Project Justification
Williams Station PFAS Treatment

Introduction

San Jose Water Company (SJWC) relies on its groundwater system as the backbone of its water supply portfolio, providing reliable, high-quality water and ensuring SJWC's operational resiliency under a wide range of conditions. SJWC's groundwater infrastructure includes 89 production wells across 18 groundwater stations, with an aggregate capacity of approximately 138.5 million gallons per day (MGD).[1] Among these facilities, Williams Station is SJWC's largest groundwater production station, with a total installed production capacity of approximately 22.36 MGD. Williams Station is located in the City of San Jose on a 14.2-acre site along San Tomas Expressway, as presented in Figure 1, and within the confined aquifer region of SJWC's distribution system, see Figure 2.

Routine monitoring since 2019 has confirmed the presence of PFAS at Williams Station, with several wells exhibiting persistent, gradually increasing concentrations. To reduce exposure risk while maintaining system reliability, six wells have been placed in "standby" status (i.e., emergency use only). Without treatment, additional wells may also need to be curtailed, which could impact system reliability during droughts or major outages. Based on bench- and pilot-scale testing conducted between 2020 and 2022, ion exchange was selected as the most reliable and cost-effective treatment to restore Williams Station's capacity, improve water quality, and enhance the reliability and safety of water delivered to customers. The project has received strong regulatory support from the San Francisco Bay Regional Water Quality Control Board, which expressed its "wholehearted support for this project", as well as the State Water Resources Control Board, Division of Drinking Water (see Letters of Support in Appendix B and C).



Figure 1. SJW Williams Station and Configuration

[1] Active Wells capacity only and based on SJWC *Operating Run Time Standard* (see Figure 7 for details)

Regulatory Background

Per- and polyfluoroalkyl substances (PFAS*)* are a large family of synthetic chemicals valued for water/grease resistance and thermal stability, used since the 1940s in consumer products and industrial applications (e.g., non-stick cookware, stain-resistant textiles, and firefighting foams). Many PFAS are persistent, commonly referred to as "forever chemicals", which can bioaccumulate and have been associated with adverse health outcomes.[2] Typically PFAS compounds are also readily transported in water and pose a significant risk to drinking water sources, both in groundwater and surface water.[3]

Under the Safe Drinking Water Act (SDWA), the U.S. Environmental Protection Agency's (USEPA) approach progressed from non-enforceable health advisories to legally enforceable standards. In 2016, USEPA issued lifetime health advisories of 70 ppt for PFOA and PFOS (individually or combined), providing technical guidance to water systems and states.[4] In June 2022, USEPA then released interim advisories of 0.004 ppt and 0.02 ppt for PFOA and PFOS respectively, and final advisories of 10 ppt and 2,000 ppt for GenX/HFPO-DA and PFBS respectively, which reflected newer toxicity science while remaining non-regulatory.[5] On April 10, 2024 (effective June 25, 2024), USEPA finalized the first *National Primary Drinking Water Regulation* for PFAS with Maximum Contaminant Level (MCL) of 4 ppt for PFOA and 4 ppt for PFOS (with Maximum Contaminant Level Goal of zero), 10 ppt for PFHxS, PFNA, and GenX, plus a new Hazard Index (HI) MCL of 1.0 for mixtures containing two or more of PFHxS, PFNA, GenX, and PFBS. Systems must complete initial monitoring and public reporting by 2027 and achieve compliance by 2029.[6] In May 2025, USEPA announced plans to retain the 4 ppt MCLs for PFOA and PFOS, propose extending compliance to 2031, and likely rescind the individual MCLs for PFHxS, PFNA, GenX and the HI mixture provision through rulemaking; this also includes a federal exemption framework and enhanced outreach via initiative like USEPA's PFAS OUT.[7] While litigation is still ongoing, the 2024 rule remains in effect unless modified by a subsequent final action or court order.

In California, the State Water Resources Control Board (SWRCB), through the Division of Drinking Water (DDW), began with advisory levels and broad monitoring authority, then advanced toward state standards. On August 23, 2019, DDW adopted Notification Levels (NL) of 5.1 ppt and 6.5 ppt for PFOA and

[2] USEPA. *Our Current Understanding of the Human Health and Environmental Risks of PFAS* (2025). https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas
[3] USEPA. *PFAS Occurrence & Contaminant Background Support Document for the Final NPDWR* (2024), pg. 17 – 20 https://www.epa.gov/system/files/documents/2024-04/updated-technical-support-document-on-pfas-occurrence_final508.pdf
[4] USEPA. *Fact Sheet*: *Drinking Water Health Advisories for PFOA and PFOS* (2025). https://www.epa.gov/sites/default/files/2016-05/documents/drinkingwaterhealthadvisories_pfoa_pfos_5_19_16.final_.1.pdf
[5] USEPA. *Federal Register - Lifetime Drinking Water Health Advisories for Four PFAS (*2022). https://www.federalregister.gov/documents/2022/06/21/2022-13158/lifetime-drinking-water-health-advisories-for-four-perfluoroalkyl-substances
[6] USEPA. *PFAS National Primary Drinking Water Regulation (Final Rule), Federal Register* (2024). https://www.federalregister.gov/documents/2024/04/26/2024-07773/pfas-national-primary-drinking-water-regulation
[7] USEPA. *EPA Announces It Will Keep Maximum Contaminant Levels for PFOA, PFOS* (2025). https://www.epa.gov/newsreleases/epa-announces-it-will-keep-maximum-contaminant-levels-pfoa-pfos

