaluations Performed

A site visit of The Dalles, OR Wicks WTP was conducted on April 6th, 2023, to evaluate the performance of the existing filtration system, as part of the water treatment plant evaluation task for the City's Water Master Plan update project. Enoch Nicholson and Talia Assi from Jacobs worked with Larry McCollum and Tyler Mitchell from the City to complete the filter evaluation. The following details the activities completed while onsite, follow up testing and information needed, and conclusions to date.

1.1 WTP Orientation

Larry and Tyler oriented Enoch and Talia to the filter system which is immediately downstream of flocculation and sedimentation. The facility includes two conventional filters (Filter 1 and Filter 2). Each filter has a filter surface area of 300 sq ft. and is rated for 6.48 gpm/sf or 2.8 MGD. The design filtration media depth is a total of 41" (26" Anthracite, 12" Sand, and 3" Garnet Coarse Gravel). These filters treat water from portions of the Dog River and Crow Creek Reservoir, the Mill Creek watersheds, and various groundwater wells that supplement the surface water flows.

Table 1. Filter Media Specifications

Parameter	2008 Filter Retrofit
Anthracite	
Effective Size (mm)	0.95-1.05
Uniformity Coefficient	<1.4
Depth (in)	26
Sand	
Effective Size (mm)	0.45-0.55
Uniformity Coefficient	<1.4
Depth (in)	12

1.2 Preparing for the Filter Evaluation

In preparation for the filter evaluation, each filter was independently taken offline and completely drained while the other remained in operation. The water level was observed across the filter as it was drained, to identify any uneven areas in the media surface. When draining Filters 1 and 2, they both appeared to show a relatively even media surface. Little to no mounding was observed it both filters except for slight build up along the corners of the troughs. In Filter 2, when checking the level of the center trough, a slight bow was observed in the middle. Once the filter was empty, four to five sites were identified in each filter for media cores. The locations of these sites are shown in the drained filters in Figures 1 and 2.

Figure 1. Filter 1 Media Core Sites

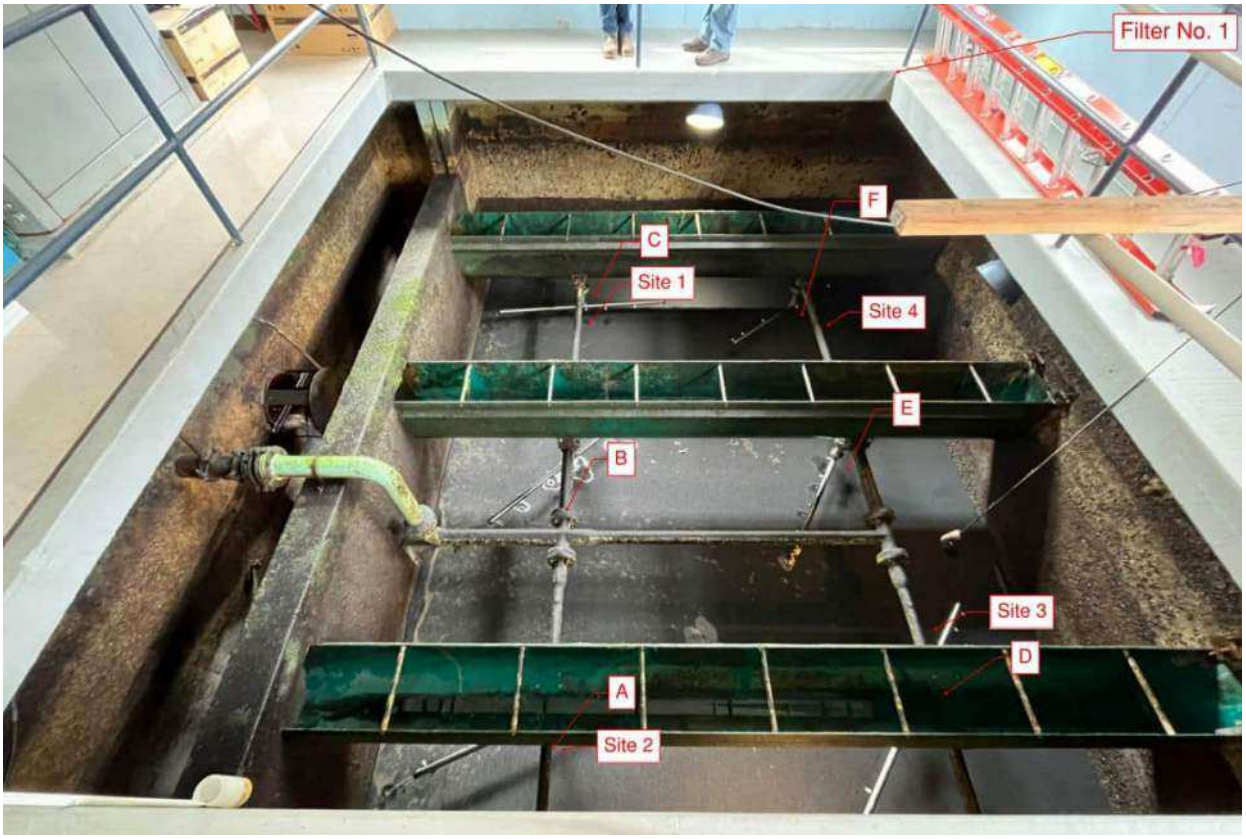
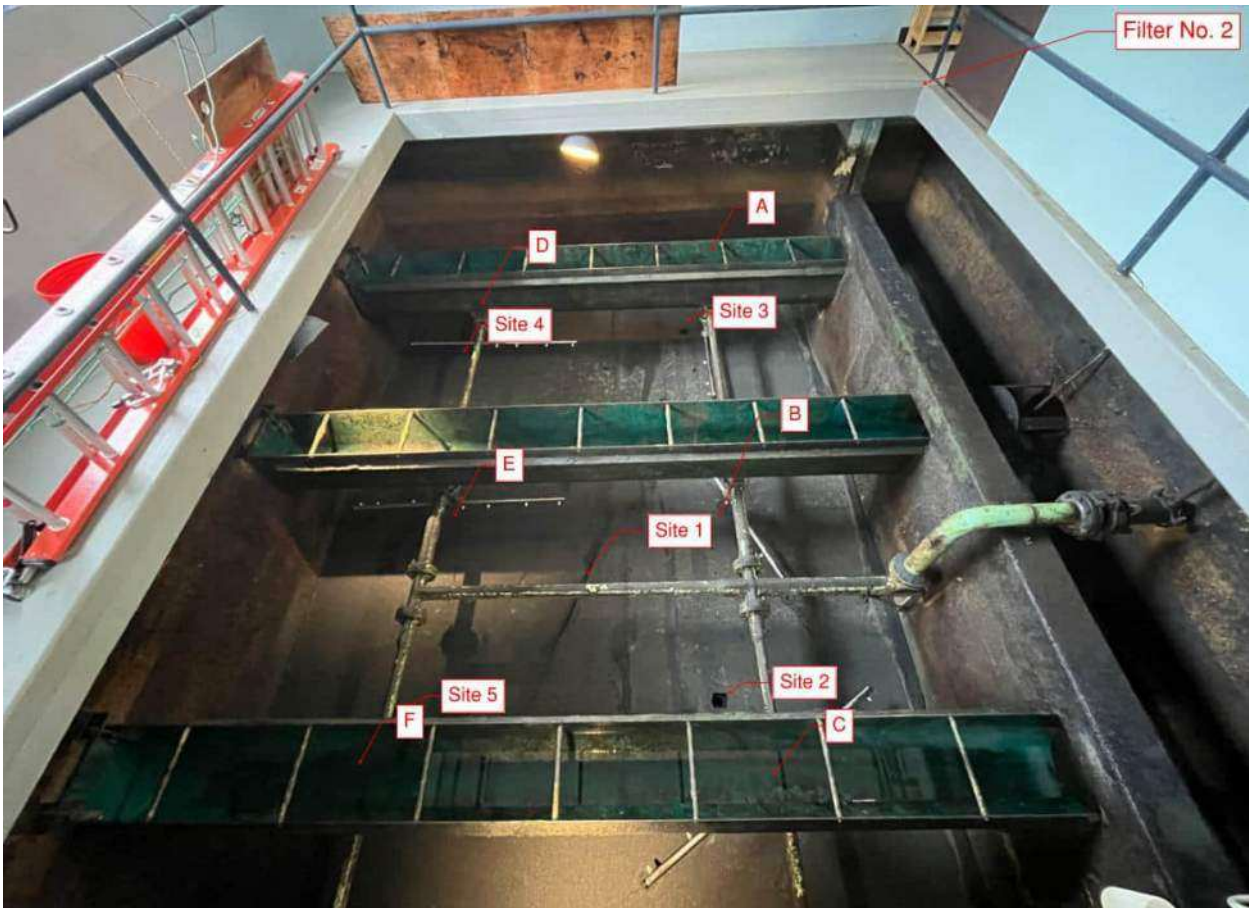


Figure 2. Filter 2 Media Core Sites



1.3 Filter Evaluation Tool Making

Three tools were then made to assist during the filter evaluation. A 49"-long ¼ inch threaded rod was used to measure the depth of various layers of media. A media corer was made from a 4-ft piece of 1.25" Sch 40 PVC pipe, with marks at 2", 6", 12", 18", 24", and 30". This was used to collect media samples from the filter while inside the filter and can be seen in Figure 3. The final tool was a backwash bed expansion measurement tool made from PVC pipe. This tool was used to measure the amount of bed expansion accomplished during the backwash process. A picture of this device is shown in Figure 4.

Figure 3. Filter Media Coring Tool

Figure 4. Backwash Bed Expansion Tool

1.4 Pre-Backwash Floc Retention Analysis

Once each filter was drained, media depth was measured as sites A through F in both filters below the troughs, at the sites shown in Figures 1 and 2 using the threaded rod. Table 2 shows the measured depths for each site. These measurements show the slight variations in media depth across the filter before a backwash. Additionally, they show the anthracite depth is closer to 19" on average, much lower than the design depth of 26".

Table 2. Pre-Backwash Media Depth Measurements

	Filter 1						Filter 2					
Site:	A	B	C	D	E	F	A	B	C	D	E	F
Bottom of Sweep to Top of Media (in)	6.5	6	7	7	6.5	7.5	-	-	-	-	-	-
Anthracite Depth (in)	20.5	21	20	18	17	20	17.5	18	18	19.5	19.5	18.5
Sand Depth (in)	33.5	34	34.5	31	31	32	31.5	31	31	31	31	30.5

A floc retention analysis was then performed in accordance with the SOP in chapter 17 of "Filter Evaluation Procedures for Granular Media, Second Edition" by Daniel K. Nix and John Scott Taylor, P.E. Media cores were collected at sites 1 through 4 in Filter 1 and sites 1 through 5 in Filter 2 using the coring tool. The sample sites were selected to represent geographically distinct areas within the filter as shown in Figures 1 and 2. At each site, the core samples were used to sample turbidity in the media at various depths (2", 6", 12", 18", 24", and 30") pre-backwash.

The samples collected for floc retention analyses were combined across the various sites in each filter to create composite samples for 0"-2" and 0"-18". These composite samples were sent for a sieve analysis to determine effective media size and uniformity coefficient.

The findings of the floc retention and the sieve analyses are discussed in the results in Section 2.

1.5 Filter Backwash

After refilling, each filter was backwashed. The normal backwash sequence was conducted by the operators manually to complete a typical backwash cycle. Backwash turbidity profile samples were collected at 30-second intervals to create a Spent Filter Backwash Profile. The water level rose too quickly and started to fill the troughs before a rate of rise could be measured. As a result, the backwash flowrate was not verified for both filters. The backwash bed expansion tool was used to measure the total bed expansion of the anthracite and sand media. This data is provided in the discussion of results in Section 2.

1.6 Post-Backwash Floc Retention Analysis

After the backwash was complete, each filter was drained and floc retention core samples were collected again from the same locations cored during the pre-backwash sampling. Data from this analysis is provided in the discussion of results in Section 2.

2. Results

Floc retention analysis and backwash turbidity provide complementary information to determine the effectiveness of the BW performance. Floc Retention Analysis shows how well the filter is getting cleaned, while BW turbidity profiles shows if the backwash is efficiently removing solids. BW turbidity profiling should be completed at filter plants approximately once per month, but the data is only useful if floc retention analysis has been completed (recommended once every 6 months) to show that the filter is getting cleaned with the current backwash sequence and system. Wicks WTP has online BW turbidity monitors in each filter, so BW turbidity profile data is collected for every filter run/backwash.

Results of the Filter Surveillance are provided in attachment B.

2.1 Pre-Backwash Filter Run Data

The basic operating parameters for the filter runs prior to the filter assessment were collected and are shown in Table 3.

Table 3. Pre-Assessment Filter Run Data

Parameter	Filter 1	Filter 2
Filter Flow (MGD)	1.5	1.5
Filtration Rate (gpm/sf)	3.4	3.4
Filter Run Time (hrs.)	16	16
Unit Filter Run Volume (gal/sf)	3,265	3,265
Total Water Produced (gal)	980,000	980,000
Raw Water Turbidity (NTU)	11.7	
Settled Water Turbidity (NTU)	2.57	

2.2 Bed Expansion

The backwash bed expansion tool includes "flutes" at heights of 2" that allow for measurement of the bed expansion in 2" intervals. Table 4 shows the bed expansion measured for each filter. Compared to the target bed expansion of 20-30%, it appears that the bed expansion in the Wicks WTP filters was at least 8 inches (filled the 8" flute, with little to no media in the 10" flute), which results in a bed expansion of approximately 25% based on the measured depth of sand and anthracite. This is in the range of what is expected for this filter media configuration, given that the media effective size was measured to be less than the design specification (as discussed below).

Table 4. Measured Filter Backwash Media Expansion

Measurement	Filter 1	Filter 2
Sand and Anthracite Depth (in)	32.5	31
Measured Bed Expansion (in)	8	8
Measured Bed Expansion (%)	25%	26%
High-Rate BW Flow Rate (gpm/sf)	12.7	
Water Temperature (°C)	5.6	
Theoretical Bed Expansion (%) (Based on Design Media Profile)	18%	18%
Theoretical Bed Expansion (%) (Based on Actual Media Profile)	26%	26%

2.3 Backwash Turbidity Profile and BW Flow

The Figures 5 and 6 below show the backwash wastewater turbidities during the backwash as well as the backwash flow rates for Filters 1 and 2, respectively. As shown in Figure 5, the BW turbidity in Filter 1 reached the AWWA recommended target of 10 NTU at approximately 9.5 minutes into the backwash.

Similarly, Figure 6 shows the BW turbidity in Filter 2 reached this target at approximately 10.5 minutes into the backwash. While these data alone would suggest that the filter is being backwashed for too long, it must be evaluated in concert with the floc retention data collected to confirm that the filter is getting clean. If the filter is not getting clean, then the backwash process should be modified, and the backwash turbidity re-evaluated.

Figure 5. Filter 1 Backwash Turbidity Profile

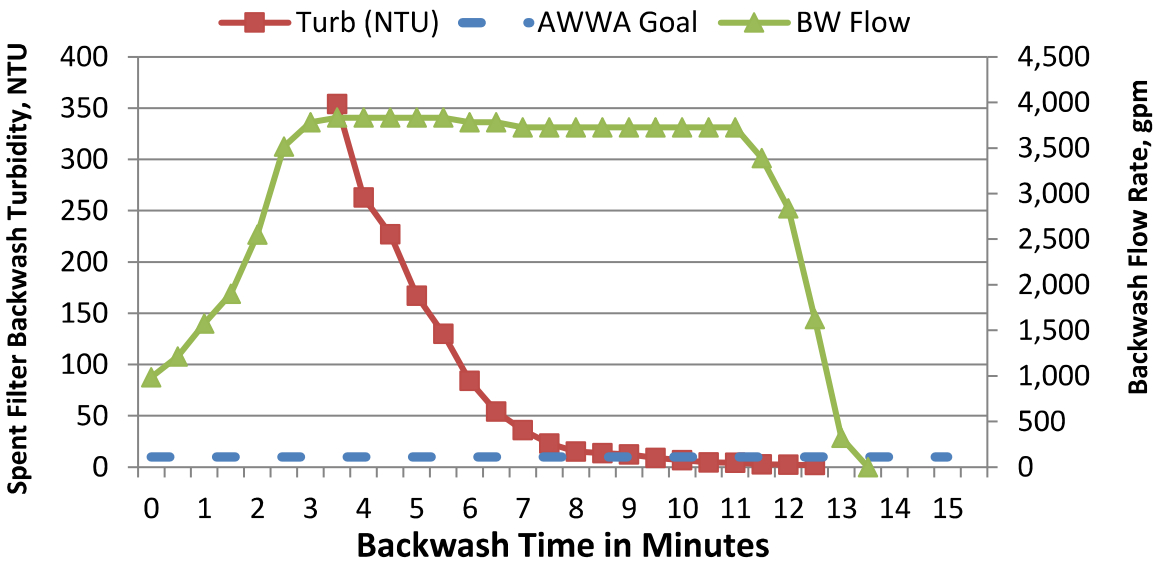
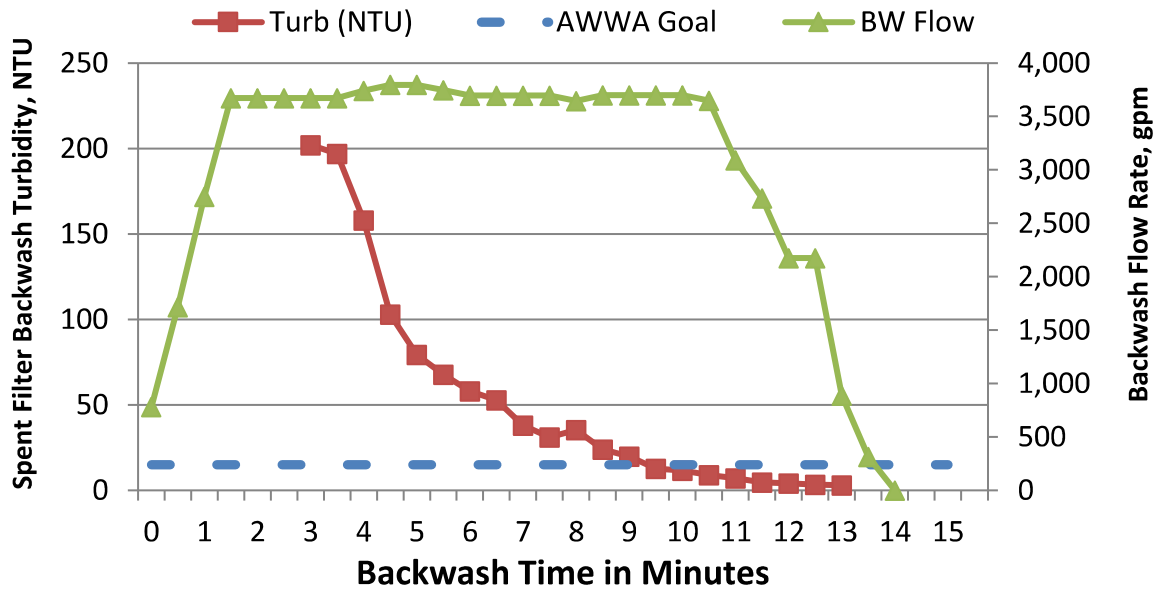


Figure 6. Filter 2 Backwash Turbidity Profile



2.4 Floc Retention Analysis

Floc retention analysis data shows how effectively the filter media stores particles during a filter run, and how well the filter is being cleaned by the backwash process. The results from Site 1 in both filters are discussed below. Attachment A includes the results for the remaining filter sites. As shown in the Figures 7 and 8 below, there is a notable drop off in floc retention past the first 2 inches of media, suggesting that much of the filtration is happening via the fine media observed on the top of the filter and the full media profile is not being effectively used to store solids during the filter runs. Media size is analyzed in the sieve analyses results in section 2.4.

In an optimized filter, it would be expected that more floc is retained in the anthracite layer and gradually less is retained in the sand layer with almost no floc retained in the garnet. This suggests that the size of the floc and the charge is adequate to allow the floc to travel into the anthracite and be removed via diffusion of particles onto the media. Both filters appear to align with the anticipated floc retention profiles below the top 2" of media.

Also show in Figures 7 and 8 is the turbidity profile following a backwash. These data show the backwash adequality removed the floc from both filters, resulting in turbidities within or slightly below the optimal post backwash range of 30-60 NTU. This suggests the backwash flowrate and duration is working effectively, but that the filter backwash is likely continuing longer than necessary to get the filter clean. The result of overcleaning of a filter is typically longer than expected filter maturation times (resulting in longer than expected filter-to-waste periods in some filters).

The data does suggest that the top media is being more readily cleaned than the lower layers of anthracite, as would be expected for a filter with surface wash sweeps (as compared to air scour backwash systems). However, no mudballs were observed in the filters, suggesting that the operators are effectively managing the filter aid polymer dose and preventing over application that would likely result in mudballs in filters with only surface wash sweeps.

Figure 7. Filter 1 - Site 1 Floc Retention Analysis

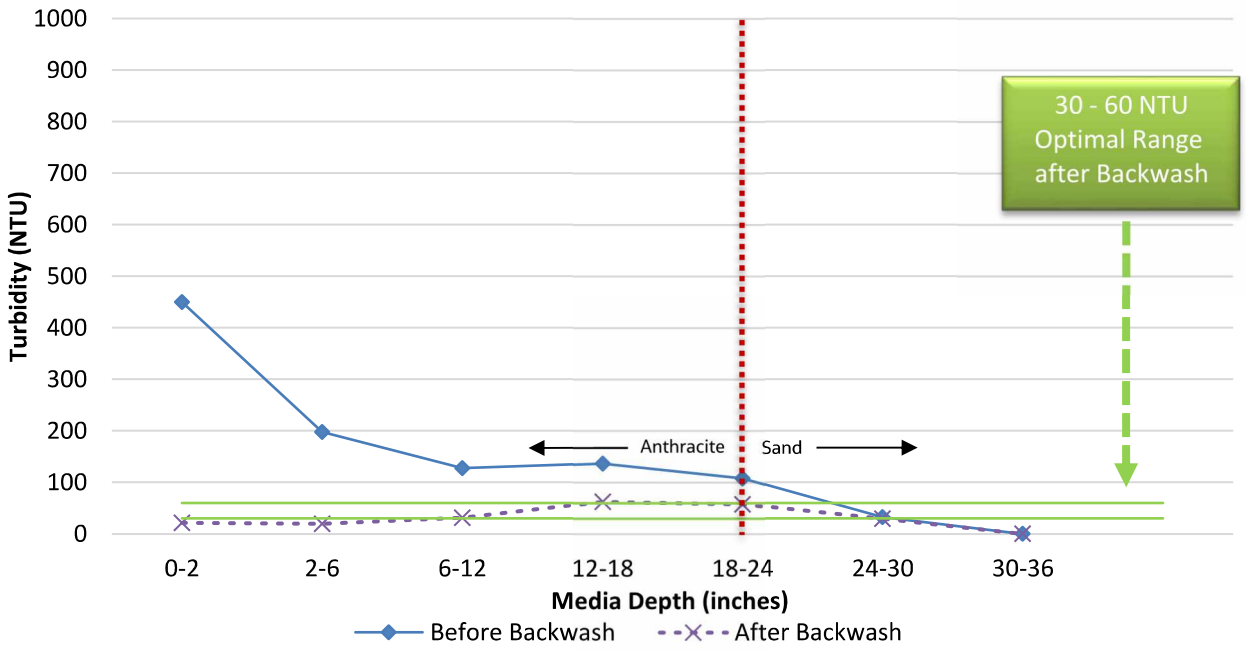
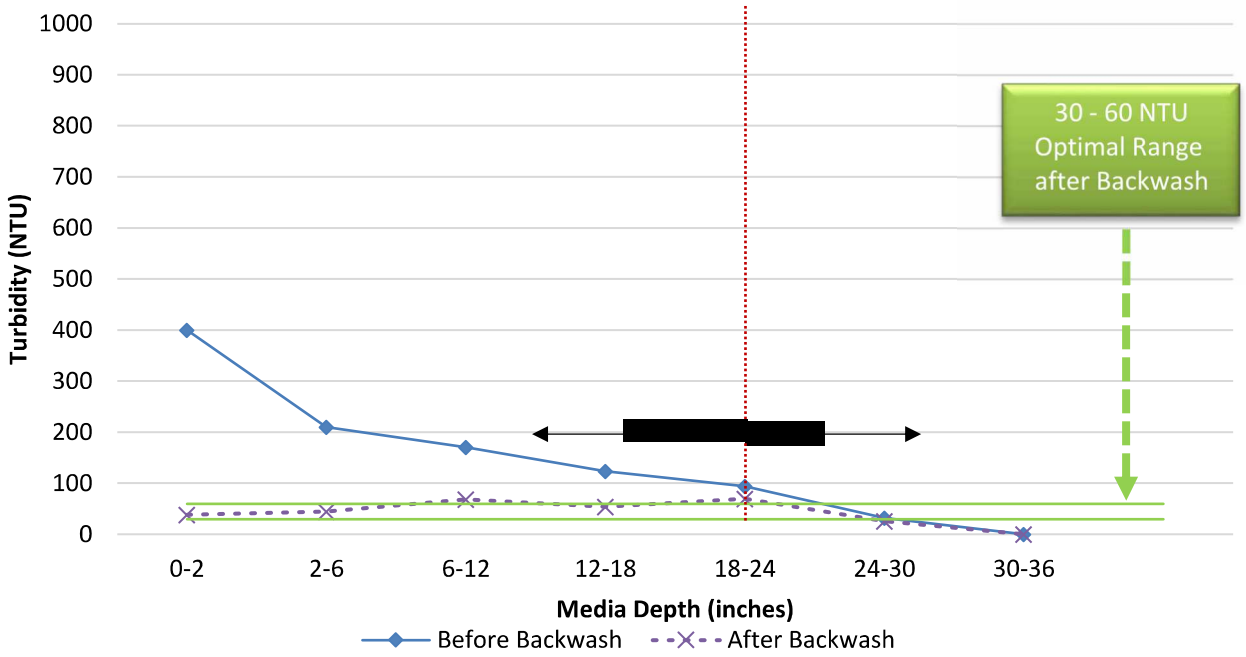


Figure 8. Filter 2 - Site 1 Floc Retention Analysis



2.5 Media Sieve Analysis

The media sieve analysis is used to determine the effective size and the uniformity coefficient of the media at various depths and determine if significant or unexpected wear and tear is present on this filter media. Table 5 summarizes the calculated effective size and uniformity coefficient for 0"-2" and 0"-18" of media depth for Filters 1 and 2 and compares it to the desired design values. The analysis shows the effective media size is less than the target range of 0.95 to 1.05 mm for both filters. Similarly, the uniformity coefficient for the media at 0"-18" is greater than the desired maximum value of 1.4. These values are consistent with the results observed in the floc retention analysis, discussed in section 2.3.

Table 5. Media Sieve Analysis Results

			Filter 1		Filter 2	
Parameter	**Units**	**Design Criteria**	**0-2"**	**0-18"**	**0-2"**	**0-18"**
Effective Size (ES)	mm	0.95-1.05	0.62	0.75	0.73	0.86
Uniformity Coefficient (UC)	-	<1.4	1.37	1.63	1.36	1.61

2.6 Filter Performance and Runtime

Operators noted that the observed filter runtimes are shorter than anticipated and typically terminate based on headloss. Filter runs prior to the test were approximately 16 hours. City staff noted that this is substantially lower than the length of filter runs achieved when the WTP initially switched to ACH from Alum for coagulation. It is assumed that this is likely a result of the top media having a substantial accumulation of fines that have not been removed in some time. The smaller media grabs too many solids, preventing the particles from making their way to the anthracite at lower depths. This results in an ineffective use of available anthracite particle storage capacity and a more rapid increase in headloss

during filter runs. If the top layer were replaced with the correct sized media, it is expected that headloss accumulation would be reduced and filter runs could be extended.

2.7 Summary of Conclusions

The following summarizes the conclusions from the analysis performed:

1. The filter backwash sequence is effectively cleaning the filter, although it is likely that the current sequence is "over cleaning" the filter which results in longer than necessary filter maturation durations.
2. The solids being removed from the filter are primarily being removed in the top of the anthracite.
3. The top layer of filter media (0"-2") is substantially smaller than the rest of the filter media, and the filter media as a whole is smaller than spec. The fines at the top of the filter are causing headloss to accumulate more rapidly and preventing effective use of all the particle storage potentially available in the anthracite media.
4. The measured anthracite depth in both filters is 6 to 8" less than the design depth of 26".
5. The current backwash controls/sequence lacks the flexibility needed to adjust the backwash sequence and optimize filter performance.
6. The changes to the backwash sequence will likely be required as soon as the filter media profile is fixed, because fixing the filter media profile is expected to have an adverse impact on particle removal that will need to be mitigated by careful adjustment of coagulant/filter aid chemistry and fine-tuning of the backwash sequence.

3. Recommendations

Based on the assessment of the Wicks WTP Filters, the following improvements are recommended. These recommendations should be completed before full-scale stress testing is conducted to determine the realistic winter capacity of the WTP to remove any uncertainty regarding the impact the issues identified have on the WTP capacity.

1. Correct the deficiencies in the filter media profile to return to the initial design media configuration. While it is possible that this could be accomplished by removing only the top 3-4" of anthracite and then topping up the filter with the 2008 media specification, this may leave some uncertainty regarding whether the filter media is the primary cause of the short filter runs. Based on this, the preferred recommendation is to replace the anthracite in its entirety with media meeting the 2008 filter media spec.
2. The backwash sequence should be updated to allow more operator control over backwash setpoints. Modifications should include the ability to:
    a. Turn off the second surface wash sweep cycle. Typically, surface wash sweeps are only run prior to the start of a backwash and the surface wash sweeps appear to be causing unwanted damage to the filter media.
    b. Adjust the duration of the high-rate backwash step based on how long it is taking to get the filter clean.
    c. Control of the backwash rates to allow for more discrete adjustment of BW flow.

   d. Generally, modern filter controls allow operators to adjust the setpoints and durations for each step of the backwash sequence, within a reasonable allowable range.

3. Operators should perform floc retention analysis and BW turbidity profiling on Filters 1 and 2 in the late fall/winter months of 2023. This should be completed at three or four representative locations in the filter. Depth to each type of media and total media depth should be noted at each core location. Backwash routine should be left as the current backwash routine normally completed by the system.

4. WTP staff should develop a protocol for regular assessment of filter performance. This can be accomplished by conducting 1 filter assessment each spring and fall or winter and summer, alternating which filter is assessed in which season. For example: Spring 2024- Filter 1, Fall 2024, Filter 2, Summer 2025, Filter 2, Winter 2025 – Filter 1, Spring 2026 – Filter 2, Fall 2026 – Filter 1, and continuing in a similar pattern.

5. Operator should evaluate the potential for use of a coagulant aid polymer during cold water seasons to enhance the settleability of the floc to reduce loading on the filters. While it is best to test several polymers from different manufacturers, Kemira's N-1986 polymer has shown promising results with other systems using ACH and Alum for coagulation in similar water quality.

6. Operators should carefully watch filter aid polymer dose and endeavor to reduce the applied dose as much as possible, as long as it does not degrade filter particle removal and effluent turbidity performance.

Attachment A
Floc Retention Analyses Results (Filters 1 and 2)

The following figures show the results of the floc retention analyses for Filter 1 (sites 2-4) and Filter 2 (sites 2-5)

Figure 9. Filter 1 - Site 2 Floc Retention Analysis

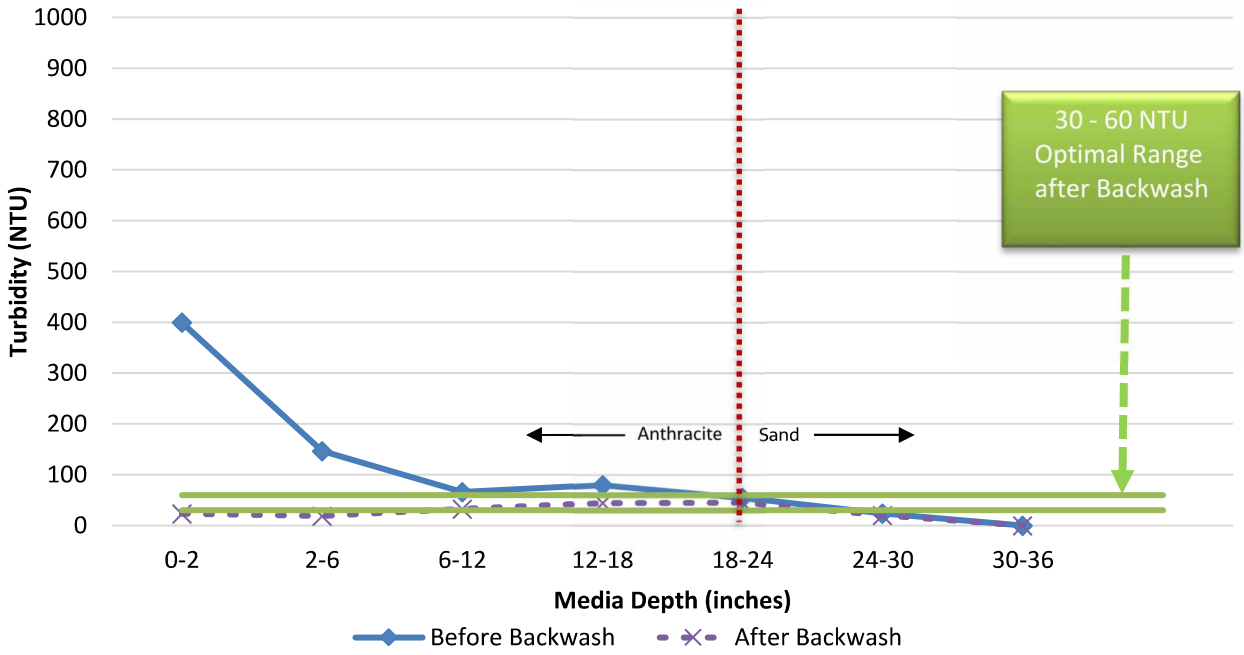


Figure 10. Filter 1 - Site 3 Floc Retention Analysis

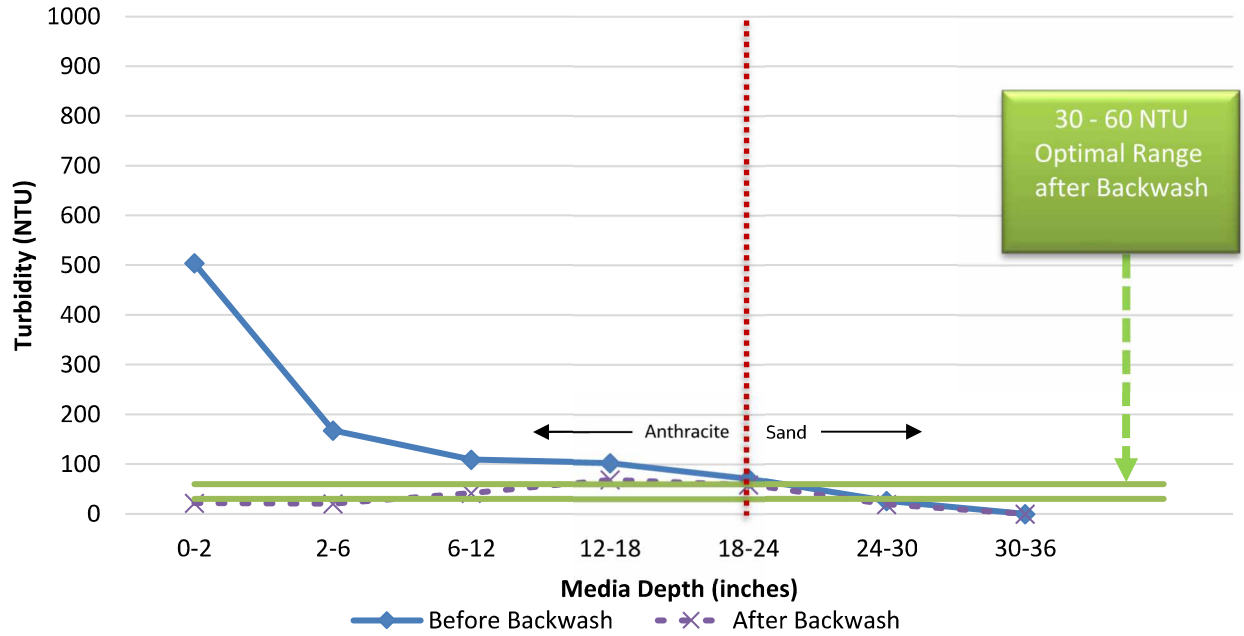


Figure 11. Filter 1 - Site 4 Floc Retention Analysis

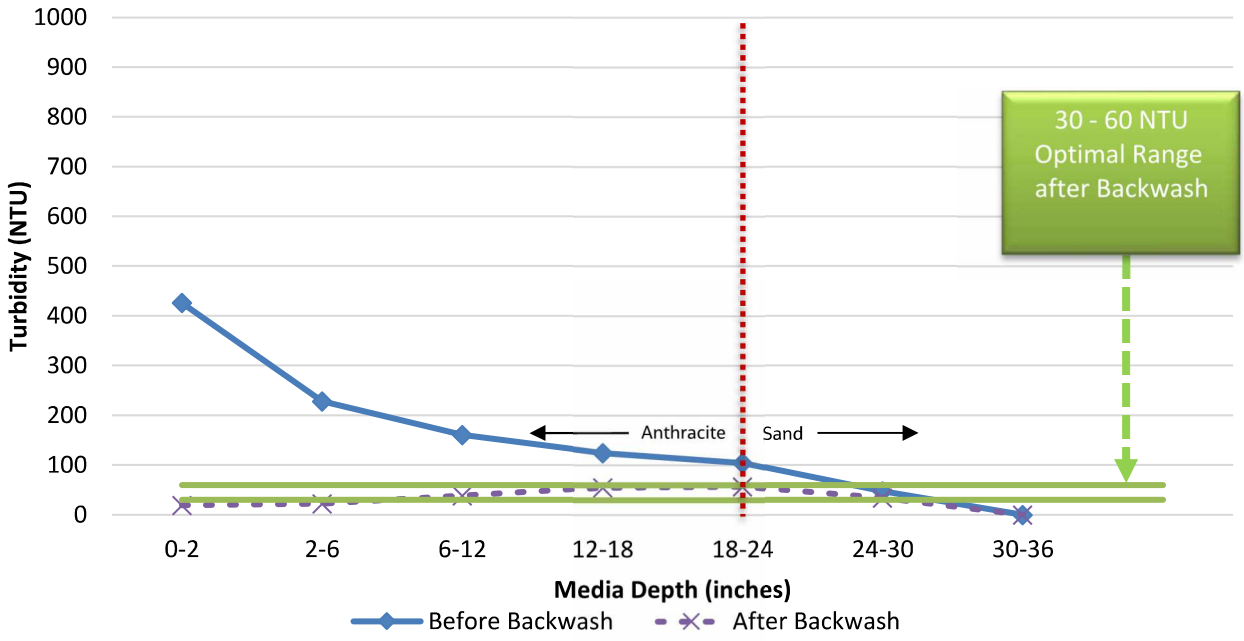


Figure 12. Filter 2 - Site 2 Floc Retention Analysis

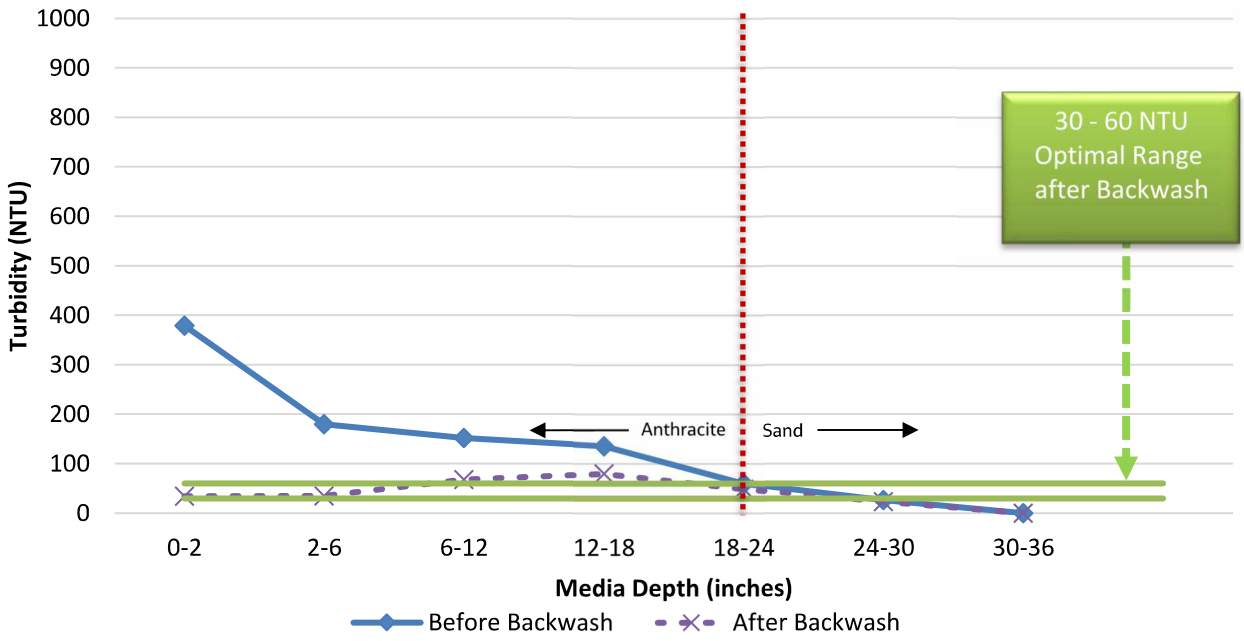


Figure 13. Filter 2 - Site 3 Floc Retention Analysis

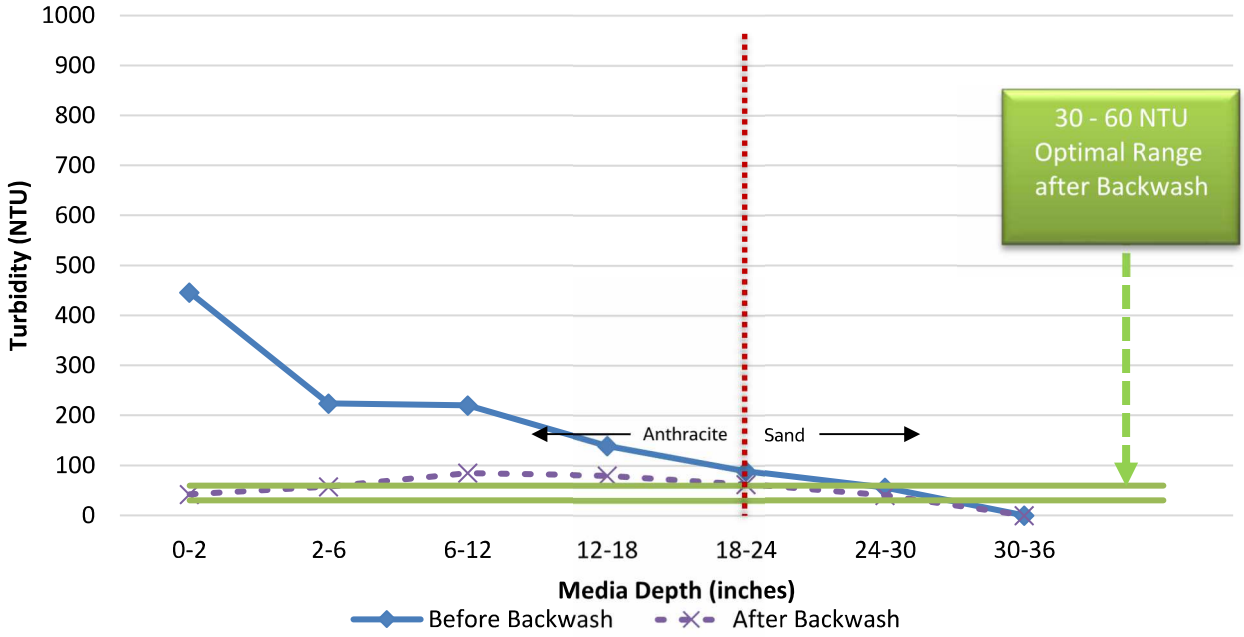


Figure 14. Filter 2 - Site 4 Floc Retention Analysis

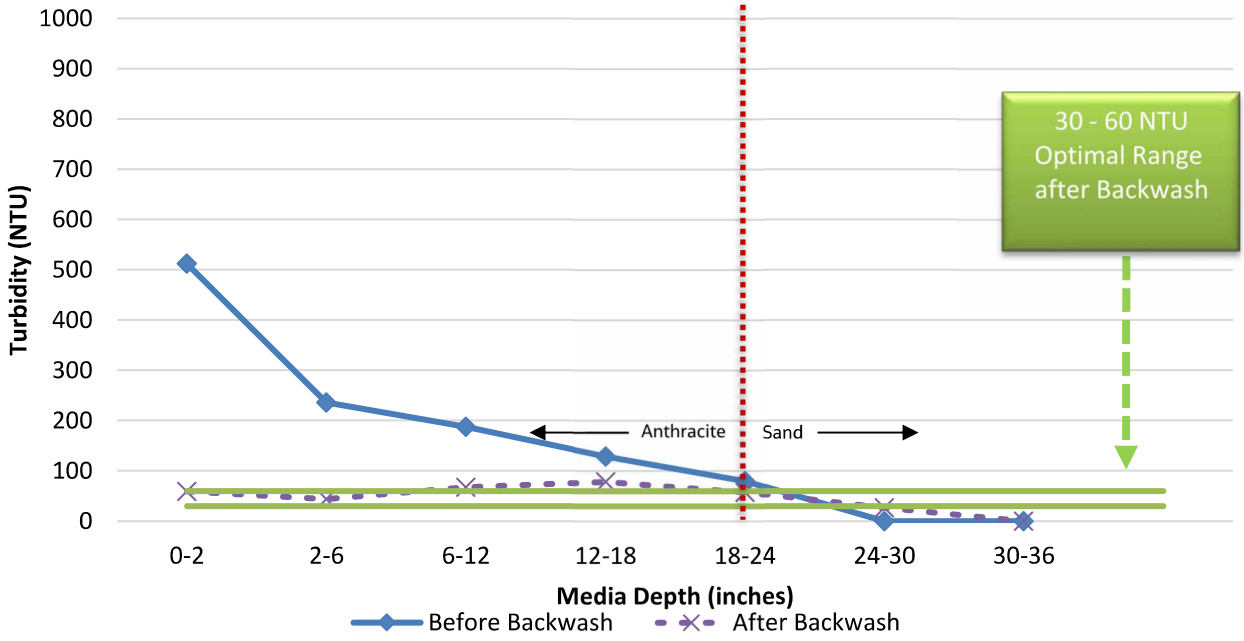
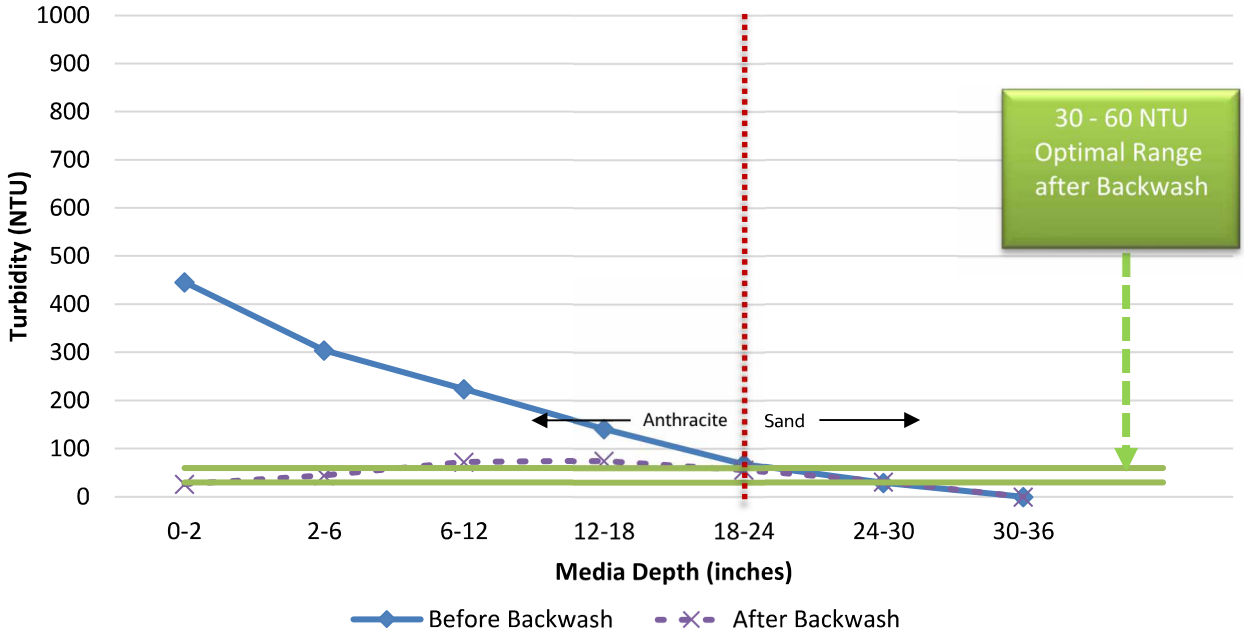


Figure 15. Filter 2 - Site 5 Floc Retention Analysis



Attachment B
Filter Run Summary Data Reports

Filter Run Data, Bed Expansion, and Backwash Rise Rate Data

Filter Surveilance Report - Page 1

Treatment Plant:	Wicks WTP - The Dalles, OR	NOTE: Gray cells denote data to be filled in. All other cels are automatically calculated.
Filter Number:	1	
Filter Surveillance Date:	4/6/2023	

Filter Run Data			Notes
Filter Bay Width	20.0	ft.	
Filter Bay Length	15.0	ft.	
Filter Bay Area	300	sq. ft.	
Number of Bays per filter	1		
Total Filter Area	300	sq. ft.	
Clean Bed Headloss	2.8	ft	
Filter Terminal Headloss	10.0	ft	
Filter Run Length	16	hours	
Filter Flow Rate	1.5	mgd	
	1,014	gpm	
Filter Hydraulic Loading Rate	3.4	gpm/sf	
Total Water Produced	979,417	gallons	
UFRV	***3,265***	***gal/sf***	
Bed Expansion Data			
Bed Expansion During Backwash	8	in	
Bed Depth at Rest	31.0	in	
Bed Expansion (Expanded/At Rest-1)	***26%***	***Target 20 to 30%***	
Backwash Rise Rate Analysis			
Backwash			
Backwash		m	
Time to R		n	
Time to R		n	
Time to R		n	
Time to R		n	
Rise Rate		m/sq. ft.	
Rise Rate		m/sq. ft.	
Rise Rate		m/sq. ft.	
Rise Rate		m/sq. ft.	
Rise Rate		m/sq. ft.	
Backwash Flow		**gpm**	

Unable to complete backwash rise rate analysis to verify backwash flow meter reading due to insufficient time between reaching high-flow and water spilling over troughs.