PFOS respectively and initiated Public Health Goal (PHG) development.[8] NLs are precautionary, non-regulatory levels that trigger notification and further assessment. The Legislature enacted AB 756 (approved July 31, 2019; effective January 1, 2020), authorizing DDW to order PFAS monitoring in drinking water sources and required that sources exceeding Response Levels (RLs) be taken offline or publicly noticed within 30 days (DDW may require treatment to continue operating source).[9] On February 6, 2020, DDW established RLs of 10 ppt and 40 ppt for PFOA and PFOS, making RL exceedances actionable under AB 756.[10] California established PFHxS advisory levels in October 2022 (NL = 3 ppt; RL = 20 ppt) and continued statewide PFAS monitoring via DDW General Orders (2022, expanded March 2024), including disadvantaged communities.[11] This was further expanded on December 12, 2025 with PFAS General Order DW-2025-0002-DDW, which broadened monitoring requirements for community water systems to support ongoing compliance planning.[12] To inform state MCLs, OEHHA adopted PHGs in April 2024 of 0.007 ppt and 1 ppt for PFOA and PFOS respectively, and DDW requested a PHG for PFHxS in May 2025 (still in development as of January 2026).[13] On October 29, 2025, DDW updated several advisory values as presented in Table 1 on the following, maintaining California's precautionary posture while state MCLs continue to be developed.[14]

Utilities face comprehensive monitoring, public reporting, and treatment requirements on aggressive timelines, initial monitoring and disclosure by 2027, with compliance by 2029, potentially extending 2031 depending on USEPA current review. Nevertheless, exceeding California RLs compels immediate operational decisions, either removing sources from service or installing treatment, and notify customers, heightening communication and compliance obligations. Treatment strategies (e.g., granular activated carbon, ion-exchange, reverse osmosis) are being deployed and the Hazard Index adds complexity by accounting for mixture risks when PFHxS co-occurs with other PFAS. Federal and state agencies have identified funding (e.g., Bipartisan Infrastructure Law funds, including $9 billion allocated specifically for emerging contaminants like PFAS) and statewide monitoring orders to support planning and implementation, particularly for small and disadvantaged systems, underscoring a sector-wide transition from advisory guidance to enforceable standards, sustained capital planning, and customer transparency.

[8] SWRCB DDW. *PFOA/PFOS Guidelines FAQ* (2019). www.waterboards.ca.gov/publications_forms/publications/factsheets/docs/pfoa_pfos_guidelines_faq_factsheet.pdf
[9] California AB 756. *Section 116378 HSC Public water systems: PFAS* (2019). https://legiscan.com/CA/text/AB756/id/2047811
[10] SWRCB. *Response Levels Lowered to 10 ppt (PFOA) and 40 ppt (PFOS)* (2020). https://www.waterboards.ca.gov/press_room/press_releases/2020/pr02062020_pfoa_pfos_response_levels.pdf
[11] SWRCB DDW. *PFAS: Per- and Polyfluoroalkyl Substances* (2025). https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/pfas.html
[12] SWRCB DDW. *PFAS General Order DW-2025-0002-DDW* (2025). https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/pfas_ddw_general_order/docs/order-dw-2025-0002-ddw-pfas-initial-monitoring.pdf
[13] OEHHA. *California adopts PHGs for PFOA (0.007 ppt) and PFOS (1 ppt)* (2024). https://mavensnotebook.com/2024/04/06/press-release-california-adopts-health-protective-goals-for-forever-chemicals-in-drinking-water/
[14] SWRCB DDW. *Drinking Water Notification Levels page* (2025). https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/NotificationLevels.html

Table 1. SWRCB-DDW Threshold and Federal MCLs as of January 2026[1]

Parameter	Notification Level (ppt)	Response Level (ppt)	USEPA MCL (ppt)	Public Health Goal (ppt)
PFOA	4	10	4	0.007
PFOS	4	40	4	1
PFHxS	3	10	10	-
PFHxA	1,000	10,000	-	-
PFBS	500	5,000	-	-
Hazard Index[2],[3]	-	-	1	-
PFNA[2]	-	-	10	-
GenX (HFPO-DA) [2]	-	-	10	-

(1) California thresholds are non-regulatory, health-based advisory, however, under AB 756 any source that exceeds a *Response Level* the utility must take the source offline, treat, or notify public within 30 days
(2) Currently under review by USEPA and may reconsider or rescind these MCLs
(3) Hazard Index is a unitless value

SJWC Water Quality Strategy

SJWC is committed to providing reliable drinking water that meets or exceeds all state and federal standards, prioritizing safety and public confidence. To uphold this commitment, SJWC adheres to internal protocols that go beyond minimum compliance. Operating near an MCL or regulatory threshold is unacceptable, particularly when concentration shows an upward trend. Since sampling, lab confirmation, and response actions all take time, SJWC maintains a prudent safety margin to reduce the risk of any exceedance and impact on public health.

Specifically for PFAS, SJWC's policy aims to keep all groundwater wells at or below 80% of the applicable MCLs. Wells nearing or exceeding this internal target are added to a watch list, prompting increased sampling frequency and heightened oversight. SJWC's Water Quality and Operations staff collaboratively assess next steps to safeguard public health and maintain system reliability. Based on the groundwater well's conditions and system needs, actions may include designating a well as "standby" (reserved for emergencies only, such as wildfire, fire flow demands, or natural disasters), exploring additional treatment, taking the well temporarily offline, or conducting intensifying sampling and monitoring. These decisions are made on a case-by-case basis to ensure groundwater resources remain safe and reliable while balancing operational needs, availability of alternative supplies, and overall water quality objectives. Wells that exceeding NLs or a proposed MCLs undergo additional review in partnership with the DDW to determine appropriate responses. This approach is consistent with USEPA, DDW, and American Water Works Association (AWWA) best management practices.[15, 16, 17] It also supports the California Public Utilities Commission's objectives in its 2010 *Water Action Plan*, which emphasizes that " … water quality

[15] USEPA. *Per- and Polyfluoroalkyl Substances (PFAS)*. https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas
[16] SWRCB DDW, *PFAS Drinking Water*. https://www.waterboards.ca.gov/pfas/drinking_water.html
[17] AWWA. *PFAS Resources*. https://www.awwa.org/resource/pfas.

is vital to the health of the consumers. Delivery safe water requires a reliable infrastructure and careful monitoring and enforcement of water quality standards."[18]

PFAS Prevalence at Williams Station

Following DDW's adoption of notification levels for PFOA and PFOS in 2019, SJWC has been proactively sampling and monitoring for PFAS at all its groundwater stations. At Williams Station, SJWC conducted voluntary initial and confirmatory sampling, revealing that several production wells had PFOS levels above the NL at the time. A summary of the most recent annual averages for PFOA, PFOS, and PFHxS across Williams Station is presented in Table 2. Sampling data from across the station since 2019 has also been compiled in Figures 3, 4, and 5, confirming the presence of these contaminants in the groundwater and, more recently, a slow but steady increase in these concentrations over time. These findings are also supported by the San Francisco Bay Regional Water Quality Board (SFBRWQB) and DDW (see Letters of Support in Appendix B and C). A more detailed analysis of each of the wells over time and by contaminant type is included in Appendix D.

Williams Station groundwater source is located within the confined aquifer zone, as presented in Figure 2, which has historically been protected against contamination by a thick layer of impermeable soil above the groundwater. This confined aquifer has provided a reliable source of clean water to SJWC customers since SJWC first began pumping and distributing water in 1866. However, the persistence and longevity of PFAS is now causing these contaminants to appear in even the most remote or protected locations, like the confined aquifer beneath Williams Station. While questions remain as to how and why PFAS is present in the confined aquifer, SJWC is not alone in finding PFAS in its groundwater supply. The prevalence of PFAS in groundwater across Santa Clara Valley has been documented by other neighboring utilities, such as San Jose Municipal Water System, which detected PFHxS in its Evergreen groundwater wells ranging from 2.3 to 3.6 ppt, and nearby California Water Service's Los Altos water system reported levels up to 6.6 ppt for PFOS, 4.3 ppt for PFHxS, and 2.8 ppt for PFBS. [19,20] Valley Water has similarly detected PFOA and PFOS in several of its wells at Campbell, which are in close proximity to SJWC's Williams Station.[21] Overall the U.S. Geological Survey's (USGS) *PFAS in U.S. Groundwater Interactive Dashboard* has estimated up to 75% probability for PFAS presence in any public groundwater supplies throughout much of Santa Clara Valley, reflecting broader environmental contamination in the region.[22]

As a result of PFAS sampling, six of the Williams Station groundwater wells have been placed on standby status, available only for emergencies as presented in Table 3. This approach protects water quality and customer health while providing operational flexibility during emergencies, given the critical importance

[18] CPUC, *Water Action Plan* (2010), pg. 3
[19] City of San Jose. *PFAS Info and Your Drinking Water*. https://www.sanjoseca.gov/your-government/departments-offices/environmental-services/water-utilities/drinking-water/water-quality/pfas
[20] Cal Water. 2024 Los Altos Suburban District Water Quality Report, pg. 15
[21] Valley Water. *Fact Sheet PFAS* (2025), pg 1
[22] USGS. *PFAS in US Groundwater Interactive Dashboard* (2024). https://geonarrative.usgs.gov/pfasinusgroundwater/

of this station, as further discussed in the *Groundwater Supply* section on page 7. In addition to PFAS, some wells have been identified as having other water quality issues, such as iron and turbidity.