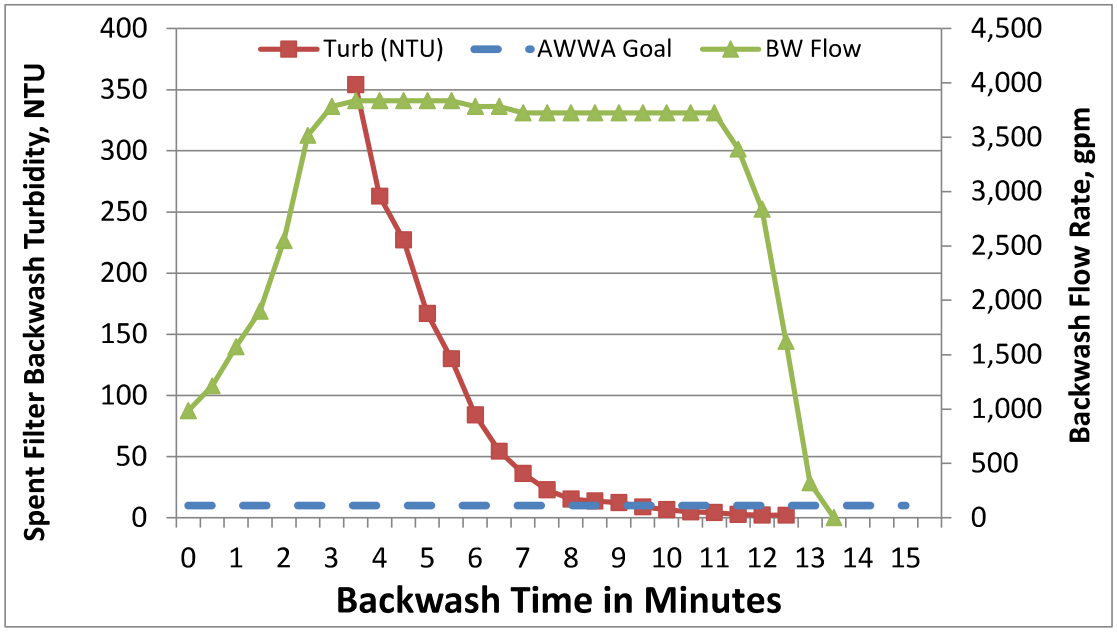
Spent Filter Backwash Turbidity Profile

Filter Surveilance Report - Page 2

Treatment Plant: Wicks WTP - The Dalles, OR

Filter Number: 1 Date: 4/6/2023

Sample #	Time (min)	Turb (NTU)	BW Turb Goal (NTU)	BW Flow (gpm)	BW Flow (gpm/sf)
	0.0		10	0	0.0
	0.5		10	986	3.3
	1.0		10	1212	4.0
	1.5		10	1574	5.2
	2.0		10	1900	6.3
	2.5		10	2550	8.5
	3.0		10	3516	11.7
22	3.5	354.0	10	3784	12.6
23	4.0	263.0	10	3835	12.8
24	4.5	227.0	10	3835	12.8
25	5.0	167.0	10	3835	12.8
26	5.5	130.0	10	3835	12.8
27	6.0	84.0	10	3835	12.8
28	6.5	54.3	10	3784	12.6
29	7.0	36.1	10	3784	12.6
30	7.5	23	10	3725	12.4
31	8.0	15.3	10	3725	12.4
32	8.5	13.7	10	3725	12.4
33	9.0	12.4	10	3725	12.4
34	9.5	8.86	10	3725	12.4
35	10.0	6.72	10	3725	12.4
36	10.5	4.62	10	3725	12.4
37	11.0	4.17	10	3725	12.4
38	11.5	2.82	10	3725	12.4
39	12.0	2.32	10	3389	11.3
40	12.5	2.05	10	2840	9.5
41	13.0		10	1623	5.4
	13.5		10	323	1.1
	14.0		10	0	0.0
	14.5		10		0.0
	15.0		10		0.0



Floc Retention Analysis

Filter Surveilance Report - Page 3

Treatment Plant: Wicks WTP - The Dalles, OR

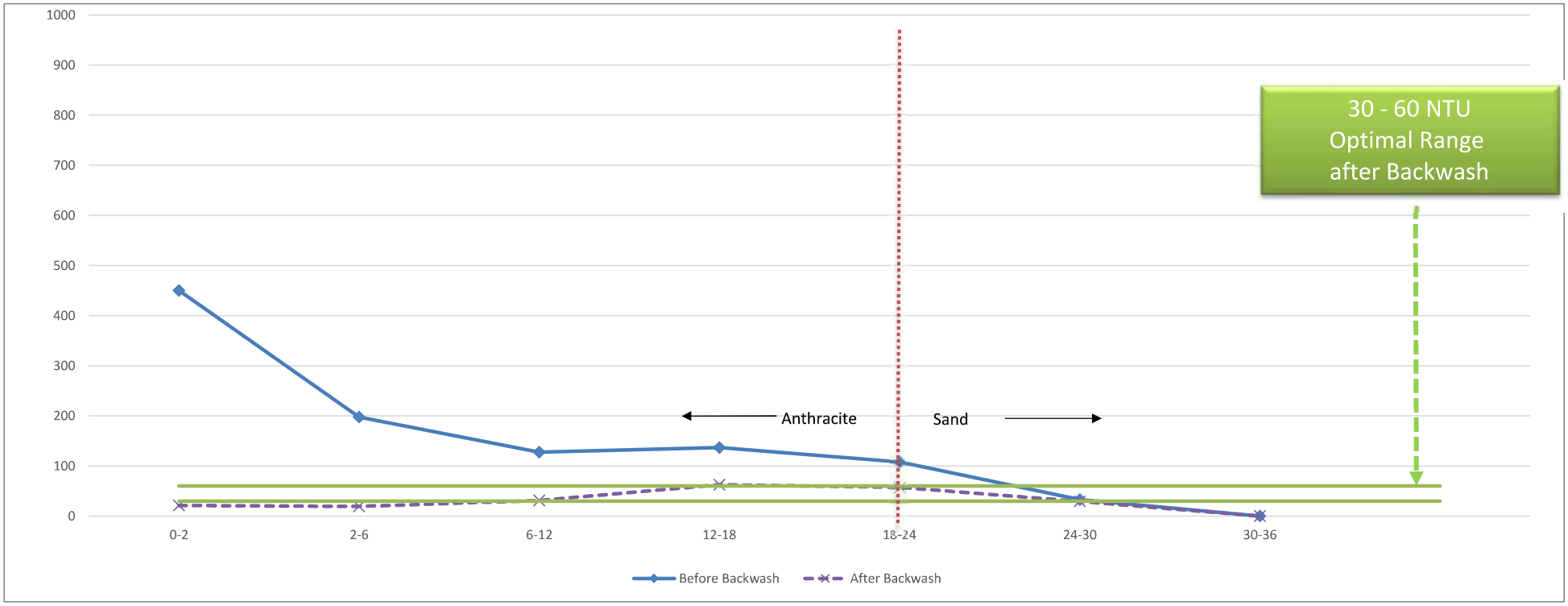
Graph Data per 100mL

Filter Number: 1

Sample Location: 1

Filter Surveillance Date: 4/6/2023

Media Depth	Before Backwash				After Backwash				Notes
	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	
0-2	366	450	61.4	225.0	22	21	48.6	10.6	
2-6	179	198	55.3	98.8	19	19	50.0	9.6	
6-12	110	127	58.0	63.6	34	31	46.5	15.6	
12-18	113	136	60.2	68.2	57	63	55.0	31.3	
18-24	83	108	64.8	54.1	48	58	60.5	28.8	
24-30	21	33	76.4	16.3	19	29	76.37	14.7	
30-36	-	-			-	-			



Floc Retention Analysis

Filter Surveilance Report - Page 4

Treatment Plant: Wicks WTP - The Dalles, OR

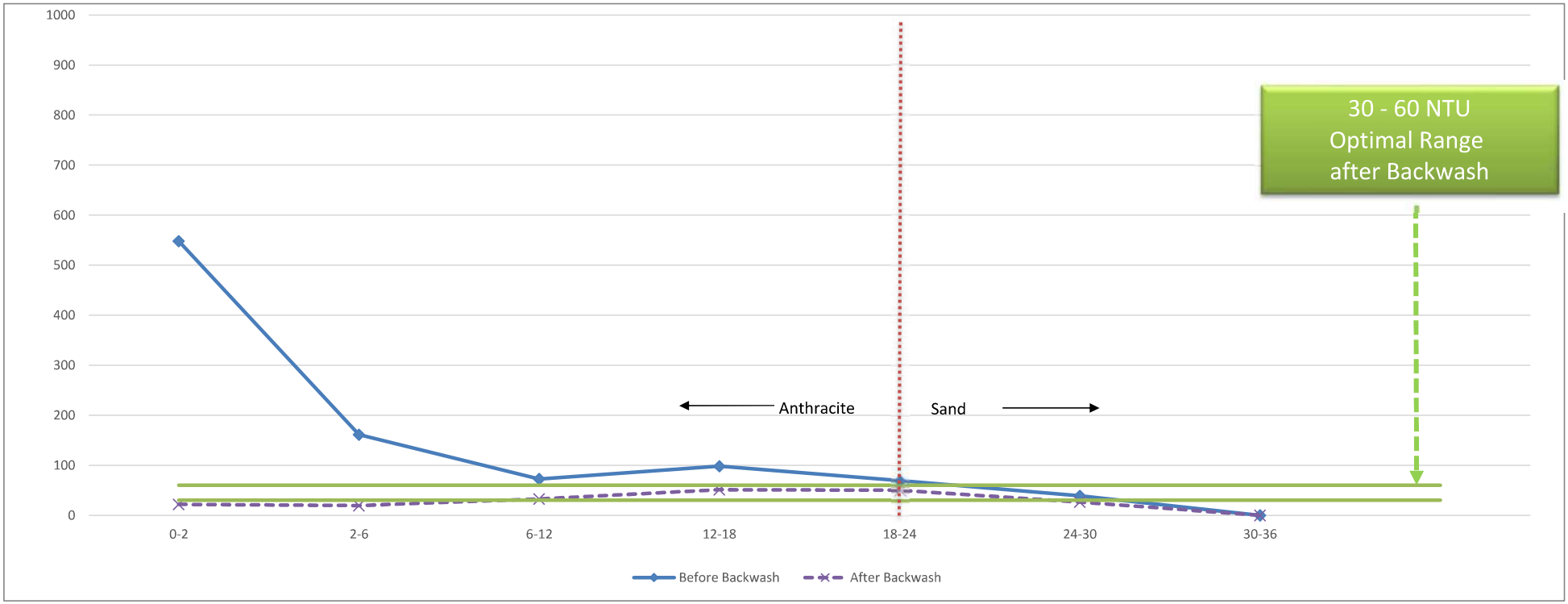
Filter Number: 1

Sample Location: 2

Filter Surveillance Date: 4/6/2023

Graph Data per 100mL

Media Depth	Before Backwash				After Backwash				Notes
	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	
0-2	399	548	68.6	274.0	23	22	48	11	
2-6	147	161	55.0	80.6	19	19	51.5	9.7	
6-12	66	72	55.2	36.2	32	33	51.0	16.4	
12-18	80	98	61.6	49.1	45	51	57.3	25.6	
18-24	54	70	63.9	34.8	45	50	55.2	25.1	
24-30	24	39	82.8	19.5	20	27	67.65	13.3	
30-36	-	-			-	-			



Floc Retention Analysis

Filter Surveilance Report - Page 5

Treatment Plant: Wicks WTP - The Dalles, OR

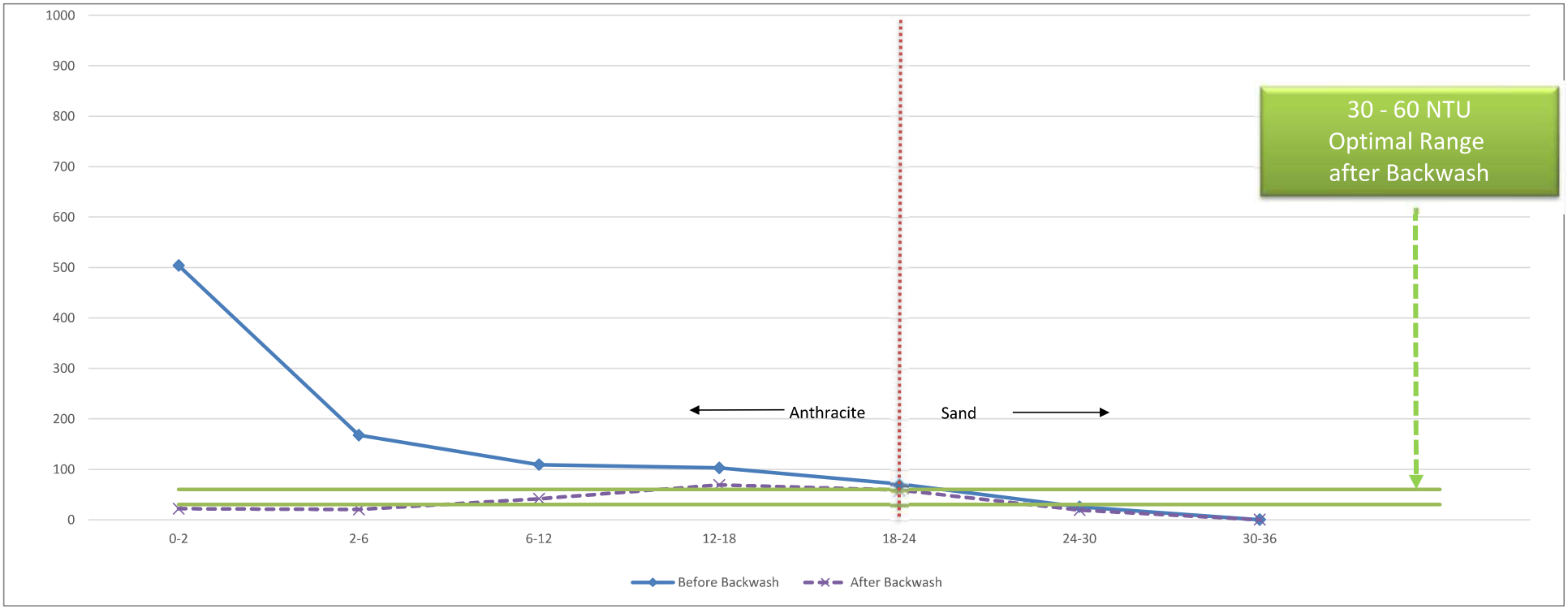
Filter Number: 1

Sample Location: 3

Filter Surveillance Date: 4/6/2023

Graph Data per 100mL

Media Depth	Before Backwash				After Backwash				Notes
	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	
0-2	376	504	67.1	252.0	23	22	47.27	10.9	
2-6	155	167	53.9	83.7	20	20	51.6	10.1	
6-12	101	109	54.2	54.5	39	41	53.5	20.7	
12-18	90	102	56.6	51.2	61	69	56.3	34.5	
18-24	60	71	58.9	35.4	45	59	65.0	29.4	
24-30	18	26	71.6	12.9	13	19	72.86	9.57	
30-36	-	-			-	-			



Floc Retention Analysis

Filter Surveilance Report - Page 6

Treatment Plant: Wicks WTP - The Dalles, OR

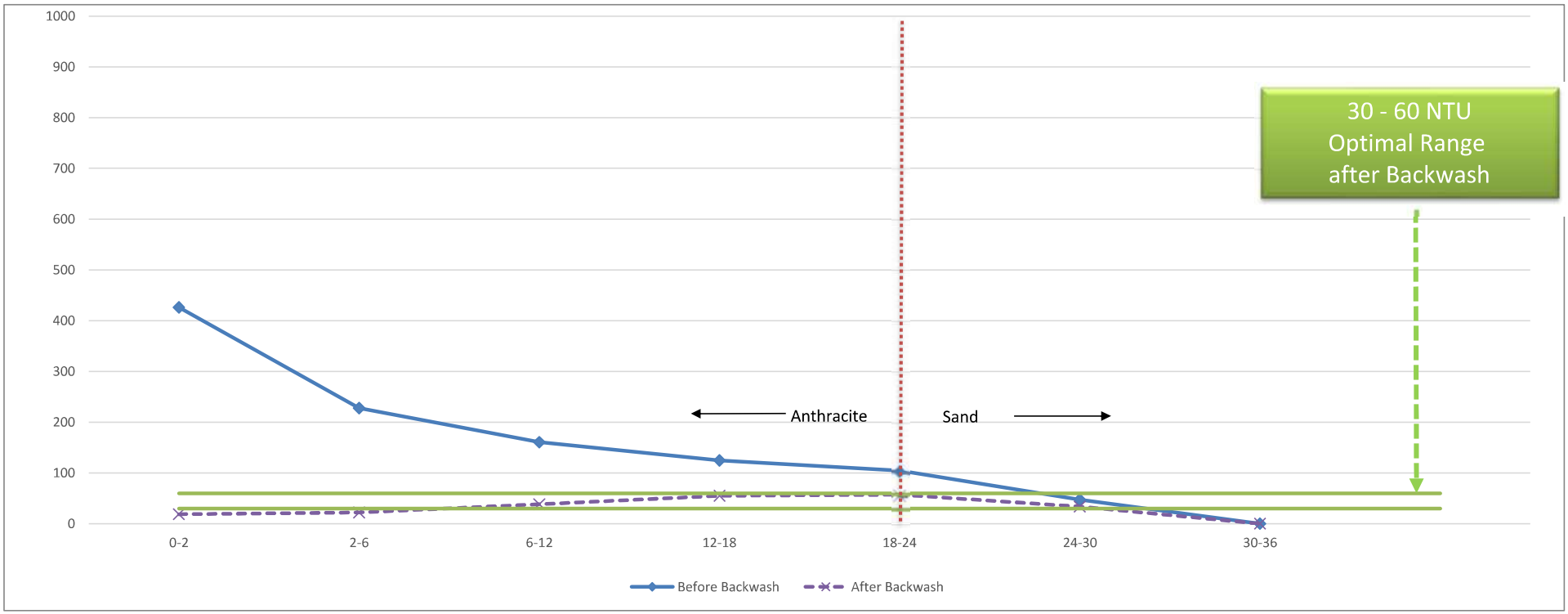
Filter Number: 1

Sample Location: 4

Filter Surveillance Date: 4/6/2023

Graph Data per 100mL

Media Depth	Before Backwash				After Backwash				Notes
	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	
0-2	343	426	62.1	213.0	21	19	45.77	9.42	
2-6	192	228	59.5	114.0	23	22	48.8	11.1	
6-12	128	160	62.7	80.2	37	38	51.7	19.2	
12-18	113	125	55.0	62.4	51	55	54.1	27.5	
18-24	80	104	64.9	52.2	48	57	59.9	28.6	
24-30	32	47	73.5	23.6	24	34	70.48	16.9	
30-36	-	-			-	-			



Filter Run Data, Bed Expansion, and Backwash Rise Rate Data

Filter Surveilance Report - Page 1

Treatment Plant:	Wicks WTP - The Dalles, OR	NOTE: Gray cells denote data to be filled in. All other cels are automatically calculated.
Filter Number:	2	
Filter Surveillance Date:	4/6/2023	

Filter Run Data			Notes
Filter Bay Width	20.0	ft.	
Filter Bay Length	15.0	ft.	
Filter Bay Area	300	sq. ft.	
Number of Bays per filter	1		
Total Filter Area	300	sq. ft.	
Clean Bed Headloss	0.8	ft	
Filter Terminal Headloss	3.7	ft	
Filter Run Length	16	hours	
Filter Flow Rate	1.5	mgd	
	1,014	gpm	
Filter Hydraulic Loading Rate	3.4	gpm/sf	
Total Water Produced	979,417	gallons	
UFRV	***3,265***	***gal/sf***	

Bed Expansion Data			
Bed Expansion During Backwash	8	in	
Bed Depth at Rest	30.0	in	
Bed Expansion (Expanded/At Rest-1)	***27%***	***Target 20 to 30%***	

Backwash Rise Rate Analysis			
Backwash Valve Setting		%	
Backwa		m	
Time to		n	
		:	
Time to		n	
		:	
Time to		n	
		:	
Time to		n	
		:	
Rise Rat		m/sq. ft.	
Rise Rat		m/sq. ft.	
Rise Rat		m/sq. ft.	
Rise Rat		m/sq. ft.	
Rise Rat		m/sq. ft.	
Backwash Flow		**gpm**	

Unable to complete backwash rise rate analysis to verify backwash flow meter reading due to insufficient time between reaching high-flow and water spilling over troughs.

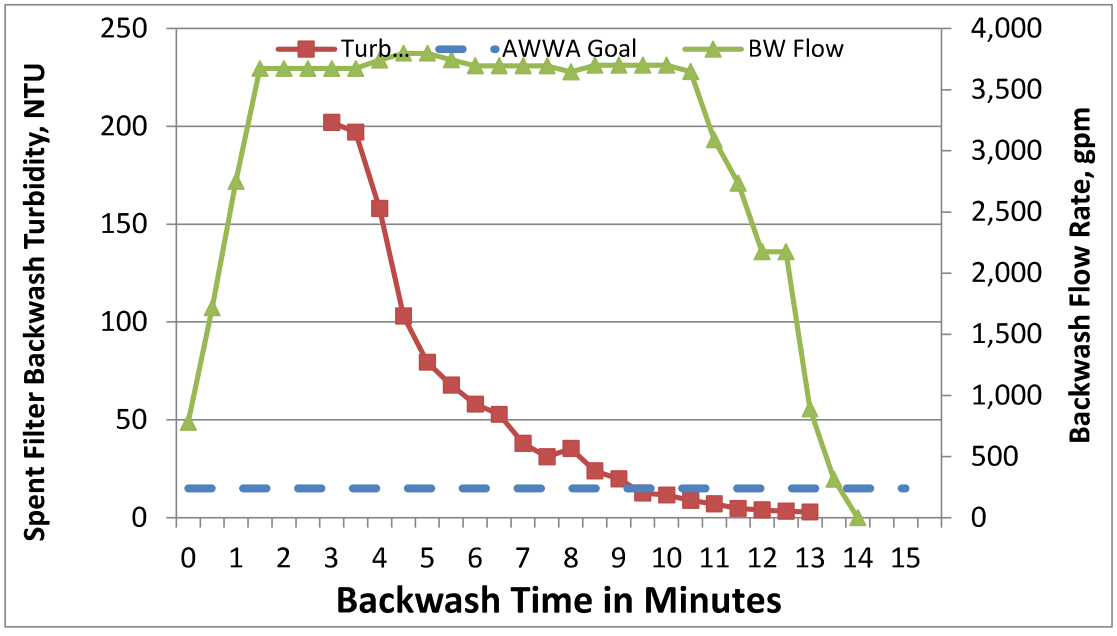
Spent Filter Backwash Turbidity Profile

Filter Surveilance Report - Page 2

Treatment Plant: Wicks WTP - The Dalles, OR

Filter Number: 2 Date: 4/6/2023

Sample #	Time (min)	Turb (NTU)	BW Turb Goal (NTU)	BW Flow (gpm)	BW Flow (gpm/sf)
	0.0		15	0	0.0
	0.5		15	781	2.6
	1.0		15	1716	5.7
	1.5		15	2749	9.2
	2.0		15	3673	12.2
	2.5		15	3673	12.2
1	3.0	202	15	3673	12.2
2	3.5	197	15	3673	12.2
3	4.0	158	15	3673	12.2
4	4.5	103	15	3740	12.5
5	5.0	79	15	3797	12.7
6	5.5	68	15	3797	12.7
7	6.0	58	15	3746	12.5
8	6.5	53	15	3695	12.3
9	7.0	38	15	3695	12.3
10	7.5	31	15	3695	12.3
11	8.0	35	15	3695	12.3
12	8.5	24	15	3645	12.2
13	9.0	20	15	3700	12.3
14	9.5	13	15	3700	12.3
15	10.0	12	15	3700	12.3
16	10.5	9	15	3700	12.3
17	11.0	7	15	3649	12.2
18	11.5	5	15	3090	10.3
19	12.0	4	15	2734	9.1
20	12.5	3	15	2175	7.3
21	13.0	3	15	2175	7.3
	13.5		15	890	3.0
	14.0		15	315	1.1
	14.5		15	0	0.0
	15.0		15		0.0



Floc Retention Analysis

Filter Surveilance Report - Page 3

Treatment Plant: Wicks WTP - The Dalles, OR

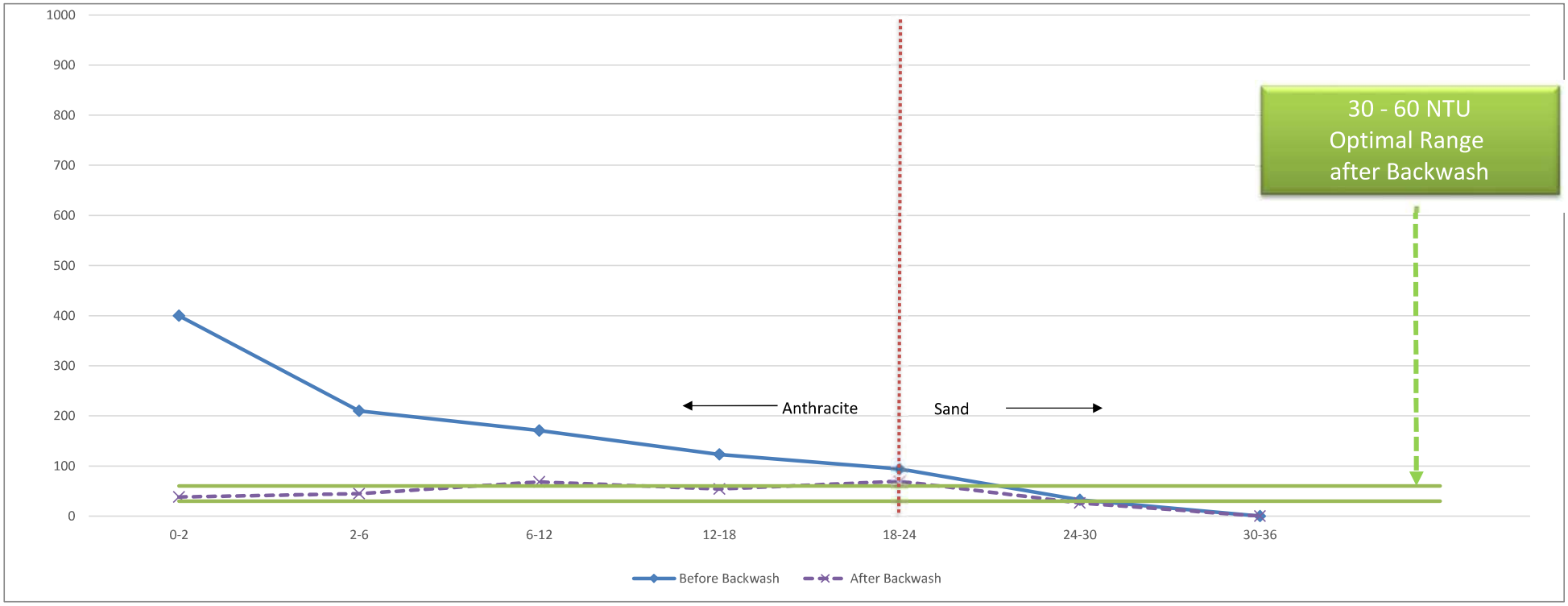
Filter Number: 2

Sample Location: 1

Filter Surveillance Date: 4/6/2023

Graph Data per 100mL

Media Depth	Before Backwash				After Backwash				Notes
	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	
0-2	317	400	63.0	200.0	38	38	49.7	19	
2-6	185	210	56.9	105.0	44	45	51.1	22.4	
6-12	146	171	58.3	85.3	68	68	50.2	34.1	
12-18	106	123	58.1	61.6	45	54	60.4	26.9	
18-24	70	94	67.2	47.0	44	70	79.3	34.8	
24-30	21	32	76.7	16.1	17	26	76.7	13	
30-36	-	-			-	-			



Floc Retention Analysis

Filter Surveilance Report - Page 4

Treatment Plant: Wicks WTP - The Dalles, OR

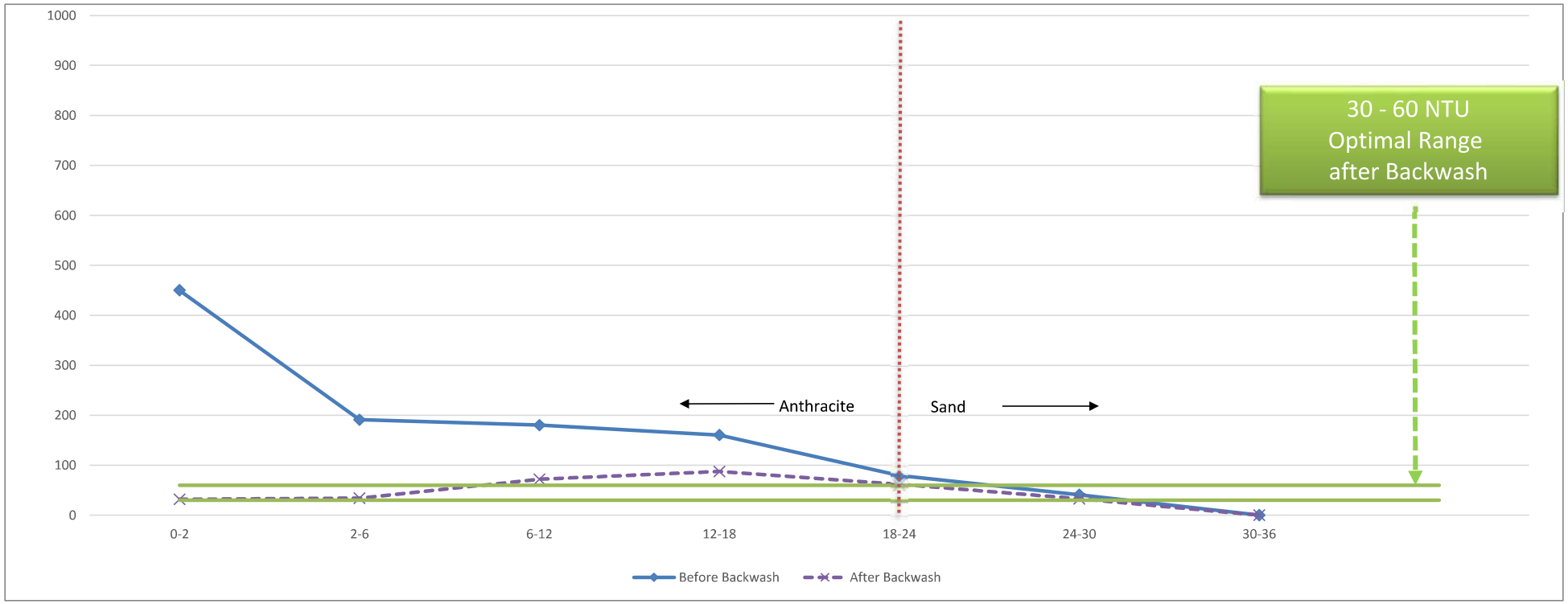
Filter Number: 2

Sample Location: 2

Filter Surveillance Date: 4/6/2023

Graph Data per 100mL

Media Depth	Before Backwash				After Backwash				Notes
	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	
0-2	379	450	59.4	225.0	34	32	46.9	16	
2-6	180	191	53.2	95.5	35	34	49.2	17.1	
6-12	152	180	59.3	90.0	68	72	53.1	36.0	
12-18	136	161	59.3	80.3	80	88	55.0	43.8	
18-24	60	79	65.9	39.6	49	62	63.3	31.0	
24-30	26	41	78.7	20.4	23	33	72.2	16.5	
30-36	-	-			-	-			



Floc Retention Analysis

Filter Surveilance Report - Page 5

Treatment Plant: Wicks WTP - The Dalles, OR

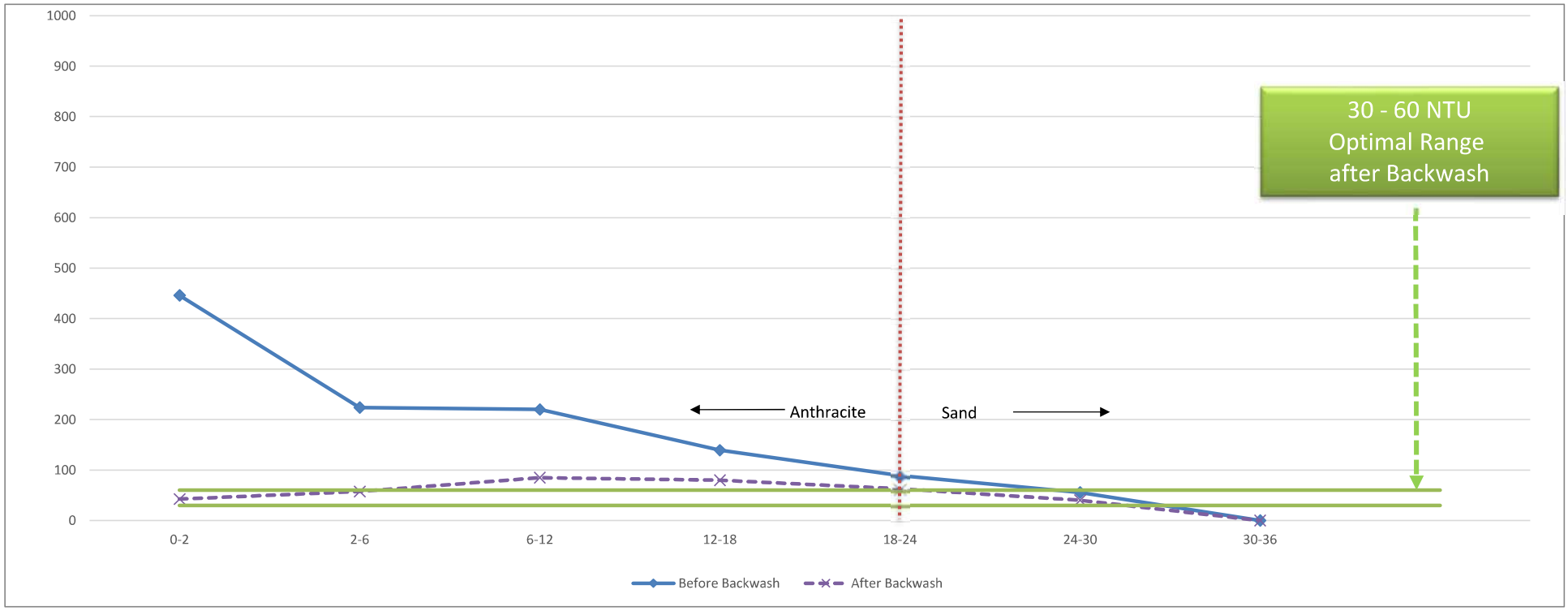
Filter Number: 2

Sample Location: 3

Filter Surveillance Date: 4/6/2023

Graph Data per 100mL

Media Depth	Before Backwash				After Backwash				Notes
	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	
0-2	390	446	57.2	223.0	45	42	47.03	21.2	
2-6	200	224	56.0	112.0	51	58	56.1	28.8	
6-12	198	220	55.5	110.0	76	85	55.9	42.4	
12-18	120	139	57.9	69.7	74	80	54.1	40.0	
18-24	67	89	66.8	44.5	52	63	60.8	31.4	
24-30	39	56	72.1	27.8	28	40	70.92	20.2	
30-36	-	-			-	-			



Floc Retention Analysis

Filter Surveilance Report - Page 6

Treatment Plant: Wicks WTP - The Dalles, OR

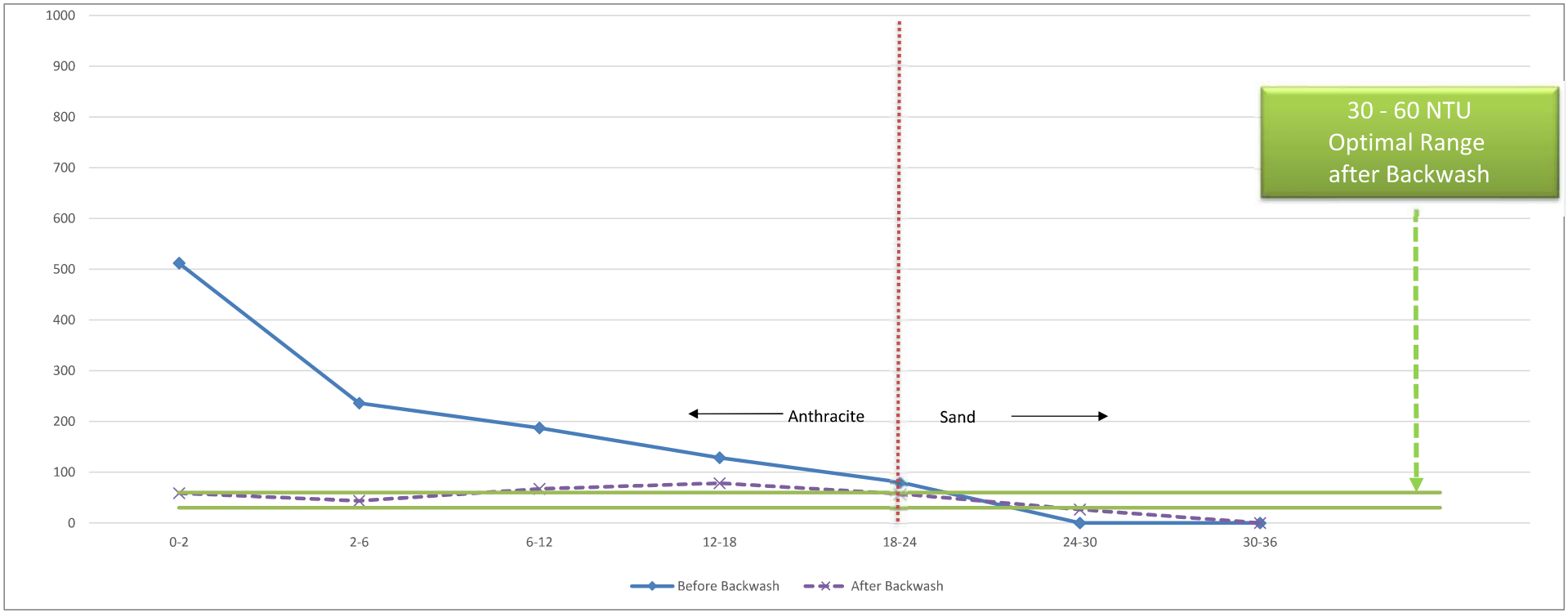
Filter Number: 2

Sample Location: 4

Filter Surveillance Date: 4/6/2023

Graph Data per 100mL

Media Depth	Before Backwash				After Backwash				Notes
	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	
0-2	456	512	56.1	256.0	56	59	52.6	29.4	
2-6	214	236	55.1	118.0	42	43	51.7	21.7	
6-12	167	187	56.1	93.7	65	67	51.7	33.5	
12-18	130	129	49.6	64.4	68	78	57.9	39.2	
18-24	64	80	62.9	40.1	46	57	62.6	28.7	
24-30	-	-	74.0		17	27	78.88	13.3	
30-36	-	-			-	-			



Floc Retention Analysis

Filter Surveilance Report - Page 7

Treatment Plant: Wicks WTP - The Dalles, OR

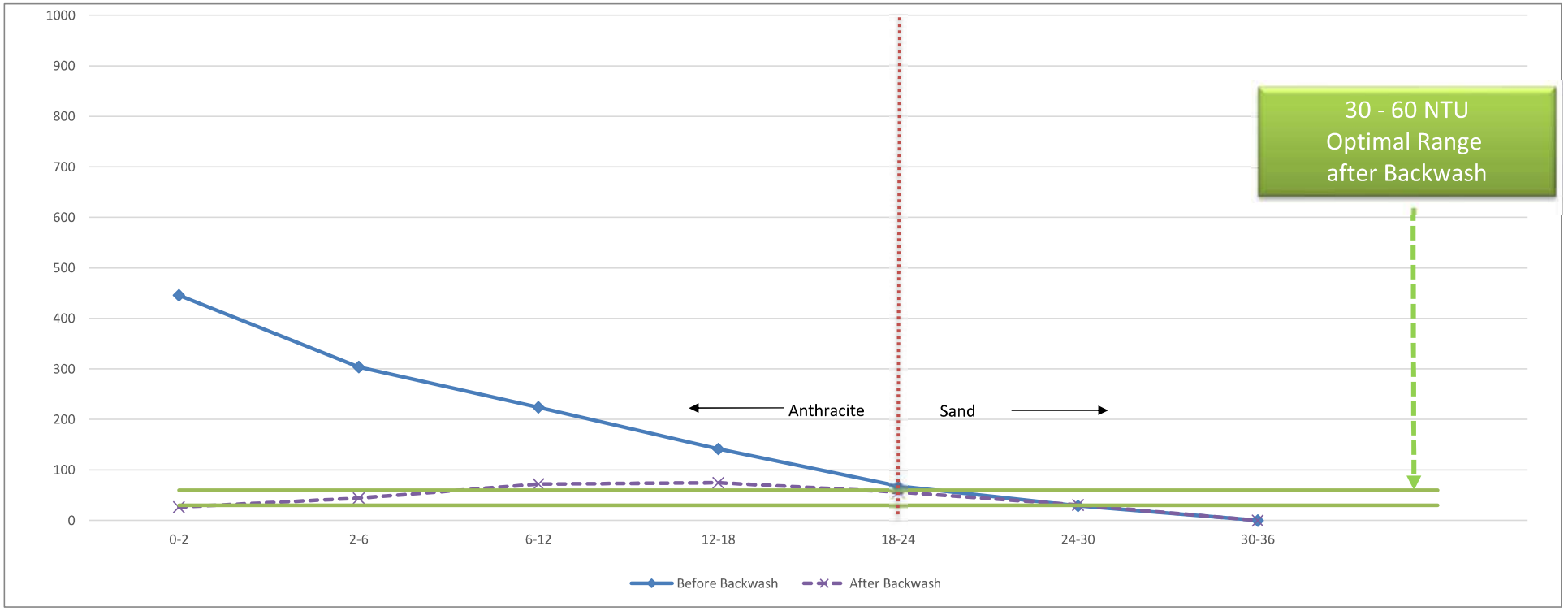
Filter Number: 2

Sample Location: 5

Filter Surveillance Date: 4/6/2023

Graph Data per 100mL

Media Depth	Before Backwash				After Backwash				Notes
	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	Turb (NTU) per 100g	Turb (NTU) per 100 mL	Sample Weight (g)	Measured Turb (NTU) (per 50mL)	
0-2	368	446	60.5	223.0	31	26	42.5	13.2	
2-6	267	304	56.9	152.0	45	44	49.1	22.1	
6-12	185	224	60.4	112.0	71	72	50.8	36.0	
12-18	137	141	51.8	70.7	72	75	52.2	37.4	
18-24	51	68	66.7	34.0	50	56	56.1	28.1	
24-30	19	29	76.7	14.5	21	31	71.7	15.4	
30-36	-	-			-	-			



Attachment B
Condition Assessment

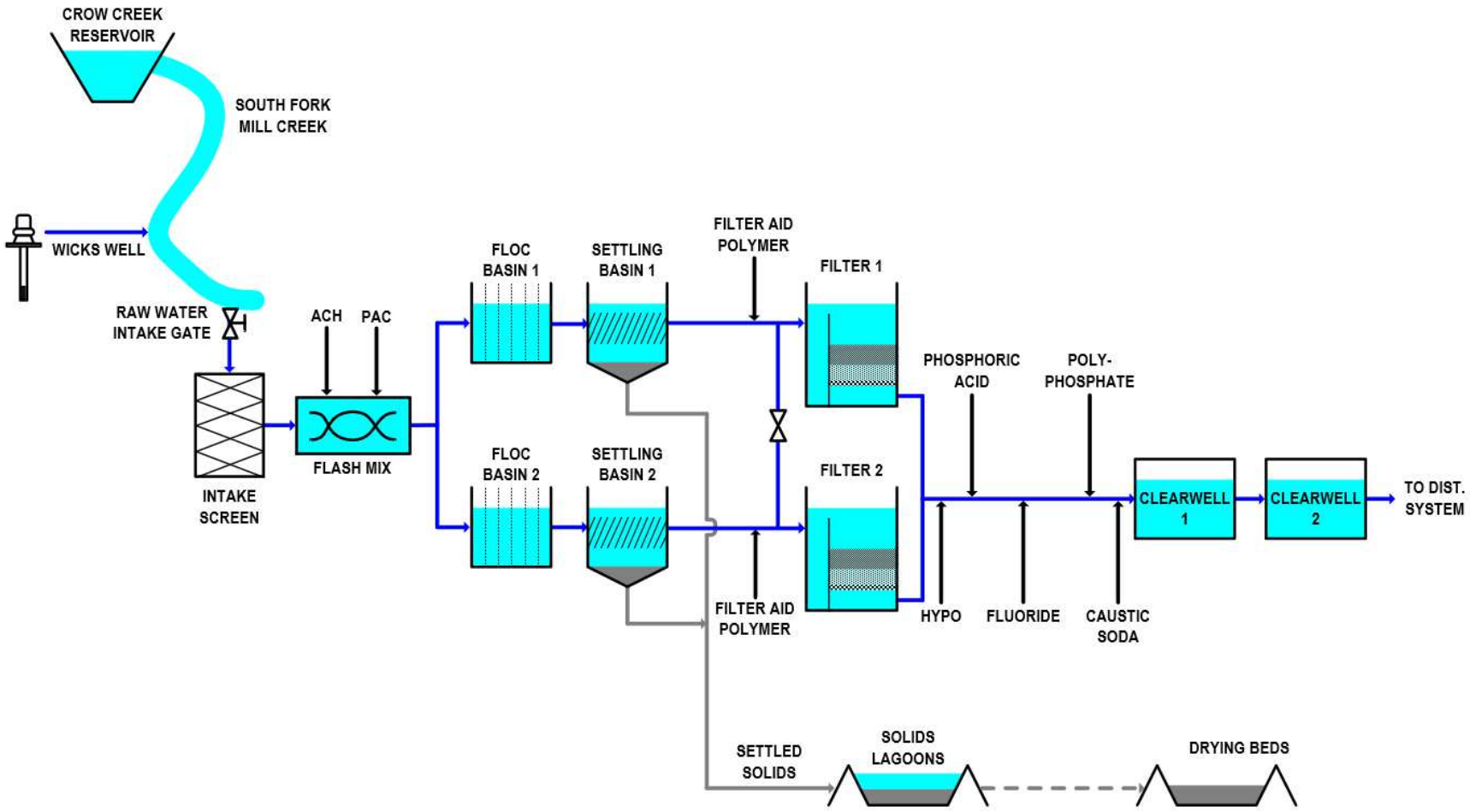
Wicks WTP Condition Assessment

Date:	September 13, 2023
Project name:	The Dalles Water System Master Plan
Project no:	D3718900
Client:	City of The Dalles, OR
Prepared by:	Talia Assi Tyler Kurtz, P.E.
Reviewed by:	Enoch Nicholson, P.E.

1. Introduction

A site visit of The Dalles, OR Wicks WTP was conducted on April 6th, 2023, to evaluate the current condition of the treatment plant. This assessment included preparing an inventory of all facilities, unit processes, and the equipment at the WTP. All observed items were evaluated to determine their condition and identify any defects. The primary goal of this assessment was gathering information to determine which facilities and equipment will need to be either repaired or replaced in future capital improvements should the existing WTP be left in operation for the coming decades. These factors will be considered in the treatment technology evaluation when determining the most appropriate treatment approach for the plant going forward. Figure 1 shows a process flow diagram of the current treatment process and the various facilities considered during this assessment.

Figure 1. Process flow diagram for Wicks WTP.



2. Facility Evaluation

The following facilities were evaluated during this assessment:

- Wicks well
- Intake structure
- Headworks
- Flocculation and sedimentation
- Filters
- Sludge lagoons
- Clearwells
- Chemical facilities
- Offices and ancillary buildings

The mechanical, structural, electrical, and instrumentation and control (I&C) assets in each facility were documented and reviewed for defects. General photos of the facilities and their defects were used to document the state of the WTP. The sections that follow summarize the defects identified at the facilities throughout the plant. The identified defects have been a prioritization rank of 1-3, with lower numbers representing a higher priority.

Higher priority defects (assigned a priority of 1) are those that present immediate challenges to the plant and may impact plant performance if not addressed, as well as safety concerns. Lower priority defects (assigned a priority of 2 or 3) are those that are less urgent but should be considered when evaluating long-term improvements and repairs. These may include opportunities to improve plant operations by adding additional measures for efficiency and automation. This summary is intended to help prioritize improvements over time.

A timeline of construction and improvement projects provided by WTP staff is provided in Attachment A. The addition of major pieces of infrastructure that were noted in this timeline are summarized in Table 2-1. While WTP staff have generally kept the facility in excellent condition, the age of critical pieces of infrastructure is problematic. The EPA estimates the useful life of concrete structures within drinking water treatment plants to be 60-70 years (EPA 2002), placing all concrete in the original Wicks WTP construction at the end of its useful life.

Table 2-1. Construction timeline of Wicks WTP.

Facility/Asset	Year Constructed
Water Treatment Plant	1950
Alum (now ACH) room, washwater tank 2, intake screen	1967
Settling tubes	1973
Clearwell 1	1982
Polymer room	1985
Chemical lab (remodeled), PAC building	1990
Drying lagoon	1991
Caustic soda building, diesel generator	1996
Fish screen/ladder	2003
Log boom, spillway brushing, sodium hypochlorite tanks, flash mixer	2012

Facility/Asset	Year Constructed
Roof on chlorine, generator, PAC, and compressor buildings. Phosphate analyzer, fluoride hopper, and fluoride feed systems are replaced/upgraded.	2014
Fluoride analyzer, plant railing	2016
Filter magnetic flow meter, raw turbidimeter, PLC and level sensor at Crow Creek Dam	2017
Flocculation basin baffles	2018

2.1 Wicks Well

The Wicks Well is a 660-gpm groundwater supply located southwest of the plant. It is used to supplement the South Fork Mill Creek water that feeds the plant. The wellhouse is adjacent to South Fork Mill Creek and is shown in Figures 2 and 3. The wellhouse can be accessed via a road that runs along the east side of the creek. Table 2-2 describes the defects evaluated during the condition assessment at this portion of the facility.

Table 2-2. Wicks Well defects.

Asset	Defect	Priority	Notes
Well Pump	The pump does not have SCADA connectivity or temperature and vibration sensors.	2	A flow meter and on/off controls should be included to integrate this well with SCADA. Will require a data connection from the WTP to the well.
Roadway	There is a lack of fencing to prevent snow and rocks from sloughing onto the roadway and any cars.	3	None.

Figure 2. Wicks Wellhouse.

Figure 3. Wicks Well pump.

2.2 Intake Structure

The intake structure includes a gate, fish screen, and diversion weir that is used to control the flow drawn from South Fork Mill Creek. The gate is just upstream of the fish screen and is controlled manually. Figures 4 and 5 show the intake gate and the fish screen, respectively. A USGS gauging station is located just upstream of the intake structure. This station is used to monitor water levels in the creek. Table 2-3 describes the defects noted during the condition assessment at this portion of the facility.

Figure 4. Intake gate.

Figure 5. Fish screen.

Table 2-3. Intake structure defects.

Asset	Defect	Priority	Notes
Gates and Fish Screen	Sufficient lighting and handrails are lacking and boards on walkways are not secure. Access to the creek for removing weir logs, including stairs and a handrail, is needed as well.	1	None.
Diversion Weir Gate	A proper lid is needed on the stop log diversion to the creek.	1	None.
"Big Wheel" Intake Gate	The "big wheel" intake gate requires manual operation - automation for remote operation should be added.	2	Elevations from previous drawing sets were reviewed. A pipeline with a flow control valve, flow meter, and inline rapid mixer could be installed to eliminate the need to operate multiple gates and optimize chemical dispersion.

Asset	Defect	Priority	Notes
Fish Screens	The fish screens are ~15 years old and may need replacement. Sediment buildup periodically requires digging out the screen to the intake. The fish screens require daily maintenance (wash down and monitoring bearings, motors, PLCs) and could be improved. The fish screen equipment should be integrated into SCADA so that alarms are visible to WTP operators.	2	Replacement of the fish screens is the responsibility of Fish and Wildlife.
USGS Gauging Station	Instrumentation installed in the USGS shed is outdated and should be replaced with a pressure transmitter with SCADA connectivity.	3	Communication wiring to the gauging station could be performed in parallel with Wicks Well, assuming wireless options were not used. There is no electrical to the gauging station currently, but electrical does go to the fish screen and could be run the short distance up to the gauging station.

2.3 Headworks

The plant headworks is a concrete flume with an overflow structure at the upstream end. A manual slide gate is used to control plant flow with excess water overflowing back into South Fork Mill Creek, as shown in Figure 6.

Downstream of the slide gate, aluminum chlorohydrate (ACH) is added at the flash mixer shown in Figure 7. PAC is also added here when it is needed. Table 2-4 summarizes the defects observed at this portion of the facility.

Figure 6. Headworks slide gate.

Figure 7. Headworks flash mix.

Table 2-4. Headworks defects.

Asset	Defect	Priority	Notes
Headworks	The headworks has no SCADA connectivity, gate actuator, or level sensor to allow for automated flow control to the plant.	2	None.
Chemical Addition/Flash Mix	There is no redundancy in the ACH injection/mixing system.	2	The old system could temporarily be relied on for redundancy, but something more efficient would be better long-term, like having a spare pump and mixer on the shelf.
Headworks	The headworks has no cover, presenting issues with leaf fall clogging pipes, gates, screens, and equipment.	3	None.

2.4 Headworks Chemical Facility

The Headworks Chemical Building is located west of the headworks. The powder activated carbon (PAC) and soda ash chemical systems are stored in this building.

2.4.1 Powder Activated Carbon

PAC is available on site for intermittent use when upstream water quality events occur that require additional treatment. Figure 8 shows the PAC storage facility and Table 2-5 summarizes the defects within this facility.

Figure 8. PAC equipment.

Table 2-5. PAC defects.

Asset	Defect	Priority	Notes
PAC Feed Hopper	There is no apparent loader/lift to raise dry PAC up to the platform when being loaded into hopper.	3	WTP staff have noted that this is due to the infrequent use of this system and bags are less than 50 lbs.

2.4.2 Soda Ash

Historically, soda ash was used intermittently during low pH events. The system is no longer in use, and soda ash is not currently stored on site, though the old equipment is still housed in the Headworks Chemical Building. This facility was not evaluated since it is not currently in use.

2.5 Flocculation and Sedimentation

There are two flocculation and sedimentation basin trains located downstream of the headworks. The plant utilizes a hydraulic baffle system to achieve mixing in the flocculation basins. The wooden baffles in

the flocculation basins were replaced in 2018 and are in good condition. Vertical turbine mixers were installed during the construction WWTP in 1949 but were removed in 1967 to poor performance.

The sedimentation basin includes inclined settling tubes and a trac-vac system that is used for sludge removal. The sludge collection system continues to operate well and performs as intended, though Train 1 has an I&C defect and both trains require electrical improvements. Figures 9 and 10 show the flocculation and sedimentation basins, respectively. Figure 11 shows the wooden beams that are used to support the failing tube settler supports. Table 2-6 details the defects observed at these basins. Given the structural defects noted in the flocculation and sedimentation basins, a structural assessment was performed, which is included in Attachment B.

Figure 9. Flocculation basins.

Figure 10. Sedimentation basin covers.

Figure 11. Tube settler supports.

Table 2-6. Flocculation and sedimentation defects.

Asset	Defect	Priority	Notes
Track Vac	Panels and switches on the track vac are due for replacement. On Train 1, the high and low speeds are reversed for the track vac system programming.	1	None.
Sedimentation Basin Covers	There is visible cracking in the covers on top of the basins.	1	FRP covers or planks may be preferable to concrete slabs. If the settling tubes are replaced with metal equipment, then the covers are no longer required. See Structural Assessment (Attachment B) for more details.
Structural Walls	External sedimentation basin walls are showing visible signs of degradation and angular cracking. They require repair and potentially long-term replacement.	2	Basins were taken offline and repaired with injection and a new epoxy coating. See Structural Assessment (Attachment B) for more details.
Tube Settlers	Settling tubes are brittle and fall apart when moved. Supports are becoming disconnected from walls.	2	Noticeable algae growth and damage to the tubes overtime led to covering the basins. Ops is interested in UV resistant settling tubes in the future.
Track Vac Compressor	Seals are leaking. There is visible vibration in the bearings and no safety provisions for high temperatures on the bearings.	2	The compressor should either be repaired or replaced. Replacement is currently budgeted by the City.

2.6 Filter Facility

The plant has two conventional dual-media filters downstream of sedimentation. These filters are enclosed in the filter building just north of the flocculation and sedimentation basins, with filter aid polymer dosed upstream of the filters. The anthracite filter media was replaced in 2023.

Contained within the same building as the filters are plant controls, a lab, offices, and ACH storage. In the Polymer Room, built adjacent to the filter building in 1985, the following chemicals are stored: filter aid polymer, polyphosphate, and phosphoric acid. Figures 12 and 13 show the filter facility. Table 2-7 details the defects observed at this portion of the facility.

Figure 12. Both filters and plant controls.

Figure 13. The exterior of the filter facility.

Table 2-7. Filter facility defects.