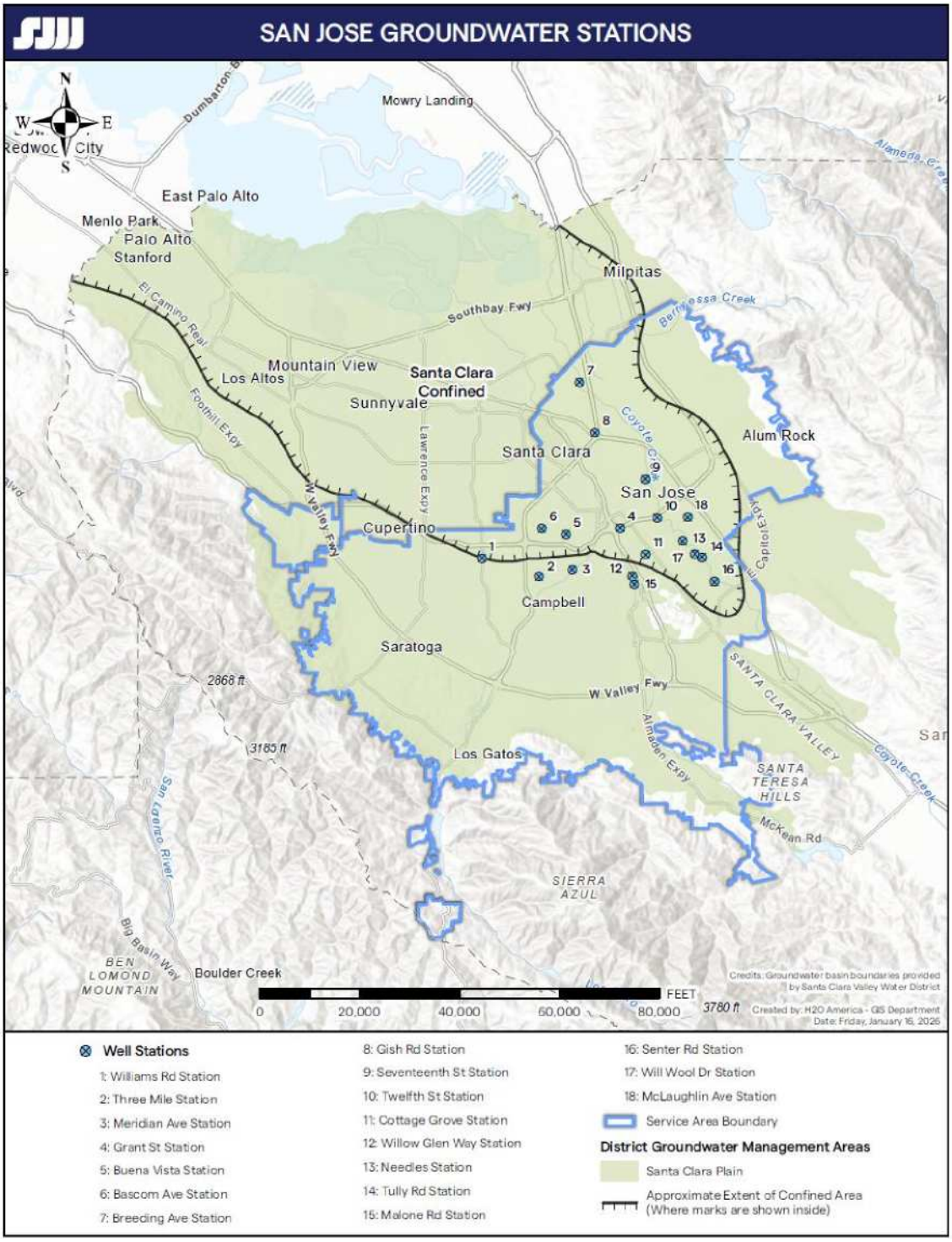


Figure 2. Location of SJWC Groundwater Stations

Table 2. Williams Station PFAS Concentration Summary as of December 2025

Well ID	Well Status	PFOS		PFOA		PFHxS	
		2025 Average (ppt)	3 Year Trend	2025 Average (ppt)	3 Year Trend	2025 Average (ppt)	3 Year Trend
W-3	Active	1.50	↑	1.41	↑	2.78	↑
W-5	Active	2.93	↑	1.97	↑	4.33	↑
W-6	Active	5.08	↑	2.10	↑	5.70	↑
W-7	Active	3.33	↑	1.50	↑	3.37	↓
W-8	Active	2.68	↑	1.42	↑	3.60	↑
W-10	Active	1.82	↑	1.33	↑	1.83	↑
W-11	Active	1.56	—	1.10	↑	2.18	↑
W-17	Active	3.58	↑	1.78	↑	4.13	↑
W-2	Standby	5.85	↑	3.03	↑	7.70	↑
W-4	Standby	1.63	↑	1.30	↑	2.45	—
W-13	Standby	4.0 *	—	1.1 *	↑	3.0 *	↑
W-12	Offline	5.72	↑	2.93	↑	5.53	↓
W-14	Standby	8.10	↑	3.18	↑	8.13	↑
W-15	Standby	7.05	↑	2.90	↑	7.08	↑
W-18	Standby	2.3 *	—	1.7 *	↑	4.8 *	↑

Notes & Legend:

*	Latest sample data point
Red	Above MCL
Orange	80% of MCL or above NL (SJW Internal Watch List)
Blue	Acceptable
↑	Trending up
—	Remained consistent
↓	Trending down

Table 3. Current List of Standby Wells at Williams Station (1/18/26)