Asset	Defect	Priority	Notes
Filter Building	Exterior walls of the filters showing signs of deterioration.	1	Cracks and weeping are occurring near the underdrain/sand layer on the outside of Filter 1. See Structural Assessment (Attachment B) for more details.
Filtration Piping	Piping is nearing the end of its life and will have to be replaced within 5-10 years.	2	None.
Surface Wash and Filter Influent Valves	Some valves are too high to access from the floor and there are no chain wheels in place.	2	None.

2.6.1 Aluminum Chlorohydrate

ACH is a coagulant added at the plant headworks upstream of flash mixer. ACH is stored in an FRP tank in the east side of the filter building. Figure 14 shows the current ACH storage area and Table 2-8 notes the defects observed with the ACH facility.

Figure 14. ACH storage tank.

Table 2-8. ACH facility defects.

Asset	Defect	Priority	Notes
ACH Pumps	Pumps/chemical feed system are not connected to SCADA.	1	None.
ACH Feed System	Chemical piping is lacking calibration columns and redundancy.	3	None.

2.6.2 Filter Aid Polymer

The filter aid polymer is stored in the Polymer Room and is added between the sedimentation basin and filters to enhance filter performance. It is purchased in 5-gallon carboys and a dilute polymer solution is blended in the filter aid polymer tank (Figure 15) before being stored in the day tank (Figure 16) where it is supplied to peristaltic pumps. Table 2-9 summarizes the defects noted in the filter aid polymer equipment.

Figure 15. Filter aid polymer tank.

Figure 16. Filter aid polymer day tank.

Table 2-9. Filter aid polymer defects.

Asset	Defect	Priority	Notes
Filter Aid Polymer Storage	No chemical containment is present.	1	None.
Filter Aid Polymer Pumps	Pumps/chemical feed system are not connected to SCADA.	1	None.
Filter Aid Polymer Feed System	Chemical piping is lacking calibration columns and redundancy.	3	None.

2.6.3 Polyphosphate

Polyphosphate is used for corrosion control and iron and manganese sequestration. It is currently stored in barrels in the Polymer Room, as seen in Figure 17. Polyphosphate is dosed in between the filters and the clearwell. Table 2-10 describes the defects noted for this facility.

Figure 17. Polyphosphate storage.

Table 2-10. Polyphosphate storage defects.

Asset	Defect	Priority	Notes
Polyphosphate Storage	No chemical containment is present.	1	None.
Polyphosphate Pumps	Pumps/chemical feed system are not connected to SCADA.	1	None.
Polyphosphate Feed System	Chemical piping is lacking calibration columns and redundancy.	3	None.

2.6.4 Phosphoric Acid

Phosphoric acid is used on site for corrosion control. It is currently stored in barrels in the filter building, as seen in Figure 18. Phosphoric acid is dosed in between the filters and the clearwell. Table 2-11 lists the defects noted for this facility.

Figure 18. Phosphoric acid storage.

Table 2-11. Phosphoric acid storage defects.

Asset	Defect	Priority	Notes
Phosphoric Acid Storage	No chemical containment is present.	1	None.
Phosphoric Acid Pumps	Pumps/chemical feed system are not connected to SCADA.	1	None.
Phosphoric Acid Feed System	Chemical piping is lacking calibration columns and redundancy.	3	None.

2.7 Washwater Tanks

Two washwater tanks store water for filter backwashing and are located above the facility on a hill to the east of the building. Washwater Tank 1 is concrete, can store about 47,000 gallons of water, and was constructed with the original facility in 1949. Washwater Tank 2 is steel, can store about 52,000 gallons of water, and was constructed in 1967. Both are pictured in Figure 19, with defects noted in Table 2-12.

Figure 19. Washwater tanks.

Table 2-12. Washwater tank defects.

Asset	Defect	Priority	Notes
Washwater Tank 1	Washwater Tank 1 shows signs of wear and degradation in its exterior paint.	1	While the exterior paint may show signs of degradation, Washwater Tank 1 is concrete and is in decent shape, structurally.
Washwater Tank 2	Washwater Tank 2 has structural issues with its roof.	1	None.
Washwater Tanks	A cover is missing on the manhole/vault (~3 ft deep, safety concern).	1	The vault contains the pressure sensor for the nearby tank.
Washwater Tanks	Both washwater tanks are a located below a rocky hill, presenting concerns that falling rocks could damage the tanks and take them out of service.	2	None.

2.8 Caustic Soda Facility

The caustic soda facility was initially constructed in 1996 and includes a fiberglass reinforced plastic (FRP) tank for the storage of caustic soda which is no longer in use (Figure 20). The plant now uses tote deliveries of caustic which are stored outside (Figure 21). The system was added at the plant for pH adjustment of finished water but now sees reduced use following the conversion from gaseous chlorine to sodium hypochlorite. Table 2-13 summarizes the defects noted in this facility.

Figure 20. Old caustic storage tank.

Figure 21. Exterior caustic storage

Table 2-13. Caustic storage facility defects.

Asset	Defect	Priority	Notes
Caustic Pumps	Pumps/chemical feed system are not connected to SCADA.	1	None.
pH Analyzer	pH analyzer is not functioning and needs to be repaired or replaced.	2	None.
Caustic Tank	Caustic system and tank are no longer in use.	3	Consider removing tank and using this room for a different purpose (i.e., analyzer room).
Sample Points and Analyzers	Sample points and analyzers in the facility are spread out around various locations.	3	The sample points and analyzers located in this building are associated with multiple systems. Ideally, they could be reconfigured so all sample points are in one location and all analyzers are in the same place.
Caustic Feed System	Chemical piping is lacking calibration columns and redundancy.	3	None.

2.9 Chlorine Facility

The Chlorine Facility located northeast of the lagoons houses the sodium hypochlorite and fluoride systems. The structure was built in 1982 and originally housed a gaseous chlorine system. In 2011, the WTP's disinfection system was converted to sodium hypochlorite.

2.9.1 Sodium Hypochlorite

Sodium hypochlorite is used downstream of filtration for disinfection of finished water. It is currently stored in two high-density polyethylene (HDPE) tanks within HDPE secondary containment tubs. Figure 22 shows one of the sodium hypochlorite storage tanks and Table 2-14 summarizes the defects noted in this facility.

Figure 22. Old caustic storage tank.

Table 2-14. Sodium hypochlorite defects.

Asset	Defect	Priority	Notes
Sodium Hypochlorite Storage Tanks	Chemical tanks do not vent to atmosphere.	1	None.
Sodium Hypochlorite Storage Tanks	Tanks are not properly anchored.	1	None.
Sodium Hypochlorite Storage Tanks	Hypo tank walls are deteriorating and quite soft.	1	Hypo tanks are due for replacement.

Asset	Defect	Priority	Notes
Sodium Hypochlorite Pumps	Pumps/chemical feed system are not connected to SCADA.	1	None.
Sodium Hypochlorite Storage Tanks	There is no level measurement instrumentation on the tanks.	2	None.
Sodium Hypochlorite Storage Tanks	Exterior filling connection for both tanks does not exist.	3	None.
Sodium Hypochlorite Feed System	Chemical piping is lacking calibration columns and redundancy.	3	None.

2.9.2 Fluoride

Fluoride is stored in the Chlorine Facility, in a separate room from the sodium hypochlorite system. Fluoride is stored dry onsite in bags and is used on site for fluoridation of the filtered water upstream of the clearwells. Figure 23 shows the fluoride storage facility and hopper on site. Table 2-15 summarizes the defects noted with the fluoride facility.

Figure 23. Fluoride feed hopper.

Table 2-15. Fluoride system defects.

Asset	Defect	Priority	Notes
Fluoride Pumps	Pumps/chemical feed system are not connected to SCADA.	1	None.
Fluoride Injection System	The existing fluoride pump (10 hp) is oversized.	3	None.
Fluoride Feed System	Chemical piping is lacking calibration columns and redundancy.	3	None.

2.10 Clearwells

Two clearwells are used for disinfection and finished water storage downstream of the filters. Figures 24 and 25 show Clearwells 1 and 2, respectively. Table 2-16 summarizes the defects observed in these clearwells.

Figure 24. Clearwell 1.

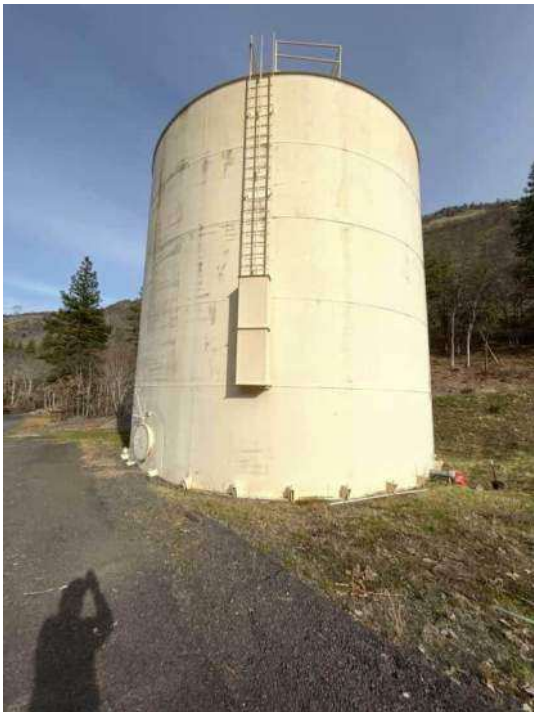


Figure 25. Clearwell 2.

Table 2-16. Clearwell defects.

Asset	Defect	Priority	Notes
Clearwell 1 Vault	The exposed concrete is crumbling and needs to be replaced. Access hatches are not secured to the concrete and do not seal properly. Drainage around the vault is poor, causing water to accumulate in the vault.	1	Replacing the hatch and seal should be considered.

Asset	Defect	Priority	Notes
Clearwell 1 Vault	The vault is a confined space, making it difficult to access the flow meters, level sensor, pressure sensors, valves, fluoride injection point, and chlorine injection point within.	1	None.
Clearwell 1 Vault Sump Pump	The sump pump does not work. A rope is currently being used as a float and the vault does not actually drain as it should.	1	None.
Clearwell 1 Vault	Minor defects in flow element and transmitter. No visible corrosion on grounding wire or terminal blocks.	2	None.
Clearwell 1	Light staining and small chips/holes in the coatings on metal surfaces was observed.	2	None.
Clearwell 1	Significant corrosion was found in the roof upon inspection in July 2023.	3	Inspection of the clearwell is scheduled for late 2023/early 2024. The clearwell may need to be taken offline until it can be repaired pending the outcome of the inspection.

2.11 Solids Handling Facilities

North of the main plant facilities, two sludge lagoons receive the collected solids from the sedimentation basins and the backwash waste from the filters. The sludge lagoons are dredged annually, and the solids are sent to the drying beds prior to final disposal. Figure 26 shows the sludge lagoons. Table 2-17 details the defects observed for these facilities.

Table 2-17. Solids handling facilities defects.

Asset	Defect	Priority	Notes
East Sludge Lagoon Effluent Weir	The effluent weir is difficult to operate and ineffective.	2	None.
Sludge Lagoons	The sludge lagoons require manual dredging to send solids to the drying beds.	2	None.
Drying Beds	There are issues with solids dispersion within the drying beds.	2	Creating more entry points and addressing short circuiting issues could help address this.

Figure 26. Both sludge lagoons.

2.12 Offices and Ancillary Buildings

Various additional offices and ancillary buildings were evaluated throughout the treatment plant including the water quality lab, plant generators, offices, mechanical shop, technical buildings, the conference room, etc. Table 2-18 details the defects that were noted at these locations.

Table 2-18. Offices and ancillary building defects.

Asset	Defect	Priority	Notes
Access Road	A sink hole (approximately 5'x3') formed adjacent to the filter/lab building and floc/sed basin walls. While the sink hole was filled in with flow fill, the cause has not been determined or addressed.	1	The cause of the sink hole should be investigated and determined. A crack in the nearby sed basin wall was patched by maintenance staff.
Shop Building	The shop building has no heat or insulation.	2	None.
Office Building	The office building adjacent to floc/sed basins is exhibiting structural degradation. It appears to be falling off the foundation	3	None.
Shop Building	The shop building is showing signs of structural degradation. The roof leaks severely.	3	None.
Plumbing Building	The plumbing building is in poor shape.	3	The building should be replaced with a new structure.

3. Conclusions

The highest priority capital improvements that were identified pose immediate concerns to the continued operation and efficiency of the WTP or the health and safety of plant staff. Some of these improvements include structural concerns associated with pretreatment and filtration facilities, chemical containment improvements, and the replacement of the sodium hypochlorite tank. Out of the 63 items found in the condition assessment, 24 were identified as high priority. The remaining 39 items identified were assigned lower priorities, with 19 being secondary priority and 20 being lowest priority.

Using guidelines provided by The Association for the Advancement of Cost Engineering (AACE), a Class 5 cost estimate was prepared. This level of cost estimate is for a project that is 0-2% complete for the purpose of concept screening. Given this level of cost estimate, the expected accuracy range on the low end is between -20% to -50% and between +30% to +100% on the high end. Jacobs' estimate is based on material, equipment, and labor pricing as of May 2024 and uses conceptual and stochastic costs and detailed items using separate labor, material, and equipment costs. The estimate uses parametric costs where design information or details are insufficient to allow a detailed item method. At this level of estimate, AACE recommends adding a 30 percent budgeting contingency when considering funding needs. The costs to address noted defects are summarized in Attachment C.

After the alternatives analysis was performed, it became clear that many of the identified defects would be addressed during expansion through the construction of new facilities. These defects are noted as such in the cost estimate provided in Attachment C. Some defects, such as the replacement of the existing sodium hypochlorite tanks and some finished water sensors, will be addressed during expansion but present immediate concerns to the continued operation of the facility while WTP construction occurs. Those items were assigned costs and are included as short-term improvements in the phasing of the proposed alternative.

4. References

Environmental Protection Agency (EPA). 2002. *The Clean Water and Drinking Water Infrastructure Gap Analysis.* EPA-816-R-02-020.

Attachment A
Wicks Plant Timeline

Wicks Plant Timeline

1949 Original Plant Drawings (dwgs in /ScannedConstructionDrawings)

1950 Plant Construction

1960 Wicks Reservoir Intake Repair (dwg in /ScannedConstructionDrawings)

1967 Wicks Improvements – Alum room addition, WWtank2, Intake Screen, Chlorine feed mods (dwgs in /ScannedConstructionDrawings)

1968 Crow Creek Dam Construction (dwgs in /ScannedConstructionDrawings)

1973 Settling Tubes Installed (dwgs in /ScannedConstructionDrawings)

1982 ClearWell #1 & plant mods (Chlorine/Fluoride Bldg...)

1985 Polymer Room

1990 Chem Lab Remodel and Carbon Bldg (dwgs in /ScannedConstructionDrawings)

1991 Drying Lagoon

1996 Historic Flood
Caustic Soda System
Diesel Generator

1999 Crow Creek Dam Telemetry

2003 Fish Screen/Ladder

2008 Clearwell #2

2009 Filter Upgrades
Convert from Alum to ACH
Prechlorination stopped (July)

2011 Convert to NaOCl (Summer)

2012 New LogBoom @ CCD
Spillway Brushing
Install new NaOCl tanks
Design, build, and install ACH Pump Diffused Flash Mixer (dwg in Mngr Office)

2013 Government Flat Complex/Blackburn Fire
Drum handler for phosphates
Upgrade Radio/modems for CCD Communications

2014 New metal roofing on Chlorine, Generator, Carbon, Compressor Bldgs
Replacement Phosphate Analyzer
Replace/Upgrade Fluoride Hopper and Feed System
Filter plant floor tile replacement/lab counters/eye-wash upgrade
Filter plant floor Asbestos/Lead Abatement

2015 Filter Media Addition to Top-off Filters

2016 Replacement Fluoride Analyzer
LT2 Sampling Begins
Begin Upgrade of Plant Railing

2017 Filter Mag Meter Installation
Replacement Raw Turbidimeter
Replace PLC and Reservoir Level Sensor @ CCD

2018 Sed Basin No 1 Sealing Project
Replace Basin Baffling

2023 Full Replacement of Anthracite Filter Media
UCMR 5

Attachment B
Structural Assessment

Wicks WTP Structural Assessment

Date: September 13, 2023
Project name: The Dalles Water System Master Plan
Project no: D3718900
Client: City of The Dalles, OR
Prepared by: Luke Scoggins, S.E.

1. Assessment Summary

A visual structural assessment of the Wicks Water Treatment Plant was performed on April 18, 2024. The primary focus was on the flocculation, sedimentation, and filter basins. Flocculation and Sedimentation Basins 2 were drained and cleaned to allow access to the interior of the basins. Similarly, Filter Basin 2 was drained to allow for visual assessment. Prior to and following the visual assessment, the facility engineering drawings were reviewed. The drawings are dated May 27, 1949.

The flocculation and sedimentation basins are open-topped reinforced concrete tanks as originally designed and are adjacent to and connected to the multi-story, reinforced concrete filter complex. The filter basins are at the interior of the building. The sedimentation basins were covered with prestressed hollow-core slabs. According to plant staff, these were added some time around 1980 to protect the plastic tube settlers from degradation due to UV exposure.

While on-site, the clearwell vault and the washwater reservoirs were briefly inspected from the exterior. The clearwell vault is a small vault with interior dimensions of 12'x6' with a 9' depth, based on the design drawings dated November 1981. The washwater reservoirs consist of two tanks, one is reinforced concrete and was built at same time as the flocculation, sedimentation, and filter basins. This tank is 24-feet in diameter with a 13.5-foot side wall height. The other is a welded steel tank with design drawings dated August 1967. It is 24-feet in diameter with a 16-foot side wall height.

The site structures were not analyzed in detail through calculations. Seismic evaluation was also not performed. Given their age, the structures were likely not designed and detailed for current seismic requirements. The sedimentation basins in particular are not expected to perform well during a moderate to severe seismic event. This is due to the strut type detailing used in the design, which relies on a tension/compression strut to support the top of basin walls and requires balanced loading conditions to satisfy this assumption.

1.1 Flocculation and Sedimentation Basins

The concrete at the exterior of Sedimentation Basin 1 was weathered at the top surface with some visible cracks. The wall on the west was mostly above grade and was painted. The paint obscured most of the concrete but was failing is some areas. The concrete surface in these exposed areas was found to be dusting and somewhat chalky, but otherwise sound. There were many small vertical cracks visible, but no significant leakage was observed (Figure 1). Most of the cracks were concentrated near the middle of the structure. Plant staff indicated that leakage was repaired on this wall some years ago through crack injection.

Figure 1. West exterior wall of Sedimentation Basin 1.

The basin interiors are uncoated. Below the operating waterline, the cement paste was gone, leaving exposed aggregate in most areas (Figures 2 and 3). Paste and small aggregate between the larger aggregate was easily removed by firm scratching with a rock hammer. In areas of the flocculation basin, the cement paste was still present, but was easily scratched off to a depth of ¼" until aggregate was encountered. Due to the amount of aggregate exposure and abrasive removal with hammer, it is estimated that the concrete surface is severely deteriorated to a depth of 1.5-inches or more from original surface in some locations. Most of the concrete surface deterioration was likely due to chemical attack from the addition of aluminum chloride and chlorine to water treated in the basins as part of the historic treatment process.

Figure 2. Interior of Sedimentation Basin 2.

Figure 3. Interior of Sedimentation Basin 2 at base of wall.

At the underside of the overhanging slabs from the walkway, exposed reinforcing was visible in many locations (Figure 4). At locations where reinforcing was exposed, it appeared that the reinforcing was close to the surface and did not have the recommended 2-inches of cover shown in the original drawings.

Figure 4. Exposed reinforcing in walkway slab over Sedimentation Basin 2.

The prestressed, hollow-core slabs covering the basins showed significant cracks, spalls, and general deterioration. The damage appears to be a result of weathering and freeze/thaw exposure. Several of the panels are beginning to split parallel to the open cores and prestressing strands (Figure 5).

Figure 5. Cracking and splitting of prestressed slab.

The tube settler steel support brackets were uncoated and showed signs of corrosion. Hardware and anchor bolts had significant rust buildup. Plant staff indicated that a few of the brackets required modifications and that anchors were added to strengthen their supports. The plastic tube settlers also appeared to have some damage and appeared brittle (Figure 6).

Figure 6. Tube settlers and supports as seen from below.

1.2 Filter Basins

The concrete at the interior of the filter basins was in similar condition to that in the sedimentation basins, but less severely deteriorated (Figure 7). Below the water line, the concrete paste at the surface was mostly gone with exposed small aggregate visible. Paste and small aggregate could be removed with moderate scratching of the rock hammer. Due to the amount of aggregate exposure and abrasive removal with hammer, it is estimated that the concrete surface is deteriorated to a depth of about ¾-inch from the original surface.

Above the weir wall, some spalling was visible with exposed reinforcing (Figure 8). It appears to be a horizontal bar in the wall that is too close to the surface and subject to corrosion, causing the concrete to spall along its length. This is likely to continue over time if unaddressed.

Figure 7. Interior of Filter 2.

Figure 8. Spalling and exposed reinforcing in Filter 2.

1.3 Clearwell Vault

Only one sidewalk door is shown in the design drawings, however an additional sidewalk door of the same size was in place at the opposite end of the vault. The opening for this door at the concrete slab appears to have been saw-cut; it is unknown when this work was done. The top surface of the concrete slab between sidewalk doors showed signs of very severe scaling. The top ½-inch to ¾-inch layer of concrete appeared to have completely debonded and was easily removed (Figure 9). The concrete below this layer remained unsound to an unknown depth. It is likely this is freeze-thaw damage possibly exacerbated through poor, premature concrete finishing during placement and/or the lack of air entrainment admixture in the original concrete mix. The concrete is likely to continue scaling to a greater depth over time.

Figure 9. Very severe scaling on the concrete slab.

1.4 Washwater Reservoirs

The reservoirs were only briefly observed from the exterior. The steel reservoir coating appeared to be in good condition. It should be noted that the primarily vulnerability for welded steel tanks is corrosion at the interior above the water line where the coating system is not well maintained. As noted, the interior was not observed.

The concrete reservoir showed signs of significant large pattern map cracking and leakage with efflorescence at most of the cracks (Figure 10). Due to the efflorescence, it is likely these cracks formed years ago and have been actively, but slowly leaking over time. It is not clear how extensive these cracks are around the perimeter of the tank or the interior. It is difficult to speculate to the cause without more information.

Figure 10. Map cracking at tank exterior.

2. Conclusions and Recommendations

2.1 Flocculation and Sedimentation Basins

These basins are 75 years old and have met their original design life. Since the additions of aluminum chloride and chlorine have stopped, the chemical attack at the concrete surface will be arrested. However, the concrete is showing some substantial deterioration overall and significant repairs would be required to bring back the concrete to original construction condition and design capacity. Although there does not appear to be any specific damage or deterioration that would lead to an imminent structural failure or water-holding ability, the concrete should be expected to continue to degrade and carbonate over time, further reducing the design capacity of the structure.

It is recommended to consider replacement of these basins within the next 15-25 years. Depending how long they must stay in service until replacement, some repairs may be warranted to keep the basins in service.

2.1.1 Prestressed Hollow-Core Slabs

The damage in these slabs is not practically repairable and they are likely to continue to degrade. As this damage and cracking continues, it may lead to sections completely cleaving off and becoming unstable and buckling due to the prestressing force becoming eccentric to the remaining concrete section. This may result in a sudden release of the stored energy of the prestressed strand as the concrete fails and strands debond. This would be an unsafe condition for any nearby personnel at the time of failure. It is recommended to safely remove and dispose of these slabs as soon as practical.

2.1.2 Exposed Reinforcing

The exposed reinforcing observed on the underside of the walkway slab is not the primary load carrying reinforcing for the cantilever slab. The deterioration will continue if not addressed, but it is expected to be slow. If the basins are to stay in service for more than 10 years, it is recommended to repair the concrete in these areas with a repair mortar to provide protection for this reinforcing.

2.1.3 Concrete Surface at Basin Interior

Due to the significant deterioration of the concrete, to repair to original condition, the defective concrete would have to be fully removed until sound concrete is found. Then a vertical surface repair mortar would be applied and properly bonded to the surface to get to the original design thickness. This process is time consuming, very costly, and is not recommended for a structure of this age where replacement is a viable alternative.

2.2 Filter Basins

These basins are 75 years old and have met their original design life. Since the additions of aluminum chloride and chlorine have stopped, the chemical attack at the concrete surface will be arrested. The concrete is showing some moderate deterioration overall. These basins are in better condition than the sedimentation basins and are expected to last longer in current exposure conditions.

2.2.1 Exposed Reinforcing

The exposed reinforcing observed is not the primary load carrying reinforcing for the wall at that location. The deterioration will continue if not addressed, but it is expected to be slow. If the basins are to stay in service for more than 10 years, it is recommended to repair the concrete in these areas with a repair mortar to provide protection for this reinforcing.

2.3 Clearwell Vault

The deteriorating concrete slab is limited in area. It could be repaired by removing the unsound concrete and properly applying a horizontal repair mortar. However, the depth of unsound concrete is unknown, and the slab is only 6-inches thick. A proper bond is critical to avoid freeze-thaw damage to the bonded interface which could cause the repair to fail. It may not be worth the cost of removing the unsound concrete, preparing the surface, and properly applying the repair mortar for this limited area of concrete. Alternatively, the slab and sidewalk doors could be removed, and an aluminum cover system installed in their place with access hatches. This could also be part of a larger modification to provide adjacent stair access to the vault to eliminate the confined space entry procedures.

2.4 Washwater Reservoirs

The welded steel tank should be inspected on the interior and its coating maintained at a regular interval to avoid damage from long-term corrosion.

The concrete tank is 75 years old and has met the original design life. The interior should be inspected for concrete surface conditions and for exposed reinforcing. Recommendations and potential repairs would be similar to the filter and sedimentation basins, depending on the interior conditions. The exterior cracks could be injected to stop the leaks, but the total rate of leakage appears very minor. Alternatively, the cracks may be left in their current condition, monitored for the remainder of the tank service, and addressed if the leakage increases significantly.

Attachment C
Defect Improvements Cost Estimate

No.	Facility	Asset	Defect	Priority (1 high - 3 low)	Necessary for WTP Expansion?	Necessary for WTP Replacement?	Mitigation Assumption	Total Cost	Notes
1	Wicks Well	Well Pump	The pump does not have SCADA connectivity or temperature and pressure sensors.	2	Y	Y	Addition of flow meter, pump controls, temp/vib sensors and integration with SCADA	$ 195,000	Assumes radio connectivity is feasible (not buried fiber)
2	Wicks Well	Roadway	There is a lack of fencing to prevent snow and rocks from sloughing onto the roadway and any cars.	3	Y	Y	Installation of 6 ft chainlink fence with wiring and anchors above roadway	$ 19,500	None
3	Intake Structure	Gates and Fish Screen	Sufficient lighting and handrails are lacking and boards on walkways are not secure. Access to the creek for removing weir logs, including stairs and a handrail, is needed as well.	1	Y	Y	Addition of stairs, handrail, and lighting around intake structure and at creek	$ 292,500	None
4	Intake Structure	Diversion Weir Gate	A proper lid is needed on the stop log diversion to the creek.	1	Y	Y	Lid replacement	$ 9,750	None
5	Intake Structure	"Big Wheel" Intake Gate	The "big wheel" intake gate requires manual operation - automation for remote operation should be added.	2	Y	Y	Actuator addition with connection to SCADA	$ 62,400	Assumes radio connectivity is feasible (not buried fiber)
6	Intake Structure	Fish Screens	The fish screens are ~15 years old and may need replacement. Sediment buildup periodically requires digging out the screen to the intake. The fish screens require daily maintenance (wash down and monitoring bearings, motors, PLCs) and could be improved. The fish screen equipment should be integrated into SCADA so that alarms are visible to WTP operators.	2	Y	Y	SCADA integration of fish screen alarms	$ 62,400	This is complete connection of fish screen to SCADA, not just one alarm. Assumes radio connectivity is feasible (not buried fiber). Assumes new radio equipment. Would need to add graphics and design interface.

No.	Facility	Asset	Defect	Priority (1 high - 3 low)	Necessary for WTP Expansion?	Necessary for WTP Replacement?	Mitigation Assumption	Total Cost	Notes
7	Intake Structure	USGS Gauging Station	Instrumentation installed in USGS shed is outdated and should be replaced with a pressure transmitter with SCADA connectivity.	3	Y	Y	Addition of pressure transmitter connected to SCADA	$ 62,400	Assumes radio connectivity is feasible (not buried fiber)
8	Headworks/ Flash Mix	Headworks	The headworks has no SCADA connectivity, gate actuator, or level sensor to allow for automated flow control to the plant.	2	Y	N	Replace entire headworks with new inline mechanical mixer, flow meter, and flow control valve	$ 1,092,000	None
9	Headworks/ Flash Mix	Chemical Addition/ Flash Mix	There is no redundancy in the ACH injection/mixing system.	2	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
10	Headworks/ Flash Mix	Headworks	The headworks has no cover, presenting issues with leaf fall clogging pipes, gates, screens, and equipment.	3	Y	N	Replace entire headworks with new inline mechanical mixer, flow meter, and flow control valve	See Item 8	None
11	Headworks Chemical Building	PAC Feed Hopper	There is no apparent loader/lift to feed dry PAC into hopper.	3	Y	N	Purchase of manual scissor lift	$ 1,500	None
12	Flocculation & Sedimentation	Track Vac	Panels and switches on the track vac are due for replacement. On train 1, the high and low speeds are reversed for the track vac system programming.	1	Y	N	Panel and switch replacement for both trac vacs, as well as reprogramming of Train 1	$ 31,200	None
13	Flocculation & Sedimentation	Sedimentation Basin Covers	There is visible cracking in the covers on top of the basins.	1	Y	Y	Demolish sedimentation basin covers and install 420 LF railing around the openings.	$ 200,850	Performed simultaneously with Item 16 below - concrete slab could be replaced with FRP slats or wooden boards, if covers are desired

No.	Facility	Asset	Defect	Priority (1 high - 3 low)	Necessary for WTP Expansion?	Necessary for WTP Replacement?	Mitigation Assumption	Total Cost	Notes
14	Flocculation & Sedimentation	Structural Walls	Sedimentation basin walls are showing visible signs of degradation and angular cracking that are in need of repair and potentially long-term replacement.	2	Y	Y	Per structural evaluation, exposed reinforcements should be coated with mortar	$ 195,000	None
15	Flocculation & Sedimentation	Sedimentation Tubes	Settling tubes are brittle and fall apart when moved. Supports are becoming disconnected from walls.	2	Y	Y	Replace existing tube settlers with SST Plate Settlers	$ 1,209,000	Performed simultaneously with Item 14 above
16	Flocculation & Sedimentation	Track Vac Compressor	Seals are leaking. There is visible vibration in the bearings and no safety provisions for high temperatures on the bearings.	2	Y	Y	Replacement of track vac compressor	$ 15,600	The WTP currently has 15k budgeted for this
17	Filter Building	Filter Building	Exterior walls of the filters are showing signs of deterioration.	3	N	N	Structural evaluation noted that the exterior walls were not a concernand can be left alone	$ -	See Structural Evaluation TM
18	Filter Building	ACH Pumps	Pumps/chemical feed system are not connected to SCADA.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
19	Filter Building	Surface Wash and Filter Influent Valves	Some valves are too high to access and there are no chain wheels in place.	2	Y	N	Purchase of new operator chains	$ 5,000	Cost assumes valves are not currently electrically actuated
20	Filter Building	Filtration Piping	Piping is nearing the end of its life and will have to be replaced within 10-15 years.	2	Y	N	Replacement of all filter related piping	$ 585,000	None

No.	Facility	Asset	Defect	Priority (1 high - 3 low)	Necessary for WTP Expansion?	Necessary for WTP Replacement?	Mitigation Assumption	Total Cost	Notes
21	Filter Building	ACH Feed System	Chemical piping is lacking calibration columns and redundancy.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
22	Polymer Room	Filter Aid Polymer Pumps	Pumps/chemical feed system are not connected to SCADA.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
23	Polymer Room	Filter Aid Polymer Feed System	Chemical piping is lacking calibration columns and redundancy.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
24	Polymer Room	Phosphoric Acid Pumps	Pumps/chemical feed system are not connected to SCADA.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
25	Polymer Room	Phosphoric Acid Storage	No chemical containment is present.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
26	Polymer Room	Polyphosphate Pumps	Pumps/chemical feed system are not connected to SCADA.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
27	Polymer Room	Polyphosphate Storage	No chemical containment is present.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
28	Polymer Room	Filter Aid Polymer Storage	No chemical containment is present.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate

No.	Facility	Asset	Defect	Priority (1 high - 3 low)	Necessary for WTP Expansion?	Necessary for WTP Replacement?	Mitigation Assumption	Total Cost	Notes
29	Polymer Room	Phosphoric Acid Pumps	Chemical piping is lacking calibration columns and redundancy.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
30	Polymer Room	Polyphosphate Pumps	Chemical piping is lacking calibration columns and redundancy.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
31	Washwater Tanks	Washwater Tank 1	Washwater Tank 1 has structural issues with its roof.	1	Y	Y	Construct a new 100,000 gallon washwater tank	$ 1,111,500	None
32	Washwater Tanks	Washwater Tank 2	Washwater Tank 2 is old and showing signs of degradation.	1	Y	Y	Construct a new 100,000 gallon washwater tank	See Item 31	None
33	Washwater Tanks	Washwater Tanks	A cover is missing on the manhole/vault (3 ft deep, safety concern).	1	Y	Y	Purchase new cover for vault	$ 5,000	None
34	Washwater Tanks	Washwater Tanks	Both washwater tanks are a located below a rocky hill, presenting concerns that falling rocks could damage the tanks and take them out of service.	2	Y	Y	6 ft chainlink fence with wiring and anchors	$ 14,625	Around 80' of fence would be needed as measured in Google Earth - rounded up to 100' to be conservative
35	Caustic Soda Building	Caustic Soda Pumps	Pumps/chemical feed system are not connected to SCADA.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
36	Caustic Soda Building	pH Analyzer	pH analyzer is not functioning and needs to be repaired or replaced.	2	Y	Y	Replacement of pH analyzer and Cl sensor, along with moving all sensors/analyzers into one location.	$ 40,000	Includes Item 37

No.	Facility	Asset	Defect	Priority (1 high - 3 low)	Necessary for WTP Expansion?	Necessary for WTP Replacement?	Mitigation Assumption	Total Cost	Notes
37	Caustic Soda Building	Samples	Sample points and analyzers in the facility are spread out around various locations.	3	Y	Y	Move chlorine analyzer from fluoride building. Captured in Item 36.	See Item 36	WTP Staff noted that the chlorine analyzer would need to be moved from the floride room to the caustic building
38	Caustic Soda Building	Caustic Soda Pumps	Chemical piping is lacking calibration columns and redundancy.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
39	Caustic Soda Building	Entire Building and Tank	Caustic system and tank are no longer in use.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
40	Chlorine Building	Sodium Hypochlorite Pumps	Pumps/chemical feed system are not connected to SCADA.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
41	Chlorine Building	Sodium Hypochlorite Storage Tanks	Chemical tanks do not vent to atmosphere.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
42	Chlorine Building	Sodium Hypochlorite Storage Tanks	Exterior filling connection for both tanks does not exist.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
43	Chlorine Building	Sodium Hypochlorite Storage Tanks	Hypo tank walls are deteriorating and quite soft.	1	N	Y	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ 20,000	While a new chemical facility is captured in alternatives analysis cost estimate, the hypo tanks need to remain in use
44	Chlorine Building	Sodium Hypochlorite Storage Tanks	Tanks are not properly anchored.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
45	Chlorine Building	Fluoride Pumps	Pumps/chemical feed system are not connected to SCADA.	1	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate

No.	Facility	Asset	Defect	Priority (1 high - 3 low)	Necessary for WTP Expansion?	Necessary for WTP Replacement?	Mitigation Assumption	Total Cost	Notes
46	Chlorine Building	Sodium Hypochlorite Storage Tanks	There is no level measurement instrumentation on the tanks.	2	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
47	Chlorine Building	Sodium Hypochlorite Pumps	Chemical piping is lacking calibration columns and redundancy.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
48	Chlorine Building	Fluoride Pumps	Chemical piping is lacking calibration columns and redundancy.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
49	Chlorine Building	Fluoride Injection System	The existing fluoride pump (10 hp) is oversized.	3	N	N	Build a new chemical facility, capable of supplying chemicals to all treatment trains	$ -	New chemical facility is captured in alternatives analysis cost estimate
50	Clearwells	Clearwell 1 Vault	Access hatches are not secured to the concrete and don't seal properly. There is no drainage setup so water accumulates in the vault.	1	Y	Y	Construction of new vault adjacent to existing vault	$ 585,000	None
51	Clearwells	Clearwell 1 Vault Sump Pump	Sump pump does not work. A rope is currently being used as a float and the vault does not actually drain when it should.	1	Y	Y	Construction of new vault adjacent to existing vault	See Item 50	None
52	Clearwells	Clearwell 1 Vault	The vault is a confined space, making it difficult to access the flow meters, level sensor, pressure sensors, valves, fluoride injection point, and chlorine injection point within.	1	Y	Y	Construction of new vault adjacent to existing vault	See Item 50	None

No.	Facility	Asset	Defect	Priority (1 high - 3 low)	Necessary for WTP Expansion?	Necessary for WTP Replacement?	Mitigation Assumption	Total Cost	Notes
53	Clearwells	Clearwell 1	Light staining and small chips/holes in the coatings on metal surfaces was observed.	2	Y	Y	Replace CW1, see Item 55	See Item 55	See Item 55
54	Clearwells	Clearwell 1 Vault	Minor defects in flow element and transmitter. No visible corrosion on grounding wire or terminal blocks.	2	Y	Y	Replace flow element and transmitter	$ 13,650	None
55	Clearwells	Clearwell 1	Significant corrosion was found in the roof upon inspection in July 2023.	2	Y	Y	Replace CW1	$ 1,560,000	Cost provided to City by Tank Industry Consultants
56	Solids Handling	Effluent Weir	The effluent weir is difficult to operate and ineffective.	2	N	N	Residuals handling improvements identified in alternatives analysis.	$ -	None
57	Solids Handling	Sludge Lagoons	The sludge lagoons require manual dredging to send solids to the drying beds.	2	N	N	Residuals handling improvements identified in alternatives analysis.	$ -	Residuals handling improvements are captured in alternatives analysis cost estimate
58	Solids Handling	Large and Small Drying Beds	There are issues with solids dispersion within the drying beds.	2	N	N	Residuals handling improvements identified in alternatives analysis.	$ -	Residuals handling improvements are captured in alternatives analysis cost estimate
59	Offices and Ancillary Buildings	Access Road	A sink hole (approximately 5'x3') formed adjacent to the filter/lab building and floc/sed basin walls. While the sink hole was filled in with flow fill, the cause has not been determined or addressed.	1	N	N	Unknown, pending geotech assessment.	$ -	Assess during geotech assessment ahead of future expansion

No.	Facility	Asset	Defect	Priority (1 high - 3 low)	Necessary for WTP Expansion?	Necessary for WTP Replacement?	Mitigation Assumption	Total Cost	Notes
60	Offices and Ancillary Buildings	Shop Building	The shop building has no heat or insulation.	3	N	N	Incorporate shop building functions in new admin building as part of WTP expansion	$ -	Admin building cost accounted for in alternatives analysis cost estimate
61	Offices and Ancillary Buildings	Shop Building	The shop building is showing signs of structural degradation. The roof leaks severely.	3	N	N	Incorporate shop building functions in new admin building as part of WTP expansion	$ -	Admin building cost accounted for in alternatives analysis cost estimate
62	Offices and Ancillary Buildings	Office Building	The office building adjacent to floc/sed basin is exhibiting structural degradation. It appears to be falling off the foundation	3	N	N	Incorporate office building functions in new admin building as part of WTP expansion	$ -	Admin building cost accounted for in alternatives analysis cost estimate
63	Offices and Ancillary Buildings	Plumbing Building	The plumbing building is in poor shape.	3	N	N	Incorporate plumbing building functions in new admin building as part of WTP expansion	$ -	Admin building cost accounted for in alternatives analysis cost estimate

Attachment C
Capacity Assessment

Wicks WTP Capacity Assessment

Date:	September 13, 2023
Project name:	The Dalles Water System Master Plan
Project no:	D3718900
Client:	City of The Dalles, OR
Prepared by:	Tyler Kurtz, P.E.
Reviewed by:	Enoch Nicholson, P.E.

1. Background

The City of The Dalles (City) is considering options to increase the capacity of the Wicks Water Treatment Plant (WTP) to meet future demands and allow for the injection of water into the City's planned aquifer storage and recovery (ASR) system in winter so that it can be withdrawn in summer. To effectively evaluate expansion alternatives, a clear understanding of the existing winter capacity of the WTP is needed. Two capacity assessments were performed to better understand the existing WTP's current capacity.

2. Introduction

The first capacity assessment was conducted from December 12-14, 2023, and the second was conducted from February 20-22, 2024. Prior to the assessment, it was estimated that one train could handle up to 2.25 MGD, with an absolute maximum of 3.0 MGD due to the rated WTP capacity of 6.0 MGD through both trains. During the assessment, the ACH dose ranged from 20.0-25.0 mg/L for the first assessment and 16.0-18.0 mg/L for the second. The polymer dose ranged from 0.020-0.028 mg/L for the first assessment and 0.025-0.027 for the second. Chemical doses were selected by operators based off jar testing and filter performance and adjusted as they would be in normal operation.

During the second capacity assessment, a couple issues arose regarding the polymer system which negatively impacted results. During the first night of the assessment, polymer was dosed to both filters when Filter 1 was taken offline and Filter 2 was brought online, causing polymer to run out prematurely. This caused the filter run beginning at 23:50 on February 20 to only last a little more than 6 hours, as turbidity breakthrough rapidly increased once the polymer ran out. Once the polymer was brought back online and properly operated, a filter run time of 14.5 hours was achieved. Additionally, there were issues with the new batch of polymer that was made once it ran out, which is thought to have created shortened filter runs on February 21. This issue was discovered and rectified the morning of February 22.

Tables 1 and 2 provides a timeline of the assessments.

Table 1. Capacity Assessment 1 timeline.

Date/Time	Notes
December 12, 2023	
0315	Filter 1 is backwashed for the last time prior to capacity assessment.
0640	Filter 2 is backwashed for the last time prior to capacity assessment.
0830	Filter 1 is taken offline. Flow is increased from 1.20 to 1.50 MGD through Filter 2.
1113	No decrease in performance is noted. It is assumed that all impacts to treatment performance because of increased flow are reflected in plant readings within ~2.5 hours, based off t_{10} and volume calculations performed by Enoch Nicholson and Tyler Mitchell. Flow is increased from 1.50 to 2.00 MGD through Filter 2.
1350	No decrease in performance is noted. Again, it is assumed that all impacts to treatment performance because of the last flow increase are reflected in plant readings by this time. Flow is increased from 2.00 to 2.20 MGD through Filter 2.
1700	No decrease in performance is noted at this point. Filter 2 is taken offline after running for a little more than 7 hours, as it is believed that the maximum flow possible is close to being reached and a "full" filter run at 2.20 MGD is desired. Flow is diverted to Filter 1, remaining at 2.20 MGD. Filter 2 is backwashed.
December 13, 2023	
0740	Filter 1 reaches terminal headloss (10.0') and is backwashed after 15.6 hours of run time at 2.20 MGD (4,767 gal/sf UFRV). Filter 1 is immediately placed back online, as Filter 2 has been drained to collect a filter media sample unrelated to capacity assessment.
1035	Flow through Filter 1 is increased from 2.20 to 2.50 MGD.
1330	Particle breakthrough begins to be seen in Filter 1, continuously increasing.
1620	Filter 1 is backwashed after 8.3 hours of run time due to reaching terminal headloss (10.0'). Approximately half of Filter 1's run time was at 2.20 MGD and half was at 2.50 MGD. Flow is diverted to Filter 2, remaining at 2.50 MGD.
2320	Filter 2 is backwashed after 6.7 hours of run time at 2.50 MGD (2,326 gal/sf UFRV) due to particle breakthrough.
2345	Flow is diverted to Filter 1 and is decreased from 2.50 to 2.20 MGD.
December 14, 2023	
0937	Filter 1 reaches terminal headloss (10.0') and is backwashed after 10.5 hours of run time at 2.20 MGD (3,208 gal/sf UFRV).
1100	Both filters are brought online, with 2.40 MGD split between them. Capacity assessment is concluded.

Table 2. Capacity Assessment 2 timeline

Date/Time	Notes
February 20, 2024	
0800	Filter 2 is backwashed for the last time prior to capacity assessment.
0905	Filter 1 is taken offline. Flow is increased from 1.40 to 2.00 MGD through Filter 2.
1220	No performance impacts noted. Flow through Filter 2 is increased from 2.00 to 2.20 MGD.
1335	Filter 1 is backwashed for the last time prior to capacity assessment.
1445	No performance impacts noted. Flow through Filter 2 is increased from 2.20 to 2.50 MGD.
1645	Flow is diverted to Filter 1 and maintained at 2.50 MGD. Filter 2 is backwashed.
2350	Flow is diverted to Filter 2 and decreased to 2.20 MGD. Filter 1 is taken offline after 7.0 hours of run time at 2.50 MGD (2,431 gal/sf UFRV) due to turbidity breakthrough.
February 21, 2024	
0610	New polymer solution is made. Later results suggest there were issues with this solution.
0610	Filter 2 is backwashed after 6.33 hours of run time (1,934 gal/sf UFRV) due to turbidity breakthrough. This likely occurred due to polymer no longer being dosed.
0703	Filter 2 is brought back online, maintaining flow at 2.20 MGD.
1600	Filter 1 is brought online at 0.8 MGD to account for additional demand.
2215	Filter 2 is backwashed after 14.5 hours of run time (4,431 gal/sf UFRV) due to turbidity breakthrough. Flow is increased to 2.30 MGD through Filter 2.
February 22, 2024	
0700	New polymer is made and filter performance notably increases, leading operators to believe that there may have been issues with the previous batch of polymer.
1200	Filter 2 is backwashed after 14.0 hours of run time (4,472 gal/sf UFRV) due to turbidity breakthrough. Flow is increased to 2.40 MGD through Filter 2 and maintained at 0.80 MGD through Filter 1.
2345	Filter 2 is backwashed prematurely prior to shift changeover after 12.33 hours of run time (4,110 gal/sf/UFRV). The capacity assessment concludes, and an even flow split is resumed.

2.1 Monitoring Plan

Table 3 presents the monitoring plan for the first capacity assessment, detailing where samples were collected in the treatment process and which parameters were tested during different phases of the capacity assessment. Water quality parameters like alkalinity, pH, turbidity, and particle counts were sampled every 4 hours according to their normal schedule, except for particle count which was continuously measured with an online analyzer. TOC and UV_{254} absorbance samples were collected for normal and high-flow samples. Normal flow samples were collected on December 14, 2023, about three hours after the plant was returned to normal operations with 2.4 MGD being split between both filters.

High-flow samples were taken on December 13, 2023, when 2.5 MGD was being sent through Filter 2 alone, approximately 4.7 hours into a filter run.

Table 3. Capacity Assessment 1 monitoring plan.

Sample Location	Alkalinity	pH	Turbidity	Particle Count	TOC	UVA_{254}
Headworks (Raw Water)	As scheduled	As scheduled	As scheduled	-	Normal flow, highest flow	Normal flow, highest flow
Post-Sedimentation Basin	-	-	As scheduled	-	Normal flow, highest flow	Normal flow, highest flow
Filter Effluent	As scheduled	As scheduled	As scheduled	Continuous	Normal flow, highest flow	Normal flow, highest flow

The monitoring plan for the second capacity assessment was updated to provide increased sampling frequency. Parameters were broken into three different categories:

1. Recorded any time the flow or flow distribution was changed:
    a. Flow to each filter
    b. Filter run time
    c. Chemical doses
2. Recorded every hour and every time the flow or flow distribution was changed:
    a. Raw water temperature
    b. Turbidities (raw, over-filter, and individual filter effluent)
3. Recorded just before capacity assessment and once equilibrium was reached at the highest flow rate:
    a. Color
    b. pH
    c. Alkalinity (raw and finished)
    d. TOC (raw, over-filter, and effluent)
    e. UVA_{254} (raw, over-filter, and effluent)

Normal flow samples were collected on February 20, 2024, just before capacity assessment began, with 1.4 MGD flowing through Filter 2. High-flow samples were taken on February 22, 2024, when 2.4 MGD was being sent through Filter 2, approximately 4.7 hours into a filter run.

2.2 Raw Water Quality

Raw water quality was measured during the capacity assessments and compared with historic data for the months the tests occurred in, shown in Tables 4 and 5. In both tests, the measured TOC and temperatures were slightly above historic averages. The alkalinity of the raw water seen during the second capacity assessment was lower than average, while the turbidity was above average. Overall, the raw water observed during the capacity assessments was generally in line with historic averages. No historic UV_{254} absorbance data was provided.

Table 4. Capacity Assessment 1 raw water quality comparison.

Parameter	Capacity Assessment 1 Raw Water	Historic December Raw Water
Temperature (°C)	5.7	4.6[1]
pH	7.60	7.56[1]
TOC (mg/L)	2.5	1.9[2]
Alkalinity (mg/L)	44.1	47.0[2]
Turbidity (NTU)	2.37	1.84[3]
UVA_{255} (cm^{-1})	0.078	--

[1] 2018-2023

[2] 2007-2023

Table 5. Capacity Assessment 2 raw water quality comparison.

Parameter	Capacity Assessment 2 Raw Water	Historic February Raw Water
Temperature (°C)	4.59	4.04[1]
pH	7.34	7.35[1]
TOC (mg/L)	4.42	2.96[2]
Alkalinity (mg/L)	28.7	41.7[2]
Turbidity (NTU)	9.40	6.16[1]
UVA_{255} (cm^{-1})	0.211	--

[1] 2018-2023

[2] 2007-2023

2.3 Turbidity and Particle Count

Turbidities measured during the capacity assessments showed that pretreatment and filtration turbidity removals were adequate up to 2.5 MGD in the first capacity assessment and 2.4 MGD in the second, with filtered water turbidity measured by the online analyzer remaining below the operational goal of 0.1 NTU throughout both assessments. During the second assessment, turbidity was also measured using the lab analyzer, which did record turbidities exceeding 0.1 NTU at each flow rate sporadically throughout the assessment. Effluent turbidity ranged from 0.021-0.054 NTU during the first assessment, with an average of 0.028 NTU over the entire assessment. In the second assessment, effluent turbidity ranged from 0.027-0.072 NTU, with an average of 0.038 NTU. Turbidities measured throughout the treatment process are plotted in Figures 1 and 2.

During the first capacity assessment, particle breakthrough was observed in Filter 1 on 12/13/23 when the flow was set at 2.5 MGD (Figure 3), but this did not manifest in turbidity breakthrough (Figure 1). Particle breakthrough was not observed at lower flow rates.

Like the first capacity assessment, particle breakthrough was observed during the second capacity assessment in Filter 1 when flow was increased to 2.5 MGD on 2/20/24 (Figure 4), but this did not manifest in turbidity breakthrough. However, sedimentation performance appeared to be negatively

impacted by the increased flow rate, as the over-filter turbidity steadily increased while this flow rate was maintained (Figure 2). An increase in raw turbidity coincided with the increasing over-filter turbidity, but to a lesser degree (4% and 28% increases, respectively). Particle breakthrough was only observed at other tested flow rates near the end of filter runs or when polymer ran out on 2/21/24.

Figure 1. Turbidity readings during Capacity Assessment 1, plotted with flow and ACH dose.

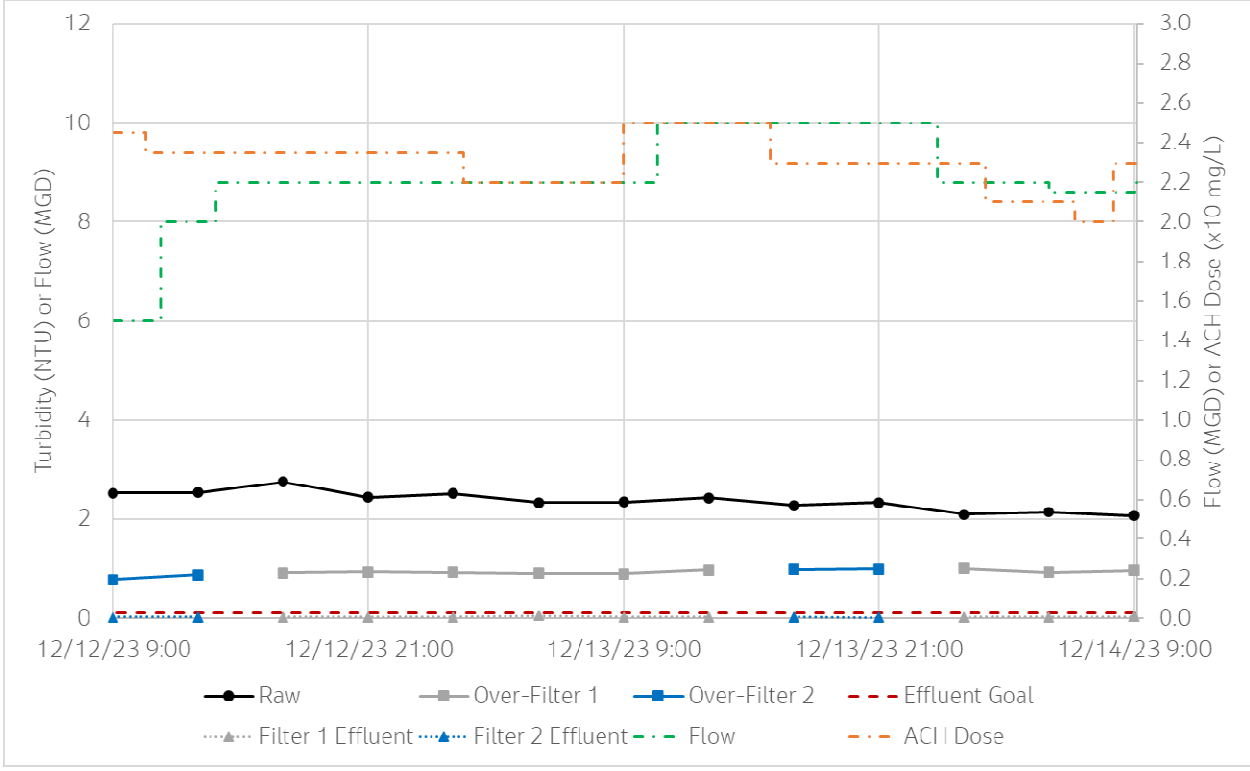


Figure 2. Turbidity readings during Capacity Assessment 2, plotted with flow and ACH dose.

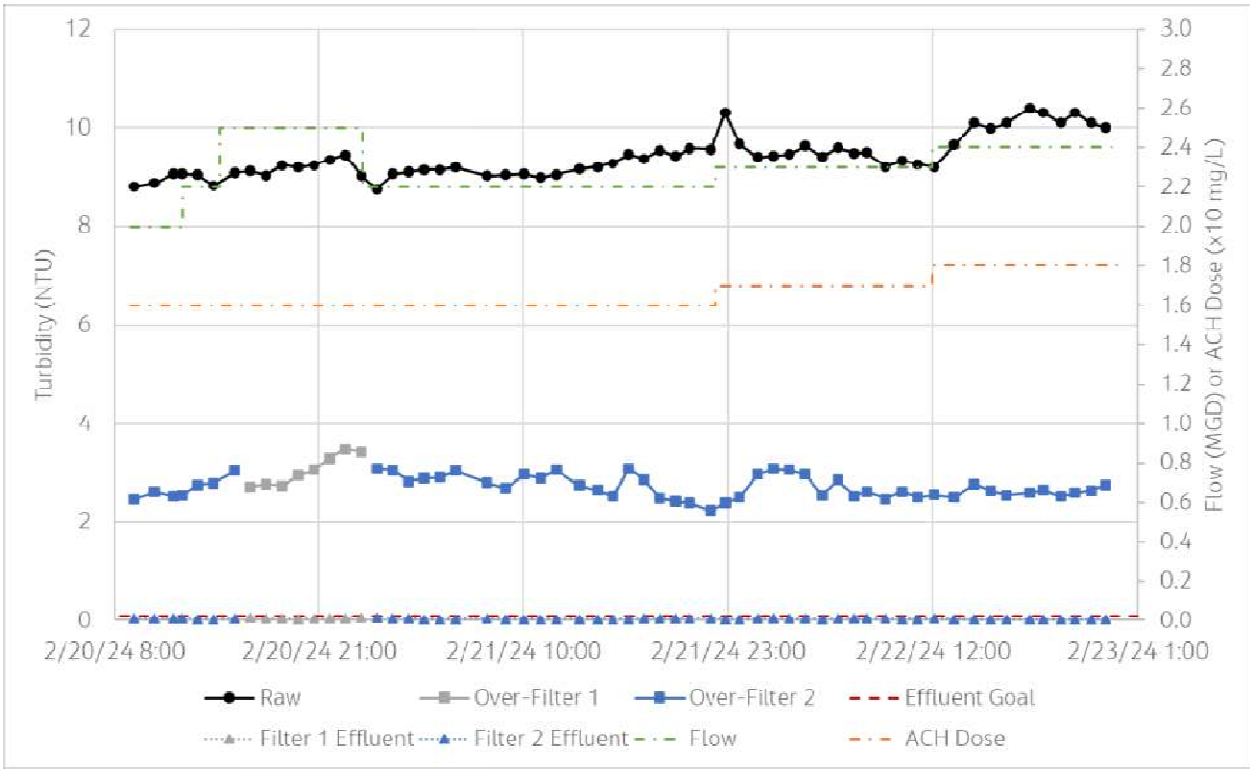


Figure 3. Particle counts for Filter 1 on December 13, 2023.

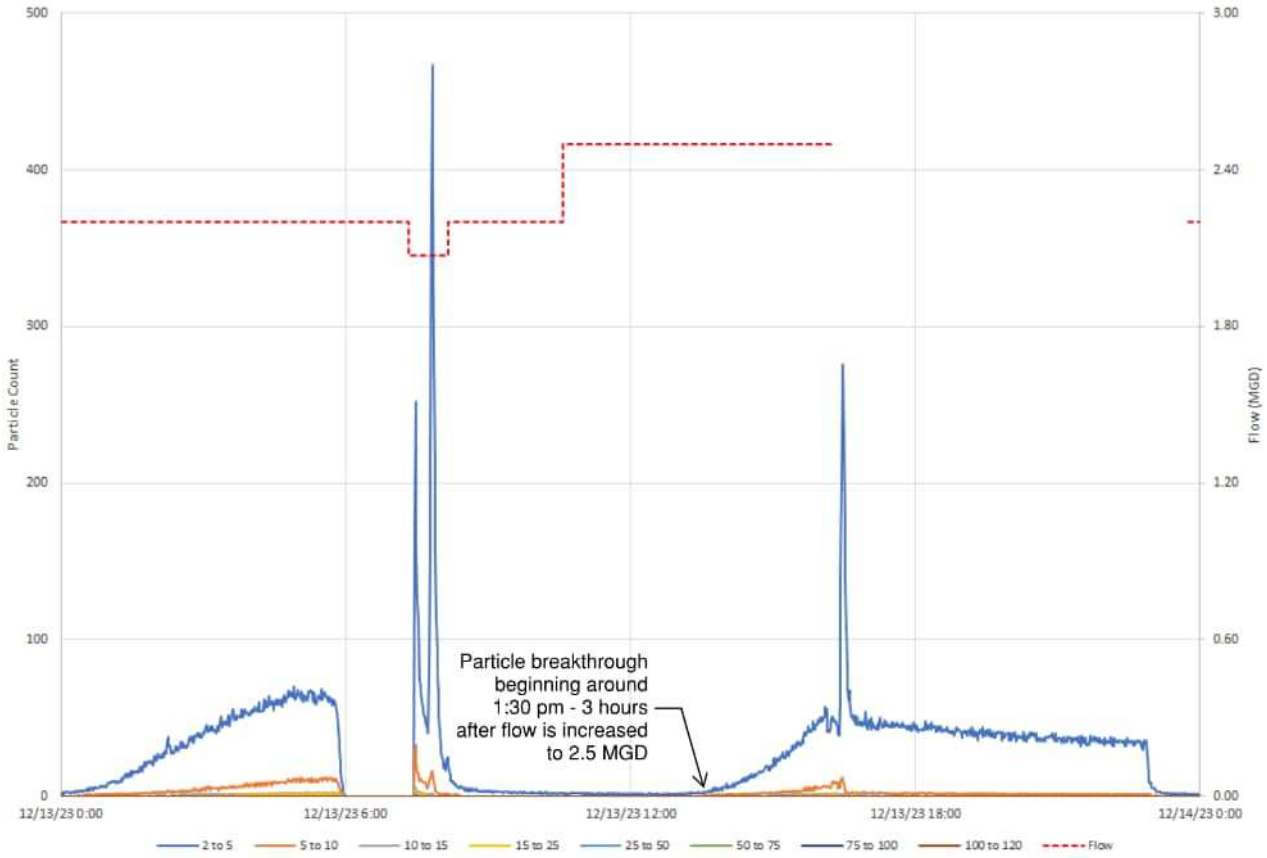
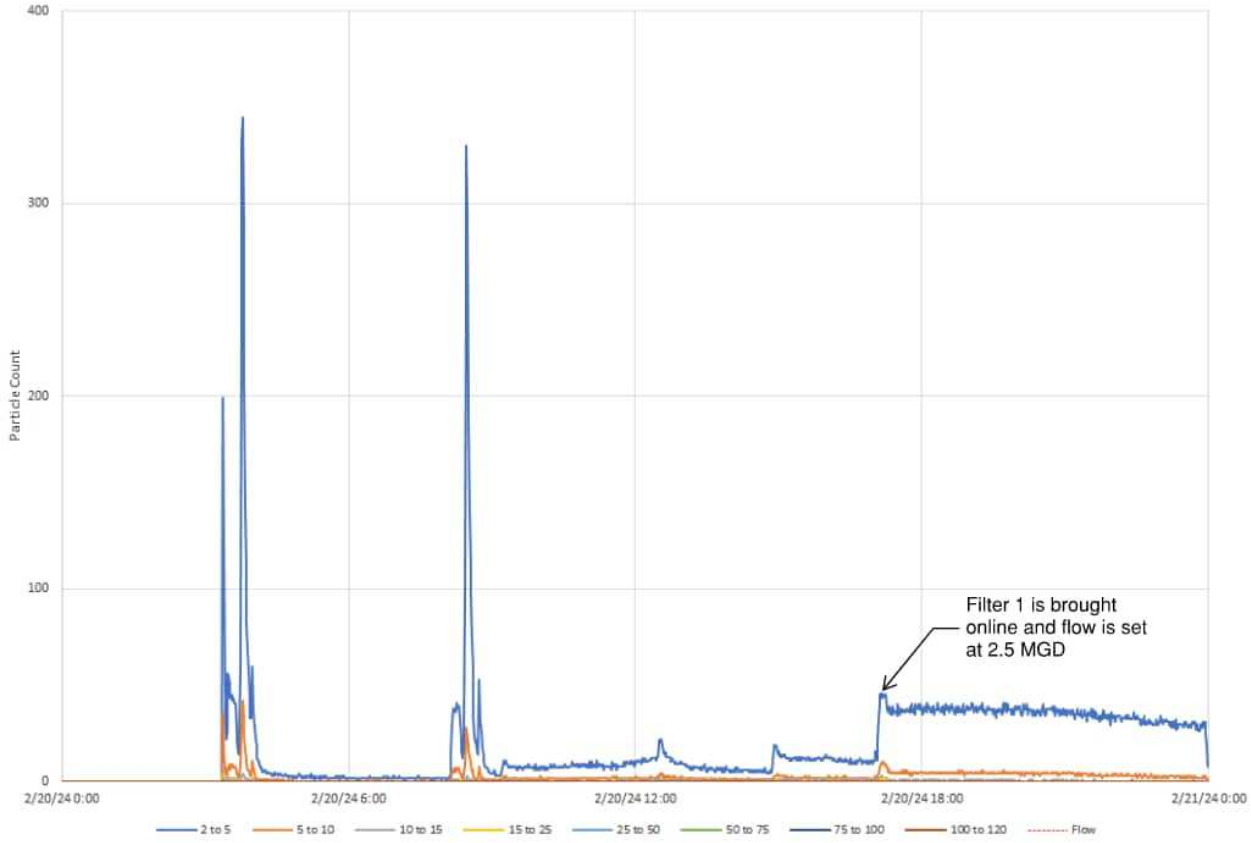


Figure 4. Particle counts for Filter 1 on February 20, 2024.



2.4 Unit Filter Run Volume

During the first capacity assessment, unit filter run volumes (UFRVs) decreased to their lowest value of 2,326 gal/sf when flow was set at 2.5 MGD. At 2.2 MGD, UFRVs of 3,208 and 4,767 gal/sf were achieved. No flows between 2.2 and 2.5 MGD were tested during the first capacity assessment due to time constraints.

UFRVs measured during the second capacity assessment were similar to those observed in the first capacity assessment. The greatest UFRV was achieved on February 21 when Filter 2 ran at 2.3 MGD for 14 hours, producing a UFRV of 4,472 gal/sf. The final filter run on February 22 achieved a similar UFRV (4,110 gal/sf) when Filter 2 ran at 2.4 MGD for 12.33 hours, though this run was ended prematurely due to an upcoming shift-change. WTP operators believed that this run would have likely run for closer to 14 hours had it been allowed to continue, which would have yielded the highest UFRV during the capacity assessments of approximately 4,700 gal/sf.

2.5 Total Organic Carbon

In the first assessment, TOC removal through pretreatment was consistent between normal and high-flow conditions, averaging 44% (Figures 5 and 6). TOC removal through the filters increased from essentially no additional TOC removal at normal flow (42% total) to 64% total at the highest flow. Water samples taken during normal flow conditions showed that UV_{254} absorbance decreased through the filters, while samples taken during high flow showed an increase. The observed increase in UV_{254} absorbance coincided with the particle breakthrough that was observed in Filter 1.

During the second assessment, TOC removal through pretreatment was again consistent between normal and high-flow conditions, averaging 31% (Figures 7 and 8). TOC removal through the filters was consistent between normal and high-flow conditions, averaging 42%.

Figure 5. TOC concentrations measured during Capacity Assessment 1.

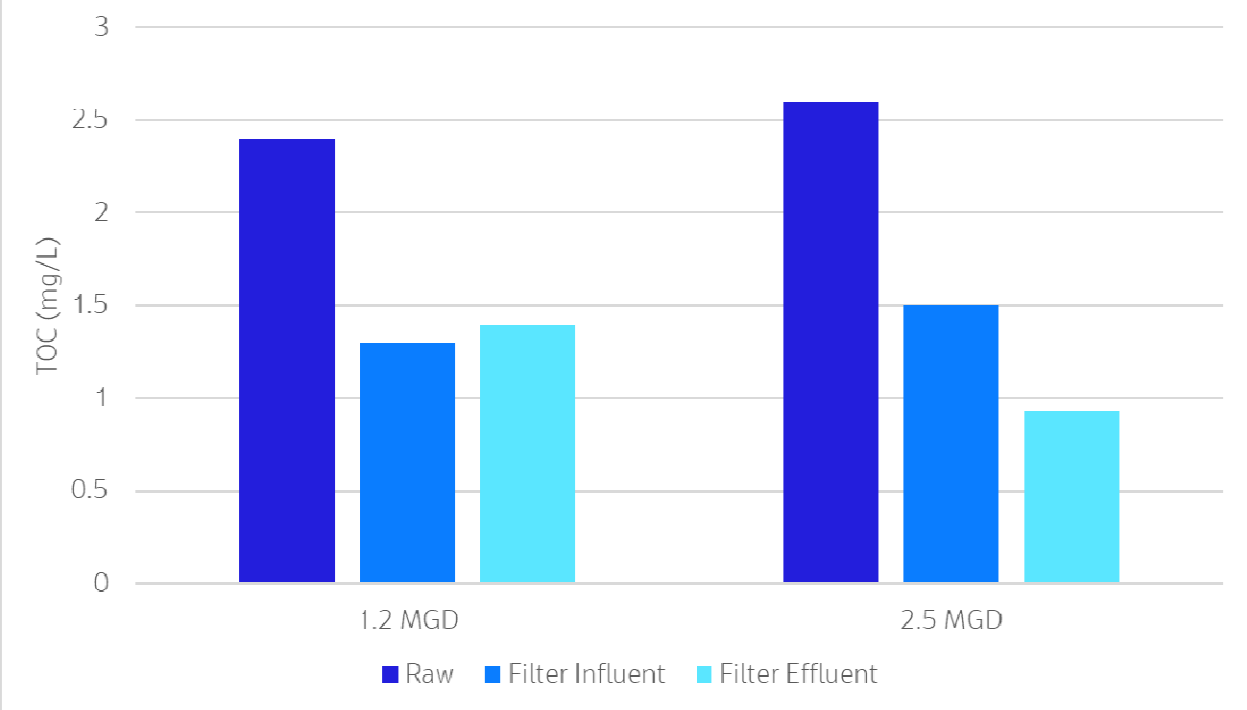


Figure 6. TOC removals through treatment during Capacity Assessment 1.

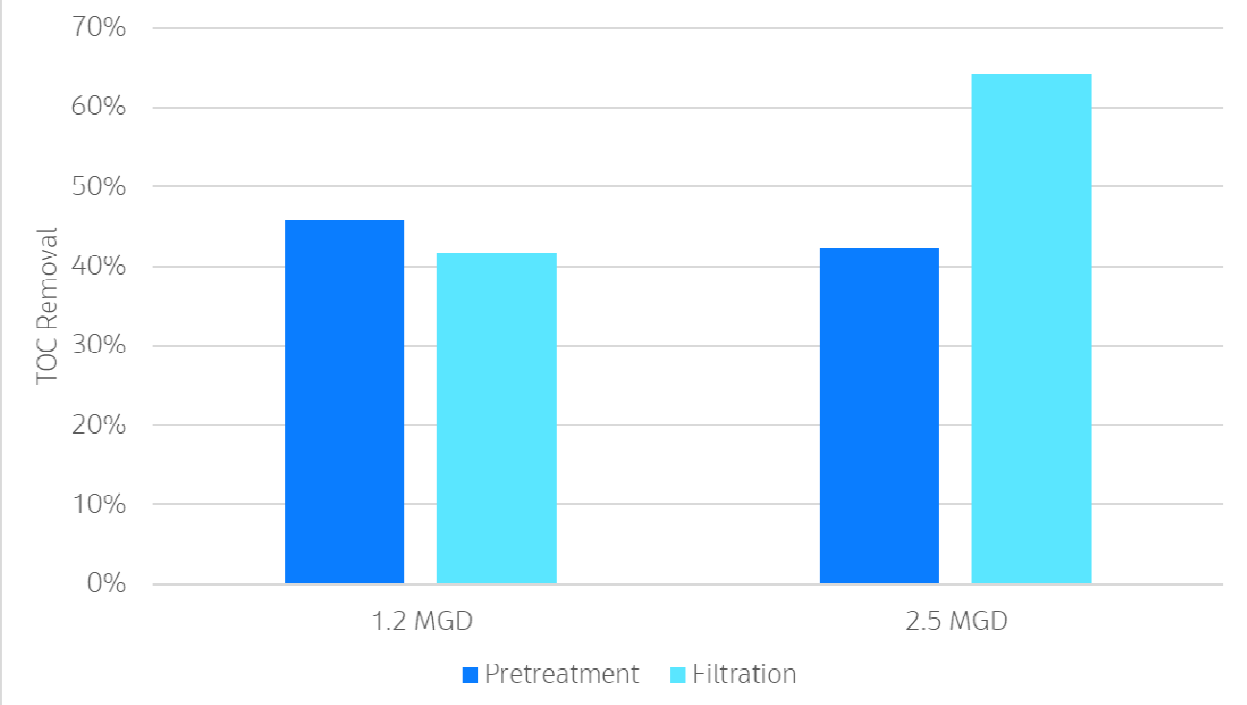


Figure 7. TOC concentrations measured during Capacity Assessment 2.

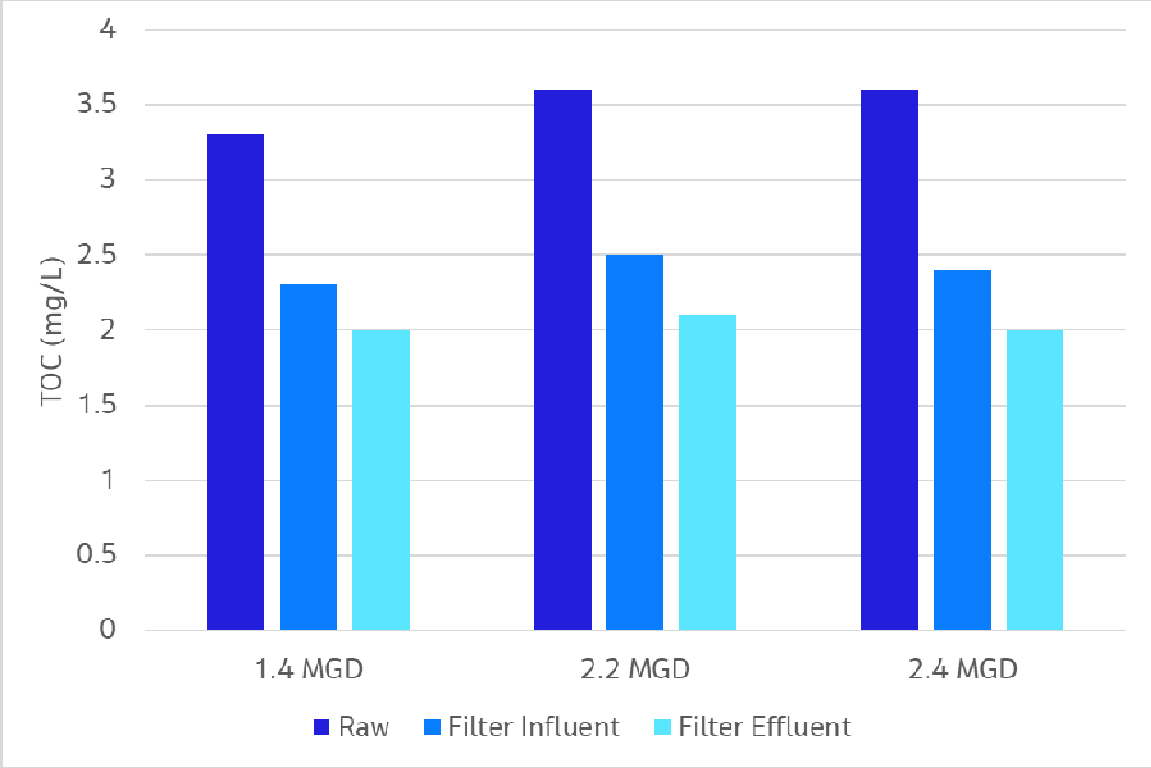
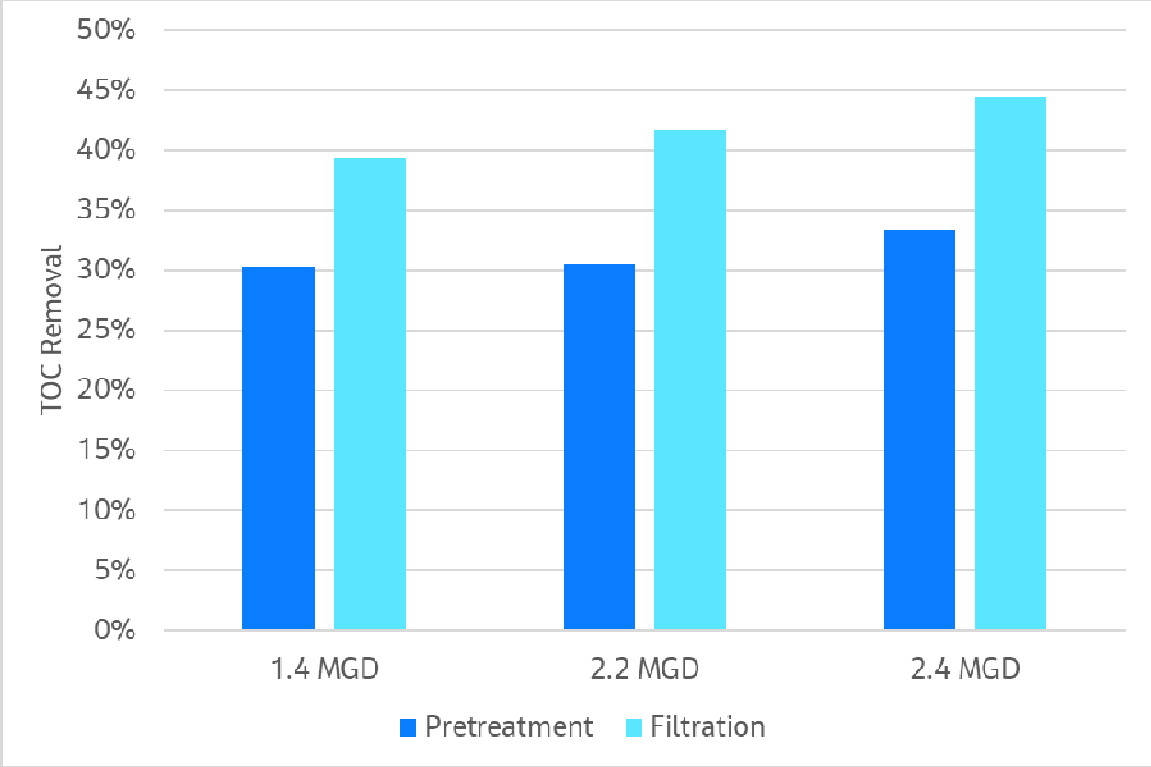


Figure 8. TOC removals through treatment during Capacity Assessment 2.



3. Conclusions

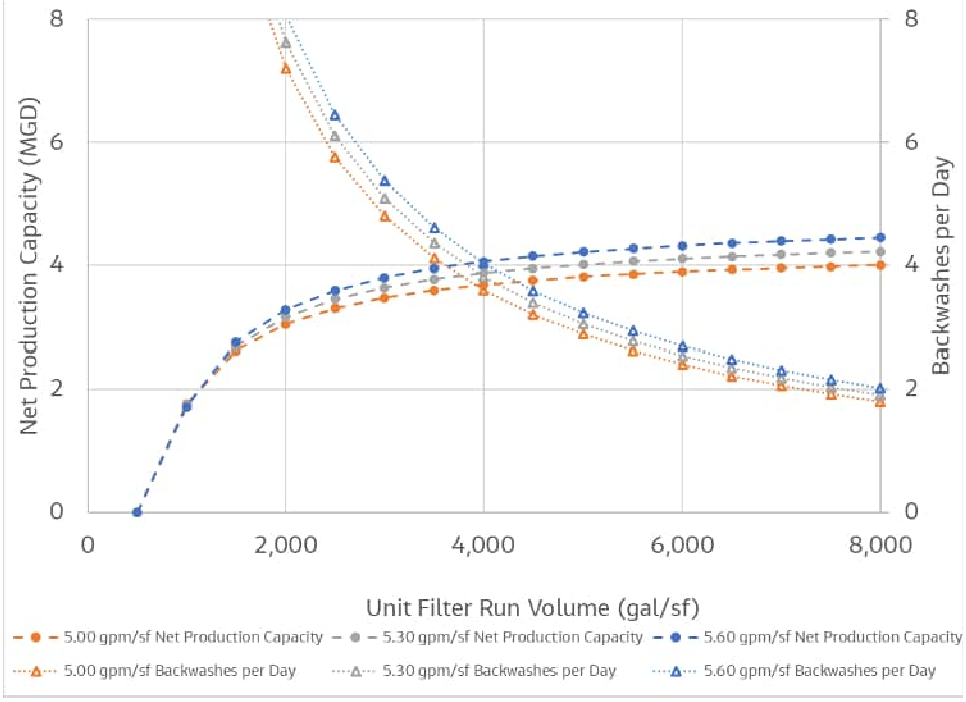
The two capacity assessments captured raw water conditions that were somewhat typical for winter in The Dalles, with a few caveats. During both capacity assessments, water temperatures were slightly above average for the month of the test. These warmer temperatures may have yielded better performance than what could be typically expected during winter, as colder temperatures will suppress sedimentation performance, leading to shorter filter run times. Turbidity was also greater than average during both assessments, particularly in the second capacity assessment.

Based on the observations from the first capacity assessment, the Wicks WTP is physically capable of an instantaneous capacity of at least 4.4 MGD during the conditions assessed in December 2023. The results of the second capacity assessment suggested that an instantaneous capacity of 4.8 MGD was feasible during winter conditions with above average temperatures and turbidities. When the flow was set to 2.4 MGD through one filter, no particle breakthrough was observed and a UFRV of 5,000 gal/sf was nearly achieved, almost meeting the UFRV goal of the facility.

However, the aforementioned flows do not account for backwash and filter to waste flows. Figure 9 shows UFRV vs net production capacity and number of backwashes per day for Wicks WTP. The net production capacity accounts for filter production that is lost during backwashes and filter to waste. As shown in Figure 9, net production capacity drops off significantly as UFRVs decrease below 3,000 gal/sf, while UFRVs greater than 5,000 gal/sf provide minimal increases to net production capacity. Filter loading rates during both capacity assessments ranged from 5.1-5.8 gpm/sf, with acceptable filter runs being observed up to 5.6 gpm/sf. UFRVs exceeding 4,000 gal/sf were achieved in both capacity assessments.

Based on both capacity tests, the net filtration capacity during average winter conditions (excluding storm events, which would significantly reduce capacity) could reach 4.8 MGD. Assuming a UFRV of 4,000 gal/sf, a net production capacity of 4.1 MGD would be achieved with both filters online.

Figure 9. Net production capacity and backwash frequency based on unit filter run volume.



Attachment D
TMDL Evaluation

Wicks WTP TMDL Evaluation

Date: September 13, 2023
Project name: The Dalles Water System Master Plan
Project no: D3718900
Client: City of The Dalles, OR
Prepared by: Erin Thatcher, P.E.
Enoch Nicholson, P.E.
Reviewed by: Enoch Nicholson, P.E.
Tyler Kurtz, P.E.

1. Introduction

This technical memorandum provides an evaluation of the Wicks Water Treatment Plant (WTP) compliance with the thermal wasteload allocations (WLAs) established in the *Middle Columbia-Hood (Miles Creek) Subbasin TMDL* (Oregon Department of Environmental Quality [DEQ], 2008). It identifies the thermal limits applicable to the Wicks WTP's current and potential future discharge to South Fork Mill Creek near the City of The Dalles, Oregon. This discharge consists of filter backwash wastewater from shallow treatment lagoons used to settle out solids before the wastewater is discharged to the creek. The shallow lagoons allow the wastewater to heat up above the background temperature of the creek and exceed the total maximum daily load (TMDL) WLA for the discharge.

2. Regulatory Requirements

Thermal WLAs assigned to the Wicks WTP in the *Miles Creek TMDL* (DEQ, 2008) apply in two distinct seasons, as indicated below in Table 1. The WLAs, or thermal load limits (TLLs), are calculated with Equation 1, shown below, using the effluent and receiving water flows and the allowable temperature increase of 0.2 °C.

Table 1. WLAs for the Wicks Water Treatment Plant (from Table 3-8 of the Middle Columbia-Hood [Miles Creek] Subbasin TMDL; DEQ, 2008).

Time Period	WLA	Human Use Allowance (HUA; ΔT_{all})	Applicable Temperature Criterion
May 16 – October 14	See Equation 1	0.2 °C	18 °C
October 15 – May 15	See Equation 1	0.2 °C	13 °C

$$TLL = 3.78541 \times Q_e \times S \times \Delta T_{all} \times \rho \quad (1)$$

Where

TLL = thermal load limit, million-kilocalories per day (mkcal/day)

Q_e = effluent flow, mgd

Q_r = upstream river flow, mgd

S = dilution = $(Q_e + Q_r)/Q_e$

ΔT_{all} = allowable HUA temperature increase at edge of mixing zone, 0.2 °C

ρ = density of water, 1 g/cm^3

Equation 2 below is used to determine compliance with the TLL determined by Equation 1.

$$\Delta T_{mz} = \frac{T_e + (S-1) \times T_c}{S} - T_c \quad (2)$$

Where:

ΔT_{mz} = temperature increase at edge of mixing zone (for comparison to HUA of 0.2 °C)

T_e = effluent temperature

S = dilution = $(Q_e + Q_r)/Q_e$

T_c = applicable temperature standard, °C

3. Evaluation Results

Tables 2 and 3 below list the TLLs for a range of future discharge flows as calculated by Equation 1, for the wet October 15 – May 15 and the dry May 16 – October 14 seasons, respectively. The tables also list the corresponding maximum allowable effluent temperatures as calculated by Equation 2. These calculations show that discharge flows near and below approximately 5,000 gallons per day (3.5 gpm) represent a negligible portion of the receiving stream and no temperature controls on such a small volume of discharge would be needed, as the wastewater would not be expected to reach the applicable maximum allowable effluent temperatures.

These estimated TLLs are based on critical receiving water flows represented by the monthly minimum of the running 7-day average of the daily flows for the station labeled "SFMC 5am Flow Reading" minus the "Wicks Raw Flow Daily Total" from June 2014 – June 2024. Typically, the receiving water flow that represented critical conditions for determining compliance with water quality criteria would be the lowest 7-day average flow that occurs once every 10 years (the "7Q10 flow"), which requires a longer dataset than currently available for the South Fork Mill Creek.

Table 2. Wet Season Thermal Load Compliance Calculated for the Wicks WTP, October 15 – May 15, Receiving Water Flow = 1.1 mgd[1]

Effluent Flow (mgd)	Thermal Load Limit (TLL), mkcal/day	Maximum Allowable Effluent Temperature (T_e)
0.005	0.86	58.6°C (137.5°F)

0.01	0.87	35.9°C (96.6°F)
0.02	0.87	24.5 (76.1°F)
0.04	0.89	18.9 (66.0°F)
0.10	0.93	15.5 (59.9°F)
0.20	1.01	14.3 (57.7°F)

[1] The receiving water flow of 1.1 mgd represents the nonparametric 10th percentile of the monthly minimum of the measured 7-day running average flows for the October 15 – May 15 season from the "SFMC 5am Flow Reading" minus the "Wicks Raw Flow Daily Total" data, June 2014 – June 2024.

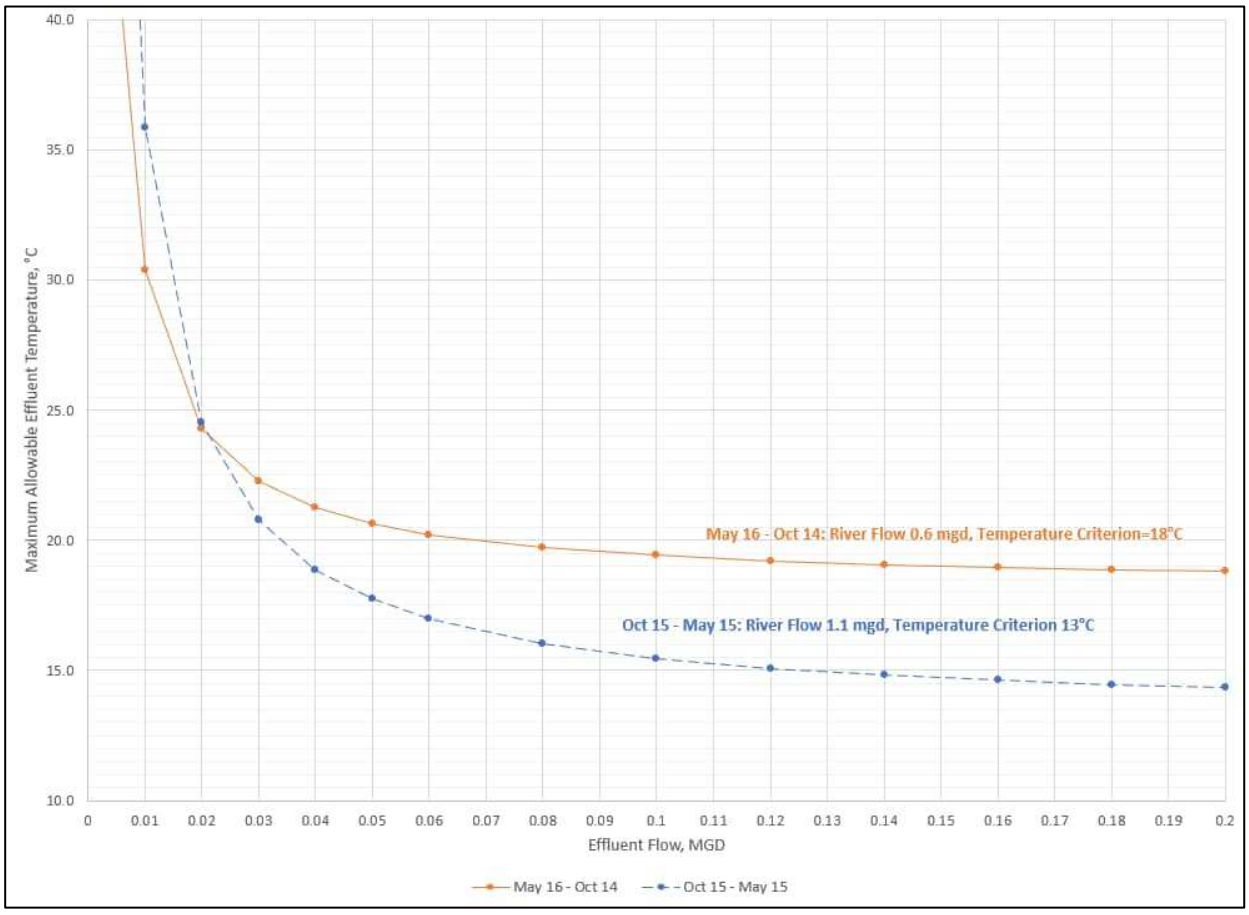
Table 3. Dry Season Thermal Load Compliance Calculated for the Wicks WTP, May 16 – October 14, River Flow = 0.6 mgd[1]

Effluent Flow (mgd)	Thermal Load Limit (TLL), mkcal/day	Maximum Allowable Effluent Temperature (T_e)
0.005	0.47	42.6°C (108.7°F)
0.01	0.47	30.4°C (86.7°F)
0.02	0.48	24.3°C (75.7°F)
0.04	0.49	21.2°C (70.2°F)
0.10	0.54	19.4°C (66.9°F)
0.20	0.61	18.8°C (65.8°F)

[1] The receiving water flow of 0.6 mgd represents the nonparametric 10th percentile of the monthly minimum of the measured 7-day running average flows for the May 16 – October 14 season from the "SFMC 5am Flow Reading" minus the "Wicks Raw Flow Daily Total" data, June 2014 – June 2024.

Figure 1 plots the maximum allowable effluent temperatures (T_e from Equation 2) against effluent (discharge) flows according to Equation 2 where ΔT_{mz} is set to the allowable HUA increase of 0.2 °C, for both seasons defined in the *Miles Creek TMDL* (DEQ, 2008). Actual measured temperatures of the discharge to South Fork Mill Creek ranged between 21 and 26 degrees Celsius in July – September 2012 based on monitoring data provided by the Wicks WTP staff, which would have required discharge flows as low or lower than 0.03 mgd to demonstrate compliance. No other discharge temperature data were available for this evaluation.

Figure 1. Maximum Allowable Effluent Temperatures per Discharge Flow According to Equation 2



The Maximum Allowable Effluent Temperatures for compliance with the corresponding TLLs listed above in Tables 2 and 3 are calculated with the maximum allowable temperature increase of 0.20°C. This does not include any margin of safety. The actual thermal load for compliance would likely be calculated on a daily basis with daily average effluent flows and temperatures, and that daily thermal load would be evaluated against the WLA. Other permits have evaluated compliance using a monthly or weekly average of those daily thermal loads evaluated against the WLA. It is recommended that the monitoring and reporting requirements and compliance mechanism (renewed General Permit or individual NPDES permit) for TLL compliance be clarified with DEQ prior to establishing any discharge flow and temperature requirements for planning and design purposes. If needed, a compliance schedule should be negotiated with DEQ.

Estimated actual excess thermal load (ETL) for the discharge can be calculated with the following equation:

$$ETL\ \left(\frac{mkcal}{day}\right) = (Q_e)(T_e - T_c)(CF) \quad (3)$$

Where

ETL = excess thermal load, mkcal/day

Q_e = effluent flow

T_e = effluent temperature, °C

T_c = temperature criterion, °C

CF = conversion factor, 2.446665 mkcal-s/°C-ft^3-day

There were no concurrent effluent flow and temperature data available for this evaluation. Effluent flow data were available for June 2014 – June 2024, and effluent temperature data were available for only part of the dry season (July-August) in 2012. According to the temperatures measured in July-August 2012 (21-26 °C) and effluent flows of 0.2 to 0.9 mgd ("Daily Backwash Total" data from 2014-2024), actual daily ETLs may typically range from approximately 1 to 12 mkcal/day, with occasional maximums up to 27 mkcal/day if higher effluent flows coincide with maximum temperatures, compared to an estimated TLL near 1 mkcal/day for the May 16-October 14 dry season (see Table 3).

4. Conclusion

This evaluation shows that the current Wicks WTP discharge to South Fork Mill Creek does not comply with the thermal WLA requirements of the *Miles Creek TMDL* (DEQ, 2008). Potential mitigation measures for thermal WLA compliance for this discharge include backwash recycle, cooling tower(s), hyporheic discharge, and riparian restoration, including various combinations of these solutions. For example, riparian restoration alone may not provide enough mitigation for the full ETL during at least part of the year (e.g., spring or fall outside of full leaf-out). Jacobs has completed formal feasibility and alternatives analyses for these types of solutions for Boise, Idaho; Ashland, Oregon; and Steamboat Springs, Colorado.

Backwash recycle, which reduces the volume of discharge and the corresponding actual thermal load, is a preferred solution for the Wicks WTP because it will also allow the plant to meet future water demands while reducing the volume of wastewater discharged to the South Fork Mill Creek to zero or near zero, which will demonstrate compliance with the *Miles Creek TMDL*.

Table 4 compares the potential solutions in terms of ability to meet the City's TMDL and water supply needs, as well as relative capital costs, based on previous Jacobs project experience (CH2M HILL, 2013; The Freshwater Trust et al., 2024; Jacobs, 2021).

Based on this evaluation, complete backwash recycling has been assumed for capital improvement planning purposes. Discharging the solids drying bed supernatant to the Creek during part or all of the year could also be evaluated as a potential alternative.

Table 4. Comparison of ETL Mitigation Solutions

Mitigation	Meets TMDL Requirements	Meets City Water Supply Needs	Relative Capital Cost
Backwash Recycle	✓	✓	$$$$
Evaporative Cooling Tower	✓		$$$
Hyporheic Discharge	?		$$$ – $$$$$ (See Note 1)
Riparian Restoration (Shading)	?		$$ – $$$$$ (See Note 1)

[1] May require combination with cooling towers for at least part of the year to fully meet mitigation requirements.

5. References

CH2M HILL. 2013. *City of Boise Temperature Compliance Evaluation.* June 10.

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Attachment E
Cost Estimate Summary

WTP Alternative A:
DAF with GMF Cost Estimate

Jacobs

Detail Report
Project Name: The Dalles WTP - 9.5mgd DAF
Project Number: D3718900
Design Stage: ROM

Estimator: Jones T
Rev No. / Data: R04 - 09/11/2024
Class Estimate: Class 5

Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
1.00						**CIP 1 - Short Term Wicks WTP Improvements**											
	04.0					Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.00.01.0400		Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor											
					13.01.99.00	Special Construction, Other											
						Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	1.00 ls					-	59,500	59,500.00 /ls	59,500	68,043.21 /ls	68,043
						13.01.99.00 Special Construction, Other	*1.00* LS						59,500	59,500.00 /LS	59,500	68,043.21 /LS	68,043
						13.00.01.0400 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	*1.00* LS						59,500	59,500.00 /LS	59,500	68,043.21 /LS	68,043
						13.01 Buildings Complete	*1.00* **LS**						**59,500**	**59,500.00 /LS**	**59,500**	**68,043.21 /LS**	**68,043**
						13.0 Special Construction	*1.00* LS						59,500	59,500.00 /LS	59,500	68,043.21 /LS	68,043
						04.0 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	*1.00* LS						59,500	59,500.00 /LS	59,500	68,043.21 /LS	68,043
	04.1					Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.00.01.0410		Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers											
					13.01.99.00	Special Construction, Other											
						Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers	1.00 ls					-	720,000	720,000.00 /ls	720,000	823,379.98 /ls	823,380
						13.01.99.00 Special Construction, Other	*1.00* LS						720,000	720,000.00 /LS	720,000	823,379.98 /LS	823,380
						13.00.01.0410 Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers	*1.00* LS						720,000	720,000.00 /LS	720,000	823,379.98 /LS	823,380
						13.01 Buildings Complete	*1.00* **LS**						**720,000**	**720,000.00 /LS**	**720,000**	**823,379.98 /LS**	**823,380**
						13.0 Special Construction	*1.00* LS						720,000	720,000.00 /LS	720,000	823,379.98 /LS	823,380
						04.1 Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers	*1.00* LS						720,000	720,000.00 /LS	720,000	823,379.98 /LS	823,380
						1.00 CIP 1 - Short Term Wicks WTP Improvements	*1.00* **LS**						**779,500**	**779,500.00 /LS**	**779,500**	**891,423.19 /LS**	**891,423**
3.1A						**CIP 3 - WTP Replacement, Phase 1A**											
	00.5					Improvements to existing Wicks WTP											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.00.01.0400		Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor											
					13.01.99.00	Special Construction, Other											
						Improvements to existing Wicks WTP	1.00 ls					-	1,377,000	1,377,000.00 /ls	1,377,000	1,689,790.11 /ls	1,689,790
						13.01.99.00 Special Construction, Other	*1.00* LS						1,377,000	1,377,000.00 /LS	1,377,000	1,689,790.11 /LS	1,689,790
						13.00.01.0400 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	*1.00* LS						1,377,000	1,377,000.00 /LS	1,377,000	1,689,790.11 /LS	1,689,790
						13.01 Buildings Complete	*1.00* **LS**						**1,377,000**	**1,377,000.00 /LS**	**1,377,000**	**1,689,790.11 /LS**	**1,689,790**
						13.0 Special Construction	*1.00* LS						1,377,000	1,377,000.00 /LS	1,377,000	1,689,790.11 /LS	1,689,790
						00.5 Improvements to existing Wicks WTP	*1.00* LS						1,377,000	1,377,000.00 /LS	1,377,000	1,689,790.11 /LS	1,689,790
	02.1					Install temporary generator											
		26.0				Electrical Work											
			26.00			Electrical											
				26.25.07.0010		Generator w/ Enclosure											
					26.25.07.02	Electrical Equipment, Generators - >100 to 200 KW											
						Electrical Wiring and Conduit Allowance	1.00 ls				5,000	-	-	5,000.00 /ls	5,000	7,385.76 /ls	7,386
						Generator Enclosure	1.00 ea	16	1,321	10,000	-	-	-	11,321.14 /ea	11,321	16,974.09 /ea	16,974
						Generator set,diesel,3 phase 4 wire,277/480 v,125 kw,incl battery,charger,muffler,automatic transfer switch&day tank,excl conduit,wiring,& concrete	1.00 ea	69	5,714	32,300	-	665	-	38,679.24 /ea	38,679	58,347.23 /ea	58,347
						26.25.07.02 Electrical Equipment, Generators - >100 to 200 KW	*1.00* LS	85	7,035	42,300	5,000	665		55,000.38 /LS	55,000	82,707.08 /LS	82,707
						26.25.07.0010 Generator w/ Enclosure	*1.00* LS	85	7,035	42,300	5,000	665		55,000.38 /LS	55,000	82,707.08 /LS	82,707
						26.00 Electrical	*1.00* **LS**	**85**	**7,035**	**42,300**	**5,000**	**665**		**55,000.38 /LS**	**55,000**	**82,707.08 /LS**	**82,707**
						26.0 Electrical Work	*1.00* LS	85	7,035	42,300	5,000	665		55,000.38 /LS	55,000	82,707.08 /LS	82,707
						02.1 Install temporary generator	*1.00* LS	85	7,035	42,300	5,000	665		55,000.38 /LS	55,000	82,707.08 /LS	82,707
	02.2					Reroute electrical feed to Wicks WTP											
		26.0				Electrical Work											
			26.10			Site Electrical											
				26.10.20.0010		Site Electrical Allowance											
					26.10.20.00	Site Electrical, Other											
						Site Electrical Allowance (~15% of Construction Costs)	1.00 ls				-	-	214,800	214,800.00 /ls	214,800	263,592.53 /ls	263,593
						26.10.20.00 Site Electrical, Other	*1.00* LS						214,800	214,800.00 /LS	214,800	263,592.53 /LS	263,593
						26.10.20.0010 Site Electrical Allowance	*1.00* LS						214,800	214,800.00 /LS	214,800	263,592.53 /LS	263,593
						26.10 Site Electrical	*1.00* **LS**						**214,800**	**214,800.00 /LS**	**214,800**	**263,592.53 /LS**	**263,593**
						26.0 Electrical Work	*1.00* LS						214,800	214,800.00 /LS	214,800	263,592.53 /LS	263,593
						02.2 Reroute electrical feed to Wicks WTP	*1.00* LS						214,800	214,800.00 /LS	214,800	263,592.53 /LS	263,593
						3.1A CIP 3 - WTP Replacement, Phase 1A	*1.00* **LS**	**85**	**7,035**	**42,300**	**5,000**	**665**	**1,591,800**	**1,646,800.38 /LS**	**1,646,800**	**2,036,089.72 /LS**	**2,036,090**
3.1B						**CIP 3 - WTP Replacement, Phase 1B**											
	01.1					Demolition - Plumbing Building											
		02.0				Existing Conditions											
			02.40			Demolition											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	25.00 CY	35	2,462		-	1,875	-	173.50 /CY	4,337	271.89 /CY	6,797
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	25.00 CY	35	2,462			1,875		173.50 /CY	4,337	271.89 /CY	6,797
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	2.50 CY	6	410		-	313	-	289.16 /CY	723	453.16 /CY	1,133
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	2.50 CY	6	410			313		289.16 /CY	723	453.16 /CY	1,133
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	60.00 ton		-	1,800	-	-	-	30.00 /ton	1,800	41.31 /ton	2,479
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	3.00 LD	6	427		-	536	-	321.06 /LD	963	503.15 /LD	1,509
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	3.00 LD	6	427	1,800		536		921.06 /LD	2,763	1,329.44 /LD	3,988
						02.01.02.0010 Demo Strucutral Concrete	27.50 CY	47	3,300	1,800		2,724		284.49 /CY	7,823	433.40 /CY	11,919
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	640.00 SF	205	14,183	-	-	16,364	-	47.73 /SF	30,546	74.80 /SF	47,871
						02.01.02.00 Sturcture/Building Demoltion	640.00 SF	205	14,183			16,364		47.73 /SF	30,546	74.80 /SF	47,871
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	140.00 ton		-	4,200	-	-	-	30.00 /ton	4,200	41.31 /ton	5,784
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	7.00 LD	14	997		-	1,251	-	321.06 /LD	2,247	503.14 /LD	3,522
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	7.00 LD	14	997	4,200		1,251		921.06 /LD	6,447	1,329.44 /LD	9,306
						02.01.02.0070 Misc. Demolition	*1.00* LS	219	15,179	4,200		17,614		36,993.88 /LS	36,994	57,177.08 /LS	57,177
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	8.00 hr	40	2,729		-	1,383	-	514.10 /hr	4,113	805.67 /hr	6,445