Well ID	Issue of Concern	Date Placed on Standby
W-2	PFOS	10/21/2019
W-4	Iron	12/2/2014
W-12	PFOS	4/19/2024[23]
W-13	Iron / PFOS	7/23/2019
W-14	PFOS	10/23/2019
W-15	PFOS	10/21/2019
W-18	Turbidity	3/12/2020

[23] Taken offline but not officially on standby status

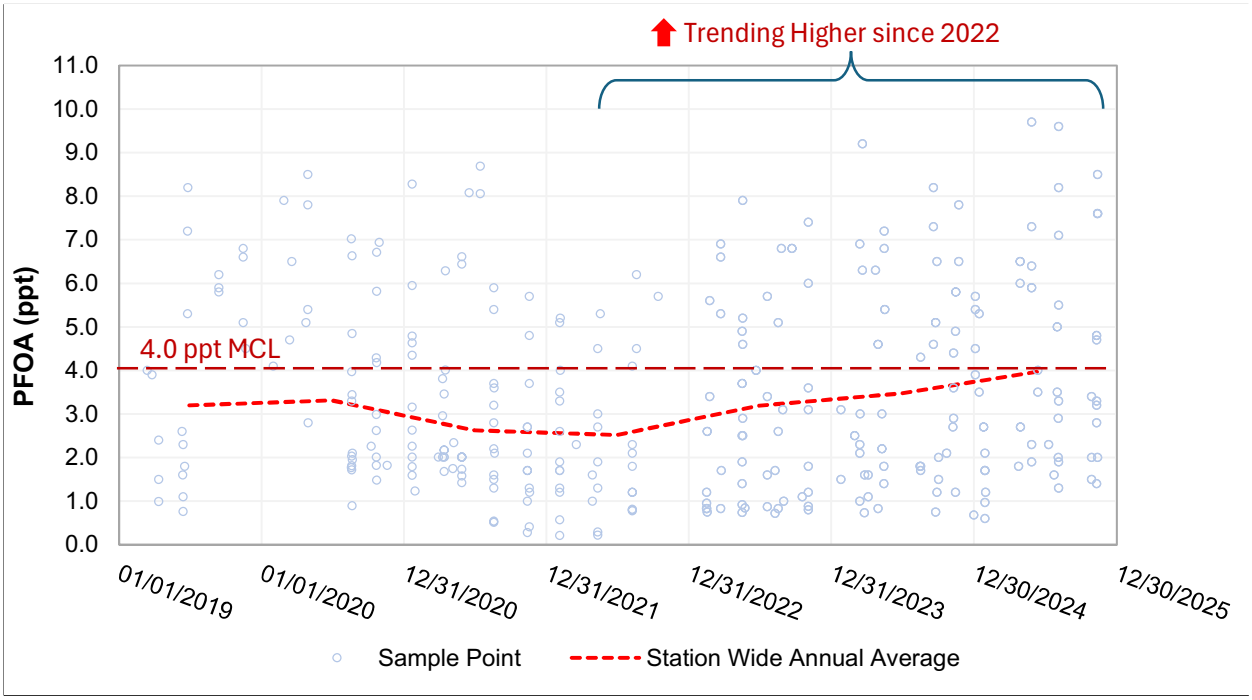


Figure 3. William Station PFOS Sample Data and Station Wide Annual Average

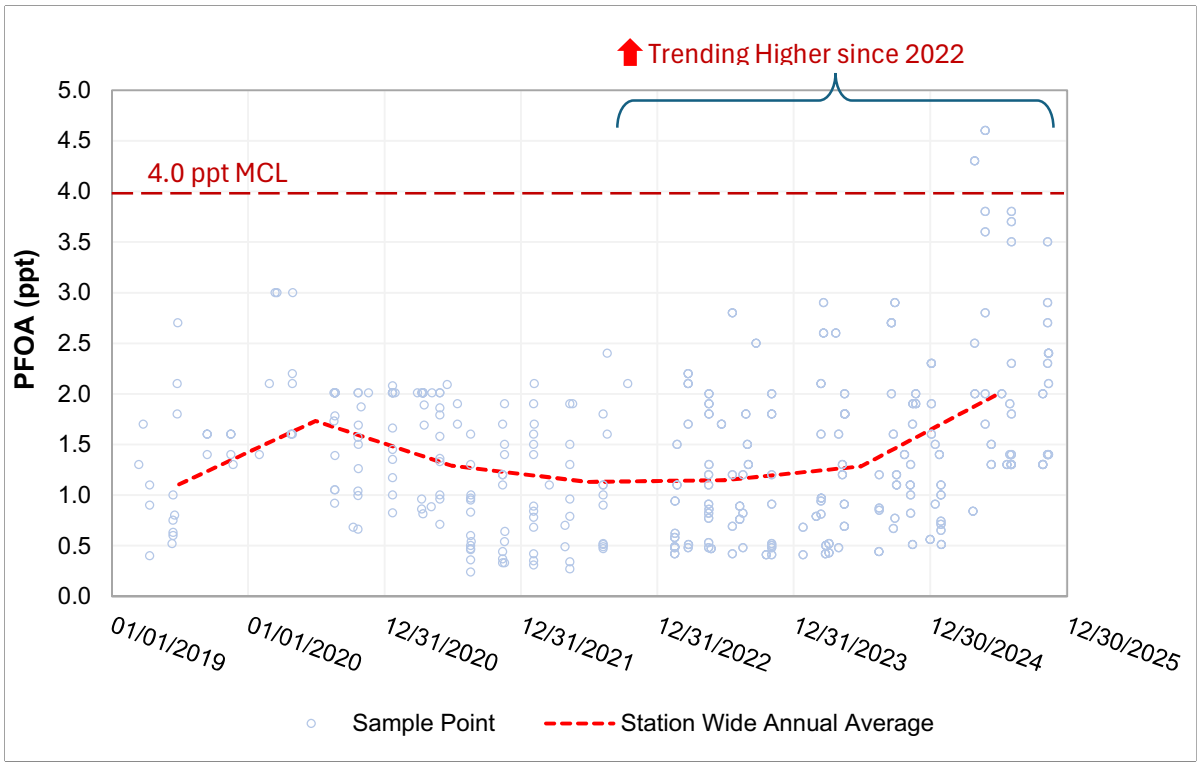


Figure 4. William Station PFOA Sample Data and Station Wide Annual Average

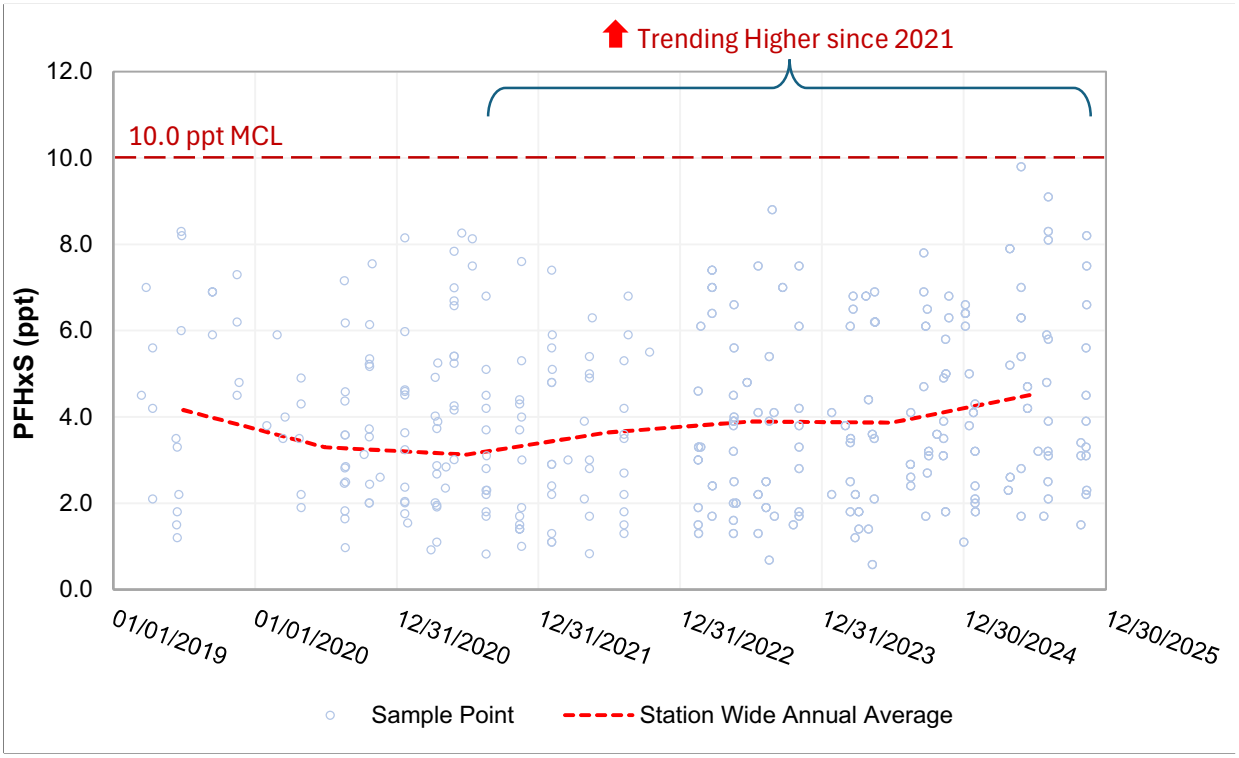


Figure 5. William Station PFHxS Sample Data and Station Wide Annual Average

Groundwater Supply & Williams Station Importance

Groundwater is a cornerstone of SJWC's water supply portfolio, operating 18 groundwater stations across its system with a combined dependable capacity of up to 138.5 million gallons per day (MGD) of drinking water (see Figure 2 for system map and station locations).[24] While individual groundwater stations may primarily support one or more specific pressure zones, SJWC maintains operational interties, zone valves, and interzone distribution facilities that allow the company to convey (i.e., "wheel") water throughout its system as conditions require. On an annual basis, groundwater typically supplies approximately 40% of total water delivered to SJWC customers, however, that share can increase materially during multi-year droughts or other major supply disruptions, as reflected in SJWC's historical supply mix presented in Figure 6. Groundwater is therefore essential to SJWC maintaining a reliable and resilient drinking water supply, as discussed in the following subsections.

Groundwater vs Imported Water

SJWC has relied on groundwater from the confined acquired for more than 160 years, having first began meeting customer demands with shallow wells and steam-driven equipment in 1866. These assets were later replaced with deeper wells equipped with electric turbine pumps by the 1910s, and groundwater

[24] Based on an SJWC *Operating Run Time Standard*, see SJWC *Groundwater Asset Management Plan* (2020), pg.17

became SJWC's primary source of water supply for the next several decades. As urban development expanded rapidly across Santa Clara Valley from the 1940s through to the 1980s, SJWC's groundwater system grew in parallel to meet customer demands, fire flow requirements, and ensure operational reliability. Even after SJWC began purchasing imported treated water delivered by Valley Water (formerly Santa Clara Valley Water District) in 1967, groundwater continued to play a critical operational role. Historical droughts and major seismic events since the 1960s have only further demonstrated the value of dependable local groundwater supplies.

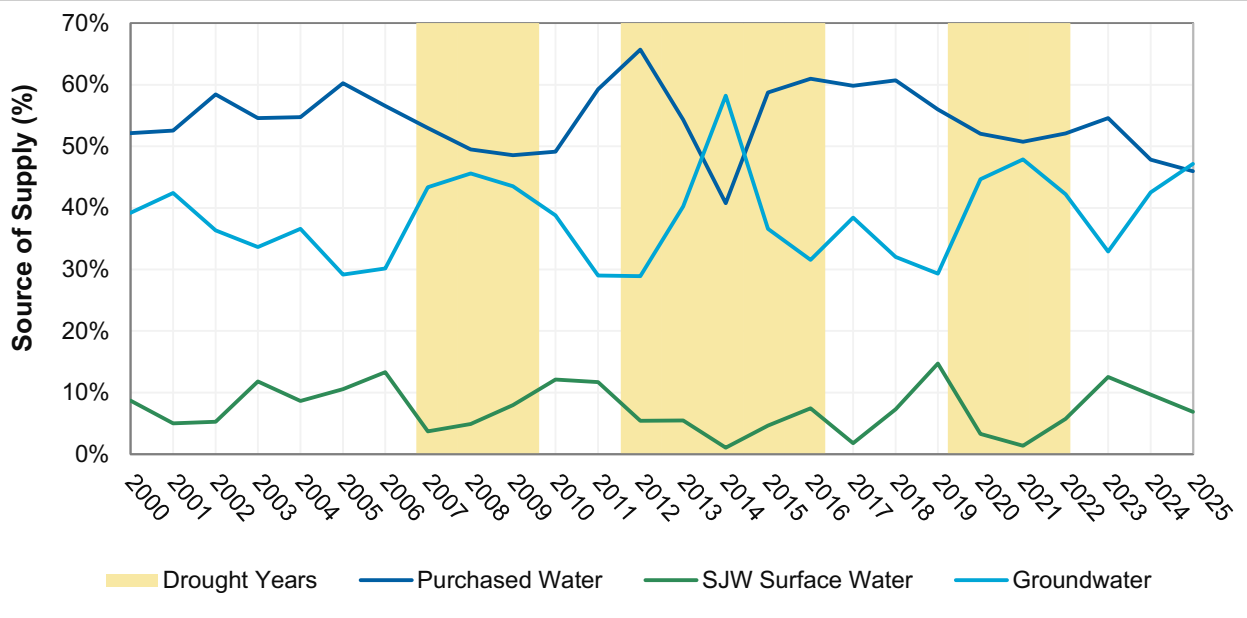


Figure 6. Historical Water Supply Sources

SJWC purchases imported treated water from Valley Water, which is primarily sourced from the State Water Project (SWP) and Central Valley Project (CVP).[25] These imported supplies are subject to significant risk associated due to inter-seasonal variability and regulatory constraints that can affect annual allocations. While Valley Water holds contracts for up to 100,000 acre-feet per year (AFY) from SWP and 152,500 AFY from the CVP, Valley Water has stated "…the actual amount of water allocated under these contracts each year is typically less than these contractual amounts and depends on hydrology and regulatory restrictions."[26] Since 2000, Valley Water has only received 100% of its SWP contract allotment once in 2006.[27] CVP supplies are similarly vulnerable, having not reached full contract amounts in decades and even dipped as low just 48,375 acre-feet in 1991.[28] Accordingly, it is critically important that SJWC maintain reliable groundwater capacity to reliably meet customer needs and fire flow protection

[25] Valley Water. Water Supply Master Plan 2040 (2019), pg. 5
[26] *Id.*, pg. 11
[27] Valley Water. *State Water Project* (2026). https://www.valleywater.org/your-water/where-your-water-comes/imported-water/state-water-project
[28] Valley Water. *CVPIA Water Management Plant* (2017). pg.5

requirements given the uncertainty in purchase imported treated water from drought, seasonal variability, regulatory actions, or even litigation (e.g., San Francisco Baykeeper et al. v. Department of Water Resources, Case No. 24WM000017 and related challenging the environmental approvals of the Delta Conveyance Project) that may material change available water supply.