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						02.01.06.01 Electrical Facility Demolition	1.00 LS	40	2,729			1,383		4,112.78 /LS	4,113	6,445.36 /LS	6,445
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	10.00 ton		-	300	-	-	-	30.00 /ton	300	41.32 /ton	413
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.50 LD	1	71	-	-	89	-	321.06 /LD	161	503.12 /LD	252
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.50 LD	1	71	300		89		921.06 /LD	461	1,329.42 /LD	665
						02.01.06.0010 Electrical Demolition	1.00 LS	41	2,801	300		1,473		4,573.31 /LS	4,573	7,110.07 /LS	7,110
						02.40 Demolition	**1.00 LS**	**307**	**21,280**	**6,300**		**21,811**		**49,390.65 /LS**	**49,391**	**76,205.70 /LS**	**76,206**
						02.0 Existing Conditions	1.00 LS	307	21,280	6,300		21,811		49,390.65 /LS	49,391	76,205.70 /LS	76,206
						01.1 Demolition - Plumbing Building	1.00 LS	307	21,280	6,300		21,811		49,390.65 /LS	49,391	76,205.70 /LS	76,206
	01.2					Demolition - Covered storage area											
		02.0				Existing Conditions											
			02.40			Demolition											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	33.20 CY	46	3,270		-	2,490	-	173.50 /CY	5,761	271.89 /CY	9,028
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	33.20 CY	46	3,270			2,490		173.50 /CY	5,761	271.89 /CY	9,028
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	3.32 CY	8	545		-	415	-	289.16 /CY	960	453.16 /CY	1,504
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	3.32 CY	8	545			415		289.16 /CY	960	453.16 /CY	1,504
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	79.69 ton		-	2,391	-	-	-	30.00 /ton	2,391	41.31 /ton	3,292
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	3.98 LD	8	567		-	712	-	321.06 /LD	1,279	503.14 /LD	2,005
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	3.98 LD	8	567	2,391		712		921.11 /LD	3,670	1,329.51 /LD	5,297
						02.01.02.0010 Demo Strucutral Concrete	36.52 CY	62	4,383	2,391		3,617		284.49 /CY	10,390	433.40 /CY	15,829
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	850.00 SF	272	18,836	-	-	21,733	-	47.73 /SF	40,569	74.80 /SF	63,578
						02.01.02.00 Sturcture/Building Demoltion	850.00 SF	272	18,836			21,733		47.73 /SF	40,569	74.80 /SF	63,578
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	185.94 ton		-	5,578	-	-	-	30.00 /ton	5,578	41.31 /ton	7,682
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	9.30 LD	19	1,324		-	1,661	-	321.06 /LD	2,985	503.15 /LD	4,678
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	9.30 LD	19	1,324	5,578		1,661		921.05 /LD	8,563	1,329.43 /LD	12,360
						02.01.02.0070 Misc. Demolition	1.00 LS	291	20,160	5,578		23,394		49,132.37 /LS	49,132	75,938.13 /LS	75,938
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	10.63 hr	53	3,625		-	1,837	-	514.10 /hr	5,462	805.67 /hr	8,560
						02.01.06.01 Electrical Facility Demolition	1.00 LS	53	3,625			1,837		5,462.28 /LS	5,462	8,560.22 /LS	8,560
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	13.28 ton		-	398	-	-	-	30.00 /ton	398	41.32 /ton	549
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.66 LD	1	95		-	119	-	321.05 /LD	213	503.13 /LD	334
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.66 LD	1	95	398		119		921.10 /LD	612	1,329.50 /LD	883
						02.01.06.0010 Electrical Demolition	1.00 LS	54	3,719	398		1,956		6,073.89 /LS	6,074	9,443.01 /LS	9,443
						02.40 Demolition	**1.00 LS**	**407**	**28,262**	**8,367**		**28,967**		**65,596.54 /LS**	**65,597**	**101,210.09 /LS**	**101,210**
						02.0 Existing Conditions	1.00 LS	407	28,262	8,367		28,967		65,596.54 /LS	65,597	101,210.09 /LS	101,210
						01.2 Demolition - Covered storage area	1.00 LS	407	28,262	8,367		28,967		65,596.54 /LS	65,597	101,210.09 /LS	101,210
	01.3					Demolition - Wicks House											
		02.0				Existing Conditions											
			02.40			Demolition											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	93.75 CY	131	9,234		-	7,032	-	173.50 /CY	16,265	271.89 /CY	25,490
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	93.75 CY	131	9,234			7,032		173.50 /CY	16,265	271.89 /CY	25,490
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	9.38 CY	22	1,539		-	1,172	-	289.16 /CY	2,711	453.16 /CY	4,248
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	9.38 CY	22	1,539			1,172		289.16 /CY	2,711	453.16 /CY	4,248
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	225.00 ton		-	6,750	-	-	-	30.00 /ton	6,750	41.31 /ton	9,296
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	11.25 LD	23	1,602		-	2,010	-	321.06 /LD	3,612	503.15 /LD	5,660
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	11.25 LD	23	1,602	6,750		2,010		921.06 /LD	10,362	1,329.44 /LD	14,956
						02.01.02.0010 Demo Strucutral Concrete	103.13 CY	176	12,374	6,750		10,214		284.49 /CY	29,338	433.40 /CY	44,695
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	2,400.00 SF	768	53,185	-	-	61,364	-	47.73 /SF	114,549	74.80 /SF	179,516
						02.01.02.00 Sturcture/Building Demoltion	2,400.00 SF	768	53,185			61,364		47.73 /SF	114,549	74.80 /SF	179,516
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	525.00 ton		-	15,750	-	-	-	30.00 /ton	15,750	41.31 /ton	21,690
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	26.25 LD	53	3,738		-	4,690	-	321.06 /LD	8,428	503.14 /LD	13,208
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	26.25 LD	53	3,738	15,750		4,690		921.06 /LD	24,178	1,329.44 /LD	34,898
						02.01.02.0070 Misc. Demolition	1.00 LS	821	56,923	15,750		66,054		138,727.04 /LS	138,727	214,414.04 /LS	214,414
				02.01.04.40		HVAC Demolition											
					02.01.04.40	HVAC Demolition											
						HVAC Demolition - Med Crew	30.00 hr	150	10,235		-	5,188	-	514.10 /hr	15,423	805.67 /hr	24,170
						02.01.04.40 HVAC Demolition	1.00 LS	150	10,235			5,188		15,422.91 /LS	15,423	24,170.06 /LS	24,170
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	37.50 ton		-	1,125	-	-	-	30.00 /ton	1,125	41.31 /ton	1,549
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.88 LD	4	267		-	335	-	321.06 /LD	602	503.14 /LD	943
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	1.88 LD	4	267	1,125		335		921.06 /LD	1,727	1,329.43 /LD	2,493
						02.01.04.40 HVAC Demolition	1.00 LS	154	10,502	1,125		5,523		17,149.89 /LS	17,150	26,662.75 /LS	26,663
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	30.00 hr	150	10,235		-	5,188	-	514.10 /hr	15,423	805.67 /hr	24,170
						02.01.06.01 Electrical Facility Demolition	1.00 LS	150	10,235			5,188		15,422.91 /LS	15,423	24,170.07 /LS	24,170
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	37.50 ton		-	1,125	-	-	-	30.00 /ton	1,125	41.31 /ton	1,549
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.88 LD	4	267		-	335	-	321.06 /LD	602	503.15 /LD	943
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	1.88 LD	4	267	1,125		335		921.06 /LD	1,727	1,329.43 /LD	2,493
						02.01.06.0010 Electrical Demolition	1.00 LS	154	10,502	1,125		5,523		17,149.89 /LS	17,150	26,662.76 /LS	26,663
						02.40 Demolition	**1.00 LS**	**1,304**	**90,302**	**24,750**		**87,313**		**202,364.78 /LS**	**202,365**	**312,434.13 /LS**	**312,434**
						02.0 Existing Conditions	1.00 LS	1,304	90,302	24,750		87,313		202,364.78 /LS	202,365	312,434.13 /LS	312,434
						01.3 Demolition - Wicks House	1.00 LS	1,304	90,302	24,750		87,313		202,364.78 /LS	202,365	312,434.13 /LS	312,434
	01.6					Demolition - Generator building											
		02.0				Existing Conditions											
			02.40			Demolition											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	10.00 CY	14	985		-	750	-	173.50 /CY	1,735	271.89 /CY	2,719
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	10.00 CY	14	985			750	-	173.50 /CY	1,735	271.89 /CY	2,719
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	1.00 CY	2	164		-	125	-	289.16 /CY	289	453.15 /CY	453
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	1.00 CY	2	164			125		289.16 /CY	289	453.15 /CY	453
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	24.00 ton		-	720	-	-	-	30.00 /ton	720	41.31 /ton	992
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.20 LD	2	171		-	214	-	321.06 /LD	385	503.15 /LD	604
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	1.20 LD	2	171	720		214		921.06 /LD	1,105	1,329.44 /LD	1,595
						02.01.02.0010 Demo Strucutral Concrete	11.00 CY	19	1,320	720		1,089		284.49 /CY	3,129	433.40 /CY	4,767
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	256.00 SF	82	5,673	-	-	6,546	-	47.73 /SF	12,219	74.80 /SF	19,148
						02.01.02.00 Sturcture/Building Demoltion	256.00 SF	82	5,673			6,546		47.73 /SF	12,219	74.80 /SF	19,148
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	56.00 ton		-	1,680	-	-	-	30.00 /ton	1,680	41.31 /ton	2,314
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	2.80 LD	6	399		-	500	-	321.06 /LD	899	503.15 /LD	1,409
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	2.80 LD	6	399	1,680		500		921.06 /LD	2,579	1,329.44 /LD	3,722
						02.01.02.0070 Misc. Demolition	1.00 LS	88	6,072	1,680		7,046		14,797.55 /LS	14,798	22,870.84 /LS	22,871
				02.01.04.40		HVAC Demolition											
					02.01.04.40	HVAC Demolition											
						HVAC Demolition - Med Crew	3.20 hr	16	1,092		-	553	-	514.10 /hr	1,645	805.67 /hr	2,578
						02.01.04.40 HVAC Demolition	1.00 LS	16	1,092			553		1,645.11 /LS	1,645	2,578.13 /LS	2,578
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	4.00 ton		-	120	-	-	-	30.00 /ton	120	41.32 /ton	165
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.20 LD	0	28		-	36	-	321.05 /LD	64	503.15 /LD	101
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.20 LD	0	28	120		36		921.05 /LD	184	1,329.45 /LD	266
						02.01.04.40 HVAC Demolition	1.00 LS	16	1,120	120		589		1,829.32 /LS	1,829	2,844.02 /LS	2,844
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	3.20 hr	16	1,092		-	553	-	514.10 /hr	1,645	805.67 /hr	2,578
						02.01.06.01 Electrical Facility Demolition	1.00 LS	16	1,092			553		1,645.11 /LS	1,645	2,578.13 /LS	2,578
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	4.00 ton		-	120	-	-	-	30.00 /ton	120	41.31 /ton	165
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.20 LD	0	28		-	36	-	321.05 /LD	64	503.25 /LD	101
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.20 LD	0	28	120		36		921.05 /LD	184	1,329.50 /LD	266
						02.01.06.0010 Electrical Demolition	1.00 LS	16	1,120	120		589		1,829.32 /LS	1,829	2,844.03 /LS	2,844
						02.40 Demolition	1.00 LS	139	9,632	2,640		9,313		21,585.57 /LS	21,586	33,326.31 /LS	33,326
						02.0 Existing Conditions	1.00 LS	139	9,632	2,640		9,313		21,585.57 /LS	21,586	33,326.31 /LS	33,326
						01.6 Demolition - Generator building	1.00 LS	139	9,632	2,640		9,313		21,585.57 /LS	21,586	33,326.31 /LS	33,326
						3.1B CIP 3 - WTP Replacement, Phase 1B	1.00 LS	2,157	149,476	42,057		147,405		338,937.54 /LS	338,938	523,176.23 /LS	523,176
3.1C						**CIP 3 - WTP Replacement, Phase 1C**											
	03.1					New 30" filtered water											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.FW30		30" FW - Finished Water											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	40.00 day		-	-	-	4,806	-	120.15 /day	4,806	188.29 /day	7,532
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	1,841.67 CY	409	29,298	-	-	30,318	-	32.37 /CY	59,616	50.73 /CY	93,428
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	561.75 ecy	218	13,184	-	-	-	-	23.47 /ecy	13,184	36.78 /ecy	20,661
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	1,023.15 ecy	82	5,943	-	-	1,074	-	6.86 /ecy	7,017	10.75 /ecy	10,997
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	561.75 lcy	90	5,853	11,797	-	1,038	-	33.27 /lcy	18,688	48.15 /lcy	27,046
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	102.31 lcy	16	1,066	1,852	-	189	-	30.37 /lcy	3,107	44.15 /lcy	4,517
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	818.52 lcy	168	11,954	-	-	16,609	-	34.90 /lcy	28,563	54.69 /lcy	44,763
						31.00.01.01 Trenching, Backfill, and Compaction	1,841.67 CY	983	67,298	13,649		54,035		73.29 /CY	134,981	113.45 /CY	208,943
					33.00.04.30	Buried Pipe, Ductile Iron, 30"											
						30" pipe, DI, RJ, excav/bkfill not included, 250#	850.00 LF	357	29,834	166,097	-	16,862	-	250.35 /LF	212,793	355.20 /LF	301,922
						30" DI, RJ, Ell, 45	17.00 ea	168	14,065	94,473	-	7,949	-	6,852.21 /ea	116,488	9,682.58 /ea	164,604
						Megalugs for DI Pipe w/ Accessories, 30"	43.00 ea	86	7,187	46,373	-	4,062	-	1,340.06 /ea	57,622	1,895.17 /ea	81,492
						Polywrap, 30" pipe	850.00 lf		-	1,122	-	-	-	1.32 /lf	1,122	1.82 /lf	1,545
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	5,952.54 /ea	5,953
						Pipe Marking, ID Tape	850.00 lf	9	710	111	-	-	-	0.97 /lf	821	1.49 /lf	1,265
						33.00.04.30 Buried Pipe, Ductile Iron, 30"	850.00 LF	644	53,802	308,926		30,007		462.04 /LF	392,735	655.04 /LF	556,781
						33.00.04.FW30 30" FW - Finished Water	850.00 LF	1,627	121,101	322,575		84,042		620.84 /LF	527,717	900.85 /LF	765,724
						33.02 Buried Process Pipe, Ductile Iron	850.00 LF	1,627	121,101	322,575		84,042		620.84 /LF	527,717	900.85 /LF	765,724
						33.0 Utilities	1.00 LS	1,627	121,101	322,575		84,042		527,716.84 /LS	527,717	765,724.01 /LS	765,724
						03.1 New 30" filtered water	1.00 LS	1,627	121,101	322,575		84,042		527,716.84 /LS	527,717	765,724.01 /LS	765,724
	03.2					New 12" BWS											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.BWS12		New 12" BWS											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	30.00 day		-	-	-	3,605	-	120.15 /day	3,605	188.29 /day	5,649
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	1,527.78 CY	340	24,305	-	-	25,151	-	32.37 /CY	49,455	50.73 /CY	77,504
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	375.43 ecy	146	8,811	-	-	-	-	23.47 /ecy	8,811	36.78 /ecy	13,808
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	1,018.52 ecy	81	5,916	-	-	1,070	-	6.86 /ecy	6,985	10.75 /ecy	10,947
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	375.43 lcy	60	3,912	7,884	-	694	-	33.27 /lcy	12,490	48.15 /lcy	18,075
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	101.85 lcy	16	1,061	1,843	-	188	-	30.37 /lcy	3,093	44.15 /lcy	4,497
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	509.26 lcy	104	7,438	-	-	10,334	-	34.90 /lcy	17,771	54.69 /lcy	27,850
						31.00.01.01 Trenching, Backfill, and Compaction	1,527.78 CY	748	51,442	9,728		41,040		66.90 /CY	102,210	103.63 /CY	158,331
					33.00.04.12	Buried Pipe, Ductile Iron, 12"											
						12" pipe, DI, RJ, excav/bkfill not included, 350#	1,100.00 LF	275	22,982	55,656	-	12,989	-	83.30 /LF	91,626	120.93 /LF	133,018
						12" DI, RJ, Ell, 45	20.00 ea	92	7,688	13,502	-	4,345	-	1,276.79 /ea	25,536	1,872.66 /ea	37,453
						Megalugs for DI Pipe w/ Accessories, 12"	55.00 ea	55	4,596	6,705	-	2,598	-	252.70 /ea	13,899	372.86 /ea	20,507
						Polywrap, 12" pipe	1,100.00 lf		-	583	-	-	-	0.53 /lf	583	0.73 /lf	803
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	5,952.55 /ea	5,953
						Pipe Marking, ID Tape	1,100.00 lf	11	919	143	-	-	-	0.97 /lf	1,062	1.49 /lf	1,637
						33.00.04.12 Buried Pipe, Ductile Iron, 12"	1,100.00 LF	457	38,191	77,338		21,066		124.18 /LF	136,595	181.25 /LF	199,372
						33.00.04.BWS12 New 12" BWS	1,100.00 LF	1,205	89,634	87,066		62,106		217.10 /LF	238,805	325.18 /LF	357,702
						33.02 Buried Process Pipe, Ductile Iron	1,100.00 LF	1,205	89,634	87,066		62,106		217.10 /LF	238,805	325.18 /LF	357,702

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						33.0 Utilities	1.00 LS	1,205	89,634	87,066		62,106		238,805.46 /LS	238,805	357,702.28 /LS	357,702
						03.2 New 12" BWS	1.00 LS	1,205	89,634	87,066		62,106		238,805.46 /LS	238,805	357,702.28 /LS	357,702
	03.3					Residuals piping											
		33.0				Utilities											
			33.02			Buried Process Pipe, Ductile Iron											
				33.00.04.SEDB04		04" Solids & 04" EDB Recycle Lines											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	148.00 day		-	-	-	17,782	-	120.15 /day	17,782	188.29 /day	27,867
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	10,456.79 CY	2,324	166,351	-	-	172,142	-	32.37 /CY	338,493	50.73 /CY	530,471
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	1,187.26 ecy	461	27,864	-	-	-	-	23.47 /ecy	27,864	36.78 /ecy	43,667
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	8,641.98 ecy	691	50,194	-	-	9,075	-	6.86 /ecy	59,269	10.75 /ecy	92,884
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	1,187.26 lcy	190	12,371	24,932	-	2,194	-	33.27 /lcy	39,498	48.15 /lcy	57,162
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	604.94 lcy	97	6,303	10,949	-	1,118	-	30.37 /lcy	18,371	44.15 /lcy	26,709
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	1,814.81 lcy	372	26,505	-	-	36,825	-	34.90 /lcy	63,330	54.69 /lcy	99,248
						31.00.01.01 Trenching, Backfill, and Compaction	10,456.79 CY	4,135	289,589	35,882		239,137		53.99 /CY	564,607	83.97 /CY	878,008
					33.00.04.04	Buried Pipe, Ductile Iron, 4"											
						4" pipe, DI, RJ, excav/bkfill not included, 350#	7,000.00 LF	1,050	88,773	193,914	-	43,050	-	46.53 /LF	325,737	67.66 /LF	473,637
						4" DI, RJ, Ell, 45	140.00 ea	266	22,489	25,690	-	10,906	-	422.04 /ea	59,085	626.53 /ea	87,715
						Megalugs for DI Pipe w/ Accessories, 4"	280.00 ea	280	23,673	10,570	-	11,480	-	163.30 /ea	45,723	248.74 /ea	69,646
						Polywrap, 4" pipe	7,000.00 lf		-	2,240	-	-	-	0.32 /lf	2,240	0.44 /lf	3,085
						Add for tie-in to existing (Adjust productivity)	4.00 ea	96	8,023	3,000	-	4,534	-	3,889.26 /ea	15,557	5,952.56 /ea	23,810
						Pipe Marking, ID Tape	7,000.00 lf	70	5,849	910	-	-	-	0.97 /lf	6,759	1.49 /lf	10,420
						33.00.04.04 Buried Pipe, Ductile Iron, 4"	7,000.00 LF	1,762	148,807	236,324		69,970		65.01 /LF	455,102	95.47 /LF	668,313
						33.00.04.SEDB04 04" Solids & 04" EDB Recycle Lines	7,000.00 LF	5,897	438,396	272,206		309,107		145.67 /LF	1,019,709	220.90 /LF	1,546,321
						33.02 Buried Process Pipe, Ductile Iron	7,000.00 LF	5,897	438,396	272,206		309,107		145.67 /LF	1,019,709	220.90 /LF	1,546,321
						33.0 Utilities	1.00 LS	5,897	438,396	272,206		309,107		1,019,708.75 /LS	1,019,709	1,546,320.83 /LS	1,546,321
						03.3 Residuals piping	1.00 LS	5,897	438,396	272,206		309,107		1,019,708.75 /LS	1,019,709	1,546,320.83 /LS	1,546,321
	90.1					Sitework Allowance											
		31.0				Earthwork											
			31.00			Site/Civil General Items											
				31.00.01.0010		Sitework Allowance											
					31.00.01.00	Site/Civil, General Conditions											
						Sitework Allowance (~6% construction costs)	1.00 ls						226,000	226,000.00 /ls	226,000	277,336.65 /ls	277,337
						31.00.01.00 Site/Civil, General Conditions	1.00 LS						226,000	226,000.00 /LS	226,000	277,336.65 /LS	277,337
						31.00.01.0010 Sitework Allowance	1.00 LS						226,000	226,000.00 /LS	226,000	277,336.65 /LS	277,337
						31.00 Site/Civil General Items	1.00 LS						226,000	226,000.00 /LS	226,000	277,336.65 /LS	277,337
						31.0 Earthwork	1.00 LS						226,000	226,000.00 /LS	226,000	277,336.65 /LS	277,337
						90.1 Sitework Allowance	1.00 LS						226,000	226,000.00 /LS	226,000	277,336.65 /LS	277,337
						3.1C CIP 3 - WTP Replacement, Phase 1C	1.00 LS	8,729	649,130	681,846		455,255	226,000	2,012,231.05 /LS	2,012,231	2,947,083.77 /LS	2,947,084
4.2A						CIP 4 - WTP Replacement, Phase 2A											
	01.7					Demolition Caustic Soda Building											
		02.0				Existing Conditions											
			02.40			Demolition											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	33.98 CY	48	3,347		-	2,549	-	173.50 /CY	5,896	280.76 /CY	9,541
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	33.98 CY	48	3,347			2,549	-	173.50 /CY	5,896	280.76 /CY	9,541
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	3.40 CY	8	558		-	425	-	289.16 /CY	983	467.93 /CY	1,590
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	3.40 CY	8	558			425	-	289.16 /CY	983	467.93 /CY	1,590
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	81.56 ton		-	2,447	-	-	-	30.00 /ton	2,447	42.85 /ton	3,495
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	4.08 LD	8	581		-	729	-	321.06 /LD	1,309	519.55 /LD	2,119
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	4.08 LD	8	581	2,447		729		921.07 /LD	3,756	1,376.53 /LD	5,613
						02.01.02.0010 Demo Strucutral Concrete	37.38 CY	64	4,486	2,447		3,702		284.49 /CY	10,635	447.94 /CY	16,745
					02.01.02.0070	Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	870.00 SF	278	19,280	-	-	22,244	-	47.73 /SF	41,524	77.24 /SF	67,196
						02.01.02.00 Sturcture/Building Demoltion	870.00 SF	278	19,280			22,244		47.73 /SF	41,524	77.24 /SF	67,196
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	190.31 ton		-	5,709	-	-	-	30.00 /ton	5,709	42.85 /ton	8,154
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	9.52 LD	19	1,355		-	1,700	-	321.06 /LD	3,055	519.55 /LD	4,944
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	9.52 LD	19	1,355	5,709		1,700		921.03 /LD	8,765	1,376.47 /LD	13,098
						02.01.02.0070 Misc. Demolition	1.00 LS	297	20,635	5,709		23,945		50,288.51 /LS	50,289	80,294.76 /LS	80,295
					02.01.06.0010	Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	12.00 hr	60	4,094		-	2,075	-	514.10 /hr	6,169	831.94 /hr	9,983
						02.01.06.01 Electrical Facility Demolition	1.00 LS	60	4,094			2,075		6,169.16 /LS	6,169	9,983.28 /LS	9,983
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	10.00 ton		-	300	-	-	-	30.00 /ton	300	42.85 /ton	428
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.50 LD	1	71		-	89	-	321.06 /LD	161	519.58 /LD	260
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.50 LD	1	71	300		89		921.06 /LD	461	1,376.52 /LD	688
						02.01.06.0010 Electrical Demolition	1.00 LS	61	4,165	300		2,164		6,629.69 /LS	6,630	10,671.54 /LS	10,672
						02.40 Demolition	1.00 LS	422	29,285	8,456		29,811		67,552.96 /LS	67,553	107,711.14 /LS	107,711
						02.0 Existing Conditions	1.00 LS	422	29,285	8,456		29,811		67,552.96 /LS	67,553	107,711.14 /LS	107,711
						01.7 Demolition Caustic Soda Building	1.00 LS	422	29,285	8,456		29,811		67,552.96 /LS	67,553	107,711.14 /LS	107,711
	01.8					Demolition Sodium Hypochlorite Building											
		02.0				Existing Conditions											
			02.40			Demolition											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	57.42 CY	80	5,655		-	4,307	-	173.50 /CY	9,962	280.76 /CY	16,121
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	57.42 CY	80	5,655			4,307	-	173.50 /CY	9,962	280.76 /CY	16,121
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	5.74 CY	13	942		-	718	-	289.16 /CY	1,660	467.93 /CY	2,686
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	5.74 CY	13	942			718	-	289.16 /CY	1,660	467.93 /CY	2,686
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	137.81 ton		-	4,134	-	-	-	30.00 /ton	4,134	42.85 /ton	5,905
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	6.89 LD	14	981		-	1,231	-	321.06 /LD	2,212	519.55 /LD	3,580
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	6.89 LD	14	981	4,134		1,231		921.11 /LD	6,346	1,376.57 /LD	9,485
						02.01.02.0010 Demo Strucutral Concrete	63.16 CY	108	7,579	4,134		6,255		284.49 /CY	17,969	447.93 /CY	28,292
					02.01.02.0070	Misc. Demolition											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	1,470.00 SF	470	32,576	-	-	37,586	-	47.73 /SF	70,161	77.24 /SF	113,539
						02.01.02.00 Sturcture/Building Demoltion	1,470.00 SF	470	32,576			37,586		47.73 /SF	70,161	77.24 /SF	113,539
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	321.56 ton			9,647	-	-	-	30.00 /ton	9,647	42.85 /ton	13,778
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	16.08 LD	32	2,290		-	2,873	-	321.06 /LD	5,162	519.55 /LD	8,354
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	16.08 LD	32	2,290	9,647		2,873		921.02 /LD	14,809	1,376.45 /LD	22,132
						02.01.02.0070 Misc. Demolition	*1.00* LS	503	34,866	9,647		40,458		84,970.55 /LS	84,971	135,670.98 /LS	135,671
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	24.00 hr	120	8,188		-	4,150	-	514.10 /hr	12,338	831.94 /hr	19,967
						02.01.06.01 Electrical Facility Demolition	*1.00* LS	120	8,188			4,150		12,338.33 /LS	12,338	19,966.54 /LS	19,967
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	20.00 ton		-	600	-	-	-	30.00 /ton	600	42.85 /ton	857
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.00 LD	2	142		-	179	-	321.06 /LD	321	519.56 /LD	520
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	1.00 LD	2	142	600		179		921.06 /LD	921	1,376.51 /LD	1,377
						02.01.06.0010 Electrical Demolition	*1.00* LS	122	8,330	600		4,329		13,259.39 /LS	13,259	21,343.05 /LS	21,343
						02.40 Demolition	*1.00* **LS**	**732**	**50,775**	**14,381**		**51,043**		**116,198.68 /LS**	**116,199**	**185,306.46 /LS**	**185,306**
						02.0 Existing Conditions	*1.00* LS	732	50,775	14,381		51,043		116,198.68 /LS	116,199	185,306.46 /LS	185,306
						01.8 Demolition Sodium Hypochlorite Building	*1.00* LS	732	50,775	14,381		51,043		116,198.68 /LS	116,199	185,306.46 /LS	185,306
	05.0					Construct new finished water chem building											
		13.0				Special Construction											
			13.01			**Buildings Complete**											
				13.00.01.0401		Construct new finished water chem building											
					13.00.01.02	Buildings, Operations											
						Building Complete - Chemical Building	3,125.00 SF				843,750	-	-	270.00 /SF	843,750	385.63 /SF	1,205,089
						13.00.01.02 Buildings, Operations	3,125.00 SF				843,750			270.00 /SF	843,750	385.63 /SF	1,205,089
						13.00.01.0401 Construct new finished water chem building	*1.00* LS				843,750			843,750.00 /LS	843,750	1,205,088.73 /LS	1,205,089
						13.01 Buildings Complete	*1.00* **LS**				**843,750**			**843,750.00 /LS**	**843,750**	**1,205,088.73 /LS**	**1,205,089**
						13.0 Special Construction	*1.00* LS				843,750			843,750.00 /LS	843,750	1,205,088.73 /LS	1,205,089
						05.0 Construct new finished water chem building	*1.00* LS				843,750			843,750.00 /LS	843,750	1,205,088.73 /LS	1,205,089
	05.1					On-Site Hypo Generation System											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						On-Site Sodium Hypo: Hypo - 11 - Equipment	1.00 ls				-	-	912,066	912,065.94 /ls	912,066	1,165,851.31 /ls	1,165,851
						11.00.99.00 Equipment, Other	*1.00* LS						912,066	912,065.94 /LS	912,066	1,165,851.31 /LS	1,165,851
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						912,066	912,065.94 /LS	912,066	1,165,851.31 /LS	1,165,851
						11.00 Equipment	*1.00* **LS**						**912,066**	**912,065.94 /LS**	**912,066**	**1,165,851.31 /LS**	**1,165,851**
						11.0 Commercial Equipment	*1.00* LS						912,066	912,065.94 /LS	912,066	1,165,851.31 /LS	1,165,851
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						On-Site Sodium Hypo: Hypo - 16 Electrical	1.00 ls				-	-	75,753	75,752.98 /ls	75,753	96,831.50 /ls	96,832
						26.00.99.00 Electrical, Other	*1.00* LS						75,753	75,752.98 /LS	75,753	96,831.50 /LS	96,832
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						75,753	75,752.98 /LS	75,753	96,831.50 /LS	96,832
						26.00 Electrical	*1.00* **LS**						**75,753**	**75,752.98 /LS**	**75,753**	**96,831.50 /LS**	**96,832**
						26.0 Electrical Work	*1.00* LS						75,753	75,752.98 /LS	75,753	96,831.50 /LS	96,832
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						On-Site Sodium Hypo: Hypo - 15 Mechanical	1.00 ls				-	-	151,506	151,505.97 /ls	151,506	193,663.00 /ls	193,663
						40.00.99.01 Process Pipe, Other	*1.00* LS						151,506	151,505.97 /LS	151,506	193,663.00 /LS	193,663
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						151,506	151,505.97 /LS	151,506	193,663.00 /LS	193,663
						40.19 Process Pipe, Other	*1.00* **LS**						**151,506**	**151,505.97 /LS**	**151,506**	**193,663.00 /LS**	**193,663**
						40.0 Process Pipe	*1.00* LS						151,506	151,505.97 /LS	151,506	193,663.00 /LS	193,663
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						On-Site Sodium Hypo: Hypo - 13 Special Construction	1.00 ls				-	-	75,753	75,752.98 /ls	75,753	96,831.50 /ls	96,832
						40.90.99.01 I&C, Other	*1.00* LS						75,753	75,752.98 /LS	75,753	96,831.50 /LS	96,832
						40.90.99.0013 Special Construction from Replica	*1.00* LS						75,753	75,752.98 /LS	75,753	96,831.50 /LS	96,832
						40.90 Instrumentation & Controls	*1.00* **LS**						**75,753**	**75,752.98 /LS**	**75,753**	**96,831.50 /LS**	**96,832**
						40.9 Instrumentation & Controls	*1.00* LS						75,753	75,752.98 /LS	75,753	96,831.50 /LS	96,832
						05.1 On-Site Hypo Generation System	*1.00* LS						1,215,078	1,215,077.87 /LS	1,215,078	1,553,177.31 /LS	1,553,177
	05.2					Fluoride Storage/Equipment											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Dry Chemical: Fluoride - 11 - Equipment	1.00 ls				-	-	391,491	391,491.42 /ls	391,491	500,425.20 /ls	500,425
						11.00.99.00 Equipment, Other	*1.00* LS						391,491	391,491.42 /LS	391,491	500,425.20 /LS	500,425
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						391,491	391,491.42 /LS	391,491	500,425.20 /LS	500,425
						11.00 Equipment	*1.00* **LS**						**391,491**	**391,491.42 /LS**	**391,491**	**500,425.20 /LS**	**500,425**
						11.0 Commercial Equipment	*1.00* LS						391,491	391,491.42 /LS	391,491	500,425.20 /LS	500,425
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Dry Chemical: Fluoride - 16 Electrical	1.00 ls				-	-	86,055	86,055.39 /ls	86,055	110,000.59 /ls	110,001
						26.00.99.00 Electrical, Other	*1.00* LS						86,055	86,055.39 /LS	86,055	110,000.59 /LS	110,001
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						86,055	86,055.39 /LS	86,055	110,000.59 /LS	110,001
						26.00 Electrical	*1.00* **LS**						**86,055**	**86,055.39 /LS**	**86,055**	**110,000.59 /LS**	**110,001**
						26.0 Electrical Work	*1.00* LS						86,055	86,055.39 /LS	86,055	110,000.59 /LS	110,001
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
					40.00.99.01	Process Pipe, Other											
						Dry Chemical: Fluoride - 15 Mechanical	1.00 ls				-	-	35,149	35,149.38 /ls	35,149	44,929.80 /ls	44,930
						40.00.99.01 Process Pipe, Other	*1.00* LS						35,149	35,149.38 /LS	35,149	44,929.80 /LS	44,930
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						35,149	35,149.38 /LS	35,149	44,929.80 /LS	44,930
						40.19 Process Pipe, Other	***1.00*** **LS**						**35,149**	**35,149.38 /LS**	**35,149**	**44,929.80 /LS**	**44,930**
						40.0 Process Pipe	*1.00* LS						35,149	35,149.38 /LS	35,149	44,929.80 /LS	44,930
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Dry Chemical: Fluoride - 13 Special Construction	1.00 ls				-	-	13,333	13,332.53 /ls	13,333	17,042.36 /ls	17,042
						40.90.99.01 I&C, Other	*1.00* LS						13,333	13,332.53 /LS	13,333	17,042.36 /LS	17,042
						40.90.99.0013 Special Construction from Replica	*1.00* LS						13,333	13,332.53 /LS	13,333	17,042.36 /LS	17,042
						40.90 Instrumentation & Controls	***1.00*** **LS**						**13,333**	**13,332.53 /LS**	**13,333**	**17,042.36 /LS**	**17,042**
						40.9 Instrumentation & Controls	*1.00* LS						13,333	13,332.53 /LS	13,333	17,042.36 /LS	17,042
						05.2 Fluoride Storage/Equipment	*1.00* LS						526,029	526,028.72 /LS	526,029	672,397.95 /LS	672,398
	05.3					Caustic Storage/Equipment											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: Caustic - 11 - Equipment	1.00 ls				-	-	28,483	28,483.12 /ls	28,483	36,408.64 /ls	36,409
						11.00.99.00 Equipment, Other	*1.00* LS						28,483	28,483.12 /LS	28,483	36,408.64 /LS	36,409
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						28,483	28,483.12 /LS	28,483	36,408.64 /LS	36,409
						11.00 Equipment	***1.00*** **LS**						**28,483**	**28,483.12 /LS**	**28,483**	**36,408.64 /LS**	**36,409**
						11.0 Commercial Equipment	*1.00* LS						28,483	28,483.12 /LS	28,483	36,408.64 /LS	36,409
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: Caustic - 16 Electrical	1.00 ls				-	-	5,454	5,454.00 /ls	5,454	6,971.59 /ls	6,972
						26.00.99.00 Electrical, Other	*1.00* LS						5,454	5,454.00 /LS	5,454	6,971.59 /LS	6,972
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						5,454	5,454.00 /LS	5,454	6,971.59 /LS	6,972
						26.00 Electrical	***1.00*** **LS**						**5,454**	**5,454.00 /LS**	**5,454**	**6,971.59 /LS**	**6,972**
						26.0 Electrical Work	*1.00* LS						5,454	5,454.00 /LS	5,454	6,971.59 /LS	6,972
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: Caustic - 15 Mechanical	1.00 ls				-	-	13,332	13,332.00 /ls	13,332	17,041.67 /ls	17,042
						40.00.99.01 Process Pipe, Other	*1.00* LS						13,332	13,332.00 /LS	13,332	17,041.67 /LS	17,042
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						13,332	13,332.00 /LS	13,332	17,041.67 /LS	17,042
						40.19 Process Pipe, Other	***1.00*** **LS**						**13,332**	**13,332.00 /LS**	**13,332**	**17,041.67 /LS**	**17,042**
						40.0 Process Pipe	*1.00* LS						13,332	13,332.00 /LS	13,332	17,041.67 /LS	17,042
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: Caustic - 13 Special Construction	1.00 ls				-	-	58,782	58,782.00 /ls	58,782	75,138.29 /ls	75,138
						40.90.99.01 I&C, Other	*1.00* LS						58,782	58,782.00 /LS	58,782	75,138.29 /LS	75,138
						40.90.99.0013 Special Construction from Replica	*1.00* LS						58,782	58,782.00 /LS	58,782	75,138.29 /LS	75,138
						40.90 Instrumentation & Controls	***1.00*** **LS**						**58,782**	**58,782.00 /LS**	**58,782**	**75,138.29 /LS**	**75,138**
						40.9 Instrumentation & Controls	*1.00* LS						58,782	58,782.00 /LS	58,782	75,138.29 /LS	75,138
						05.3 Caustic Storage/Equipment	*1.00* LS						106,051	106,051.12 /LS	106,051	135,560.19 /LS	135,560
	05.4					Polyphosphate Storage/Equipment											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: PolyPhos - 11 - Equipment	1.00 ls				-	-	28,483	28,483.12 /ls	28,483	36,408.64 /ls	36,409
						11.00.99.00 Equipment, Other	*1.00* LS						28,483	28,483.12 /LS	28,483	36,408.64 /LS	36,409
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						28,483	28,483.12 /LS	28,483	36,408.64 /LS	36,409
						11.00 Equipment	***1.00*** **LS**						**28,483**	**28,483.12 /LS**	**28,483**	**36,408.64 /LS**	**36,409**
						11.0 Commercial Equipment	*1.00* LS						28,483	28,483.12 /LS	28,483	36,408.64 /LS	36,409
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: PolyPhos - 16 Electrical	1.00 ls				-	-	4,848	4,848.00 /ls	4,848	6,196.98 /ls	6,197
						26.00.99.00 Electrical, Other	*1.00* LS						4,848	4,848.00 /LS	4,848	6,196.98 /LS	6,197
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						4,848	4,848.00 /LS	4,848	6,196.98 /LS	6,197
						26.00 Electrical	***1.00*** **LS**						**4,848**	**4,848.00 /LS**	**4,848**	**6,196.98 /LS**	**6,197**
						26.0 Electrical Work	*1.00* LS						4,848	4,848.00 /LS	4,848	6,196.98 /LS	6,197
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: PolyPhos - 15 Mechanical	1.00 ls				-	-	12,726	12,726.00 /ls	12,726	16,267.05 /ls	16,267
						40.00.99.01 Process Pipe, Other	*1.00* LS						12,726	12,726.00 /LS	12,726	16,267.05 /LS	16,267
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						12,726	12,726.00 /LS	12,726	16,267.05 /LS	16,267
						40.19 Process Pipe, Other	***1.00*** **LS**						**12,726**	**12,726.00 /LS**	**12,726**	**16,267.05 /LS**	**16,267**
						40.0 Process Pipe	*1.00* LS						12,726	12,726.00 /LS	12,726	16,267.05 /LS	16,267
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: PolyPhos - 13 Special Construction	1.00 ls				-	-	53,934	53,934.00 /ls	53,934	68,941.32 /ls	68,941
						40.90.99.01 I&C, Other	*1.00* LS						53,934	53,934.00 /LS	53,934	68,941.32 /LS	68,941
						40.90.99.0013 Special Construction from Replica	*1.00* LS						53,934	53,934.00 /LS	53,934	68,941.32 /LS	68,941
						40.90 Instrumentation & Controls	***1.00*** **LS**						**53,934**	**53,934.00 /LS**	**53,934**	**68,941.32 /LS**	**68,941**
						40.9 Instrumentation & Controls	*1.00* LS						53,934	53,934.00 /LS	53,934	68,941.32 /LS	68,941

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						05.4 Polyphosphate Storage/Equipment	*1.00* LS						99,991	99,991.12 /LS	99,991	127,813.99 /LS	127,814
	05.5					Phosphoric Acid Storage/Equipment											
		11.0				Commercial Equipment											
			11.00			Equipment											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: PhosAcid - 11 - Equipment	1.00 ls				-	-	28,483	28,483.12 /ls	28,483	36,408.64 /ls	36,409
						11.00.99.00 Equipment, Other	*1.00* LS						28,483	28,483.12 /LS	28,483	36,408.64 /LS	36,409
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						28,483	28,483.12 /LS	28,483	36,408.64 /LS	36,409
						11.00 Equipment	*1.00* **LS**						**28,483**	**28,483.12 /LS**	**28,483**	**36,408.64 /LS**	**36,409**
						11.0 Commercial Equipment	*1.00* LS						28,483	28,483.12 /LS	28,483	36,408.64 /LS	36,409
		26.0				Electrical Work											
			26.00			Electrical											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: PhosAcid - 16 Electrical	1.00 ls				-	-	4,242	4,242.00 /ls	4,242	5,422.34 /ls	5,422
						26.00.99.00 Electrical, Other	*1.00* LS						4,242	4,242.00 /LS	4,242	5,422.34 /LS	5,422
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						4,242	4,242.00 /LS	4,242	5,422.34 /LS	5,422
						26.00 Electrical	*1.00* **LS**						**4,242**	**4,242.00 /LS**	**4,242**	**5,422.34 /LS**	**5,422**
						26.0 Electrical Work	*1.00* LS						4,242	4,242.00 /LS	4,242	5,422.34 /LS	5,422
		40.0				Process Pipe											
			40.19			Process Pipe, Other											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: PhosAcid - 15 Mechanical	1.00 ls				-	-	11,514	11,514.00 /ls	11,514	14,717.82 /ls	14,718
						40.00.99.01 Process Pipe, Other	*1.00* LS						11,514	11,514.00 /LS	11,514	14,717.82 /LS	14,718
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						11,514	11,514.00 /LS	11,514	14,717.82 /LS	14,718
						40.19 Process Pipe, Other	*1.00* **LS**						**11,514**	**11,514.00 /LS**	**11,514**	**14,717.82 /LS**	**14,718**
						40.0 Process Pipe	*1.00* LS						11,514	11,514.00 /LS	11,514	14,717.82 /LS	14,718
		40.9				Instrumentation & Controls											
			40.90			Instrumentation & Controls											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: PhosAcid - 13 Special Construction	1.00 ls				-	-	52,116	52,116.00 /ls	52,116	66,617.45 /ls	66,617
						40.90.99.01 I&C, Other	*1.00* LS						52,116	52,116.00 /LS	52,116	66,617.45 /LS	66,617
						40.90.99.0013 Special Construction from Replica	*1.00* LS						52,116	52,116.00 /LS	52,116	66,617.45 /LS	66,617
						40.90 Instrumentation & Controls	*1.00* **LS**						**52,116**	**52,116.00 /LS**	**52,116**	**66,617.45 /LS**	**66,617**
						40.9 Instrumentation & Controls	*1.00* LS						52,116	52,116.00 /LS	52,116	66,617.45 /LS	66,617
						05.5 Phosphoric Acid Storage/Equipment	*1.00* LS						96,355	96,355.12 /LS	96,355	123,166.25 /LS	123,166
	06.0					Construct new backwash supply pump station											
		11.0				Commercial Equipment											
			11.00			Equipment											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Filter BW PS: BWS - 11 - Equipment	1.00 ls				-	-	149,076	149,076.00 /ls	149,076	190,556.88 /ls	190,557
						11.00.99.00 Equipment, Other	*1.00* LS						149,076	149,076.00 /LS	149,076	190,556.88 /LS	190,557
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						149,076	149,076.00 /LS	149,076	190,556.88 /LS	190,557
						11.00 Equipment	*1.00* **LS**						**149,076**	**149,076.00 /LS**	**149,076**	**190,556.88 /LS**	**190,557**
						11.0 Commercial Equipment	*1.00* LS						149,076	149,076.00 /LS	149,076	190,556.88 /LS	190,557
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.00.01.0401		Construct new finished water chem building											
					13.00.01.02	Buildings, Operations											
						Building Complete - Pump Station Building	360.00 SF				97,200	-	-	270.00 /SF	97,200	385.63 /SF	138,826
						13.00.01.02 Buildings, Operations	360.00 SF				97,200			270.00 /SF	97,200	385.63 /SF	138,826
						13.00.01.0401 Construct new finished water chem building	*1.00* LS				97,200			97,200.00 /LS	97,200	138,826.22 /LS	138,826
						13.01 Buildings Complete	*1.00* **LS**				**97,200**			**97,200.00 /LS**	**97,200**	**138,826.22 /LS**	**138,826**
						13.0 Special Construction	*1.00* LS				97,200			97,200.00 /LS	97,200	138,826.22 /LS	138,826
		26.0				Electrical Work											
			26.00			Electrical											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Filter BW PS: BWS - 16 Electrical	1.00 ls				-	-	76,962	76,962.00 /ls	76,962	98,376.94 /ls	98,377
						26.00.99.00 Electrical, Other	*1.00* LS						76,962	76,962.00 /LS	76,962	98,376.94 /LS	98,377
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						76,962	76,962.00 /LS	76,962	98,376.94 /LS	98,377
						26.00 Electrical	*1.00* **LS**						**76,962**	**76,962.00 /LS**	**76,962**	**98,376.94 /LS**	**98,377**
						26.0 Electrical Work	*1.00* LS						76,962	76,962.00 /LS	76,962	98,376.94 /LS	98,377
		40.0				Process Pipe											
			40.19			Process Pipe, Other											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Filter BW PS: BWS - 15 Mechanical	1.00 ls				-	-	127,866	127,866.00 /ls	127,866	163,445.14 /ls	163,445
						40.00.99.01 Process Pipe, Other	*1.00* LS						127,866	127,866.00 /LS	127,866	163,445.14 /LS	163,445
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						127,866	127,866.00 /LS	127,866	163,445.14 /LS	163,445
						40.19 Process Pipe, Other	*1.00* **LS**						**127,866**	**127,866.00 /LS**	**127,866**	**163,445.14 /LS**	**163,445**
						40.0 Process Pipe	*1.00* LS						127,866	127,866.00 /LS	127,866	163,445.14 /LS	163,445
		40.9				Instrumentation & Controls											
			40.90			Instrumentation & Controls											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Filter BW PS: BWS - 13 Special Construction	1.00 ls				-	-	41,208	41,208.00 /ls	41,208	52,674.26 /ls	52,674
						40.90.99.01 I&C, Other	*1.00* LS						41,208	41,208.00 /LS	41,208	52,674.26 /LS	52,674
						40.90.99.0013 Special Construction from Replica	*1.00* LS						41,208	41,208.00 /LS	41,208	52,674.26 /LS	52,674
						40.90 Instrumentation & Controls	*1.00* **LS**						**41,208**	**41,208.00 /LS**	**41,208**	**52,674.26 /LS**	**52,674**
						40.9 Instrumentation & Controls	*1.00* LS						41,208	41,208.00 /LS	41,208	52,674.26 /LS	52,674
						06.0 Construct new backwash supply pump station	*1.00* LS				97,200		395,112	492,312.00 /LS	492,312	643,879.44 /LS	643,879
						4.2A CIP 4 - WTP Replacement, Phase 2A	*1.00* **LS**	1,154	80,060	22,837	940,950	80,854	2,438,616	3,563,317.59 /LS	3,563,318	4,754,101.46 /LS	4,754,101
4.2B						**CIP 4 - WTP Replacement, Phase 2B**											
	07.0					Construct new admin building											
		13.0				Special Construction											
			13.01			Buildings Complete											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
				13.01.99.0013		Administration Building (RS Means 1-Story Office)											
					13.01.99.00	Special Construction, Other											
						Administration Building (RS Means 1-Story Office)	4,000.00 SF				-	-	1,320,000	330.00 /SF	1,320,000	421.82 /SF	1,687,294
						13.01.99.00 Special Construction, Other	*1.00* LS						1,320,000	1,320,000.00 /LS	1,320,000	1,687,294.37 /LS	1,687,294
						13.01.99.0013 Administration Building (RS Means 1-Story Office)	4,000.00 SF						1,320,000	330.00 /SF	1,320,000	421.82 /SF	1,687,294
						13.01 Buildings Complete	*1.00* LS						1,320,000	1,320,000.00 /LS	1,320,000	1,687,294.37 /LS	1,687,294
						13.0 Special Construction	*1.00* LS						1,320,000	1,320,000.00 /LS	1,320,000	1,687,294.37 /LS	1,687,294
						07.0 Construct new admin building	*1.00* LS						1,320,000	1,320,000.00 /LS	1,320,000	1,687,294.37 /LS	1,687,294
	90.2					Sitework/Site Electrical/Yard Piping/SCADA Allowance											
		26.0				Electrical Work											
			26.10			**Site Electrical**											
				26.10.20.0010		Site Electrical Allowance											
					26.10.20.00	Site Electrical, Other											
						Site Electrical Allowance (~15% of Construction Costs)	1.00 ls				-	-	730,000	730,000.00 /ls	730,000	933,124.91 /ls	933,125
						26.10.20.00 Site Electrical, Other	*1.00* LS						730,000	730,000.00 /LS	730,000	933,124.91 /LS	933,125
						26.10.20.0010 Site Electrical Allowance	*1.00* LS						730,000	730,000.00 /LS	730,000	933,124.91 /LS	933,125
						26.10 Site Electrical	*1.00* LS						730,000	730,000.00 /LS	730,000	933,124.91 /LS	933,125
						26.0 Electrical Work	*1.00* LS						730,000	730,000.00 /LS	730,000	933,124.91 /LS	933,125
		31.0				Earthwork											
			31.00			**Site/Civil General Items**											
				31.00.01.0010		Sitework Allowance											
					31.00.01.00	Site/Civil, General Conditions											
						Sitework Allowance (~6% construction costs)	1.00 ls						290,000	290,000.00 /ls	290,000	370,693.46 /ls	370,693
						31.00.01.00 Site/Civil, General Conditions	*1.00* LS						290,000	290,000.00 /LS	290,000	370,693.46 /LS	370,693
						31.00.01.0010 Sitework Allowance	*1.00* LS						290,000	290,000.00 /LS	290,000	370,693.46 /LS	370,693
						31.00 Site/Civil General Items	*1.00* LS						290,000	290,000.00 /LS	290,000	370,693.46 /LS	370,693
						31.0 Earthwork	*1.00* LS						290,000	290,000.00 /LS	290,000	370,693.46 /LS	370,693
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.07.0010		Plant Computer System (SCADA allowance)											
					40.90.07.01	I&C, SCADA											
						SCADA Software Development (~6% of Constuction Costs)	1.00 ls						290,000	290,000.00 /ls	290,000	370,693.46 /ls	370,693
						40.90.07.01 I&C, SCADA	*1.00* LS						290,000	290,000.00 /LS	290,000	370,693.46 /LS	370,693
						40.90.07.0010 Plant Computer System (SCADA allowance)	*1.00* LS						290,000	290,000.00 /LS	290,000	370,693.46 /LS	370,693
						40.90 Instrumentation & Controls	*1.00* LS						290,000	290,000.00 /LS	290,000	370,693.46 /LS	370,693
						40.9 Instrumentation & Controls	*1.00* LS						290,000	290,000.00 /LS	290,000	370,693.46 /LS	370,693
						90.2 Sitework/Site Electrical/Yard Piping/SCADA Allowance	*1.00* LS						1,310,000	1,310,000.00 /LS	1,310,000	1,674,511.83 /LS	1,674,512
						4.2B CIP 4 - WTP Replacement, Phase 2B	*1.00* LS						2,630,000	2,630,000.00 /LS	2,630,000	3,361,806.20 /LS	3,361,806
5.3A						**CIP 5 - WTP Replacement, Phase 3A**											
	01.4					Demolition - Conference room											
		02.0				Existing Conditions											
			02.40			**Demolition**											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	30.47 CY	43	3,001		-	2,285	-	173.50 /CY	5,286	294.07 /CY	8,960
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	30.47 CY	43	3,001			2,285	-	173.50 /CY	5,286	294.07 /CY	8,960
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	3.05 CY	7	500		-	381	-	289.16 /CY	881	490.12 /CY	1,493
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	3.05 CY	7	500			381	-	289.16 /CY	881	490.12 /CY	1,493
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	73.13 ton		-	2,194	-	-	-	30.00 /ton	2,194	45.15 /ton	3,302
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	3.66 LD	7	521		-	653	-	321.06 /LD	1,174	544.18 /LD	1,990
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	3.66 LD	7	521	2,194		653		921.10 /LD	3,368	1,447.24 /LD	5,291
						02.01.02.0010 Demo Strucutral Concrete	33.52 CY	57	4,022	2,194		3,319		284.49 /CY	9,535	469.76 /CY	15,745
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	780.00 SF	250	17,285	-	-	19,943	-	47.73 /SF	37,229	80.90 /SF	63,102
						02.01.02.00 Sturcture/Building Demoltion	780.00 SF	250	17,285			19,943		47.73 /SF	37,229	80.90 /SF	63,102
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	170.63 ton		-	5,119	-	-	-	30.00 /ton	5,119	45.15 /ton	7,704
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	8.53 LD	17	1,215		-	1,524	-	321.06 /LD	2,739	544.18 /LD	4,642
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	8.53 LD	17	1,215	5,119		1,524		921.07 /LD	7,858	1,447.20 /LD	12,346
						02.01.02.0070 Misc. Demolition	*1.00* LS	267	18,500	5,119		21,468		45,086.20 /LS	45,086	75,447.79 /LS	75,448
				02.01.04.40		HVAC Demolition											
					02.01.04.40	HVAC Demolition											
						HVAC Demolition - Med Crew	9.75 hr	49	3,326		-	1,686	-	514.10 /hr	5,012	871.39 /hr	8,496
						02.01.04.40 HVAC Demolition	*1.00* LS	49	3,326			1,686		5,012.45 /LS	5,012	8,496.02 /LS	8,496
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	12.19 ton		-	366	-	-	-	30.00 /ton	366	45.15 /ton	550
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.61 LD	1	87		-	109	-	321.05 /LD	196	544.17 /LD	331
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.61 LD	1	87	366		109		921.44 /LD	561	1,447.77 /LD	882
						02.01.04.40 HVAC Demolition	*1.00* LS	50	3,413	366		1,795		5,573.61 /LS	5,574	9,377.71 /LS	9,378
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	9.75 hr	49	3,326		-	1,686	-	514.10 /hr	5,012	871.39 /hr	8,496
						02.01.06.01 Electrical Facility Demolition	0.00	49	3,326			1,686		/LS	5,012	/LS	8,496
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	12.19 ton		-	366	-	-	-	30.00 /ton	366	45.15 /ton	550
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.61 LD	1	87		-	109	-	321.05 /LD	196	544.15 /LD	331
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.61 LD	1	87	366		109		921.44 /LD	561	1,447.75 /LD	882
						02.01.06.0010 Electrical Demolition	*1.00* LS	50	3,413	366		1,795		5,573.61 /LS	5,574	9,377.70 /LS	9,378
						02.40 Demolition	*1.00* LS	424	29,348	8,044		28,377		65,768.25 /LS	65,768	109,947.77 /LS	109,948
						02.0 Existing Conditions	*1.00* LS	424	29,348	8,044		28,377		65,768.25 /LS	65,768	109,947.77 /LS	109,948
						01.4 Demolition - Conference room	*1.00* LS	424	29,348	8,044		28,377		65,768.25 /LS	65,768	109,947.77 /LS	109,948
	01.5					Demolition - Maintenance shed											
		02.0				Existing Conditions											
			02.40			**Demolition**											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	69.06 CY	97	6,802		-	5,180	-	173.50 /CY	11,982	294.07 /CY	20,309
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	69.06 CY	97	6,802			5,180		173.50 /CY	11,982	294.07 /CY	20,309
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											

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Detail Report
Project Name: The Dalles WTP - 9.5mgd DAF
Project Number: D3718900
Design Stage: ROM

Estimator: Jones T
Rev No. / Data: R04 - 09/11/2024
Class Estimate: Class 5

Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	6.91 CY	16	1,134		-	863	-	289.16 /CY	1,997	490.12 /CY	3,385
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	6.91 CY	16	1,134			863		289.16 /CY	1,997	490.12 /CY	3,385
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	165.75 ton		-	4,973	-	-	-	30.00 /ton	4,973	45.15 /ton	7,484
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	8.29 LD	17	1,180		-	1,481	-	321.06 /LD	2,661	544.19 /LD	4,510
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	8.29 LD	17	1,180	4,973		1,481		921.02 /LD	7,633	1,447.12 /LD	11,994
						02.01.02.0010 Demo Strucutral Concrete	75.97 CY	129	9,116	4,973		7,524		284.49 /CY	21,612	469.77 /CY	35,688
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	1,768.00 SF	566	39,180	-	-	45,205	-	47.73 /SF	84,385	80.90 /SF	143,031
						02.01.02.00 Sturcture/Building Demoltion	1,768.00 SF	566	39,180			45,205		47.73 /SF	84,385	80.90 /SF	143,031
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	386.75 ton		-	11,603	-	-	-	30.00 /ton	11,603	45.15 /ton	17,462
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	19.34 LD	39	2,754		-	3,455	-	321.06 /LD	6,209	544.18 /LD	10,523
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	19.34 LD	39	2,754	11,603		3,455		921.04 /LD	17,811	1,447.15 /LD	27,985
						02.01.02.0070 Misc. Demolition	1.00 LS	604	41,933	11,603		48,660		102,195.74 /LS	102,196	171,015.59 /LS	171,016
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	22.10 hr	111	7,540		-	3,822	-	514.10 /hr	11,362	871.39 /hr	19,258
						02.01.06.01 Electrical Facility Demolition	1.00 LS	111	7,540			3,822		11,361.54 /LS	11,362	19,257.63 /LS	19,258
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	27.63 ton		-	829	-	-	-	30.00 /ton	829	45.15 /ton	1,247
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.38 LD	3	197		-	247	-	321.06 /LD	443	544.19 /LD	752
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	1.38 LD	3	197	829		247		921.17 /LD	1,272	1,447.34 /LD	1,999
						02.01.06.0010 Electrical Demolition	1.00 LS	113	7,736	829		4,068		12,633.67 /LS	12,634	21,256.40 /LS	21,256
						02.40 Demolition	**1.00 LS**	**847**	**58,786**	**17,404**		**60,252**		**136,441.87 /LS**	**136,442**	**227,959.98 /LS**	**227,960**
						02.0 Existing Conditions	1.00 LS	847	58,786	17,404		60,252		136,441.87 /LS	136,442	227,959.98 /LS	227,960
						01.5 Demolition - Maintenance shed	1.00 LS	847	58,786	17,404		60,252		136,441.87 /LS	136,442	227,959.98 /LS	227,960
	04.0					Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor											
		13.0				Special Construction											
			13.01			**Buildings Complete**											
				13.00.01.0400		Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor											
					13.01.99.00	Special Construction, Other											
						Improvements to existing Wicks WTP	1.00 ls					-	266,000	266,000.00 /ls	266,000	360,425.56 /ls	360,426
						13.01.99.00 Special Construction, Other	1.00 LS						266,000	266,000.00 /LS	266,000	360,425.56 /LS	360,426
						13.00.01.0400 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	1.00 LS						266,000	266,000.00 /LS	266,000	360,425.56 /LS	360,426
						13.01 Buildings Complete	**1.00 LS**						**266,000**	**266,000.00 /LS**	**266,000**	**360,425.56 /LS**	**360,426**
						13.0 Special Construction	1.00 LS						266,000	266,000.00 /LS	266,000	360,425.56 /LS	360,426
						04.0 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	1.00 LS						266,000	266,000.00 /LS	266,000	360,425.56 /LS	360,426
	10.1					New 24" raw water											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.RW24		New 24" raw water											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	34.00 day		-	-	-	4,085	-	120.15 /day	4,085	203.65 /day	6,924
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	1,316.05 CY	292	20,936	-	-	21,665	-	32.37 /CY	42,601	54.87 /CY	72,209
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	252.91 ecy	98	5,936	-	-	-	-	23.47 /ecy	5,936	39.78 /ecy	10,061
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	962.96 ecy	77	5,593	-	-	1,011	-	6.86 /ecy	6,604	11.62 /ecy	11,194
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	252.91 lcy	40	2,635	5,311	-	467	-	33.27 /lcy	8,414	52.40 /lcy	13,252
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	96.30 lcy	15	1,003	1,743	-	178	-	30.37 /lcy	2,924	48.03 /lcy	4,626
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	353.09 lcy	72	5,157	-	-	7,165	-	34.90 /lcy	12,322	59.15 /lcy	20,885
						31.00.01.01 Trenching, Backfill, and Compaction	1,316.05 CY	596	41,260	7,054		34,572		62.98 /CY	82,886	105.73 /CY	139,150
					33.00.04.24	Buried Pipe, Ductile Iron, 24"											
						24" pipe, DI, RJ, excav/bkfill not included, 350#	1,200.00 LF	432	36,102	189,562	-	20,405	-	205.06 /LF	246,069	317.55 /LF	381,065
						24" DI, RJ, Ell, 45	20.00 ea	170	14,207	52,850	-	8,030	-	3,754.33 /ea	75,087	5,861.44 /ea	117,229
						Megalugs for DI Pipe w/ Accessories, 24"	60.00 ea	120	10,028	28,230	-	5,668	-	732.11 /ea	43,926	1,151.51 /ea	69,091
						Polywrap, 24" pipe	1,200.00 lf		-	1,332	-	-	-	1.11 /lf	1,332	1.67 /lf	2,005
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.73 /ea	6,450
						Add for tie-in to existing, wet tap by subcontractor	1.00 ea		-	-	25,000	-	-	25,000.00 /ea	25,000	37,624.58 /ea	37,625
						Pipe Marking, ID Tape	1,200.00 lf	12	1,003	156	-	-	-	0.97 /lf	1,159	1.61 /lf	1,934
						33.00.04.24 Buried Pipe, Ductile Iron, 24"	1,200.00 LF	758	63,346	272,880	25,000	35,236		330.38 /LF	396,461	512.83 /LF	615,398
						33.00.04.RW24 New 24" raw water	1,200.00 LF	1,354	104,606	279,934	25,000	69,807		399.46 /LF	479,347	628.79 /LF	754,549
						33.02 Buried Process Pipe, Ductile Iron	**1,200.00 LF**	**1,354**	**104,606**	**279,934**	**25,000**	**69,807**		**399.46 /LF**	**479,347**	**628.79 /LF**	**754,549**
						33.0 Utilities	1.00 LS	1,354	104,606	279,934	25,000	69,807		479,347.43 /LS	479,347	754,548.50 /LS	754,549
						10.1 New 24" raw water	1,200.00 LF	1,354	104,606	279,934	25,000	69,807		399.46 /LF	479,347	628.79 /LF	754,549
						5.3A CIP 5 - WTP Replacement, Phase 3A	**1.00 LS**	**2,625**	**192,740**	**305,381**	**25,000**	**158,436**	**266,000**	**947,557.55 /LS**	**947,558**	**1,452,881.81 /LS**	**1,452,882**
5.3B						**CIP 5 - WTP Replacement, Phase 3B**											
	08.1					Rapid Mix											
		13.0				Special Construction											
			13.01			**Buildings Complete**											
				13.01.99.0701		Inline Rapid Mix: New_WTP											
					13.01.99.00	Special Construction, Other											
						Inline Rapid Mix: New_WTP Costs from Replica (Total Costs)	1.00 ls				-	-	789,618	789,618.00 /ls	789,618	1,069,919.20 /ls	1,069,919
						13.01.99.00 Special Construction, Other	1.00 LS						789,618	789,618.00 /LS	789,618	1,069,919.20 /LS	1,069,919
						13.01.99.0701 Inline Rapid Mix: New_WTP	1.00 LS						789,618	789,618.00 /LS	789,618	1,069,919.20 /LS	1,069,919
						13.01 Buildings Complete	**1.00 LS**						**789,618**	**789,618.00 /LS**	**789,618**	**1,069,919.20 /LS**	**1,069,919**
						13.0 Special Construction	1.00 LS						789,618	789,618.00 /LS	789,618	1,069,919.20 /LS	1,069,919
						08.1 Rapid Mix	1.00 LS						789,618	789,618.00 /LS	789,618	1,069,919.20 /LS	1,069,919
	08.2					Flocculation											
		13.0				Special Construction											
			13.01			**Buildings Complete**											
				13.01.99.0702		Flocculation: NewWTP_DAF											
					13.01.99.00	Special Construction, Other											
						Flocculation: NewWTP_DAF Costs from Replica (Total Costs)	1.00 ls				-	-	961,722	961,722.00 /ls	961,722	1,303,117.25 /ls	1,303,117
						13.01.99.00 Special Construction, Other	1.00 LS						961,722	961,722.00 /LS	961,722	1,303,117.25 /LS	1,303,117
						13.01.99.0702 Flocculation: NewWTP_DAF	1.00 LS						961,722	961,722.00 /LS	961,722	1,303,117.25 /LS	1,303,117
						13.01 Buildings Complete	**1.00 LS**						**961,722**	**961,722.00 /LS**	**961,722**	**1,303,117.25 /LS**	**1,303,117**
						13.0 Special Construction	1.00 LS						961,722	961,722.00 /LS	961,722	1,303,117.25 /LS	1,303,117
						08.2 Flocculation	1.00 LS						961,722	961,722.00 /LS	961,722	1,303,117.25 /LS	1,303,117
	08.3					DAF											
		13.0				Special Construction											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
			13.01			**Buildings Complete**											
				13.01.99.0703		DAF: New_WTP											
					13.01.99.00	Special Construction, Other											
						DAF: New_WTP Costs from Replica (Total Costs)	1.00 ls				-	-	3,956,574	3,956,574.00 /ls	3,956,574	5,361,091.73 /ls	5,361,092
						13.01.99.00 Special Construction, Other	*1.00* LS						3,956,574	3,956,574.00 /LS	3,956,574	5,361,091.73 /LS	5,361,092
						13.01.99.0703 DAF: New_WTP	*1.00* LS						3,956,574	3,956,574.00 /LS	3,956,574	5,361,091.73 /LS	5,361,092
						13.01 Buildings Complete	*1.00* **LS**						**3,956,574**	**3,956,574.00 /LS**	**3,956,574**	**5,361,091.73 /LS**	**5,361,092**
						13.0 Special Construction	*1.00* LS						3,956,574	3,956,574.00 /LS	3,956,574	5,361,091.73 /LS	5,361,092
						08.3 DAF	*1.00* LS						3,956,574	3,956,574.00 /LS	3,956,574	5,361,091.73 /LS	5,361,092
	08.4					Filtration											
		13.0				Special Construction											
			13.01			**Buildings Complete**											
				13.01.99.0704		Filters: New_WTP											
					13.01.99.00	Special Construction, Other											
						Filters: New_WTP Costs from Replica (Total Costs)	1.00 ls				-	-	5,594,592	5,594,592.00 /ls	5,594,592	7,580,578.78 /ls	7,580,579
						13.01.99.00 Special Construction, Other	*1.00* LS						5,594,592	5,594,592.00 /LS	5,594,592	7,580,578.78 /LS	7,580,579
						13.01.99.0704 Filters: New_WTP	*1.00* LS						5,594,592	5,594,592.00 /LS	5,594,592	7,580,578.78 /LS	7,580,579
						13.01 Buildings Complete	*1.00* **LS**						**5,594,592**	**5,594,592.00 /LS**	**5,594,592**	**7,580,578.78 /LS**	**7,580,579**
						13.0 Special Construction	*1.00* LS						5,594,592	5,594,592.00 /LS	5,594,592	7,580,578.78 /LS	7,580,579
						08.4 Filtration	*1.00* LS						5,594,592	5,594,592.00 /LS	5,594,592	7,580,578.78 /LS	7,580,579
	08.5					Shoring											
		31.0				Earthwork											
			31.16			**Earthworks, Sheeting/Shoring & Cofferdams**											
				31.16.01.0010		Shoring											
					31.16.01.00	Earthworks, Sheeting and Shoring											
						Shoring, sheet pile, subcontracted	7,590.00 SF	987		-	569,250	-	-	75.00 /SF	569,250	109.12 /SF	828,249
						31.16.01.00 Earthworks, Sheeting and Shoring	7,590.00 SF	987			569,250			75.00 /SF	569,250	109.12 /SF	828,249
						31.16.01.0010 Shoring	7,590.00 SF	987			569,250			75.00 /SF	569,250	109.12 /SF	828,249
						31.16 Earthworks, Sheeting/Shoring & Cofferdams	**7,590.00 SF**	**987**			**569,250**			**75.00 /SF**	**569,250**	**109.12 /SF**	**828,249**
						31.0 Earthwork	*1.00* LS	987			569,250			569,250.00 /LS	569,250	828,249.24 /LS	828,249
						08.5 Shoring	*1.00* LS	987			569,250			569,250.00 /LS	569,250	828,249.24 /LS	828,249
	08.6					Dewatering											
		31.0				Earthwork											
			31.19			**Dewatering and Bypass Pumping**											
				31.15.02.0010		Dewatering											
					31.15.02.00	Site Preparation, Dewatering											
						Dewatering Wellpoints, Complete System, Mob	1.00 ea	24		-	15,000	-	-	15,000.00 /ea	15,000	21,824.75 /ea	21,825
						Dewatering Wellpoints, Complete System, Install	5.00 day	240	15,990	-	-	15,203	-	6,238.62 /day	31,193	10,262.43 /day	51,312
						Dewatering Wellpoints, Complete System, Rental, First Month	1.00 mo		-	-	-	35,000	-	35,000.00 /mo	35,000	57,574.42 /mo	57,574
						Dewatering Wellpoints, Complete System, Rental, after first month, Monthly	23.00 mo		-	-	-	460,000	-	20,000.00 /mo	460,000	32,899.67 /mo	756,692
						Dewatering Wellpoints, Complete System, Operation - Labor to maintain / check pumps/ fuel and lube	24.00 MO	2,160	130,996	-	-	9,975	-	5,873.79 /MO	140,971	9,662.29 /MO	231,895
						Dewatering Wellpoints, Complete System, Removal	5.00 day	240	15,990	-	-	10,431	-	5,284.06 /day	26,420	8,692.19 /day	43,461
						Dewatering Wellpoints, Complete System, Demob	1.00 ea	24		-	10,000	-	-	10,000.00 /ea	10,000	14,549.84 /ea	14,550
						31.15.02.00 Site Preparation, Dewatering	24.00 MO	2,688	162,976		25,000	530,609		29,941.02 /MO	718,584	49,054.56 /MO	1,177,309
						31.15.02.0010 Dewatering	24.00 MO	2,688	162,976		25,000	530,609		29,941.02 /MO	718,584	49,054.56 /MO	1,177,309
						31.19 Dewatering and Bypass Pumping	**24.00 MO**	**2,688**	**162,976**		**25,000**	**530,609**		**29,941.02 /MO**	**718,584**	**49,054.56 /MO**	**1,177,309**
						31.0 Earthwork	*1.00* LS	2,688	162,976		25,000	530,609		718,584.40 /LS	718,584	1,177,309.34 /LS	1,177,309
						08.6 Dewatering	*1.00* LS	2,688	162,976		25,000	530,609		718,584.40 /LS	718,584	1,177,309.34 /LS	1,177,309
	09.0					Construct new treatment chem building											
		13.0				Special Construction											
			13.01			**Buildings Complete**											
				13.00.01.0801		Construct new treatment chem building											
					13.00.01.02	Buildings, Operations											
						Building Complete - Chemical Building	1,584.00 SF				427,680	-	-	270.00 /SF	427,680	406.35 /SF	643,651
						13.00.01.02 Buildings, Operations	1,584.00 SF				427,680			270.00 /SF	427,680	406.35 /SF	643,651
						13.00.01.0801 Construct new treatment chem building	*1.00* LS				427,680			427,680.00 /LS	427,680	643,651.26 /LS	643,651
						13.01 Buildings Complete	*1.00* **LS**				**427,680**			**427,680.00 /LS**	**427,680**	**643,651.26 /LS**	**643,651**
						13.0 Special Construction	*1.00* LS				427,680			427,680.00 /LS	427,680	643,651.26 /LS	643,651
						09.0 Construct new treatment chem building	*1.00* LS				427,680			427,680.00 /LS	427,680	643,651.26 /LS	643,651
	09.1					Coagulant (ACH)											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: ACH - 11 - Equipment	1.00 ls				-	-	55,146	55,146.00 /ls	55,146	74,721.91 /ls	74,722
						11.00.99.00 Equipment, Other	*1.00* LS						55,146	55,146.00 /LS	55,146	74,721.91 /LS	74,722
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						55,146	55,146.00 /LS	55,146	74,721.91 /LS	74,722
						11.00 Equipment	*1.00* **LS**						**55,146**	**55,146.00 /LS**	**55,146**	**74,721.91 /LS**	**74,722**
						11.0 Commercial Equipment	*1.00* LS						55,146	55,146.00 /LS	55,146	74,721.91 /LS	74,722
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: ACH - 16 Electrical	1.00 ls				-	-	112,110	112,110.00 /ls	112,110	151,907.18 /ls	151,907
						26.00.99.00 Electrical, Other	*1.00* LS						112,110	112,110.00 /LS	112,110	151,907.18 /LS	151,907
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						112,110	112,110.00 /LS	112,110	151,907.18 /LS	151,907
						26.00 Electrical	*1.00* **LS**						**112,110**	**112,110.00 /LS**	**112,110**	**151,907.18 /LS**	**151,907**
						26.0 Electrical Work	*1.00* LS						112,110	112,110.00 /LS	112,110	151,907.18 /LS	151,907
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: ACH - 15 Mechanical	1.00 ls				-	-	23,028	23,028.00 /ls	23,028	31,202.56 /ls	31,203
						40.00.99.01 Process Pipe, Other	*1.00* LS						23,028	23,028.00 /LS	23,028	31,202.56 /LS	31,203
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						23,028	23,028.00 /LS	23,028	31,202.56 /LS	31,203
						40.19 Process Pipe, Other	*1.00* **LS**						**23,028**	**23,028.00 /LS**	**23,028**	**31,202.56 /LS**	**31,203**
						40.0 Process Pipe	*1.00* LS						23,028	23,028.00 /LS	23,028	31,202.56 /LS	31,203
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: ACH - 13 Special Construction	1.00 ls				-	-	61,812	61,812.00 /ls	61,812	83,754.23 /ls	83,754

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						40.90.99.01 I&C, Other	1.00 LS						61,812	61,812.00 /LS	61,812	83,754.23 /LS	83,754
						40.90.99.0013 Special Construction from Replica	1.00 LS						61,812	61,812.00 /LS	61,812	83,754.23 /LS	83,754
						40.90 Instrumentation & Controls	**1.00 LS**						**61,812**	**61,812.00 /LS**	**61,812**	**83,754.23 /LS**	**83,754**
						40.9 Instrumentation & Controls	1.00 LS						61,812	61,812.00 /LS	61,812	83,754.23 /LS	83,754
						09.1 Coagulant (ACH)	1.00 LS						252,096	252,096.00 /LS	252,096	341,585.88 /LS	341,586
	09.2					Filter Aid Polymer											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: FilPolymer - 11 - Equipment	1.00 ls				-	-	65,518	65,518.00 /ls	65,518	88,775.79 /ls	88,776
						11.00.99.00 Equipment, Other	1.00 LS						65,518	65,518.00 /LS	65,518	88,775.79 /LS	88,776
						11.00.99.0011 Equipment Costs from Replica	1.00 LS						65,518	65,518.00 /LS	65,518	88,775.79 /LS	88,776
						11.00 Equipment	**1.00 LS**						**65,518**	**65,518.00 /LS**	**65,518**	**88,775.79 /LS**	**88,776**
						11.0 Commercial Equipment	1.00 LS						65,518	65,518.00 /LS	65,518	88,775.79 /LS	88,776
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: FilPolymer - 16 Electrical	1.00 ls				-	-	4,848	4,848.00 /ls	4,848	6,568.96 /ls	6,569
						26.00.99.00 Electrical, Other	1.00 LS						4,848	4,848.00 /LS	4,848	6,568.96 /LS	6,569
						26.00.99.0016 Electrical Costs from Replica	1.00 LS						4,848	4,848.00 /LS	4,848	6,568.96 /LS	6,569
						26.00 Electrical	**1.00 LS**						**4,848**	**4,848.00 /LS**	**4,848**	**6,568.96 /LS**	**6,569**
						26.0 Electrical Work	1.00 LS						4,848	4,848.00 /LS	4,848	6,568.96 /LS	6,569
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: FilPolymer - 15 Mechanical	1.00 ls				-	-	13,332	13,332.00 /ls	13,332	18,064.64 /ls	18,065
						40.00.99.01 Process Pipe, Other	1.00 LS						13,332	13,332.00 /LS	13,332	18,064.64 /LS	18,065
						40.00.99.0015 Mechanical Costs from Replica	1.00 LS						13,332	13,332.00 /LS	13,332	18,064.64 /LS	18,065
						40.19 Process Pipe, Other	**1.00 LS**						**13,332**	**13,332.00 /LS**	**13,332**	**18,064.64 /LS**	**18,065**
						40.0 Process Pipe	1.00 LS						13,332	13,332.00 /LS	13,332	18,064.64 /LS	18,065
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: FilPolymer - 13 Special Construction	1.00 ls				-	-	52,722	52,722.00 /ls	52,722	71,437.43 /ls	71,437
						40.90.99.01 I&C, Other	1.00 LS						52,722	52,722.00 /LS	52,722	71,437.43 /LS	71,437
						40.90.99.0013 Special Construction from Replica	1.00 LS						52,722	52,722.00 /LS	52,722	71,437.43 /LS	71,437
						40.90 Instrumentation & Controls	**1.00 LS**						**52,722**	**52,722.00 /LS**	**52,722**	**71,437.43 /LS**	**71,437**
						40.9 Instrumentation & Controls	1.00 LS						52,722	52,722.00 /LS	52,722	71,437.43 /LS	71,437
						09.2 Filter Aid Polymer	1.00 LS						136,420	136,420.00 /LS	136,420	184,846.82 /LS	184,847
	10.2					New 30" filtered water											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.FW30		30" FW - Finished Water											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	2.00 day		-	-	-	240	-	120.15 /day	240	203.65 /day	407
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	130.00 CY	29	2,068	-	-	2,140	-	32.37 /CY	4,208	54.87 /CY	7,133
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	39.65 ecy	15	931	-	-	-	-	23.47 /ecy	931	39.78 /ecy	1,577
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	72.22 ecy	6	419	-	-	76	-	6.86 /ecy	495	11.62 /ecy	840
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	39.65 lcy	6	413	833	-	73	-	33.27 /lcy	1,319	52.40 /lcy	2,078
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	7.22 lcy	1	75	131	-	13	-	30.37 /lcy	219	48.03 /lcy	347
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	57.78 lcy	12	844	-	-	1,172	-	34.90 /lcy	2,016	59.15 /lcy	3,418
						31.00.01.01 Trenching, Backfill, and Compaction	130.00 CY	69	4,750	963		3,715		72.53 /CY	9,429	121.53 /CY	15,799
					33.00.04.30	Buried Pipe, Ductile Iron, 30"											
						30" pipe, DI, RJ, excav/bkfill not included, 250#	60.00 LF	25	2,106	11,724	-	1,190	-	250.35 /LF	15,021	387.20 /LF	23,232
						30" DI, RJ, Ell, 90	1.00 ea	10	827	6,473	-	468	-	7,767.65 /ea	7,768	11,936.23 /ea	11,936
						Megalugs for DI Pipe w/ Accessories, 30"	4.00 ea	8	669	4,314	-	378	-	1,340.06 /ea	5,360	2,066.46 /ea	8,266
						Polywrap, 30" pipe	60.00 lf		-	79	-	-	-	1.32 /lf	79	1.99 /lf	119
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.71 /ea	6,450
						Pipe Marking, ID Tape	60.00 lf	1	50	8	-	-	-	0.97 /lf	58	1.61 /lf	97
						33.00.04.30 Buried Pipe, Ductile Iron, 30"	60.00 LF	68	5,658	23,348		3,169		536.25 /LF	32,175	835.00 /LF	50,100
						33.00.04.FW30 30" FW - Finished Water	60.00 LF	137	10,408	24,311		6,885		693.40 /LF	41,604	1,098.31 /LF	65,899
						33.02 Buried Process Pipe, Ductile Iron	**60.00 LF**	**137**	**10,408**	**24,311**		**6,885**		**693.40 /LF**	**41,604**	**1,098.31 /LF**	**65,899**
						33.0 Utilities	1.00 LS	137	10,408	24,311		6,885		41,603.95 /LS	41,604	65,898.84 /LS	65,899
						10.2 New 30" filtered water	60.00 LF	137	10,408	24,311		6,885		693.40 /LF	41,604	1,098.31 /LF	65,899
	10.3					New 14" BWS											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.BWS14		New 14" BWS											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	3.00 day		-	-	-	360	-	120.15 /day	360	203.65 /day	611
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	146.71 CY	33	2,334	-	-	2,415	-	32.37 /CY	4,749	54.87 /CY	8,050
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	37.50 ecy	15	880	-	-	-	-	23.47 /ecy	880	39.78 /ecy	1,492
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	95.68 ecy	8	556	-	-	100	-	6.86 /ecy	656	11.62 /ecy	1,112
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	37.50 lcy	6	391	788	-	69	-	33.27 /lcy	1,248	52.40 /lcy	1,965
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	9.57 lcy	2	100	173	-	18	-	30.37 /lcy	291	48.04 /lcy	460
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	51.03 lcy	10	745	-	-	1,035	-	34.90 /lcy	1,781	59.15 /lcy	3,018
						31.00.01.01 Trenching, Backfill, and Compaction	146.71 CY	73	5,005	961		3,999		67.92 /CY	9,965	113.88 /CY	16,708
					33.00.04.14	Buried Pipe, Ductile Iron, 14"											
						14" pipe, DI, RJ, excav/bkfill not included, 350#	100.00 LF	27	2,256	7,235	-	1,275	-	107.67 /LF	10,767	168.75 /LF	16,875
						14" DI, RJ, Ell, 45	1.00 ea	5	443	1,026	-	250	-	1,719.25 /ea	1,719	2,719.15 /ea	2,719
						Megalugs for DI Pipe w/ Accessories, 14"	4.00 ea	6	501	624	-	283	-	352.11 /ea	1,408	567.19 /ea	2,269
						Polywrap, 14" pipe	100.00 lf		-	59	-	-	-	0.59 /lf	59	0.89 /lf	89
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.71 /ea	6,450
						Pipe Marking, ID Tape	100.00 lf	1	84	13	-	-	-	0.97 /lf	97	1.61 /lf	161
						33.00.04.14 Buried Pipe, Ductile Iron, 14"	100.00 LF	63	5,290	9,707		2,943		179.39 /LF	17,939	285.63 /LF	28,563
						33.00.04.BWS14 New 14" BWS	100.00 LF	136	10,295	10,668		6,941		279.04 /LF	27,904	452.70 /LF	45,270
						33.02 Buried Process Pipe, Ductile Iron	**100.00 LF**	**136**	**10,295**	**10,668**		**6,941**		**279.04 /LF**	**27,904**	**452.70 /LF**	**45,270**

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						33.0 Utilities	1.00 LS	136	10,295	10,668		6,941		27,904.13 /LS	27,904	45,270.20 /LS	45,270
						10.3 New 14" BWS	100.00 LF	136	10,295	10,668		6,941		279.04 /LF	27,904	452.70 /LF	45,270
	11.1					BW EQ Basin											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.01.99.1101		Surge Basin-Decanter: BW_EQ											
					13.01.99.00	Special Construction, Other											
						Surge Basin-Decanter: BW_EQ (Cost from RPD_Residuals Replica Cost Estimate)	1.00 ls				-	-	1,044,000	1,044,000.00 /ls	1,044,000	1,414,602.58 /ls	1,414,603
						13.01.99.00 Special Construction, Other	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,602.58 /LS	1,414,603
						13.01.99.1101 Surge Basin-Decanter: BW_EQ	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,602.58 /LS	1,414,603
						13.01 Buildings Complete	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,602.58 /LS	1,414,603
						13.0 Special Construction	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,602.58 /LS	1,414,603
						11.1 BW EQ Basin	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,602.58 /LS	1,414,603
	11.2					BW Clarifier											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.01.99.1102		Package WTP: BW_Clar											
					13.01.99.00	Special Construction, Other											
						Package WTP: BW_Clar (Cost from RPD_Residuals Replica Cost Estimate)	1.00 ls				-	-	717,000	717,000.00 /ls	717,000	971,523.03 /ls	971,523
						13.01.99.00 Special Construction, Other	1.00 LS						717,000	717,000.00 /LS	717,000	971,523.03 /LS	971,523
						13.01.99.1102 Package WTP: BW_Clar	1.00 LS						717,000	717,000.00 /LS	717,000	971,523.03 /LS	971,523
						13.01 Buildings Complete	1.00 LS						717,000	717,000.00 /LS	717,000	971,523.03 /LS	971,523
						13.0 Special Construction	1.00 LS						717,000	717,000.00 /LS	717,000	971,523.03 /LS	971,523
						11.2 BW Clarifier	1.00 LS						717,000	717,000.00 /LS	717,000	971,523.03 /LS	971,523
	11.3					Engineered Drying Beds											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.01.99.1104		Sludge Drying Beds: New											
					13.01.99.00	Special Construction, Other											
						Sludge Drying Beds: New (Cost from RPD_Residuals Replica Cost Estimate)	1.00 ls				-	-	1,022,000	1,022,000.00 /ls	1,022,000	1,384,792.94 /ls	1,384,793
						13.01.99.00 Special Construction, Other	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,792.94 /LS	1,384,793
						13.01.99.1104 Sludge Drying Beds: New	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,792.94 /LS	1,384,793
						13.01 Buildings Complete	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,792.94 /LS	1,384,793
						13.0 Special Construction	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,792.94 /LS	1,384,793
						11.3 Engineered Drying Beds	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,792.94 /LS	1,384,793
	11.4					EDB Recycle Pump Station											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.01.99.1105		WPSPS: Recycle											
					13.01.99.00	Special Construction, Other											
						WPSPS: Recycle (Cost from RPD_Residuals Replica Cost Estimate)	1.00 ls				-	-	429,000	429,000.00 /ls	429,000	581,287.84 /ls	581,288
						13.01.99.00 Special Construction, Other	1.00 LS						429,000	429,000.00 /LS	429,000	581,287.84 /LS	581,288
						13.01.99.1105 WPSPS: Recycle	1.00 LS						429,000	429,000.00 /LS	429,000	581,287.84 /LS	581,288
						13.01 Buildings Complete	1.00 LS						429,000	429,000.00 /LS	429,000	581,287.84 /LS	581,288
						13.0 Special Construction	1.00 LS						429,000	429,000.00 /LS	429,000	581,287.84 /LS	581,288
						11.4 EDB Recycle Pump Station	1.00 LS						429,000	429,000.00 /LS	429,000	581,287.84 /LS	581,288
	12.1					20" BWW & FTW											
		33.0				Utilities											
			33.02			Buried Process Pipe, Ductile Iron											
				33.00.04.BWWFTW20		20" BWW & FTW											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	5.00 day		-	-	-	601	-	120.15 /day	601	203.65 /day	1,018
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	102.84 CY	23	1,636	-	-	1,693	-	32.37 /CY	3,329	54.87 /CY	5,643
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	28.73 ecy	11	674	-	-	-	-	23.47 /ecy	674	39.78 /ecy	1,143
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	62.96 ecy	5	366	-	-	66	-	6.86 /ecy	432	11.62 /ecy	732
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	28.73 lcy	5	299	603	-	53	-	33.27 /lcy	956	52.40 /lcy	1,505
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	6.30 lcy	1	66	114	-	12	-	30.37 /lcy	191	48.03 /lcy	303
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	39.88 lcy	8	582	-	-	809	-	34.90 /lcy	1,392	59.15 /lcy	2,359
						31.00.01.01 Trenching, Backfill, and Compaction	102.84 CY	53	3,623	717		3,234		73.65 /CY	7,575	123.52 /CY	12,702
					33.00.04.20	Buried Pipe, Ductile Iron, 20"											
						20" pipe, DI, RJ, excav/bkfill not included, 350#	60.00 LF	20	1,655	7,042	-	935	-	160.53 /LF	9,632	249.79 /LF	14,987
						20" DI, RJ, Ell, 45	4.00 ea	29	2,407	7,653	-	1,360	-	2,855.08 /ea	11,420	4,475.79 /ea	17,903
						Megalugs for DI Pipe w/ Accessories, 20"	8.00 ea	12	1,003	2,779	-	567	-	543.61 /ea	4,349	855.39 /ea	6,843
						Polywrap, 20" pipe	60.00 lf		-	52	-	-	-	0.87 /lf	52	1.31 /lf	79
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.72 /ea	6,450
						Pipe Marking, ID Tape	60.00 lf	1	50	8	-	-	-	0.97 /lf	58	1.61 /lf	97
						33.00.04.20 Buried Pipe, Ductile Iron, 20"	60.00 LF	85	7,120	18,284		3,996		490.00 /LF	29,400	772.64 /LF	46,359
						33.00.04.BWWFTW20 20" BWW & FTW	60.00 LF	138	10,744	19,001		7,230		616.24 /LF	36,975	984.35 /LF	59,061
						33.02 Buried Process Pipe, Ductile Iron	60.00 LF	138	10,744	19,001		7,230		616.24 /LF	36,975	984.35 /LF	59,061
						33.0 Utilities	1.00 LS	138	10,744	19,001		7,230		36,974.62 /LS	36,975	59,061.11 /LS	59,061
						12.1 20" BWW & FTW	60.00 LF	138	10,744	19,001		7,230		616.24 /LF	36,975	984.35 /LF	59,061
	12.2					04" BWW & FTW											
		33.0				Utilities											
			33.02			Buried Process Pipe, Ductile Iron											
				33.00.04.BWWFTW04		04" BWW & FTW											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	5.00 day		-	-	-	601	-	120.15 /day	601	203.65 /day	1,018
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	339.98 CY	76	5,409	-	-	5,597	-	32.37 /CY	11,005	54.87 /CY	18,654
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	65.34 ecy	25	1,533	-	-	-	-	23.47 /ecy	1,533	39.78 /ecy	2,599
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	248.77 ecy	20	1,445	-	-	261	-	6.86 /ecy	1,706	11.62 /ecy	2,892
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	65.34 lcy	10	681	1,372	-	121	-	33.27 /lcy	2,174	52.40 /lcy	3,424
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	24.88 lcy	4	259	450	-	46	-	30.37 /lcy	756	48.03 /lcy	1,195
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	91.21 lcy	19	1,332	-	-	1,851	-	34.90 /lcy	3,183	59.15 /lcy	5,395
						31.00.01.01 Trenching, Backfill, and Compaction	339.98 CY	154	10,659	1,822		8,476		61.64 /CY	20,958	103.47 /CY	35,177
					33.00.04.04	Buried Pipe, Ductile Iron, 4"											
						4" pipe, DI, RJ, excav/bkfill not included, 350#	20.00 LF	3	254	554	-	123	-	46.53 /LF	931	73.61 /LF	1,472
						4" DI, RJ, Ell, 45	4.00 ea	8	643	734	-	312	-	422.04 /ea	1,688	680.48 /ea	2,722
						Megalugs for DI Pipe w/ Accessories, 4"	8.00 ea	8	676	302	-	328	-	163.30 /ea	1,306	269.61 /ea	2,157
						Polywrap, 4" pipe	20.00 lf		-	6	-	-	-	0.32 /lf	6	0.48 /lf	10
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.70 /ea	6,450

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Detail Report
Project Name: The Dalles WTP - 9.5mgd DAF
Project Number: D3718900
Design Stage: ROM

Estimator: Jones T
Rev No. / Data: R04 - 09/11/2024
Class Estimate: Class 5

Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
					33.00.04.04	Buried Pipe, Ductile Iron, 4"											
						Pipe Marking, ID Tape	20.00 lf	0	17	3	-	-	-	0.97 /lf	19	1.61 /lf	32
						33.00.04.04 Buried Pipe, Ductile Iron, 4"	20.00 LF	43	3,595	2,349		1,896		392.01 /LF	7,840	642.13 /LF	12,843
						33.00.04.BWWFTW04 04" BWW & FTW	20.00 LF	197	14,254	4,172		10,373		1,439.90 /LF	28,798	2,400.98 /LF	48,020
						33.02 Buried Process Pipe, Ductile Iron	**20.00 LF**	**197**	**14,254**	**4,172**		**10,373**		**1,439.90 /LF**	**28,798**	**2,400.98 /LF**	**48,020**
						33.0 Utilities	*1.00* LS	197	14,254	4,172		10,373		28,798.07 /LS	28,798	48,019.67 /LS	48,020
						12.2 04" BWW & FTW	20.00 LF	197	14,254	4,172		10,373		1,439.90 /LF	28,798	2,400.98 /LF	48,020
	12.3					04" Combined Recycle BW & EDB											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.BWEDB04		04" Combined Recycle BW & EDB											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	5.00 day		-	-	-	601	-	120.15 /day	601	203.65 /day	1,018
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	21.93 CY	5	349	-	-	361	-	32.37 /CY	710	54.87 /CY	1,203
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	4.22 ecy	2	99	-	-	-	-	23.47 /ecy	99	39.78 /ecy	168
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	16.05 ecy	1	93	-	-	17	-	6.86 /ecy	110	11.62 /ecy	187
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	4.22 lcy	1	44	89	-	8	-	33.27 /lcy	140	52.40 /lcy	221
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	1.60 lcy	0	17	29	-	3	-	30.37 /lcy	49	48.04 /lcy	77
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	5.88 lcy	1	86	-	-	119	-	34.90 /lcy	205	59.15 /lcy	348
						31.00.01.01 Trenching, Backfill, and Compaction	21.93 CY	10	688	118		1,109		87.27 /CY	1,914	146.91 /CY	3,222
					33.00.04.04	Buried Pipe, Ductile Iron, 4"											
						4" pipe, DI, RJ, excav/bkfill not included, 350#	310.00 LF	47	3,931	8,588	-	1,907	-	46.53 /LF	14,426	73.61 /LF	22,819
						4" DI, RJ, Ell, 45	8.00 ea	15	1,285	1,468	-	623	-	422.04 /ea	3,376	680.48 /ea	5,444
						Megalugs for DI Pipe w/ Accessories, 4"	16.00 ea	16	1,353	604	-	656	-	163.30 /ea	2,613	269.61 /ea	4,314
						Polywrap, 4" pipe	310.00 lf		-	99	-	-	-	0.32 /lf	99	0.48 /lf	149
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.72 /ea	6,450
						Pipe Marking, ID Tape	310.00 lf	3	259	40	-	-	-	0.97 /lf	299	1.61 /lf	500
						33.00.04.04 Buried Pipe, Ductile Iron, 4"	310.00 LF	105	8,834	11,549		4,319		79.68 /LF	24,702	127.99 /LF	39,676
						33.00.04.BWEDB04 04" Combined Recycle BW & EDB	310.00 LF	115	9,522	11,667		5,428		85.86 /LF	26,616	138.38 /LF	42,897
						33.02 Buried Process Pipe, Ductile Iron	**310.00 LF**	**115**	**9,522**	**11,667**		**5,428**		**85.86 /LF**	**26,616**	**138.38 /LF**	**42,897**
						33.0 Utilities	*1.00* LS	115	9,522	11,667		5,428		26,616.26 /LS	26,616	42,897.43 /LS	42,897
						12.3 04" Combined Recycle BW & EDB	310.00 LF	115	9,522	11,667		5,428		85.86 /LF	26,616	138.38 /LF	42,897
	90.2					Sitework/Site Electrical/Yard Piping/SCADA Allowance											
		26.0				Electrical Work											
			26.10			**Site Electrical**											
				26.10.20.0010		Site Electrical Allowance											
					26.10.20.00	Site Electrical, Other											
						Site Electrical Allowance (~15% of Construction Costs)	1.00 ls				-	-	2,160,000	2,160,000.00 /ls	2,160,000	2,926,763.95 /ls	2,926,764
						26.10.20.00 Site Electrical, Other	*1.00* LS						2,160,000	2,160,000.00 /LS	2,160,000	2,926,763.95 /LS	2,926,764
						26.10.20.0010 Site Electrical Allowance	*1.00* LS						2,160,000	2,160,000.00 /LS	2,160,000	2,926,763.95 /LS	2,926,764
						26.10 Site Electrical	*1.00* LS						2,160,000	2,160,000.00 /LS	2,160,000	2,926,763.95 /LS	2,926,764
						26.0 Electrical Work	*1.00* LS						2,160,000	2,160,000.00 /LS	2,160,000	2,926,763.95 /LS	2,926,764
		31.0				Earthwork											
			31.00			**Site/Civil General Items**											
				31.00.01.0010		Sitework Allowance											
					31.00.01.00	Site/Civil, General Conditions											
						Sitework Allowance (~6% construction costs)	1.00 ls						865,000	865,000.00 /ls	865,000	1,172,060.56 /ls	1,172,061
						31.00.01.00 Site/Civil, General Conditions	*1.00* LS						865,000	865,000.00 /LS	865,000	1,172,060.56 /LS	1,172,061
						31.00.01.0010 Sitework Allowance	*1.00* LS						865,000	865,000.00 /LS	865,000	1,172,060.56 /LS	1,172,061
						31.00 Site/Civil General Items	*1.00* LS						865,000	865,000.00 /LS	865,000	1,172,060.56 /LS	1,172,061
						31.0 Earthwork	*1.00* LS						865,000	865,000.00 /LS	865,000	1,172,060.56 /LS	1,172,061
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.07.0010		Plant Computer System (SCADA allowance)											
					40.90.07.01	I&C, SCADA											
						SCADA Software Development (~6% of Constuction Costs)	1.00 ls						865,000	865,000.00 /ls	865,000	1,172,060.56 /ls	1,172,061
						40.90.07.01 I&C, SCADA	*1.00* LS						865,000	865,000.00 /LS	865,000	1,172,060.56 /LS	1,172,061
						40.90.07.0010 Plant Computer System (SCADA allowance)	*1.00* LS						865,000	865,000.00 /LS	865,000	1,172,060.56 /LS	1,172,061
						40.90 Instrumentation & Controls	*1.00* LS						865,000	865,000.00 /LS	865,000	1,172,060.56 /LS	1,172,061
						40.9 Instrumentation & Controls	*1.00* LS						865,000	865,000.00 /LS	865,000	1,172,060.56 /LS	1,172,061
						90.2 Sitework/Site Electrical/Yard Piping/SCADA Allowance	*1.00* LS						3,890,000	3,890,000.00 /LS	3,890,000	5,270,885.07 /LS	5,270,885
						5.3B CIP 5 - WTP Replacement, Phase 3B	*1.00* LS	4,397	218,198	69,818	1,021,930	567,465	18,793,022	20,670,433.43 /LS	20,670,433	28,374,588.21 /LS	28,374,588

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Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	1,296,639		######## hrs	
Material	1,164,240			
Subcontract	1,992,880			
Equipment	1,410,080		######## hrs	
Other	26,724,938			
Subtotal Raw Costs	32,588,777	32,588,777		
Location Adj. Factor	108,269			4.000 %
Productivity Adjustment	406,008			15.000 %
Subtotal Adj. Factors	514,277	33,103,054		
Escalation CIP 1 - April 2025	15,504			1.989 %
Escalation CIP 2 - April 2026				4.947 %
Escalation CIP 3 - January 2028	413,630			10.346 %
Escalation CIP 4 - August 2029	957,239			15.456 %
Escalation CIP 5 - November 2031	5,000,025			23.129 %
Subtotal Escalation	6,386,398	39,489,452		
Existing Conditions I,OH&P	108,735			15.000 %
Concrete Work I,OH&P				
Masonry Work I,OH&P				15.000 %
Metals Work I,OH&P				15.000 %
Architectural (Div 6-12)I,OH&P				15.000 %
Special Construction I,OH&P	205,295			15.000 %
Conveying Equipment I,OH&P				15.000 %
Mechanical Work I,OH&P				20.000 %
Electrical Work I,OH&P	13,750			25.000 %
Site/Civil I,OH&P	128,783			10.000 %
Buried Piping I,OH&P	364,121			15.000 %
Tank Construction I,OH&P				20.000 %
Process Piping I,OH&P				25.000 %
Instruments & Controls I,OH&P				18.000 %
Material Handling I,OH&P				10.000 %
Process Equipment I,OH&P				15.000 %
Subtotal Subcontractor I,OH&P	820,684	40,310,136		
Total Cost To Prime Contractor		40,310,136		
General Conditions	4,031,014			10.000 %
Subtotal Indirect Costs	4,031,014	44,341,150		
Prime Contractor Home OfficeOH	5,320,938			12.000 %
Prime Contractor Profit	4,434,115			10.000 %
Mobilization/Demobilization	1,330,235			3.000 %
Subtotal OH&P	11,085,288	55,426,438		
Design Contingency	16,627,931			30.000 %
Subtotal Contingency	16,627,931	72,054,369		
Total Prime Contractor Costs		72,054,369		
Total		***72,054,369***		

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WTP Alternative B:
Plate Settlers with GMF Cost Estimate

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Detail Report
Project Name: The Dalles WTP - 9.5mgd Sed
Project Number: D3718900
Design Stage: ROM

Estimator: Jones T
Rev No. / Data: R03 - 08/13/2024
Class Estimate: Class 5

Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
1.00						CIP 1 - Short Term Wicks WTP Improvements											
	04.0					Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.00.01.0400		Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor											
					13.01.99.00	Special Construction, Other											
						Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	1.00 ls					-	59,500	59,500.00 /ls	59,500	68,033.10 /ls	68,033
						13.01.99.00 Special Construction, Other	*1.00* LS						59,500	59,500.00 /LS	59,500	68,033.10 /LS	68,033
						13.00.01.0400 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	*1.00* LS						59,500	59,500.00 /LS	59,500	68,033.10 /LS	68,033
						13.01 Buildings Complete	*1.00* LS						59,500	59,500.00 /LS	59,500	68,033.10 /LS	68,033
						13.0 Special Construction	*1.00* LS						59,500	59,500.00 /LS	59,500	68,033.10 /LS	68,033
						04.0 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	*1.00* LS						59,500	59,500.00 /LS	59,500	68,033.10 /LS	68,033
	04.1					Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.00.01.0410		Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers											
					13.01.99.00	Special Construction, Other											
						Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers	1.00 ls					-	720,000	720,000.00 /ls	720,000	823,257.60 /ls	823,258
						13.01.99.00 Special Construction, Other	*1.00* LS						720,000	720,000.00 /LS	720,000	823,257.60 /LS	823,258
						13.00.01.0410 Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers	*1.00* LS						720,000	720,000.00 /LS	720,000	823,257.60 /LS	823,258
						13.01 Buildings Complete	*1.00* LS						720,000	720,000.00 /LS	720,000	823,257.60 /LS	823,258
						13.0 Special Construction	*1.00* LS						720,000	720,000.00 /LS	720,000	823,257.60 /LS	823,258
						04.1 Demo Sed Basin Covers, Repair Sed Basin Walls, Replace Plate Settlers	*1.00* LS						720,000	720,000.00 /LS	720,000	823,257.60 /LS	823,258
						1.00 CIP 1 - Short Term Wicks WTP Improvements	*1.00* LS						779,500	779,500.00 /LS	779,500	891,290.70 /LS	891,291
3.1A						CIP 3 - WTP Replacement, Phase 1A											
	00.5					Improvements to existing Wicks WTP											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.00.01.0400		Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor											
					13.01.99.00	Special Construction, Other											
						Improvements to existing Wicks WTP	1.00 ls					-	1,377,000	1,377,000.00 /ls	1,377,000	1,689,556.06 /ls	1,689,556
						13.01.99.00 Special Construction, Other	*1.00* LS						1,377,000	1,377,000.00 /LS	1,377,000	1,689,556.06 /LS	1,689,556
						13.00.01.0400 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	*1.00* LS						1,377,000	1,377,000.00 /LS	1,377,000	1,689,556.06 /LS	1,689,556
						13.01 Buildings Complete	*1.00* LS						1,377,000	1,377,000.00 /LS	1,377,000	1,689,556.06 /LS	1,689,556
						13.0 Special Construction	*1.00* LS						1,377,000	1,377,000.00 /LS	1,377,000	1,689,556.06 /LS	1,689,556
						00.5 Improvements to existing Wicks WTP	*1.00* LS						1,377,000	1,377,000.00 /LS	1,377,000	1,689,556.06 /LS	1,689,556
	02.1					Install temporary generator											
		26.0				Electrical Work											
			26.00			Electrical											
				26.25.07.0010		Generator w/ Enclosure											
					26.25.07.02	Electrical Equipment, Generators - >100 to 200 KW											
						Electrical Wiring and Conduit Allowance	1.00 ls				5,000	-	-	5,000.00 /ls	5,000	7,384.92 /ls	7,385
						Generator Enclosure	1.00 ea	16	1,321	10,000	-	-	-	11,321.14 /ea	11,321	16,972.17 /ea	16,972
						Generator set,diesel,3 phase 4 wire,277/480 v,125 kw,incl battery,charger,muffler,automatic transfer switch&day tank,excl conduit,wiring,& concrete	1.00 ea	69	5,714	32,300	-	665	-	38,679.24 /ea	38,679	58,340.65 /ea	58,341
						26.25.07.02 Electrical Equipment, Generators - >100 to 200 KW	*1.00* LS	85	7,035	42,300	5,000	665		55,000.38 /LS	55,000	82,697.74 /LS	82,698
						26.25.07.0010 Generator w/ Enclosure	*1.00* LS	85	7,035	42,300	5,000	665		55,000.38 /LS	55,000	82,697.74 /LS	82,698
						26.00 Electrical	*1.00* LS	85	7,035	42,300	5,000	665		55,000.38 /LS	55,000	82,697.74 /LS	82,698
						26.0 Electrical Work	*1.00* LS	85	7,035	42,300	5,000	665		55,000.38 /LS	55,000	82,697.74 /LS	82,698
						02.1 Install temporary generator	*1.00* LS	85	7,035	42,300	5,000	665		55,000.38 /LS	55,000	82,697.74 /LS	82,698
	02.2					Reroute electrical feed to Wicks WTP											
		26.0				Electrical Work											
			26.10			Site Electrical											
				26.10.20.0010		Site Electrical Allowance											
					26.10.20.00	Site Electrical, Other											
						Site Electrical Allowance (~15% of Construction Costs)	1.00 ls				-	-	214,800	214,800.00 /ls	214,800	263,556.02 /ls	263,556
						26.10.20.00 Site Electrical, Other	*1.00* LS						214,800	214,800.00 /LS	214,800	263,556.02 /LS	263,556
						26.10.20.0010 Site Electrical Allowance	*1.00* LS						214,800	214,800.00 /LS	214,800	263,556.02 /LS	263,556
						26.10 Site Electrical	*1.00* LS						214,800	214,800.00 /LS	214,800	263,556.02 /LS	263,556
						26.0 Electrical Work	*1.00* LS						214,800	214,800.00 /LS	214,800	263,556.02 /LS	263,556
						02.2 Reroute electrical feed to Wicks WTP	*1.00* LS						214,800	214,800.00 /LS	214,800	263,556.02 /LS	263,556
						3.1A CIP 3 - WTP Replacement, Phase 1A	*1.00* LS	85	7,035	42,300	5,000	665	1,591,800	1,646,800.38 /LS	1,646,800	2,035,809.82 /LS	2,035,810
3.1B						CIP 3 - WTP Replacement, Phase 1B											
	01.1					Demolition - Plumbing Building											
		02.0				Existing Conditions											
			02.40			Demolition											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	25.00 CY	35	2,462		-	1,875	-	173.50 /CY	4,337	271.86 /CY	6,797
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	25.00 CY	35	2,462			1,875		173.50 /CY	4,337	271.86 /CY	6,797
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	2.50 CY	6	410		-	313	-	289.16 /CY	723	453.11 /CY	1,133
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	2.50 CY	6	410			313		289.16 /CY	723	453.11 /CY	1,133
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	60.00 ton		-	1,800	-	-	-	30.00 /ton	1,800	41.31 /ton	2,479
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	3.00 LD	6	427		-	536	-	321.06 /LD	963	503.09 /LD	1,509
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	3.00 LD	6	427	1,800		536		921.06 /LD	2,763	1,329.28 /LD	3,988
						02.01.02.0010 Demo Strucutral Concrete	27.50 CY	47	3,300	1,800		2,724		284.49 /CY	7,823	433.35 /CY	11,917
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	640.00 SF	205	14,183	-	-	16,364	-	47.73 /SF	30,546	74.79 /SF	47,866
						02.01.02.00 Sturcture/Building Demoltion	640.00 SF	205	14,183			16,364		47.73 /SF	30,546	74.79 /SF	47,866
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	140.00 ton		-	4,200	-	-	-	30.00 /ton	4,200	41.31 /ton	5,783
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	7.00 LD	14	997		-	1,251	-	321.06 /LD	2,247	503.09 /LD	3,522
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	7.00 LD	14	997	4,200		1,251		921.06 /LD	6,447	1,329.28 /LD	9,305
						02.01.02.0070 Misc. Demolition	*1.00* LS	219	15,179	4,200		17,614		36,993.88 /LS	36,994	57,170.80 /LS	57,171
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	8.00 hr	40	2,729		-	1,383	-	514.10 /hr	4,113	805.58 /hr	6,445

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						02.01.06.01 Electrical Facility Demolition	*1.00* LS	40	2,729			1,383		4,112.78 /LS	4,113	6,444.65 /LS	6,445
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	10.00 ton		-	300	-	-	-	30.00 /ton	300	41.31 /ton	413
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.50 LD	1	71	-	-	89	-	321.06 /LD	161	503.08 /LD	252
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.50 LD	1	71	300		89		921.06 /LD	461	1,329.28 /LD	665
						02.01.06.0010 Electrical Demolition	*1.00* LS	41	2,801	300		1,473		4,573.31 /LS	4,573	7,109.29 /LS	7,109
						02.40 Demolition	*1.00* **LS**	**307**	**21,280**	**6,300**		**21,811**		**49,390.65 /LS**	**49,391**	**76,197.31 /LS**	**76,197**
						02.0 Existing Conditions	*1.00* LS	307	21,280	6,300		21,811		49,390.65 /LS	49,391	76,197.31 /LS	76,197
						01.1 Demolition - Plumbing Building	*1.00* LS	307	21,280	6,300		21,811		49,390.65 /LS	49,391	76,197.31 /LS	76,197
	01.2					Demolition - Covered storage area											
		02.0				Existing Conditions											
			02.40			**Demolition**											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	33.20 CY	46	3,270		-	2,490	-	173.50 /CY	5,761	271.86 /CY	9,027
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	33.20 CY	46	3,270			2,490		173.50 /CY	5,761	271.86 /CY	9,027
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	3.32 CY	8	545		-	415	-	289.16 /CY	960	453.11 /CY	1,504
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	3.32 CY	8	545			415		289.16 /CY	960	453.11 /CY	1,504
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	79.69 ton		-	2,391	-	-	-	30.00 /ton	2,391	41.31 /ton	3,292
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	3.98 LD	8	567		-	712	-	321.06 /LD	1,279	503.09 /LD	2,004
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	3.98 LD	8	567	2,391		712		921.11 /LD	3,670	1,329.35 /LD	5,296
						02.01.02.0010 Demo Strucutral Concrete	36.52 CY	62	4,383	2,391		3,617		284.49 /CY	10,390	433.35 /CY	15,827
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	850.00 SF	272	18,836	-	-	21,733	-	47.73 /SF	40,569	74.79 /SF	63,572
						02.01.02.00 Sturcture/Building Demoltion	850.00 SF	272	18,836			21,733		47.73 /SF	40,569	74.79 /SF	63,572
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	185.94 ton		-	5,578	-	-	-	30.00 /ton	5,578	41.31 /ton	7,681
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	9.30 LD	19	1,324		-	1,661	-	321.06 /LD	2,985	503.09 /LD	4,677
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	9.30 LD	19	1,324	5,578		1,661		921.05 /LD	8,563	1,329.27 /LD	12,358
						02.01.02.0070 Misc. Demolition	*1.00* LS	291	20,160	5,578		23,394		49,132.37 /LS	49,132	75,929.77 /LS	75,930
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	10.63 hr	53	3,625		-	1,837	-	514.10 /hr	5,462	805.58 /hr	8,559
						02.01.06.01 Electrical Facility Demolition	*1.00* LS	53	3,625			1,837		5,462.28 /LS	5,462	8,559.30 /LS	8,559
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	13.28 ton		-	398	-	-	-	30.00 /ton	398	41.31 /ton	549
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.66 LD	1	95		-	119	-	321.05 /LD	213	503.07 /LD	334
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.66 LD	1	95	398		119		921.10 /LD	612	1,329.34 /LD	883
						02.01.06.0010 Electrical Demolition	*1.00* LS	54	3,719	398		1,956		6,073.89 /LS	6,074	9,441.98 /LS	9,442
						02.40 Demolition	*1.00* **LS**	**407**	**28,262**	**8,367**		**28,967**		**65,596.54 /LS**	**65,597**	**101,198.93 /LS**	**101,199**
						02.0 Existing Conditions	*1.00* LS	407	28,262	8,367		28,967		65,596.54 /LS	65,597	101,198.93 /LS	101,199
						01.2 Demolition - Covered storage area	*1.00* LS	407	28,262	8,367		28,967		65,596.54 /LS	65,597	101,198.93 /LS	101,199
	01.3					Demolition - Wicks House											
		02.0				Existing Conditions											
			02.40			**Demolition**											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	93.75 CY	131	9,234		-	7,032	-	173.50 /CY	16,265	271.86 /CY	25,487
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	93.75 CY	131	9,234			7,032		173.50 /CY	16,265	271.86 /CY	25,487
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	9.38 CY	22	1,539		-	1,172	-	289.16 /CY	2,711	453.11 /CY	4,248
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	9.38 CY	22	1,539			1,172		289.16 /CY	2,711	453.11 /CY	4,248
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	225.00 ton		-	6,750	-	-	-	30.00 /ton	6,750	41.31 /ton	9,295
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	11.25 LD	23	1,602		-	2,010	-	321.06 /LD	3,612	503.09 /LD	5,660
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	11.25 LD	23	1,602	6,750		2,010		921.06 /LD	10,362	1,329.28 /LD	14,954
						02.01.02.0010 Demo Strucutral Concrete	103.13 CY	176	12,374	6,750		10,214		284.49 /CY	29,338	433.35 /CY	44,690
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	2,400.00 SF	768	53,185	-	-	61,364	-	47.73 /SF	114,549	74.79 /SF	179,497
						02.01.02.00 Sturcture/Building Demoltion	2,400.00 SF	768	53,185			61,364		47.73 /SF	114,549	74.79 /SF	179,497
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	525.00 ton		-	15,750	-	-	-	30.00 /ton	15,750	41.31 /ton	21,687
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	26.25 LD	53	3,738		-	4,690	-	321.06 /LD	8,428	503.09 /LD	13,206
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	26.25 LD	53	3,738	15,750		4,690		921.06 /LD	24,178	1,329.28 /LD	34,894
						02.01.02.0070 Misc. Demolition	*1.00* LS	821	56,923	15,750		66,054		138,727.04 /LS	138,727	214,390.46 /LS	214,390
				02.01.04.40		HVAC Demolition											
					02.01.04.40	HVAC Demolition											
						HVAC Demolition - Med Crew	30.00 hr	150	10,235		-	5,188	-	514.10 /hr	15,423	805.58 /hr	24,167
						02.01.04.40 HVAC Demolition	*1.00* LS	150	10,235			5,188		15,422.91 /LS	15,423	24,167.44 /LS	24,167
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	37.50 ton		-	1,125	-	-	-	30.00 /ton	1,125	41.31 /ton	1,549
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.88 LD	4	267		-	335	-	321.06 /LD	602	503.09 /LD	943
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	1.88 LD	4	267	1,125		335		921.06 /LD	1,727	1,329.27 /LD	2,492
						02.01.04.40 HVAC Demolition	*1.00* LS	154	10,502	1,125		5,523		17,149.89 /LS	17,150	26,659.83 /LS	26,660
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	30.00 hr	150	10,235		-	5,188	-	514.10 /hr	15,423	805.58 /hr	24,167
						02.01.06.01 Electrical Facility Demolition	*1.00* LS	150	10,235			5,188		15,422.91 /LS	15,423	24,167.45 /LS	24,167
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	37.50 ton		-	1,125	-	-	-	30.00 /ton	1,125	41.31 /ton	1,549
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.88 LD	4	267		-	335	-	321.06 /LD	602	503.09 /LD	943
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	1.88 LD	4	267	1,125		335		921.06 /LD	1,727	1,329.28 /LD	2,492
						02.01.06.0010 Electrical Demolition	*1.00* LS	154	10,502	1,125		5,523		17,149.89 /LS	17,150	26,659.85 /LS	26,660
						02.40 Demolition	*1.00* **LS**	**1,304**	**90,302**	**24,750**		**87,313**		**202,364.78 /LS**	**202,365**	**312,399.74 /LS**	**312,400**
						02.0 Existing Conditions	*1.00* LS	1,304	90,302	24,750		87,313		202,364.78 /LS	202,365	312,399.74 /LS	312,400
						01.3 Demolition - Wicks House	*1.00* LS	1,304	90,302	24,750		87,313		202,364.78 /LS	202,365	312,399.74 /LS	312,400
	01.6					Demolition - Generator building											
		02.0				Existing Conditions											
			02.40			**Demolition**											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	10.00 CY	14	985		-	750	-	173.50 /CY	1,735	271.86 /CY	2,719
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	10.00 CY	14	985			750	-	173.50 /CY	1,735	271.86 /CY	2,719
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	1.00 CY	2	164		-	125	-	289.16 /CY	289	453.11 /CY	453
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	1.00 CY	2	164			125	-	289.16 /CY	289	453.11 /CY	453
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	24.00 ton		-	720	-	-	-	30.00 /ton	720	41.31 /ton	991
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.20 LD	2	171		-	214	-	321.06 /LD	385	503.09 /LD	604
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	1.20 LD	2	171	720		214	-	921.06 /LD	1,105	1,329.28 /LD	1,595
						02.01.02.0010 Demo Strucutral Concrete	11.00 CY	19	1,320	720		1,089		284.49 /CY	3,129	433.35 /CY	4,767
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	256.00 SF	82	5,673	-	-	6,546	-	47.73 /SF	12,219	74.79 /SF	19,146
						02.01.02.00 Sturcture/Building Demoltion	256.00 SF	82	5,673			6,546	-	47.73 /SF	12,219	74.79 /SF	19,146
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	56.00 ton		-	1,680	-	-	-	30.00 /ton	1,680	41.31 /ton	2,313
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	2.80 LD	6	399		-	500	-	321.06 /LD	899	503.09 /LD	1,409
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	2.80 LD	6	399	1,680		500	-	921.06 /LD	2,579	1,329.28 /LD	3,722
						02.01.02.0070 Misc. Demolition	0.00	88	6,072	1,680		7,046		/LS	14,798	/LS	22,868
				02.01.04.40		HVAC Demolition											
					02.01.04.40	HVAC Demolition											
						HVAC Demolition - Med Crew	3.20 hr	16	1,092		-	553	-	514.10 /hr	1,645	805.58 /hr	2,578
						02.01.04.40 HVAC Demolition	1.00 LS	16	1,092			553		1,645.11 /LS	1,645	2,577.86 /LS	2,578
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	4.00 ton		-	120	-	-	-	30.00 /ton	120	41.31 /ton	165
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.20 LD	0	28		-	36	-	321.05 /LD	64	503.10 /LD	101
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.20 LD	0	28	120		36		921.05 /LD	184	1,329.25 /LD	266
						02.01.04.40 HVAC Demolition	1.00 LS	16	1,120	120		589		1,829.32 /LS	1,829	2,843.71 /LS	2,844
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	3.20 hr	16	1,092		-	553	-	514.10 /hr	1,645	805.58 /hr	2,578
						02.01.06.01 Electrical Facility Demolition	1.00 LS	16	1,092			553		1,645.11 /LS	1,645	2,577.85 /LS	2,578
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	4.00 ton		-	120	-	-	-	30.00 /ton	120	41.31 /ton	165
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.20 LD	0	28		-	36	-	321.05 /LD	64	503.20 /LD	101
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.20 LD	0	28	120		36		921.05 /LD	184	1,329.35 /LD	266
						02.01.06.0010 Electrical Demolition	1.00 LS	16	1,120	120		589		1,829.32 /LS	1,829	2,843.72 /LS	2,844
						02.40 Demolition	1.00 LS	139	9,632	2,640		9,313		21,585.57 /LS	21,586	33,322.64 /LS	33,323
						02.0 Existing Conditions	1.00 LS	139	9,632	2,640		9,313		21,585.57 /LS	21,586	33,322.64 /LS	33,323
						01.6 Demolition - Generator building	1.00 LS	139	9,632	2,640		9,313		21,585.57 /LS	21,586	33,322.64 /LS	33,323
						3.1B CIP 3 - WTP Replacement, Phase 1B	1.00 LS	2,157	149,476	42,057		147,405		338,937.54 /LS	338,938	523,118.62 /LS	523,119
3.1C						**CIP 3 - WTP Replacement, Phase 1C**											
	03.1					New 30" filtered water											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.FW30		30" FW - Finished Water											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	40.00 day		-	-	-	4,806	-	120.15 /day	4,806	188.27 /day	7,531
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	1,841.67 CY	409	29,298	-	-	30,318	-	32.37 /CY	59,616	50.72 /CY	93,417
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	561.75 ecy	218	13,184	-	-	-	-	23.47 /ecy	13,184	36.78 /ecy	20,659
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	1,023.15 ecy	82	5,943	-	-	1,074	-	6.86 /ecy	7,017	10.75 /ecy	10,996
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	561.75 lcy	90	5,853	11,797	-	1,038	-	33.27 /lcy	18,688	48.14 /lcy	27,043
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	102.31 lcy	16	1,066	1,852	-	189	-	30.37 /lcy	3,107	44.15 /lcy	4,517
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	818.52 lcy	168	11,954	-	-	16,609	-	34.90 /lcy	28,563	54.68 /lcy	44,758
						31.00.01.01 Trenching, Backfill, and Compaction	1,841.67 CY	983	67,298	13,649		54,035		73.29 /CY	134,981	113.44 /CY	208,920
					33.00.04.30	Buried Pipe, Ductile Iron, 30"											
						30" pipe, DI, RJ, excav/bkfill not included, 250#	850.00 LF	357	29,834	166,097	-	16,862	-	250.35 /LF	212,793	355.16 /LF	301,885
						30" DI, RJ, Ell, 45	17.00 ea	168	14,065	94,473	-	7,949	-	6,852.21 /ea	116,488	9,681.42 /ea	164,584
						Megalugs for DI Pipe w/ Accessories, 30"	43.00 ea	86	7,187	46,373	-	4,062	-	1,340.06 /ea	57,622	1,894.94 /ea	81,482
						Polywrap, 30" pipe	850.00 lf		-	1,122	-	-	-	1.32 /lf	1,122	1.82 /lf	1,545
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	5,951.88 /ea	5,952
						Pipe Marking, ID Tape	850.00 lf	9	710	111	-	-	-	0.97 /lf	821	1.49 /lf	1,265
						33.00.04.30 Buried Pipe, Ductile Iron, 30"	850.00 LF	644	53,802	308,926		30,007		462.04 /LF	392,735	654.96 /LF	556,714
						33.00.04.FW30 30" FW - Finished Water	850.00 LF	1,627	121,101	322,575		84,042		620.84 /LF	527,717	900.75 /LF	765,634
						33.02 Buried Process Pipe, Ductile Iron	850.00 LF	1,627	121,101	322,575		84,042		620.84 /LF	527,717	900.75 /LF	765,634
						33.0 Utilities	1.00 LS	1,627	121,101	322,575		84,042		527,716.84 /LS	527,717	765,634.31 /LS	765,634
						03.1 New 30" filtered water	1.00 LS	1,627	121,101	322,575		84,042		527,716.84 /LS	527,717	765,634.31 /LS	765,634
	03.2					New 12" BWS											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.BWS12		New 12" BWS											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	30.00 day		-	-	-	3,605	-	120.15 /day	3,605	188.27 /day	5,648
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	1,527.78 CY	340	24,305	-	-	25,151	-	32.37 /CY	49,455	50.72 /CY	77,496
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	375.43 ecy	146	8,811	-	-	-	-	23.47 /ecy	8,811	36.78 /ecy	13,807
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	1,018.52 ecy	81	5,916	-	-	1,070	-	6.86 /ecy	6,985	10.75 /ecy	10,946
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	375.43 lcy	60	3,912	7,884	-	694	-	33.27 /lcy	12,490	48.14 /lcy	18,073
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	101.85 lcy	16	1,061	1,843	-	188	-	30.37 /lcy	3,093	44.15 /lcy	4,496
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	509.26 lcy	104	7,438	-	-	10,334	-	34.90 /lcy	17,771	54.68 /lcy	27,847
						31.00.01.01 Trenching, Backfill, and Compaction	1,527.78 CY	748	51,442	9,728		41,040		66.90 /CY	102,210	103.62 /CY	158,313
					33.00.04.12	Buried Pipe, Ductile Iron, 12"											
						12" pipe, DI, RJ, excav/bkfill not included, 350#	1,100.00 LF	275	22,982	55,656	-	12,989	-	83.30 /LF	91,626	120.91 /LF	133,003
						12" DI, RJ, Ell, 45	20.00 ea	92	7,688	13,502	-	4,345	-	1,276.79 /ea	25,536	1,872.45 /ea	37,449
						Megalugs for DI Pipe w/ Accessories, 12"	55.00 ea	55	4,596	6,705	-	2,598	-	252.70 /ea	13,899	372.82 /ea	20,505
						Polywrap, 12" pipe	1,100.00 lf		-	583	-	-	-	0.53 /lf	583	0.73 /lf	803
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	5,951.89 /ea	5,952
						Pipe Marking, ID Tape	1,100.00 lf	11	919	143	-	-	-	0.97 /lf	1,062	1.49 /lf	1,637
						33.00.04.12 Buried Pipe, Ductile Iron, 12"	1,100.00 LF	457	38,191	77,338		21,066		124.18 /LF	136,595	181.23 /LF	199,348
						33.00.04.BWS12 New 12" BWS	1,100.00 LF	1,205	89,634	87,066		62,106		217.10 /LF	238,805	325.15 /LF	357,662
						33.02 Buried Process Pipe, Ductile Iron	1,100.00 LF	1,205	89,634	87,066		62,106		217.10 /LF	238,805	325.15 /LF	357,662

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						33.0 Utilities	1.00 LS	1,205	89,634	87,066		62,106		238,805.46 /LS	238,805	357,661.70 /LS	357,662
						03.2 New 12" BWS	1.00 LS	1,205	89,634	87,066		62,106		238,805.46 /LS	238,805	357,661.70 /LS	357,662
	03.3					Residuals piping											
		33.0				Utilities											
			33.02			Buried Process Pipe, Ductile Iron											
				33.00.04.SEDB04		04" Solids & 04" EDB Recycle Lines											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	148.00 day		-	-	-	17,782	-	120.15 /day	17,782	188.27 /day	27,864
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	10,456.79 CY	2,324	166,351	-	-	172,142	-	32.37 /CY	338,493	50.72 /CY	530,413
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	1,187.26 ecy	461	27,864	-	-	-	-	23.47 /ecy	27,864	36.78 /ecy	43,662
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	8,641.98 ecy	691	50,194	-	-	9,075	-	6.86 /ecy	59,269	10.75 /ecy	92,874
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	1,187.26 lcy	190	12,371	24,932	-	2,194	-	33.27 /lcy	39,498	48.14 /lcy	57,155
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	604.94 lcy	97	6,303	10,949	-	1,118	-	30.37 /lcy	18,371	44.15 /lcy	26,706
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	1,814.81 lcy	372	26,505	-	-	36,825	-	34.90 /lcy	63,330	54.68 /lcy	99,237
						31.00.01.01 Trenching, Backfill, and Compaction	10,456.79 CY	4,135	289,589	35,882		239,137		53.99 /CY	564,607	83.96 /CY	877,912
					33.00.04.04	Buried Pipe, Ductile Iron, 4"											
						4" pipe, DI, RJ, excav/bkfill not included, 350#	7,000.00 LF	1,050	88,773	193,914	-	43,050	-	46.53 /LF	325,737	67.65 /LF	473,581
						4" DI, RJ, Ell, 45	140.00 ea	266	22,489	25,690	-	10,906	-	422.04 /ea	59,085	626.46 /ea	87,704
						Megalugs for DI Pipe w/ Accessories, 4"	280.00 ea	280	23,673	10,570	-	11,480	-	163.30 /ea	45,723	248.71 /ea	69,639
						Polywrap, 4" pipe	7,000.00 lf		-	2,240	-	-	-	0.32 /lf	2,240	0.44 /lf	3,084
						Add for tie-in to existing (Adjust productivity)	4.00 ea	96	8,023	3,000	-	4,534	-	3,889.26 /ea	15,557	5,951.90 /ea	23,808
						Pipe Marking, ID Tape	7,000.00 lf	70	5,849	910	-	-	-	0.97 /lf	6,759	1.49 /lf	10,419
						33.00.04.04 Buried Pipe, Ductile Iron, 4"	7,000.00 LF	1,762	148,807	236,324		69,970		65.01 /LF	455,102	95.46 /LF	668,235
						33.00.04.SEDB04 04" Solids & 04" EDB Recycle Lines	7,000.00 LF	5,897	438,396	272,206		309,107		145.67 /LF	1,019,709	220.88 /LF	1,546,148
						33.02 Buried Process Pipe, Ductile Iron	7,000.00 LF	5,897	438,396	272,206		309,107		145.67 /LF	1,019,709	220.88 /LF	1,546,148
						33.0 Utilities	1.00 LS	5,897	438,396	272,206		309,107		1,019,708.75 /LS	1,019,709	1,546,147.51 /LS	1,546,148
						03.3 Residuals piping	1.00 LS	5,897	438,396	272,206		309,107		1,019,708.75 /LS	1,019,709	1,546,147.51 /LS	1,546,148
	90.1					Sitework Allowance											
		31.0				Earthwork											
			31.00			Site/Civil General Items											
				31.00.01.0010		Sitework Allowance											
					31.00.01.00	Site/Civil, General Conditions											
						Sitework Allowance (~6% construction costs)	1.00 ls						226,000	226,000.00 /ls	226,000	277,298.24 /ls	277,298
						31.00.01.00 Site/Civil, General Conditions	1.00 LS						226,000	226,000.00 /LS	226,000	277,298.24 /LS	277,298
						31.00.01.0010 Sitework Allowance	1.00 LS						226,000	226,000.00 /LS	226,000	277,298.24 /LS	277,298
						31.00 Site/Civil General Items	1.00 LS						226,000	226,000.00 /LS	226,000	277,298.24 /LS	277,298
						31.0 Earthwork	1.00 LS						226,000	226,000.00 /LS	226,000	277,298.24 /LS	277,298
						90.1 Sitework Allowance	1.00 LS						226,000	226,000.00 /LS	226,000	277,298.24 /LS	277,298
						3.1C CIP 3 - WTP Replacement, Phase 1C	1.00 LS	8,729	649,130	681,846		455,255	226,000	2,012,231.05 /LS	2,012,231	2,946,741.76 /LS	2,946,742
4.2A						CIP 4 - WTP Replacement, Phase 2A											
	01.7					Demolition Caustic Soda Building											
		02.0				Existing Conditions											
			02.40			Demolition											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	33.98 CY	48	3,347		-	2,549	-	173.50 /CY	5,896	280.73 /CY	9,540
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	33.98 CY	48	3,347			2,549		173.50 /CY	5,896	280.73 /CY	9,540
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	3.40 CY	8	558		-	425	-	289.16 /CY	983	467.88 /CY	1,590
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	3.40 CY	8	558			425		289.16 /CY	983	467.88 /CY	1,590
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	81.56 ton		-	2,447	-	-	-	30.00 /ton	2,447	42.84 /ton	3,494
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	4.08 LD	8	581	-	-	729	-	321.06 /LD	1,309	519.50 /LD	2,119
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	4.08 LD	8	581	2,447		729		921.07 /LD	3,756	1,376.37 /LD	5,613
						02.01.02.0010 Demo Strucutral Concrete	37.38 CY	64	4,486	2,447		3,702		284.49 /CY	10,635	447.89 /CY	16,743
					02.01.02.0070	Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	870.00 SF	278	19,280	-	-	22,244	-	47.73 /SF	41,524	77.23 /SF	67,189
						02.01.02.00 Sturcture/Building Demoltion	870.00 SF	278	19,280			22,244		47.73 /SF	41,524	77.23 /SF	67,189
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	190.31 ton		-	5,709	-	-	-	30.00 /ton	5,709	42.84 /ton	8,153
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	9.52 LD	19	1,355		-	1,700	-	321.06 /LD	3,055	519.49 /LD	4,944
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	9.52 LD	19	1,355	5,709		1,700		921.03 /LD	8,765	1,376.31 /LD	13,097
						02.01.02.0070 Misc. Demolition	1.00 LS	297	20,635	5,709		23,945		50,288.51 /LS	50,289	80,286.21 /LS	80,286
					02.01.06.0010	Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	12.00 hr	60	4,094		-	2,075	-	514.10 /hr	6,169	831.85 /hr	9,982
						02.01.06.01 Electrical Facility Demolition	1.00 LS	60	4,094			2,075		6,169.16 /LS	6,169	9,982.24 /LS	9,982
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	10.00 ton		-	300	-	-	-	30.00 /ton	300	42.84 /ton	428
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.50 LD	1	71		-	89	-	321.06 /LD	161	519.50 /LD	260
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.50 LD	1	71	300		89		921.06 /LD	461	1,376.34 /LD	688
						02.01.06.0010 Electrical Demolition	1.00 LS	61	4,165	300		2,164		6,629.69 /LS	6,630	10,670.41 /LS	10,670
						02.40 Demolition	1.00 LS	422	29,285	8,456		29,811		67,552.96 /LS	67,553	107,699.65 /LS	107,700
						02.0 Existing Conditions	1.00 LS	422	29,285	8,456		29,811		67,552.96 /LS	67,553	107,699.65 /LS	107,700
						01.7 Demolition Caustic Soda Building	1.00 LS	422	29,285	8,456		29,811		67,552.96 /LS	67,553	107,699.65 /LS	107,700
	01.8					Demolition Sodium Hypochlorite Building											
		02.0				Existing Conditions											
			02.40			Demolition											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	57.42 CY	80	5,655		-	4,307	-	173.50 /CY	9,962	280.73 /CY	16,120
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	57.42 CY	80	5,655			4,307		173.50 /CY	9,962	280.73 /CY	16,120
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	5.74 CY	13	942		-	718	-	289.16 /CY	1,660	467.88 /CY	2,686
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	5.74 CY	13	942			718		289.16 /CY	1,660	467.88 /CY	2,686
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	137.81 ton		-	4,134	-	-	-	30.00 /ton	4,134	42.84 /ton	5,904
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	6.89 LD	14	981		-	1,231	-	321.06 /LD	2,212	519.49 /LD	3,579
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	6.89 LD	14	981	4,134		1,231		921.11 /LD	6,346	1,376.41 /LD	9,483
						02.01.02.0010 Demo Strucutral Concrete	63.16 CY	108	7,579	4,134		6,255		284.49 /CY	17,969	447.89 /CY	28,289
					02.01.02.0070	Misc. Demolition											

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Detail Report
Project Name: The Dalles WTP - 9.5mgd Sed
Project Number: D3718900
Design Stage: ROM

Estimator: Jones T
Rev No. / Data: R03 - 08/13/2024
Class Estimate: Class 5

Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	1,470.00 SF	470	32,576	-	-	37,586	-	47.73 /SF	70,161	77.23 /SF	113,527
						02.01.02.00 Sturcture/Building Demoltion	1,470.00 SF	470	32,576			37,586		47.73 /SF	70,161	77.23 /SF	113,527
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	321.56 ton			9,647	-	-	-	30.00 /ton	9,647	42.84 /ton	13,776
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	16.08 LD	32	2,290		-	2,873	-	321.06 /LD	5,162	519.50 /LD	8,353
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	16.08 LD	32	2,290	9,647		2,873		921.02 /LD	14,809	1,376.29 /LD	22,129
						02.01.02.0070 Misc. Demolition	0.00	503	34,866	9,647		40,458		/LS	84,971	/LS	135,657
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	24.00 hr	120	8,188		-	4,150	-	514.10 /hr	12,338	831.85 /hr	19,964
						02.01.06.01 Electrical Facility Demolition	1.00 LS	120	8,188			4,150		12,338.33 /LS	12,338	19,964.44 /LS	19,964
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	20.00 ton		-	600	-	-	-	30.00 /ton	600	42.84 /ton	857
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.00 LD	2	142		-	179	-	321.06 /LD	321	519.49 /LD	519
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	1.00 LD	2	142	600		179		921.06 /LD	921	1,376.35 /LD	1,376
						02.01.06.0010 Electrical Demolition	1.00 LS	122	8,330	600		4,329		13,259.39 /LS	13,259	21,340.79 /LS	21,341
						02.40 Demolition	1.00 LS	732	50,775	14,381		51,043		116,198.68 /LS	116,199	185,286.71 /LS	185,287
						02.0 Existing Conditions	1.00 LS	732	50,775	14,381		51,043		116,198.68 /LS	116,199	185,286.71 /LS	185,287
						01.8 Demolition Sodium Hypochlorite Building	1.00 LS	732	50,775	14,381		51,043		116,198.68 /LS	116,199	185,286.71 /LS	185,287
	05.0					Construct new finished water chem building											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.00.01.0401		Construct new finished water chem building											
					13.00.01.02	Buildings, Operations											
						Building Complete - Chemical Building	3,125.00 SF				843,750	-	-	270.00 /SF	843,750	385.58 /SF	1,204,945
						13.00.01.02 Buildings, Operations	3,125.00 SF				843,750			270.00 /SF	843,750	385.58 /SF	1,204,945
						13.00.01.0401 Construct new finished water chem building	1.00 LS				843,750			843,750.00 /LS	843,750	1,204,945.32 /LS	1,204,945
						13.01 Buildings Complete	1.00 LS				843,750			843,750.00 /LS	843,750	1,204,945.32 /LS	1,204,945
						13.0 Special Construction	1.00 LS				843,750			843,750.00 /LS	843,750	1,204,945.32 /LS	1,204,945
						05.0 Construct new finished water chem building	1.00 LS				843,750			843,750.00 /LS	843,750	1,204,945.32 /LS	1,204,945
	05.1					On-Site Hypo Generation System											
		11.0				Commercial Equipment											
			11.00			Equipment											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						On-Site Sodium Hypo: Hypo - 11 - Equipment	1.00 ls				-	-	912,066	912,065.94 /ls	912,066	1,165,696.29 /ls	1,165,696
						11.00.99.00 Equipment, Other	1.00 LS						912,066	912,065.94 /LS	912,066	1,165,696.29 /LS	1,165,696
						11.00.99.0011 Equipment Costs from Replica	1.00 LS						912,066	912,065.94 /LS	912,066	1,165,696.29 /LS	1,165,696
						11.00 Equipment	1.00 LS						912,066	912,065.94 /LS	912,066	1,165,696.29 /LS	1,165,696
						11.0 Commercial Equipment	1.00 LS						912,066	912,065.94 /LS	912,066	1,165,696.29 /LS	1,165,696
		26.0				Electrical Work											
			26.00			Electrical											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						On-Site Sodium Hypo: Hypo - 16 Electrical	1.00 ls				-	-	75,753	75,752.98 /ls	75,753	96,818.63 /ls	96,819
						26.00.99.00 Electrical, Other	1.00 LS						75,753	75,752.98 /LS	75,753	96,818.63 /LS	96,819
						26.00.99.0016 Electrical Costs from Replica	1.00 LS						75,753	75,752.98 /LS	75,753	96,818.63 /LS	96,819
						26.00 Electrical	1.00 LS						75,753	75,752.98 /LS	75,753	96,818.63 /LS	96,819
						26.0 Electrical Work	1.00 LS						75,753	75,752.98 /LS	75,753	96,818.63 /LS	96,819
		40.0				Process Pipe											
			40.19			Process Pipe, Other											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						On-Site Sodium Hypo: Hypo - 15 Mechanical	1.00 ls				-	-	151,506	151,505.97 /ls	151,506	193,637.25 /ls	193,637
						40.00.99.01 Process Pipe, Other	1.00 LS						151,506	151,505.97 /LS	151,506	193,637.25 /LS	193,637
						40.00.99.0015 Mechanical Costs from Replica	1.00 LS						151,506	151,505.97 /LS	151,506	193,637.25 /LS	193,637
						40.19 Process Pipe, Other	1.00 LS						151,506	151,505.97 /LS	151,506	193,637.25 /LS	193,637
						40.0 Process Pipe	1.00 LS						151,506	151,505.97 /LS	151,506	193,637.25 /LS	193,637
		40.9				Instrumentation & Controls											
			40.90			Instrumentation & Controls											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						On-Site Sodium Hypo: Hypo - 13 Special Construction	1.00 ls				-	-	75,753	75,752.98 /ls	75,753	96,818.62 /ls	96,819
						40.90.99.01 I&C, Other	1.00 LS						75,753	75,752.98 /LS	75,753	96,818.62 /LS	96,819
						40.90.99.0013 Special Construction from Replica	1.00 LS						75,753	75,752.98 /LS	75,753	96,818.62 /LS	96,819
						40.90 Instrumentation & Controls	1.00 LS						75,753	75,752.98 /LS	75,753	96,818.62 /LS	96,819
						40.9 Instrumentation & Controls	1.00 LS						75,753	75,752.98 /LS	75,753	96,818.62 /LS	96,819
						05.1 On-Site Hypo Generation System	1.00 LS						1,215,078	1,215,077.87 /LS	1,215,078	1,552,970.79 /LS	1,552,971
	05.2					Fluoride Storage/Equipment											
		11.0				Commercial Equipment											
			11.00			Equipment											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Dry Chemical: Fluoride - 11 - Equipment	1.00 ls				-	-	391,491	391,491.42 /ls	391,491	500,358.66 /ls	500,359
						11.00.99.00 Equipment, Other	1.00 LS						391,491	391,491.42 /LS	391,491	500,358.66 /LS	500,359
						11.00.99.0011 Equipment Costs from Replica	1.00 LS						391,491	391,491.42 /LS	391,491	500,358.66 /LS	500,359
						11.00 Equipment	1.00 LS						391,491	391,491.42 /LS	391,491	500,358.66 /LS	500,359
						11.0 Commercial Equipment	1.00 LS						391,491	391,491.42 /LS	391,491	500,358.66 /LS	500,359
		26.0				Electrical Work											
			26.00			Electrical											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Dry Chemical: Fluoride - 16 Electrical	1.00 ls				-	-	86,055	86,055.39 /ls	86,055	109,985.97 /ls	109,986
						26.00.99.00 Electrical, Other	1.00 LS						86,055	86,055.39 /LS	86,055	109,985.97 /LS	109,986
						26.00.99.0016 Electrical Costs from Replica	1.00 LS						86,055	86,055.39 /LS	86,055	109,985.97 /LS	109,986
						26.00 Electrical	1.00 LS						86,055	86,055.39 /LS	86,055	109,985.97 /LS	109,986
						26.0 Electrical Work	1.00 LS						86,055	86,055.39 /LS	86,055	109,985.97 /LS	109,986
		40.0				Process Pipe											
			40.19			Process Pipe, Other											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
					40.00.99.01	Process Pipe, Other											
						Dry Chemical: Fluoride - 15 Mechanical	1.00 ls				-	-	35,149	35,149.38 /ls	35,149	44,923.83 /ls	44,924
						40.00.99.01 Process Pipe, Other	*1.00* LS						35,149	35,149.38 /LS	35,149	44,923.83 /LS	44,924
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						35,149	35,149.38 /LS	35,149	44,923.83 /LS	44,924
						40.19 Process Pipe, Other	*1.00* **LS**						**35,149**	**35,149.38 /LS**	**35,149**	**44,923.83 /LS**	**44,924**
						40.0 Process Pipe	*1.00* LS						35,149	35,149.38 /LS	35,149	44,923.83 /LS	44,924
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Dry Chemical: Fluoride - 13 Special Construction	1.00 ls				-	-	13,333	13,332.53 /ls	13,333	17,040.09 /ls	17,040
						40.90.99.01 I&C, Other	*1.00* LS						13,333	13,332.53 /LS	13,333	17,040.09 /LS	17,040
						40.90.99.0013 Special Construction from Replica	*1.00* LS						13,333	13,332.53 /LS	13,333	17,040.09 /LS	17,040
						40.90 Instrumentation & Controls	*1.00* **LS**						**13,333**	**13,332.53 /LS**	**13,333**	**17,040.09 /LS**	**17,040**
						40.9 Instrumentation & Controls	*1.00* LS						13,333	13,332.53 /LS	13,333	17,040.09 /LS	17,040
						05.2 Fluoride Storage/Equipment	*1.00* LS						526,029	526,028.72 /LS	526,029	672,308.55 /LS	672,309
	05.3					Caustic Storage/Equipment											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: Caustic - 11 - Equipment	1.00 ls				-	-	28,483	28,483.12 /ls	28,483	36,403.80 /ls	36,404
						11.00.99.00 Equipment, Other	*1.00* LS						28,483	28,483.12 /LS	28,483	36,403.80 /LS	36,404
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						28,483	28,483.12 /LS	28,483	36,403.80 /LS	36,404
						11.00 Equipment	*1.00* **LS**						**28,483**	**28,483.12 /LS**	**28,483**	**36,403.80 /LS**	**36,404**
						11.0 Commercial Equipment	*1.00* LS						28,483	28,483.12 /LS	28,483	36,403.80 /LS	36,404
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: Caustic - 16 Electrical	1.00 ls				-	-	5,454	5,454.00 /ls	5,454	6,970.66 /ls	6,971
						26.00.99.00 Electrical, Other	*1.00* LS						5,454	5,454.00 /LS	5,454	6,970.66 /LS	6,971
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						5,454	5,454.00 /LS	5,454	6,970.66 /LS	6,971
						26.00 Electrical	*1.00* **LS**						**5,454**	**5,454.00 /LS**	**5,454**	**6,970.66 /LS**	**6,971**
						26.0 Electrical Work	*1.00* LS						5,454	5,454.00 /LS	5,454	6,970.66 /LS	6,971
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: Caustic - 15 Mechanical	1.00 ls				-	-	13,332	13,332.00 /ls	13,332	17,039.40 /ls	17,039
						40.00.99.01 Process Pipe, Other	*1.00* LS						13,332	13,332.00 /LS	13,332	17,039.40 /LS	17,039
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						13,332	13,332.00 /LS	13,332	17,039.40 /LS	17,039
						40.19 Process Pipe, Other	*1.00* **LS**						**13,332**	**13,332.00 /LS**	**13,332**	**17,039.40 /LS**	**17,039**
						40.0 Process Pipe	*1.00* LS						13,332	13,332.00 /LS	13,332	17,039.40 /LS	17,039
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: Caustic - 13 Special Construction	1.00 ls				-	-	58,782	58,782.00 /ls	58,782	75,128.30 /ls	75,128
						40.90.99.01 I&C, Other	*1.00* LS						58,782	58,782.00 /LS	58,782	75,128.30 /LS	75,128
						40.90.99.0013 Special Construction from Replica	*1.00* LS						58,782	58,782.00 /LS	58,782	75,128.30 /LS	75,128
						40.90 Instrumentation & Controls	*1.00* **LS**						**58,782**	**58,782.00 /LS**	**58,782**	**75,128.30 /LS**	**75,128**
						40.9 Instrumentation & Controls	*1.00* LS						58,782	58,782.00 /LS	58,782	75,128.30 /LS	75,128
						05.3 Caustic Storage/Equipment	*1.00* LS						106,051	106,051.12 /LS	106,051	135,542.16 /LS	135,542
	05.4					Polyphosphate Storage/Equipment											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: PolyPhos - 11 - Equipment	1.00 ls				-	-	28,483	28,483.12 /ls	28,483	36,403.80 /ls	36,404
						11.00.99.00 Equipment, Other	*1.00* LS						28,483	28,483.12 /LS	28,483	36,403.80 /LS	36,404
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						28,483	28,483.12 /LS	28,483	36,403.80 /LS	36,404
						11.00 Equipment	*1.00* **LS**						**28,483**	**28,483.12 /LS**	**28,483**	**36,403.80 /LS**	**36,404**
						11.0 Commercial Equipment	*1.00* LS						28,483	28,483.12 /LS	28,483	36,403.80 /LS	36,404
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: PolyPhos - 16 Electrical	1.00 ls				-	-	4,848	4,848.00 /ls	4,848	6,196.16 /ls	6,196
						26.00.99.00 Electrical, Other	*1.00* LS						4,848	4,848.00 /LS	4,848	6,196.16 /LS	6,196
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						4,848	4,848.00 /LS	4,848	6,196.16 /LS	6,196
						26.00 Electrical	*1.00* **LS**						**4,848**	**4,848.00 /LS**	**4,848**	**6,196.16 /LS**	**6,196**
						26.0 Electrical Work	*1.00* LS						4,848	4,848.00 /LS	4,848	6,196.16 /LS	6,196
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: PolyPhos - 15 Mechanical	1.00 ls				-	-	12,726	12,726.00 /ls	12,726	16,264.88 /ls	16,265
						40.00.99.01 Process Pipe, Other	*1.00* LS						12,726	12,726.00 /LS	12,726	16,264.88 /LS	16,265
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						12,726	12,726.00 /LS	12,726	16,264.88 /LS	16,265
						40.19 Process Pipe, Other	*1.00* **LS**						**12,726**	**12,726.00 /LS**	**12,726**	**16,264.88 /LS**	**16,265**
						40.0 Process Pipe	*1.00* LS						12,726	12,726.00 /LS	12,726	16,264.88 /LS	16,265
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: PolyPhos - 13 Special Construction	1.00 ls				-	-	53,934	53,934.00 /ls	53,934	68,932.15 /ls	68,932
						40.90.99.01 I&C, Other	*1.00* LS						53,934	53,934.00 /LS	53,934	68,932.15 /LS	68,932
						40.90.99.0013 Special Construction from Replica	*1.00* LS						53,934	53,934.00 /LS	53,934	68,932.15 /LS	68,932
						40.90 Instrumentation & Controls	*1.00* **LS**						**53,934**	**53,934.00 /LS**	**53,934**	**68,932.15 /LS**	**68,932**
						40.9 Instrumentation & Controls	*1.00* LS						53,934	53,934.00 /LS	53,934	68,932.15 /LS	68,932

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						05.4 Polyphosphate Storage/Equipment	*1.00* LS						99,991	99,991.12 /LS	99,991	127,796.99 /LS	127,797
	05.5					Phosphoric Acid Storage/Equipment											
		11.0				Commercial Equipment											
			11.00			Equipment											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: PhosAcid - 11 - Equipment	1.00 ls				-	-	28,483	28,483.12 /ls	28,483	36,403.80 /ls	36,404
						11.00.99.00 Equipment, Other	*1.00* LS						28,483	28,483.12 /LS	28,483	36,403.80 /LS	36,404
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						28,483	28,483.12 /LS	28,483	36,403.80 /LS	36,404
						11.00 Equipment	*1.00* **LS**						**28,483**	**28,483.12 /LS**	**28,483**	**36,403.80 /LS**	**36,404**
						11.0 Commercial Equipment	*1.00* LS						28,483	28,483.12 /LS	28,483	36,403.80 /LS	36,404
		26.0				Electrical Work											
			26.00			Electrical											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: PhosAcid - 16 Electrical	1.00 ls				-	-	4,242	4,242.00 /ls	4,242	5,421.63 /ls	5,422
						26.00.99.00 Electrical, Other	*1.00* LS						4,242	4,242.00 /LS	4,242	5,421.63 /LS	5,422
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						4,242	4,242.00 /LS	4,242	5,421.63 /LS	5,422
						26.00 Electrical	*1.00* **LS**						**4,242**	**4,242.00 /LS**	**4,242**	**5,421.63 /LS**	**5,422**
						26.0 Electrical Work	*1.00* LS						4,242	4,242.00 /LS	4,242	5,421.63 /LS	5,422
		40.0				Process Pipe											
			40.19			Process Pipe, Other											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: PhosAcid - 15 Mechanical	1.00 ls				-	-	11,514	11,514.00 /ls	11,514	14,715.86 /ls	14,716
						40.00.99.01 Process Pipe, Other	*1.00* LS						11,514	11,514.00 /LS	11,514	14,715.86 /LS	14,716
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						11,514	11,514.00 /LS	11,514	14,715.86 /LS	14,716
						40.19 Process Pipe, Other	*1.00* **LS**						**11,514**	**11,514.00 /LS**	**11,514**	**14,715.86 /LS**	**14,716**
						40.0 Process Pipe	*1.00* LS						11,514	11,514.00 /LS	11,514	14,715.86 /LS	14,716
		40.9				Instrumentation & Controls											
			40.90			Instrumentation & Controls											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: PhosAcid - 13 Special Construction	1.00 ls				-	-	52,116	52,116.00 /ls	52,116	66,608.59 /ls	66,609
						40.90.99.01 I&C, Other	*1.00* LS						52,116	52,116.00 /LS	52,116	66,608.59 /LS	66,609
						40.90.99.0013 Special Construction from Replica	*1.00* LS						52,116	52,116.00 /LS	52,116	66,608.59 /LS	66,609
						40.90 Instrumentation & Controls	*1.00* **LS**						**52,116**	**52,116.00 /LS**	**52,116**	**66,608.59 /LS**	**66,609**
						40.9 Instrumentation & Controls	*1.00* LS						52,116	52,116.00 /LS	52,116	66,608.59 /LS	66,609
						05.5 Phosphoric Acid Storage/Equipment	*1.00* LS						96,355	96,355.12 /LS	96,355	123,149.88 /LS	123,150
	06.0					Construct new backwash supply pump station											
		11.0				Commercial Equipment											
			11.00			Equipment											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Filter BW PS: BWS - 11 - Equipment	1.00 ls				-	-	149,076	149,076.00 /ls	149,076	190,531.54 /ls	190,532
						11.00.99.00 Equipment, Other	*1.00* LS						149,076	149,076.00 /LS	149,076	190,531.54 /LS	190,532
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						149,076	149,076.00 /LS	149,076	190,531.54 /LS	190,532
						11.00 Equipment	*1.00* **LS**						**149,076**	**149,076.00 /LS**	**149,076**	**190,531.54 /LS**	**190,532**
						11.0 Commercial Equipment	*1.00* LS						149,076	149,076.00 /LS	149,076	190,531.54 /LS	190,532
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.00.01.0401		Construct new finished water chem building											
					13.00.01.02	Buildings, Operations											
						Building Complete - Pump Station Building	360.00 SF				97,200	-	-	270.00 /SF	97,200	385.58 /SF	138,810
						13.00.01.02 Buildings, Operations	360.00 SF				97,200			270.00 /SF	97,200	385.58 /SF	138,810
						13.00.01.0401 Construct new finished water chem building	*1.00* LS				97,200			97,200.00 /LS	97,200	138,809.70 /LS	138,810
						13.01 Buildings Complete	*1.00* **LS**				**97,200**			**97,200.00 /LS**	**97,200**	**138,809.70 /LS**	**138,810**
						13.0 Special Construction	*1.00* LS				97,200			97,200.00 /LS	97,200	138,809.70 /LS	138,810
		26.0				Electrical Work											
			26.00			Electrical											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Filter BW PS: BWS - 16 Electrical	1.00 ls				-	-	76,962	76,962.00 /ls	76,962	98,363.86 /ls	98,364
						26.00.99.00 Electrical, Other	*1.00* LS						76,962	76,962.00 /LS	76,962	98,363.86 /LS	98,364
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						76,962	76,962.00 /LS	76,962	98,363.86 /LS	98,364
						26.00 Electrical	*1.00* **LS**						**76,962**	**76,962.00 /LS**	**76,962**	**98,363.86 /LS**	**98,364**
						26.0 Electrical Work	*1.00* LS						76,962	76,962.00 /LS	76,962	98,363.86 /LS	98,364
		40.0				Process Pipe											
			40.19			Process Pipe, Other											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Filter BW PS: BWS - 15 Mechanical	1.00 ls				-	-	127,866	127,866.00 /ls	127,866	163,423.40 /ls	163,423
						40.00.99.01 Process Pipe, Other	*1.00* LS						127,866	127,866.00 /LS	127,866	163,423.40 /LS	163,423
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						127,866	127,866.00 /LS	127,866	163,423.40 /LS	163,423
						40.19 Process Pipe, Other	*1.00* **LS**						**127,866**	**127,866.00 /LS**	**127,866**	**163,423.40 /LS**	**163,423**
						40.0 Process Pipe	*1.00* LS						127,866	127,866.00 /LS	127,866	163,423.40 /LS	163,423
		40.9				Instrumentation & Controls											
			40.90			Instrumentation & Controls											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Filter BW PS: BWS - 13 Special Construction	1.00 ls				-	-	41,208	41,208.00 /ls	41,208	52,667.26 /ls	52,667
						40.90.99.01 I&C, Other	*1.00* LS						41,208	41,208.00 /LS	41,208	52,667.26 /LS	52,667
						40.90.99.0013 Special Construction from Replica	*1.00* LS						41,208	41,208.00 /LS	41,208	52,667.26 /LS	52,667
						40.90 Instrumentation & Controls	*1.00* **LS**						**41,208**	**41,208.00 /LS**	**41,208**	**52,667.26 /LS**	**52,667**
						40.9 Instrumentation & Controls	*1.00* LS						41,208	41,208.00 /LS	41,208	52,667.26 /LS	52,667
						06.0 Construct new backwash supply pump station	*1.00* LS				97,200		395,112	492,312.00 /LS	492,312	643,795.76 /LS	643,796
						4.2A CIP 4 - WTP Replacement, Phase 2A	*1.00* **LS**	1,154	80,060	22,837	940,950	80,854	2,438,616	3,563,317.59 /LS	3,563,318	4,753,495.81 /LS	4,753,496
4.2B						**CIP 4 - WTP Replacement, Phase 2B**											
	07.0					Construct new admin building											
		13.0				Special Construction											
			13.01			Buildings Complete											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
				13.01.99.0013		Administration Building (RS Means 1-Story Office)											
					13.01.99.00	Special Construction, Other											
						Administration Building (RS Means 1-Story Office)	4,000.00 SF				-	-	1,320,000	330.00 /SF	1,320,000	421.77 /SF	1,687,070
						13.01.99.00 Special Construction, Other	*1.00* LS						1,320,000	1,320,000.00 /LS	1,320,000	1,687,070.01 /LS	1,687,070
						13.01.99.0013 Administration Building (RS Means 1-Story Office)	4,000.00 SF						1,320,000	330.00 /SF	1,320,000	421.77 /SF	1,687,070
						13.01 Buildings Complete	*1.00* LS						1,320,000	1,320,000.00 /LS	1,320,000	1,687,070.01 /LS	1,687,070
						13.0 Special Construction	*1.00* LS						1,320,000	1,320,000.00 /LS	1,320,000	1,687,070.01 /LS	1,687,070
						07.0 Construct new admin building	*1.00* LS						1,320,000	1,320,000.00 /LS	1,320,000	1,687,070.01 /LS	1,687,070
	90.2					Sitework/Site Electrical/Yard Piping/SCADA Allowance											
		26.0				Electrical Work											
			26.10			**Site Electrical**											
				26.10.20.0010		Site Electrical Allowance											
					26.10.20.00	Site Electrical, Other											
						Site Electrical Allowance (~15% of Construction Costs)	1.00 ls				-	-	730,000	730,000.00 /ls	730,000	933,000.84 /ls	933,001
						26.10.20.00 Site Electrical, Other	*1.00* LS						730,000	730,000.00 /LS	730,000	933,000.84 /LS	933,001
						26.10.20.0010 Site Electrical Allowance	*1.00* LS						730,000	730,000.00 /LS	730,000	933,000.84 /LS	933,001
						26.10 Site Electrical	*1.00* LS						730,000	730,000.00 /LS	730,000	933,000.84 /LS	933,001
						26.0 Electrical Work	*1.00* LS						730,000	730,000.00 /LS	730,000	933,000.84 /LS	933,001
		31.0				Earthwork											
			31.00			**Site/Civil General Items**											
				31.00.01.0010		Sitework Allowance											
					31.00.01.00	Site/Civil, General Conditions											
						Sitework Allowance (~6% construction costs)	1.00 ls						290,000	290,000.00 /ls	290,000	370,644.17 /ls	370,644
						31.00.01.00 Site/Civil, General Conditions	*1.00* LS						290,000	290,000.00 /LS	290,000	370,644.17 /LS	370,644
						31.00.01.0010 Sitework Allowance	*1.00* LS						290,000	290,000.00 /LS	290,000	370,644.17 /LS	370,644
						31.00 Site/Civil General Items	*1.00* LS						290,000	290,000.00 /LS	290,000	370,644.17 /LS	370,644
						31.0 Earthwork	*1.00* LS						290,000	290,000.00 /LS	290,000	370,644.17 /LS	370,644
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.07.0010		Plant Computer System (SCADA allowance)											
					40.90.07.01	I&C, SCADA											
						SCADA Software Development (~6% of Constuction Costs)	1.00 ls						290,000	290,000.00 /ls	290,000	370,644.17 /ls	370,644
						40.90.07.01 I&C, SCADA	*1.00* LS						290,000	290,000.00 /LS	290,000	370,644.17 /LS	370,644
						40.90.07.0010 Plant Computer System (SCADA allowance)	*1.00* LS						290,000	290,000.00 /LS	290,000	370,644.17 /LS	370,644
						40.90 Instrumentation & Controls	*1.00* LS						290,000	290,000.00 /LS	290,000	370,644.17 /LS	370,644
						40.9 Instrumentation & Controls	*1.00* LS						290,000	290,000.00 /LS	290,000	370,644.17 /LS	370,644
						90.2 Sitework/Site Electrical/Yard Piping/SCADA Allowance	*1.00* LS						1,310,000	1,310,000.00 /LS	1,310,000	1,674,289.18 /LS	1,674,289
						4.2B CIP 4 - WTP Replacement, Phase 2B	*1.00* LS						2,630,000	2,630,000.00 /LS	2,630,000	3,361,359.19 /LS	3,361,359
5.3A						**CIP 5 - WTP Replacement, Phase 3A**											
	01.4					Demolition - Conference room											
		02.0				Existing Conditions											
			02.40			**Demolition**											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	30.47 CY	43	3,001		-	2,285	-	173.50 /CY	5,286	294.04 /CY	8,959
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	30.47 CY	43	3,001			2,285	-	173.50 /CY	5,286	294.04 /CY	8,959
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											
						Demolition Concrete Other	3.05 CY	7	500		-	381	-	289.16 /CY	881	490.07 /CY	1,493
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	3.05 CY	7	500			381	-	289.16 /CY	881	490.07 /CY	1,493
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	73.13 ton		-	2,194	-	-	-	30.00 /ton	2,194	45.14 /ton	3,301
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	3.66 LD	7	521		-	653	-	321.06 /LD	1,174	544.13 /LD	1,989
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	3.66 LD	7	521	2,194		653		921.10 /LD	3,368	1,447.08 /LD	5,291
						02.01.02.0010 Demo Strucutral Concrete	33.52 CY	57	4,022	2,194		3,319		284.49 /CY	9,535	469.71 /CY	15,743
				02.01.02.0070		Misc. Demolition											
					02.01.02.00	Sturcture/Building Demoltion											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	780.00 SF	250	17,285		-	19,943	-	47.73 /SF	37,229	80.89 /SF	63,095
						02.01.02.00 Sturcture/Building Demoltion	780.00 SF	250	17,285			19,943		47.73 /SF	37,229	80.89 /SF	63,095
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	170.63 ton		-	5,119	-	-	-	30.00 /ton	5,119	45.14 /ton	7,703
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	8.53 LD	17	1,215		-	1,524	-	321.06 /LD	2,739	544.13 /LD	4,642
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	8.53 LD	17	1,215	5,119		1,524		921.07 /LD	7,858	1,447.05 /LD	12,345
						02.01.02.0070 Misc. Demolition	*1.00* LS	267	18,500	5,119		21,468		45,086.20 /LS	45,086	75,440.13 /LS	75,440
				02.01.04.40		HVAC Demolition											
					02.01.04.40	HVAC Demolition											
						HVAC Demolition - Med Crew	9.75 hr	49	3,326		-	1,686	-	514.10 /hr	5,012	871.30 /hr	8,495
						02.01.04.40 HVAC Demolition	0.00	49	3,326			1,686		/LS	5,012	/LS	8,495
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	12.19 ton		-	366	-	-	-	30.00 /ton	366	45.15 /ton	550
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.61 LD	1	87		-	109	-	321.05 /LD	196	544.12 /LD	331
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.61 LD	1	87	366		109		921.44 /LD	561	1,447.62 /LD	882
						02.01.04.40 HVAC Demolition	*1.00* LS	50	3,413	366		1,795		5,573.61 /LS	5,574	9,376.76 /LS	9,377
				02.01.06.0010		Electrical Demolition											
					02.01.06.01	Electrical Facility Demolition											
						Electrical Demolition - Med Crew	9.75 hr	49	3,326		-	1,686	-	514.10 /hr	5,012	871.30 /hr	8,495
						02.01.06.01 Electrical Facility Demolition	*1.00* LS	49	3,326			1,686		5,012.45 /LS	5,012	8,495.16 /LS	8,495
					31.20.15.00	Earthworks, Sitework, Hauling and Dump Fees											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	12.19 ton		-	366	-	-	-	30.00 /ton	366	45.15 /ton	550
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	0.61 LD	1	87		-	109	-	321.05 /LD	196	544.11 /LD	331
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	0.61 LD	1	87	366		109		921.44 /LD	561	1,447.60 /LD	882
						02.01.06.0010 Electrical Demolition	*1.00* LS	50	3,413	366		1,795		5,573.61 /LS	5,574	9,376.75 /LS	9,377
						02.40 Demolition	*1.00* LS	424	29,348	8,044		28,377		65,768.25 /LS	65,768	109,936.59 /LS	109,937
						02.0 Existing Conditions	*1.00* LS	424	29,348	8,044		28,377		65,768.25 /LS	65,768	109,936.59 /LS	109,937
						01.4 Demolition - Conference room	*1.00* LS	424	29,348	8,044		28,377		65,768.25 /LS	65,768	109,936.59 /LS	109,937
	01.5					Demolition - Maintenance shed											
		02.0				Existing Conditions											
			02.40			**Demolition**											
				02.01.02.0010		Demo Strucutral Concrete											
					02.01.02.02	Selective Demolition, Cut-out, Concrete, Slabs											
						Demo Concrete Foundations	69.06 CY	97	6,802		-	5,180	-	173.50 /CY	11,982	294.04 /CY	20,307
						02.01.02.02 Selective Demolition, Cut-out, Concrete, Slabs	69.06 CY	97	6,802			5,180		173.50 /CY	11,982	294.04 /CY	20,307
					02.01.02.99	Selective Demolition, Cut-out, Concrete, Other											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
					02.01.02.99	**Selective Demolition, Cut-out, Concrete, Other**											
						Demolition Concrete Other	6.91 CY	16	1,134		-	863	-	289.16 /CY	1,997	490.07 /CY	3,384
						02.01.02.99 Selective Demolition, Cut-out, Concrete, Other	**6.91 CY**	**16**	**1,134**			**863**		**289.16 /CY**	**1,997**	**490.07 /CY**	**3,384**
					31.20.15.00	**Earthworks, Sitework, Hauling and Dump Fees**											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	165.75 ton		-	4,973	-	-	-	30.00 /ton	4,973	45.14 /ton	7,483
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	8.29 LD	17	1,180		-	1,481	-	321.06 /LD	2,661	544.13 /LD	4,510
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	**8.29 LD**	**17**	**1,180**	**4,973**		**1,481**		**921.02 /LD**	**7,633**	**1,446.96 /LD**	**11,992**
						02.01.02.0010 Demo Strucutral Concrete	**75.97 CY**	**129**	**9,116**	**4,973**		**7,524**		**284.49 /CY**	**21,612**	**469.72 /CY**	**35,684**
				02.01.02.0070		**Misc. Demolition**											
					02.01.02.00	**Sturcture/Building Demoltion**											
						Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	1,768.00 SF	566	39,180	-	-	45,205	-	47.73 /SF	84,385	80.89 /SF	143,016
						02.01.02.00 Sturcture/Building Demoltion	**1,768.00 SF**	**566**	**39,180**			**45,205**		**47.73 /SF**	**84,385**	**80.89 /SF**	**143,016**
					31.20.15.00	**Earthworks, Sitework, Hauling and Dump Fees**											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	386.75 ton		-	11,603	-	-	-	30.00 /ton	11,603	45.14 /ton	17,460
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	19.34 LD	39	2,754		-	3,455	-	321.06 /LD	6,209	544.13 /LD	10,522
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	**19.34 LD**	**39**	**2,754**	**11,603**		**3,455**		**921.04 /LD**	**17,811**	**1,446.99 /LD**	**27,982**
						02.01.02.0070 Misc. Demolition	**0.00**	**604**	**41,933**	**11,603**		**48,660**		**/LS**	**102,196**	**/LS**	**170,998**
				02.01.06.0010		**Electrical Demolition**											
					02.01.06.01	**Electrical Facility Demolition**											
						Electrical Demolition - Med Crew	22.10 hr	111	7,540		-	3,822	-	514.10 /hr	11,362	871.30 /hr	19,256
						02.01.06.01 Electrical Facility Demolition	***1.00* LS**	**111**	**7,540**			**3,822**		**11,361.54 /LS**	**11,362**	**19,255.71 /LS**	**19,256**
					31.20.15.00	**Earthworks, Sitework, Hauling and Dump Fees**											
						Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	27.63 ton		-	829	-	-	-	30.00 /ton	829	45.14 /ton	1,247
						Haul Debris to Republic Services Landfill - 60 Miles Round Trip (2hr per load) 10CY/load (neatline)	1.38 LD	3	197		-	247	-	321.06 /LD	443	544.13 /LD	751
						31.20.15.00 Earthworks, Sitework, Hauling and Dump Fees	**1.38 LD**	**3**	**197**	**829**		**247**		**921.17 /LD**	**1,272**	**1,447.18 /LD**	**1,999**
						02.01.06.0010 Electrical Demolition	***1.00* LS**	**113**	**7,736**	**829**		**4,068**		**12,633.67 /LS**	**12,634**	**21,254.26 /LS**	**21,254**
						02.40 Demolition	***1.00* LS**	**847**	**58,786**	**17,404**		**60,252**		**136,441.87 /LS**	**136,442**	**227,936.79 /LS**	**227,937**
						02.0 Existing Conditions	***1.00* LS**	**847**	**58,786**	**17,404**		**60,252**		**136,441.87 /LS**	**136,442**	**227,936.79 /LS**	**227,937**
						01.5 Demolition - Maintenance shed	***1.00* LS**	**847**	**58,786**	**17,404**		**60,252**		**136,441.87 /LS**	**136,442**	**227,936.79 /LS**	**227,937**
	04.0					**Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor**											
		13.0				**Special Construction**											
			13.01			**Buildings Complete**											
				13.00.01.0400		**Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor**											
					13.01.99.00	**Special Construction, Other**											
						Improvements to existing Wicks WTP	1.00 ls					-	266,000	266,000.00 /ls	266,000	360,380.34 /ls	360,380
						13.01.99.00 Special Construction, Other	***1.00* LS**						**266,000**	**266,000.00 /LS**	**266,000**	**360,380.34 /LS**	**360,380**
						13.00.01.0400 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	***1.00* LS**						**266,000**	**266,000.00 /LS**	**266,000**	**360,380.34 /LS**	**360,380**
						13.01 Buildings Complete	***1.00* LS**						**266,000**	**266,000.00 /LS**	**266,000**	**360,380.34 /LS**	**360,380**
						13.0 Special Construction	***1.00* LS**						**266,000**	**266,000.00 /LS**	**266,000**	**360,380.34 /LS**	**360,380**
						04.0 Replace pH Analyer, Sodium Hypochlorite Tanks, Track Vac Air Compressor	***1.00* LS**						**266,000**	**266,000.00 /LS**	**266,000**	**360,380.34 /LS**	**360,380**
	10.1					**New 24" raw water**											
		33.0				**Utilities**											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.RW24		**New 24" raw water**											
					31.00.01.01	**Trenching, Backfill, and Compaction**											
						Rent trench box, 8000 lb., 8' x 16'	34.00 day		-	-	-	4,085	-	120.15 /day	4,085	203.63 /day	6,924
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	1,316.05 CY	292	20,936	-	-	21,665	-	32.37 /CY	42,601	54.86 /CY	72,201
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	252.91 ecy	98	5,936	-	-	-	-	23.47 /ecy	5,936	39.78 /ecy	10,060
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	962.96 ecy	77	5,593	-	-	1,011	-	6.86 /ecy	6,604	11.62 /ecy	11,193
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	252.91 lcy	40	2,635	5,311	-	467	-	33.27 /lcy	8,414	52.39 /lcy	13,251
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	96.30 lcy	15	1,003	1,743	-	178	-	30.37 /lcy	2,924	48.03 /lcy	4,625
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	353.09 lcy	72	5,157	-	-	7,165	-	34.90 /lcy	12,322	59.14 /lcy	20,883
						31.00.01.01 Trenching, Backfill, and Compaction	**1,316.05 CY**	**596**	**41,260**	**7,054**		**34,572**		**62.98 /CY**	**82,886**	**105.72 /CY**	**139,136**
					33.00.04.24	**Buried Pipe, Ductile Iron, 24"**											
						24" pipe, DI, RJ, excav/bkfill not included, 350#	1,200.00 LF	432	36,102	189,562	-	20,405	-	205.06 /LF	246,069	317.52 /LF	381,023
						24" DI, RJ, Ell, 45	20.00 ea	170	14,207	52,850	-	8,030	-	3,754.33 /ea	75,087	5,860.81 /ea	117,216
						Megalugs for DI Pipe w/ Accessories, 24"	60.00 ea	120	10,028	28,230	-	5,668	-	732.11 /ea	43,926	1,151.39 /ea	69,083
						Polywrap, 24" pipe	1,200.00 lf		-	1,332	-	-	-	1.11 /lf	1,332	1.67 /lf	2,004
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.06 /ea	6,449
						Add for tie-in to existing, wet tap by subcontractor	1.00 ea		-	-	25,000	-	-	25,000.00 /ea	25,000	37,620.33 /ea	37,620
						Pipe Marking, ID Tape	1,200.00 lf	12	1,003	156	-	-	-	0.97 /lf	1,159	1.61 /lf	1,934
						33.00.04.24 Buried Pipe, Ductile Iron, 24"	**1,200.00 LF**	**758**	**63,346**	**272,880**	**25,000**	**35,236**		**330.38 /LF**	**396,461**	**512.78 /LF**	**615,331**
						33.00.04.RW24 New 24" raw water	**1,200.00 LF**	**1,354**	**104,606**	**279,934**	**25,000**	**69,807**		**399.46 /LF**	**479,347**	**628.72 /LF**	**754,467**
						33.02 Buried Process Pipe, Ductile Iron	**1,200.00 LF**	**1,354**	**104,606**	**279,934**	**25,000**	**69,807**		**399.46 /LF**	**479,347**	**628.72 /LF**	**754,467**
						33.0 Utilities	***1.00* LS**	**1,354**	**104,606**	**279,934**	**25,000**	**69,807**		**479,347.43 /LS**	**479,347**	**754,467.03 /LS**	**754,467**
						10.1 New 24" raw water	**1,200.00 LF**	**1,354**	**104,606**	**279,934**	**25,000**	**69,807**		**399.46 /LF**	**479,347**	**628.72 /LF**	**754,467**
						5.3A CIP 5 - WTP Replacement, Phase 3A	***1.00* LS**	**2,625**	**192,740**	**305,381**	**25,000**	**158,436**	**266,000**	**947,557.55 /LS**	**947,558**	**1,452,720.75 /LS**	**1,452,721**
5.3B						**CIP 5 - WTP Replacement, Phase 3B**											
	08.1					**Rapid Mix**											
		13.0				**Special Construction**											
			13.01			**Buildings Complete**											
				13.01.99.0701		**Flocculation: RM_Basin**											
					13.01.99.00	**Special Construction, Other**											
						Inline Rapid Mix: New_WTP Costs from Replica (Total Costs)	1.00 ls				-	-	789,618	789,618.00 /ls	789,618	1,069,784.99 /ls	1,069,785
						13.01.99.00 Special Construction, Other	***1.00* LS**						**789,618**	**789,618.00 /LS**	**789,618**	**1,069,784.99 /LS**	**1,069,785**
						13.01.99.0701 Flocculation: RM_Basin	***1.00* LS**						**789,618**	**789,618.00 /LS**	**789,618**	**1,069,784.99 /LS**	**1,069,785**
						13.01 Buildings Complete	***1.00* LS**						**789,618**	**789,618.00 /LS**	**789,618**	**1,069,784.99 /LS**	**1,069,785**
						13.0 Special Construction	***1.00* LS**						**789,618**	**789,618.00 /LS**	**789,618**	**1,069,784.99 /LS**	**1,069,785**
						08.1 Rapid Mix	***1.00* LS**						**789,618**	**789,618.00 /LS**	**789,618**	**1,069,784.99 /LS**	**1,069,785**
	08.2					**Flocculation**											
		13.0				**Special Construction**											
			13.01			**Buildings Complete**											
				13.01.99.0702		**Flocculation: NewWTP_Sed**											
					13.01.99.00	**Special Construction, Other**											
						Flocculation: NewWTP_Sed Costs from Replica (Total Costs)	1.00 ls				-	-	1,277,448	1,277,448.00 /ls	1,277,448	1,730,703.60 /ls	1,730,704
						13.01.99.00 Special Construction, Other	***1.00* LS**						**1,277,448**	**1,277,448.00 /LS**	**1,277,448**	**1,730,703.60 /LS**	**1,730,704**
						13.01.99.0702 Flocculation: NewWTP_Sed	***1.00* LS**						**1,277,448**	**1,277,448.00 /LS**	**1,277,448**	**1,730,703.60 /LS**	**1,730,704**
						13.01 Buildings Complete	***1.00* LS**						**1,277,448**	**1,277,448.00 /LS**	**1,277,448**	**1,730,703.60 /LS**	**1,730,704**
						13.0 Special Construction	***1.00* LS**						**1,277,448**	**1,277,448.00 /LS**	**1,277,448**	**1,730,703.60 /LS**	**1,730,704**
						08.2 Flocculation	***1.00* LS**						**1,277,448**	**1,277,448.00 /LS**	**1,277,448**	**1,730,703.60 /LS**	**1,730,704**
	08.3					**Sedimentation Basin**											
		13.0				**Special Construction**											

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
			13.01			**Buildings Complete**											
				13.01.99.0703		Lamella Clarifier: New_WTP											
					13.01.99.00	Special Construction, Other											
						Lamella Clarifier: New_WTP Costs from Replica (Total Costs)	1.00 ls				-	-	2,145,931	2,145,930.55 /ls	2,145,931	2,907,335.34 /ls	2,907,335
						13.01.99.00 Special Construction, Other	*1.00* LS						2,145,931	2,145,930.55 /LS	2,145,931	2,907,335.34 /LS	2,907,335
						13.01.99.0703 Lamella Clarifier: New_WTP	*1.00* LS						2,145,931	2,145,930.55 /LS	2,145,931	2,907,335.34 /LS	2,907,335
						13.01 Buildings Complete	*1.00* **LS**						**2,145,931**	**2,145,930.55 /LS**	**2,145,931**	**2,907,335.34 /LS**	**2,907,335**
						13.0 Special Construction	*1.00* LS						2,145,931	2,145,930.55 /LS	2,145,931	2,907,335.34 /LS	2,907,335
						08.3 Sedimentation Basin	*1.00* LS						2,145,931	2,145,930.55 /LS	2,145,931	2,907,335.34 /LS	2,907,335
	08.4					Filtration											
		13.0				Special Construction											
			13.01			**Buildings Complete**											
				13.01.99.0704		Filters: New_WTP											
					13.01.99.00	Special Construction, Other											
						Filters: New_WTP Costs from Replica (Total Costs)	1.00 ls				-	-	5,594,812	5,594,812.44 /ls	5,594,812	7,579,926.53 /ls	7,579,927
						13.01.99.00 Special Construction, Other	*1.00* LS						5,594,812	5,594,812.44 /LS	5,594,812	7,579,926.53 /LS	7,579,927
						13.01.99.0704 Filters: New_WTP	*1.00* LS						5,594,812	5,594,812.44 /LS	5,594,812	7,579,926.53 /LS	7,579,927
						13.01 Buildings Complete	*1.00* **LS**						**5,594,812**	**5,594,812.44 /LS**	**5,594,812**	**7,579,926.53 /LS**	**7,579,927**
						13.0 Special Construction	*1.00* LS						5,594,812	5,594,812.44 /LS	5,594,812	7,579,926.53 /LS	7,579,927
						08.4 Filtration	*1.00* LS						5,594,812	5,594,812.44 /LS	5,594,812	7,579,926.53 /LS	7,579,927
	08.5					Shoring											
		31.0				Earthwork											
			31.16			**Earthworks, Sheeting/Shoring & Cofferdams**											
				31.16.01.0010		Shoring											
					31.16.01.00	Earthworks, Sheeting and Shoring											
						Shoring, sheet pile, subcontracted	7,370.00 SF	958		-	552,750	-	-	75.00 /SF	552,750	101.61 /SF	748,873
						31.16.01.00 Earthworks, Sheeting and Shoring	7,370.00 SF	958			552,750			75.00 /SF	552,750	101.61 /SF	748,873
						31.16.01.0010 Shoring	7,370.00 SF	958			552,750			75.00 /SF	552,750	101.61 /SF	748,873
						31.16 Earthworks, Sheeting/Shoring & Cofferdams	**7,370.00 SF**	**958**			**552,750**			**75.00 /SF**	**552,750**	**101.61 /SF**	**748,873**
						31.0 Earthwork	*1.00* LS	958			552,750			552,750.00 /LS	552,750	748,873.08 /LS	748,873
						08.5 Shoring	*1.00* LS	958			552,750			552,750.00 /LS	552,750	748,873.08 /LS	748,873
	08.6					Dewatering											
		31.0				Earthwork											
			31.19			**Dewatering and Bypass Pumping**											
				31.15.02.0010		Dewatering											
					31.15.02.00	Site Preparation, Dewatering											
						Dewatering Wellpoints, Complete System, Mob	1.00 ea	24		-	15,000	-	-	15,000.00 /ea	15,000	20,322.20 /ea	20,322
						Dewatering Wellpoints, Complete System, Install	5.00 day	240	15,990	-	-	15,203	-	6,238.62 /day	31,193	10,261.37 /day	51,307
						Dewatering Wellpoints, Complete System, Rental, First Month	1.00 mo		-	-	-	35,000	-	35,000.00 /mo	35,000	57,568.46 /mo	57,568
						Dewatering Wellpoints, Complete System, Rental, after first month, Monthly	23.00 mo			-	-	460,000	-	20,000.00 /mo	460,000	32,896.27 /mo	756,614
						Dewatering Wellpoints, Complete System, Operation - Labor to maintain / check pumps/ fuel and lube	24.00 MO	2,160	130,996	-	-	9,975	-	5,873.79 /MO	140,971	9,661.29 /MO	231,871
						Dewatering Wellpoints, Complete System, Removal	5.00 day	240	15,990	-	-	10,431	-	5,284.06 /day	26,420	8,691.30 /day	43,456
						Dewatering Wellpoints, Complete System, Demob	1.00 ea	24		-	10,000	-	-	10,000.00 /ea	10,000	13,548.14 /ea	13,548
						31.15.02.00 Site Preparation, Dewatering	24.00 MO	2,688	162,976		25,000	530,609		29,941.02 /MO	718,584	48,945.30 /MO	1,174,687
						31.15.02.0010 Dewatering	24.00 MO	2,688	162,976		25,000	530,609		29,941.02 /MO	718,584	48,945.30 /MO	1,174,687
						31.19 Dewatering and Bypass Pumping	**24.00 MO**	**2,688**	**162,976**		**25,000**	**530,609**		**29,941.02 /MO**	**718,584**	**48,945.30 /MO**	**1,174,687**
						31.0 Earthwork	*1.00* LS	2,688	162,976		25,000	530,609		718,584.40 /LS	718,584	1,174,687.20 /LS	1,174,687
						08.6 Dewatering	*1.00* LS	2,688	162,976		25,000	530,609		718,584.40 /LS	718,584	1,174,687.20 /LS	1,174,687
	09.0					Construct new treatment chem building											
		13.0				Special Construction											
			13.01			**Buildings Complete**											
				13.00.01.0801		Construct new treatment chem building											
					13.00.01.02	Buildings, Operations											
						Building Complete - Chemical Building	1,584.00 SF				427,680	-	-	270.00 /SF	427,680	406.30 /SF	643,579
						13.00.01.02 Buildings, Operations	1,584.00 SF				427,680			270.00 /SF	427,680	406.30 /SF	643,579
						13.00.01.0801 Construct new treatment chem building	*1.00* LS				427,680			427,680.00 /LS	427,680	643,578.57 /LS	643,579
						13.01 Buildings Complete	*1.00* **LS**				**427,680**			**427,680.00 /LS**	**427,680**	**643,578.57 /LS**	**643,579**
						13.0 Special Construction	*1.00* LS				427,680			427,680.00 /LS	427,680	643,578.57 /LS	643,579
						09.0 Construct new treatment chem building	*1.00* LS				427,680			427,680.00 /LS	427,680	643,578.57 /LS	643,579
	09.1					Coagulant (ACH)											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: ACH - 11 - Equipment	1.00 ls				-	-	55,146	55,146.00 /ls	55,146	74,712.54 /ls	74,713
						11.00.99.00 Equipment, Other	*1.00* LS						55,146	55,146.00 /LS	55,146	74,712.54 /LS	74,713
						11.00.99.0011 Equipment Costs from Replica	*1.00* LS						55,146	55,146.00 /LS	55,146	74,712.54 /LS	74,713
						11.00 Equipment	*1.00* **LS**						**55,146**	**55,146.00 /LS**	**55,146**	**74,712.54 /LS**	**74,713**
						11.0 Commercial Equipment	*1.00* LS						55,146	55,146.00 /LS	55,146	74,712.54 /LS	74,713
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: ACH - 16 Electrical	1.00 ls				-	-	112,110	112,110.00 /ls	112,110	151,888.12 /ls	151,888
						26.00.99.00 Electrical, Other	*1.00* LS						112,110	112,110.00 /LS	112,110	151,888.12 /LS	151,888
						26.00.99.0016 Electrical Costs from Replica	*1.00* LS						112,110	112,110.00 /LS	112,110	151,888.12 /LS	151,888
						26.00 Electrical	*1.00* **LS**						**112,110**	**112,110.00 /LS**	**112,110**	**151,888.12 /LS**	**151,888**
						26.0 Electrical Work	*1.00* LS						112,110	112,110.00 /LS	112,110	151,888.12 /LS	151,888
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: ACH - 15 Mechanical	1.00 ls				-	-	23,028	23,028.00 /ls	23,028	31,198.64 /ls	31,199
						40.00.99.01 Process Pipe, Other	*1.00* LS						23,028	23,028.00 /LS	23,028	31,198.64 /LS	31,199
						40.00.99.0015 Mechanical Costs from Replica	*1.00* LS						23,028	23,028.00 /LS	23,028	31,198.64 /LS	31,199
						40.19 Process Pipe, Other	*1.00* **LS**						**23,028**	**23,028.00 /LS**	**23,028**	**31,198.64 /LS**	**31,199**
						40.0 Process Pipe	*1.00* LS						23,028	23,028.00 /LS	23,028	31,198.64 /LS	31,199
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: ACH - 13 Special Construction	1.00 ls				-	-	61,812	61,812.00 /ls	61,812	83,743.72 /ls	83,744

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						40.90.99.01 I&C, Other	1.00 LS						61,812	61,812.00 /LS	61,812	83,743.72 /LS	83,744
						40.90.99.0013 Special Construction from Replica	1.00 LS						61,812	61,812.00 /LS	61,812	83,743.72 /LS	83,744
						40.90 Instrumentation & Controls	**1.00 LS**						**61,812**	**61,812.00 /LS**	**61,812**	**83,743.72 /LS**	**83,744**
						40.9 Instrumentation & Controls	1.00 LS						61,812	61,812.00 /LS	61,812	83,743.72 /LS	83,744
						09.1 Coagulant (ACH)	1.00 LS						252,096	252,096.00 /LS	252,096	341,543.02 /LS	341,543
	09.2					Filter Aid Polymer											
		11.0				Commercial Equipment											
			11.00			**Equipment**											
				11.00.99.0011		Equipment Costs from Replica											
					11.00.99.00	Equipment, Other											
						Liquid Chemical: FilPolymer - 11 - Equipment	1.00 ls				-	-	65,518	65,518.00 /ls	65,518	88,764.66 /ls	88,765
						11.00.99.00 Equipment, Other	1.00 LS						65,518	65,518.00 /LS	65,518	88,764.66 /LS	88,765
						11.00.99.0011 Equipment Costs from Replica	1.00 LS						65,518	65,518.00 /LS	65,518	88,764.66 /LS	88,765
						11.00 Equipment	**1.00 LS**						**65,518**	**65,518.00 /LS**	**65,518**	**88,764.66 /LS**	**88,765**
						11.0 Commercial Equipment	1.00 LS						65,518	65,518.00 /LS	65,518	88,764.66 /LS	88,765
		26.0				Electrical Work											
			26.00			**Electrical**											
				26.00.99.0016		Electrical Costs from Replica											
					26.00.99.00	Electrical, Other											
						Liquid Chemical: FilPolymer - 16 Electrical	1.00 ls				-	-	4,848	4,848.00 /ls	4,848	6,568.14 /ls	6,568
						26.00.99.00 Electrical, Other	1.00 LS						4,848	4,848.00 /LS	4,848	6,568.14 /LS	6,568
						26.00.99.0016 Electrical Costs from Replica	1.00 LS						4,848	4,848.00 /LS	4,848	6,568.14 /LS	6,568
						26.00 Electrical	**1.00 LS**						**4,848**	**4,848.00 /LS**	**4,848**	**6,568.14 /LS**	**6,568**
						26.0 Electrical Work	1.00 LS						4,848	4,848.00 /LS	4,848	6,568.14 /LS	6,568
		40.0				Process Pipe											
			40.19			**Process Pipe, Other**											
				40.00.99.0015		Mechanical Costs from Replica											
					40.00.99.01	Process Pipe, Other											
						Liquid Chemical: FilPolymer - 15 Mechanical	1.00 ls				-	-	13,332	13,332.00 /ls	13,332	18,062.36 /ls	18,062
						40.00.99.01 Process Pipe, Other	1.00 LS						13,332	13,332.00 /LS	13,332	18,062.36 /LS	18,062
						40.00.99.0015 Mechanical Costs from Replica	1.00 LS						13,332	13,332.00 /LS	13,332	18,062.36 /LS	18,062
						40.19 Process Pipe, Other	**1.00 LS**						**13,332**	**13,332.00 /LS**	**13,332**	**18,062.36 /LS**	**18,062**
						40.0 Process Pipe	1.00 LS						13,332	13,332.00 /LS	13,332	18,062.36 /LS	18,062
		40.9				Instrumentation & Controls											
			40.90			**Instrumentation & Controls**											
				40.90.99.0013		Special Construction from Replica											
					40.90.99.01	I&C, Other											
						Liquid Chemical: FilPolymer - 13 Special Construction	1.00 ls				-	-	52,722	52,722.00 /ls	52,722	71,428.47 /ls	71,428
						40.90.99.01 I&C, Other	1.00 LS						52,722	52,722.00 /LS	52,722	71,428.47 /LS	71,428
						40.90.99.0013 Special Construction from Replica	1.00 LS						52,722	52,722.00 /LS	52,722	71,428.47 /LS	71,428
						40.90 Instrumentation & Controls	**1.00 LS**						**52,722**	**52,722.00 /LS**	**52,722**	**71,428.47 /LS**	**71,428**
						40.9 Instrumentation & Controls	1.00 LS						52,722	52,722.00 /LS	52,722	71,428.47 /LS	71,428
						09.2 Filter Aid Polymer	1.00 LS						136,420	136,420.00 /LS	136,420	184,823.63 /LS	184,824
	10.2					New 30" filtered water											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.FW30		30" FW - Finished Water											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	2.00 day		-	-	-	240	-	120.15 /day	240	203.63 /day	407
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	130.00 CY	29	2,068	-	-	2,140	-	32.37 /CY	4,208	54.86 /CY	7,132
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	39.65 ecy	15	931	-	-	-	-	23.47 /ecy	931	39.78 /ecy	1,577
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	72.22 ecy	6	419	-	-	76	-	6.86 /ecy	495	11.62 /ecy	839
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	39.65 lcy	6	413	833	-	73	-	33.27 /lcy	1,319	52.39 /lcy	2,077
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	7.22 lcy	1	75	131	-	13	-	30.37 /lcy	219	48.03 /lcy	347
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	57.78 lcy	12	844	-	-	1,172	-	34.90 /lcy	2,016	59.14 /lcy	3,417
						31.00.01.01 Trenching, Backfill, and Compaction	130.00 CY	69	4,750	963		3,715		72.53 /CY	9,429	121.52 /CY	15,797
					33.00.04.30	Buried Pipe, Ductile Iron, 30"											
						30" pipe, DI, RJ, excav/bkfill not included, 250#	60.00 LF	25	2,106	11,724	-	1,190	-	250.35 /LF	15,021	387.16 /LF	23,230
						30" DI, RJ, Ell, 90	1.00 ea	10	827	6,473	-	468	-	7,767.65 /ea	7,768	11,934.91 /ea	11,935
						Megalugs for DI Pipe w/ Accessories, 30"	4.00 ea	8	669	4,314	-	378	-	1,340.06 /ea	5,360	2,066.24 /ea	8,265
						Polywrap, 30" pipe	60.00 lf		-	79	-	-	-	1.32 /lf	79	1.99 /lf	119
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.05 /ea	6,449
						Pipe Marking, ID Tape	60.00 lf	1	50	8	-	-	-	0.97 /lf	58	1.61 /lf	97
						33.00.04.30 Buried Pipe, Ductile Iron, 30"	60.00 LF	68	5,658	23,348		3,169		536.25 /LF	32,175	834.91 /LF	50,094
						33.00.04.FW30 30" FW - Finished Water	60.00 LF	137	10,408	24,311		6,885		693.40 /LF	41,604	1,098.20 /LF	65,892
						33.02 Buried Process Pipe, Ductile Iron	**60.00 LF**	**137**	**10,408**	**24,311**		**6,885**		**693.40 /LF**	**41,604**	**1,098.20 /LF**	**65,892**
						33.0 Utilities	1.00 LS	137	10,408	24,311		6,885		41,603.95 /LS	41,604	65,891.78 /LS	65,892
						10.2 New 30" filtered water	60.00 LF	137	10,408	24,311		6,885		693.40 /LF	41,604	1,098.20 /LF	65,892
	10.3					New 14" BWS											
		33.0				Utilities											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.BWS14		New 14" BWS											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	3.00 day		-	-	-	360	-	120.15 /day	360	203.63 /day	611
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	146.71 CY	33	2,334	-	-	2,415	-	32.37 /CY	4,749	54.86 /CY	8,049
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	37.50 ecy	15	880	-	-	-	-	23.47 /ecy	880	39.78 /ecy	1,492
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	95.68 ecy	8	556	-	-	100	-	6.86 /ecy	656	11.62 /ecy	1,112
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	37.50 lcy	6	391	788	-	69	-	33.27 /lcy	1,248	52.39 /lcy	1,965
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	9.57 lcy	2	100	173	-	18	-	30.37 /lcy	291	48.03 /lcy	460
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	51.03 lcy	10	745	-	-	1,035	-	34.90 /lcy	1,781	59.14 /lcy	3,018
						31.00.01.01 Trenching, Backfill, and Compaction	146.71 CY	73	5,005	961		3,999		67.92 /CY	9,965	113.87 /CY	16,706
					33.00.04.14	Buried Pipe, Ductile Iron, 14"											
						14" pipe, DI, RJ, excav/bkfill not included, 350#	100.00 LF	27	2,256	7,235	-	1,275	-	107.67 /LF	10,767	168.73 /LF	16,873
						14" DI, RJ, Ell, 45	1.00 ea	5	443	1,026	-	250	-	1,719.25 /ea	1,719	2,718.86 /ea	2,719
						Megalugs for DI Pipe w/ Accessories, 14"	4.00 ea	6	501	624	-	283	-	352.11 /ea	1,408	567.13 /ea	2,269
						Polywrap, 14" pipe	100.00 lf		-	59	-	-	-	0.59 /lf	59	0.89 /lf	89
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.05 /ea	6,449
						Pipe Marking, ID Tape	100.00 lf	1	84	13	-	-	-	0.97 /lf	97	1.61 /lf	161
						33.00.04.14 Buried Pipe, Ductile Iron, 14"	100.00 LF	63	5,290	9,707		2,943		179.39 /LF	17,939	285.60 /LF	28,560
						33.00.04.BWS14 New 14" BWS	100.00 LF	136	10,295	10,668		6,941		279.04 /LF	27,904	452.65 /LF	45,265
						33.02 Buried Process Pipe, Ductile Iron	**100.00 LF**	**136**	**10,295**	**10,668**		**6,941**		**279.04 /LF**	**27,904**	**452.65 /LF**	**45,265**

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
						33.0 Utilities	1.00 LS	136	10,295	10,668		6,941		27,904.13 /LS	27,904	45,265.46 /LS	45,265
						10.3 New 14" BWS	100.00 LF	136	10,295	10,668		6,941		279.04 /LF	27,904	452.65 /LF	45,265
	11.1					BW EQ Basin											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.01.99.1101		Surge Basin-Decanter: BW_EQ											
					13.01.99.00	Special Construction, Other											
						Surge Basin-Decanter: BW_EQ (Cost from RPD_Residuals Replica Cost Estimate)	1.00 ls				-	-	1,044,000	1,044,000.00 /ls	1,044,000	1,414,425.13 /ls	1,414,425
						13.01.99.00 Special Construction, Other	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,425.13 /LS	1,414,425
						13.01.99.1101 Surge Basin-Decanter: BW_EQ	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,425.13 /LS	1,414,425
						13.01 Buildings Complete	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,425.13 /LS	1,414,425
						13.0 Special Construction	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,425.13 /LS	1,414,425
						11.1 BW EQ Basin	1.00 LS						1,044,000	1,044,000.00 /LS	1,044,000	1,414,425.13 /LS	1,414,425
	11.2					BW Clarifier											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.01.99.1102		Package WTP: BW_Clar											
					13.01.99.00	Special Construction, Other											
						Package WTP: BW_Clar (Cost from RPD_Residuals Replica Cost Estimate)	1.00 ls				-	-	717,000	717,000.00 /ls	717,000	971,401.16 /ls	971,401
						13.01.99.00 Special Construction, Other	1.00 LS						717,000	717,000.00 /LS	717,000	971,401.16 /LS	971,401
						13.01.99.1102 Package WTP: BW_Clar	1.00 LS						717,000	717,000.00 /LS	717,000	971,401.16 /LS	971,401
						13.01 Buildings Complete	1.00 LS						717,000	717,000.00 /LS	717,000	971,401.16 /LS	971,401
						13.0 Special Construction	1.00 LS						717,000	717,000.00 /LS	717,000	971,401.16 /LS	971,401
						11.2 BW Clarifier	1.00 LS						717,000	717,000.00 /LS	717,000	971,401.16 /LS	971,401
	11.3					Engineered Drying Beds											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.01.99.1104		Sludge Drying Beds: New											
					13.01.99.00	Special Construction, Other											
						Sludge Drying Beds: New (Cost from RPD_Residuals Replica Cost Estimate)	1.00 ls				-	-	1,022,000	1,022,000.00 /ls	1,022,000	1,384,619.24 /ls	1,384,619
						13.01.99.00 Special Construction, Other	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,619.24 /LS	1,384,619
						13.01.99.1104 Sludge Drying Beds: New	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,619.24 /LS	1,384,619
						13.01 Buildings Complete	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,619.24 /LS	1,384,619
						13.0 Special Construction	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,619.24 /LS	1,384,619
						11.3 Engineered Drying Beds	1.00 LS						1,022,000	1,022,000.00 /LS	1,022,000	1,384,619.24 /LS	1,384,619
	11.4					EDB Recycle Pump Station											
		13.0				Special Construction											
			13.01			Buildings Complete											
				13.01.99.1105		WPSPS: Recycle											
					13.01.99.00	Special Construction, Other											
						WPSPS: Recycle (Cost from RPD_Residuals Replica Cost Estimate)	1.00 ls				-	-	429,000	429,000.00 /ls	429,000	581,214.92 /ls	581,215
						13.01.99.00 Special Construction, Other	1.00 LS						429,000	429,000.00 /LS	429,000	581,214.92 /LS	581,215
						13.01.99.1105 WPSPS: Recycle	1.00 LS						429,000	429,000.00 /LS	429,000	581,214.92 /LS	581,215
						13.01 Buildings Complete	1.00 LS						429,000	429,000.00 /LS	429,000	581,214.92 /LS	581,215
						13.0 Special Construction	1.00 LS						429,000	429,000.00 /LS	429,000	581,214.92 /LS	581,215
						11.4 EDB Recycle Pump Station	1.00 LS						429,000	429,000.00 /LS	429,000	581,214.92 /LS	581,215
	12.1					20" BWW & FTW											
		33.0				Utilities											
			33.02			Buried Process Pipe, Ductile Iron											
				33.00.04.BWWFTW20		20" BWW & FTW											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	5.00 day		-	-	-	601	-	120.15 /day	601	203.63 /day	1,018
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	102.84 CY	23	1,636	-	-	1,693	-	32.37 /CY	3,329	54.86 /CY	5,642
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	28.73 ecy	11	674	-	-	-	-	23.47 /ecy	674	39.78 /ecy	1,143
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	62.96 ecy	5	366	-	-	66	-	6.86 /ecy	432	11.62 /ecy	732
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	28.73 lcy	5	299	603	-	53	-	33.27 /lcy	956	52.39 /lcy	1,505
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	6.30 lcy	1	66	114	-	12	-	30.37 /lcy	191	48.03 /lcy	303
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	39.88 lcy	8	582	-	-	809	-	34.90 /lcy	1,392	59.14 /lcy	2,359
						31.00.01.01 Trenching, Backfill, and Compaction	102.84 CY	53	3,623	717		3,234		73.65 /CY	7,575	123.50 /CY	12,701
					33.00.04.20	Buried Pipe, Ductile Iron, 20"											
						20" pipe, DI, RJ, excav/bkfill not included, 350#	60.00 LF	20	1,655	7,042	-	935	-	160.53 /LF	9,632	249.76 /LF	14,986
						20" DI, RJ, Ell, 45	4.00 ea	29	2,407	7,653	-	1,360	-	2,855.08 /ea	11,420	4,475.31 /ea	17,901
						Megalugs for DI Pipe w/ Accessories, 20"	8.00 ea	12	1,003	2,779	-	567	-	543.61 /ea	4,349	855.30 /ea	6,842
						Polywrap, 20" pipe	60.00 lf		-	52	-	-	-	0.87 /lf	52	1.31 /lf	79
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.06 /ea	6,449
						Pipe Marking, ID Tape	60.00 lf	1	50	8	-	-	-	0.97 /lf	58	1.61 /lf	97
						33.00.04.20 Buried Pipe, Ductile Iron, 20"	60.00 LF	85	7,120	18,284		3,996		490.00 /LF	29,400	772.56 /LF	46,354
						33.00.04.BWWFTW20 20" BWW & FTW	60.00 LF	138	10,744	19,001		7,230		616.24 /LF	36,975	984.25 /LF	59,055
						33.02 Buried Process Pipe, Ductile Iron	60.00 LF	138	10,744	19,001		7,230		616.24 /LF	36,975	984.25 /LF	59,055
						33.0 Utilities	1.00 LS	138	10,744	19,001		7,230		36,974.62 /LS	36,975	59,054.83 /LS	59,055
						12.1 20" BWW & FTW	60.00 LF	138	10,744	19,001		7,230		616.24 /LF	36,975	984.25 /LF	59,055
	12.2					04" BWW & FTW											
		33.0				Utilities											
			33.02			Buried Process Pipe, Ductile Iron											
				33.00.04.BWWFTW04		04" BWW & FTW											
					31.00.01.01	Trenching, Backfill, and Compaction											
						Rent trench box, 8000 lb., 8' x 16'	5.00 day		-	-	-	601	-	120.15 /day	601	203.63 /day	1,018
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	339.98 CY	76	5,409	-	-	5,597	-	32.37 /CY	11,005	54.86 /CY	18,652
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	65.34 ecy	25	1,533	-	-	-	-	23.47 /ecy	1,533	39.78 /ecy	2,599
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	248.77 ecy	20	1,445	-	-	261	-	6.86 /ecy	1,706	11.62 /ecy	2,892
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	65.34 lcy	10	681	1,372	-	121	-	33.27 /lcy	2,174	52.39 /lcy	3,423
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	24.88 lcy	4	259	450	-	46	-	30.37 /lcy	756	48.03 /lcy	1,195
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	91.21 lcy	19	1,332	-	-	1,851	-	34.90 /lcy	3,183	59.14 /lcy	5,394
						31.00.01.01 Trenching, Backfill, and Compaction	339.98 CY	154	10,659	1,822		8,476		61.64 /CY	20,958	103.46 /CY	35,173
					33.00.04.04	Buried Pipe, Ductile Iron, 4"											
						4" pipe, DI, RJ, excav/bkfill not included, 350#	20.00 LF	3	254	554	-	123	-	46.53 /LF	931	73.60 /LF	1,472
						4" DI, RJ, Ell, 45	4.00 ea	8	643	734	-	312	-	422.04 /ea	1,688	680.41 /ea	2,722
						Megalugs for DI Pipe w/ Accessories, 4"	8.00 ea	8	676	302	-	328	-	163.30 /ea	1,306	269.59 /ea	2,157
						Polywrap, 4" pipe	20.00 lf		-	6	-	-	-	0.32 /lf	6	0.48 /lf	10
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.05 /ea	6,449

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Area	Bid Item	Work Pkg	Trade Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total Price	Grand Total Amount
					33.00.04.04	**Buried Pipe, Ductile Iron, 4"**											
						Pipe Marking, ID Tape	20.00 lf	0	17	3	-	-	-	0.97 /lf	19	1.61 /lf	32
						33.00.04.04 Buried Pipe, Ductile Iron, 4"	**20.00 LF**	**43**	**3,595**	**2,349**		**1,896**		**392.01 /LF**	**7,840**	**642.06 /LF**	**12,841**
						33.00.04.BWWFTW04 04" BWW & FTW	**20.00 LF**	**197**	**14,254**	**4,172**		**10,373**		**1,439.90 /LF**	**28,798**	**2,400.74 /LF**	**48,015**
						33.02 Buried Process Pipe, Ductile Iron	**20.00 LF**	**197**	**14,254**	**4,172**		**10,373**		**1,439.90 /LF**	**28,798**	**2,400.74 /LF**	**48,015**
						33.0 Utilities	***1.00*** **LS**	**197**	**14,254**	**4,172**		**10,373**		**28,798.07 /LS**	**28,798**	**48,014.76 /LS**	**48,015**
						12.2 04" BWW & FTW	**20.00 LF**	**197**	**14,254**	**4,172**		**10,373**		**1,439.90 /LF**	**28,798**	**2,400.74 /LF**	**48,015**
	12.3					**04" Combined Recycle BW & EDB**											
		33.0				**Utilities**											
			33.02			**Buried Process Pipe, Ductile Iron**											
				33.00.04.BWEDB04		**04" Combined Recycle BW & EDB**											
					31.00.01.01	**Trenching, Backfill, and Compaction**											
						Rent trench box, 8000 lb., 8' x 16'	5.00 day		-	-	-	601	-	120.15 /day	601	203.63 /day	1,018
						Excavating, trench or continuous footing, Near Existing Utilities, 1-1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	21.93 CY	5	349	-	-	361	-	32.37 /CY	710	54.86 /CY	1,203
						Backfill, 6" layers, compaction in layers, hand tamp, PIPE ZONE	4.22 ecy	2	99	-	-	-	-	23.47 /ecy	99	39.77 /ecy	168
						Backfill, 12" layers, compaction in layers, roller compaction with operator walking, ABOVE PIPE ZONE	16.05 ecy	1	93	-	-	17	-	6.86 /ecy	110	11.62 /ecy	187
						Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, PIPE ZONE	4.22 lcy	1	44	89	-	8	-	33.27 /lcy	140	52.39 /lcy	221
						Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, BEDDING	1.60 lcy	0	17	29	-	3	-	30.37 /lcy	49	48.03 /lcy	77
						Hauling,excavated borrow material,loose cubic yards,20 mile round trip,0.4 load/hr,base wide rate,12 cy truck,highway haulers,excludes loading	5.88 lcy	1	86	-	-	119	-	34.90 /lcy	205	59.14 /lcy	348
						31.00.01.01 Trenching, Backfill, and Compaction	**21.93 CY**	**10**	**688**	**118**		**1,109**		**87.27 /CY**	**1,914**	**146.90 /CY**	**3,221**
					33.00.04.04	**Buried Pipe, Ductile Iron, 4"**											
						4" pipe, DI, RJ, excav/bkfill not included, 350#	310.00 LF	47	3,931	8,588	-	1,907	-	46.53 /LF	14,426	73.60 /LF	22,817
						4" DI, RJ, Ell, 45	8.00 ea	15	1,285	1,468	-	623	-	422.04 /ea	3,376	680.41 /ea	5,443
						Megalugs for DI Pipe w/ Accessories, 4"	16.00 ea	16	1,353	604	-	656	-	163.30 /ea	2,613	269.58 /ea	4,313
						Polywrap, 4" pipe	310.00 lf		-	99	-	-	-	0.32 /lf	99	0.48 /lf	149
						Add for tie-in to existing (Adjust productivity)	1.00 ea	24	2,006	750	-	1,134	-	3,889.25 /ea	3,889	6,449.05 /ea	6,449
						Pipe Marking, ID Tape	310.00 lf	3	259	40	-	-	-	0.97 /lf	299	1.61 /lf	500
						33.00.04.04 Buried Pipe, Ductile Iron, 4"	**310.00 LF**	**105**	**8,834**	**11,549**		**4,319**		**79.68 /LF**	**24,702**	**127.97 /LF**	**39,672**
						33.00.04.BWEDB04 04" Combined Recycle BW & EDB	**310.00 LF**	**115**	**9,522**	**11,667**		**5,428**		**85.86 /LF**	**26,616**	**138.36 /LF**	**42,893**
						33.02 Buried Process Pipe, Ductile Iron	**310.00 LF**	**115**	**9,522**	**11,667**		**5,428**		**85.86 /LF**	**26,616**	**138.36 /LF**	**42,893**
						33.0 Utilities	**0.00**	**115**	**9,522**	**11,667**		**5,428**		**/LS**	**26,616**	**/LS**	**42,893**
						12.3 04" Combined Recycle BW & EDB	**310.00 LF**	**115**	**9,522**	**11,667**		**5,428**		**85.86 /LF**	**26,616**	**138.36 /LF**	**42,893**
	90.2					**Sitework/Site Electrical/Yard Piping/SCADA Allowance**											
		26.0				**Electrical Work**											
			26.10			**Site Electrical**											
				26.10.20.0010		**Site Electrical Allowance**											
					26.10.20.00	**Site Electrical, Other**											
						Site Electrical Allowance (~15% of Construction Costs)	1.00 ls				-	-	2,432,000	2,432,000.00 /ls	2,432,000	3,294,906.05 /ls	3,294,906
						26.10.20.00 Site Electrical, Other	***1.00*** **LS**						**2,432,000**	**2,432,000.00 /LS**	**2,432,000**	**3,294,906.05 /LS**	**3,294,906**
						26.10.20.0010 Site Electrical Allowance	***1.00*** **LS**						**2,432,000**	**2,432,000.00 /LS**	**2,432,000**	**3,294,906.05 /LS**	**3,294,906**
						26.10 Site Electrical	***1.00*** **LS**						**2,432,000**	**2,432,000.00 /LS**	**2,432,000**	**3,294,906.05 /LS**	**3,294,906**
						26.0 Electrical Work	***1.00*** **LS**						**2,432,000**	**2,432,000.00 /LS**	**2,432,000**	**3,294,906.05 /LS**	**3,294,906**
		31.0				**Earthwork**											
			31.00			**Site/Civil General Items**											
				31.00.01.0010		**Sitework Allowance**											
					31.00.01.00	**Site/Civil, General Conditions**											
						Sitework Allowance (~6% construction costs)	1.00 ls						973,000	973,000.00 /ls	973,000	1,318,233.38 /ls	1,318,233
						31.00.01.00 Site/Civil, General Conditions	***1.00*** **LS**						**973,000**	**973,000.00 /LS**	**973,000**	**1,318,233.38 /LS**	**1,318,233**
						31.00.01.0010 Sitework Allowance	***1.00*** **LS**						**973,000**	**973,000.00 /LS**	**973,000**	**1,318,233.38 /LS**	**1,318,233**
						31.00 Site/Civil General Items	***1.00*** **LS**						**973,000**	**973,000.00 /LS**	**973,000**	**1,318,233.38 /LS**	**1,318,233**
						31.0 Earthwork	***1.00*** **LS**						**973,000**	**973,000.00 /LS**	**973,000**	**1,318,233.38 /LS**	**1,318,233**
		40.9				**Instrumentation & Controls**											
			40.90			**Instrumentation & Controls**											
				40.90.07.0010		**Plant Computer System (SCADA allowance)**											
					40.90.07.01	**I&C, SCADA**											
						SCADA Software Development (~6% of Constuction Costs)	1.00 ls						973,000	973,000.00 /ls	973,000	1,318,233.38 /ls	1,318,233
						40.90.07.01 I&C, SCADA	***1.00*** **LS**						**973,000**	**973,000.00 /LS**	**973,000**	**1,318,233.38 /LS**	**1,318,233**
						40.90.07.0010 Plant Computer System (SCADA allowance)	***1.00*** **LS**						**973,000**	**973,000.00 /LS**	**973,000**	**1,318,233.38 /LS**	**1,318,233**
						40.90 Instrumentation & Controls	***1.00*** **LS**						**973,000**	**973,000.00 /LS**	**973,000**	**1,318,233.38 /LS**	**1,318,233**
						40.9 Instrumentation & Controls	***1.00*** **LS**						**973,000**	**973,000.00 /LS**	**973,000**	**1,318,233.38 /LS**	**1,318,233**
						90.2 Sitework/Site Electrical/Yard Piping/SCADA Allowance	***1.00*** **LS**						**4,378,000**	**4,378,000.00 /LS**	**4,378,000**	**5,931,372.81 /LS**	**5,931,373**
						5.3B CIP 5 - WTP Replacement, Phase 3B	***1.00*** **LS**	**4,369**	**218,198**	**69,818**	**1,005,430**	**567,465**	**17,786,325**	**19,647,236.42 /LS**	**19,647,236**	**26,925,408.97 /LS**	**26,925,409**

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Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	1,296,639		######## hrs	
Material	1,164,240			
Subcontract	1,976,380			
Equipment	1,410,080		######## hrs	
Other	25,718,241			
Subtotal Raw Costs	**31,565,580**	**31,565,580**		
Location Adj. Factor	108,269			4.000 %
Productivity Adjustment	406,008			15.000 %
Subtotal Adj. Factors	**514,277**	**32,079,857**		
Escalation CIP 1 - April 2025	15,504			1.989 %
Escalation CIP 2 - April 2026				4.947 %
Escalation CIP 3 - January 2028	413,630			10.346 %
Escalation CIP 4 - August 2029	957,239			15.456 %
Escalation CIP 5 - November 2031	4,763,370			23.129 %
Subtotal Escalation	**6,149,743**	**38,229,600**		
Existing Conditions I,OH&P	108,735			15.000 %
Concrete Work I,OH&P				15.000 %
Masonry Work I,OH&P				15.000 %
Metals Work I,OH&P				15.000 %
Architectural (Div 6-12) OH&P				15.000 %
Special Construction I,OH&P	205,295			15.000 %
Conveying Equipment I,OH&P				15.000 %
Mechanical Work I,OH&P				20.000 %
Electrical Work I,OH&P	13,750			25.000 %
Site/Civil OH&P	69,358			10.000 %
Buried Piping I,OH&P	364,121			15.000 %
Tank Construction I,OH&P				20.000 %
Process Piping I,OH&P				25.000 %
Instruments & Controls I,OH&P				18.000 %
Material Handling I,OH&P				10.000 %
Process Equipment I,OH&P				15.000 %
Subtotal Subcontractor I,OH&P	**761,259**	**38,990,859**		
Total Cost To Prime Contractor		**38,990,859**		
General Conditions	3,899,086			10.000 %
Subtotal Indirect Costs	**3,899,086**	**42,889,945**		
Prime Contractor Home OfficeOH	5,146,793			12.000 %
Prime Contractor Profit	4,288,995			10.000 %
Mobilization/Demobilization	1,286,698			3.000 %
Subtotal OH&P	**10,722,486**	**53,612,431**		
Design Contingency	16,083,730			30.000 %
Subtotal Contingency	**16,083,730**	**69,696,161**		
Total Prime Contractor Costs		**69,696,161**		
Total		***69,696,161***		

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Table E-1. 20-Year O&M and Life Cycle Costs Associated with Each Alternative

Project Element	DAF with GMF	Plate Settlers with GMF
Rapid Mix	$81,000	$81,000
Flocculation	$196,000	$270,000
Dissolved Air Flotation	$2,194,000	N/A
Sedimentation Basin with Plate Settlers	N/A	$949,000
Filters	$896,000	$896,000
Filter Backwash Supply Pump Station	$231,000	$231,000
ACH	$89,000	$89,000
Filter Aid Polymer	$280,000	$280,000
Phosphoric Acid	$56,000	$56,000
Polyphosphates	$59,000	$59,000
Caustic Soda	$242,000	$242,000
On-Site Sodium Hypochlorite Generation	$1,343,000	$1,343,000
Fluoride	$320,000	$320,000
Backwash EQ Basin and Recycle Pump Station	$138,000	$138,000
Backwash Clarifier	$704,000	$704,000
Engineered Drying Beds	$1,043,000	$1,043,000
EDB Decant Pump Station	$110,000	$110,000
Additional WTP O&M	$3,237,000	$3,237,000
WTP O&M Labor	$12,724,000	$12,724,000
20-Year O&M Costs	$23,943,000	$22,772,000

AACE Class 5 Cost Estimate (Accuracy range: -20% to -50% to +30% to +100%)

Attachment F
MODA Scoring

Table F-1. Evaluation Scores for the Treatment Alternatives

Evaluation Criterion	DAF with GMF	Plate Settlers with GMF
Construction		
Footprint	10,260 sf	12,502 sf
Constructability	3	3
Expansion complexity	5	5
Operation		
Winter capacity	80	60
Chemical use	4	3
Level of automation	4	3
Ease of operation	4	3
Maintenance requirements	3	4
Solids production	4	3
Production Efficiency	97%	96%
Water Quality		
Microbial removal and turbidity reduction	4	4
Ability to mitigate future taste and odor and cyanotoxin concerns	4	3

Table F-2. Project Team Consensus Weights

Evaluation Criterion	Weight
Construction	35%
Footprint	9%
Constructability	15%
Expansion complexity	10%
Operation	31%
Winter capacity	6%
Chemical use	3%
Level of automation	4%
Ease of operation	5%
Maintenance requirements	4%
Solids production	4%
Production Efficiency	5%
Water Quality	35%
Microbial removal and turbidity reduction	19%
Ability to mitigate future taste and odor and cyanotoxin concerns	16%

Note: Totals may not add up to 100% due to rounding.