In addition, purchased imported treated water is also vulnerable to unplanned outages, maintenance shutdowns, and natural disasters that affect Valley Water's conveyance infrastructure. For example, SJWC has experienced over nine major outages from Valley Water within the last five years, lasting up to 24 days. Without available groundwater capacity, SJWC may not have been able to respond effectively and keep customers in water. Valley Water has also cautioned retailers that a major earthquake on the San Andreas Fault could disrupt purchased imported treated water deliveries for up to 30 days before minimum service levels can be restored.[29] Fires following earthquakes are widely recognized as one of the greatest post-disaster challenges in dense urban areas, underscoring the need for reliable water supplies to protect the public, critical infrastructure, and post-event recovery according to the State of California Seismic Safety Commission Report. [30] Without dependable and operational groundwater supplies, SJWC would be significantly less able to respond to a major natural disaster and provide effective fire protection while meeting ongoing customer demands during recovery.

Accordingly, SJWC must maintain sufficient, dependable groundwater capacity to ensure continuous service when purchased imported treated water is constrained or unavailable, and to provide operational flexibility during droughts, outages, and emergency events. This conclusion was supported by SJWC's 2020 *Groundwater Well Asset Management Plan*, prepared by GHD, an internationally recognized professional engineering firm with expertise in asset management and groundwater operations. GHD evaluated SJWC's well supply capacity under three scenarios: (1) normal operations, (2) drought conditions, and (3) emergency events. As summarized in Figure 7, GHD concluded that SJWC's current groundwater capacity is sufficient to meet system demands across these scenarios, however, this finding assumes that SJWC maintains the existing level of groundwater capacity over the long term, given the vulnerability of imported supplies and the significant risk to customers if dependable groundwater capacity is not preserved. To support long-term capacity, GHD also developed a capital improvement program (CIP) budget and schedule that included acquiring additional land and constructing new wells based on the probability of existing wells, in their current condition, to fail in the future. While SJWC continues to pursue this strategy, suitable land and well sites are increasingly difficulty to secure due to high development demand and land costs in the Bay Area. Therefore, maintaining existing well capacity, particularly for wells that are otherwise in good condition and far from their end of useful life, like Williams Station, is a critical operational responsibility to preserve the system level capacity and resilience identified by GHD.

[29] Valley Water. *2020 Urban Water Management Plan*, pg. 60
[30] Pacific Earthquake Engineering Research Center. *Water Supply in regard to Fire Following Earthquake* (2011). pg.v

SUPPLY AND DEMAND ANALYSIS

SJW's supply and demand analysis has been evaluated for three key scenarios assuming 2045 projected Maximum Day Demand (MDD). The following figure summarizes the available supply and estimated demand in 2045 for the three scenarios. A detailed explanation of this in-depth analysis can be found in Section 6.1 Well Supply Capacity Evaluation of the GWAMP.

CURRENT AND FUTURE SUPPLY NEEDS

SJW's current groundwater supply is sufficient to meet system demands for the 2045 normal, drought, and emergency scenarios. It is recommended that SJW maintain at a minimum its current estimated groundwater production capacity to ensure reliable source water availability. The proposed capital groundwater projects in this EAMP, derived from the GWAMP, are based on this recommendation that current production capacity must be maintained.

	Supply[1,2]	–	Demand	=	Surplus
Normal Scenario • 2045 projected MDD based on UWMP • 61% of demand met by local surface and import water • Remaining demand met by groundwater	Surface & Import 110.6 MG Groundwater 138.5 MG[2]	–	181.3 MG	=	67.8 MG
Drought Scenario • Decreased surface and import water supply • 30% of demand met by surface and import water • 20% reduction in MDD due to heightened conservation	Surface & Import 43.5 MG Groundwater 138.5 MG2[2]	–	145.1 MG	=	37.0 MG
Emergency Scenario • No surface or import water supply for 30 days; 100% supply by groundwater • Fire flow demand included • 20% reduction in MDD due to heightened conservation	Surface & Import 0 MG Groundwater 207.8 MG[3]	–	System 145.1 MG Fire Flow 22.6 MG	=	40.1 MG

NOTES:
1. Groundwater production is limited based on SJW's Operating Run Time Standard, as defined in Section 6.1.3 SJW Groundwater Well Operating Run Time Standard in the GWAMP. This critical standard curbs the adverse effects of overproduction such as the drying up of wells, reduction of water in streams and lakes, deterioration of water quality, increased pumping costs, and permanent land subsidence. **2.** The maximum sustainable groundwater production rate is 138.5 MGD. The Normal and Drought Scenarios, both characterized as long-term scenarios, are analyzed using this rate. It is calculated by taking the total groundwater production rate (277 MGD) and multiplying it by the maximum hours of sustainable well operation in a given day (12 hours/24 hours). **3.** The maximum emergency groundwater production rate is 207.8 MGD, which is the rate used to analyze the Emergency Scenario. It is calculated by taking the total groundwater production rate (277 MGD) and multiplying it by the maximum hours of short-term well operation in a given day (18 hours/24 hours).

Figure 7. SJW Groundwater Supply Needs as presented in CPUC GRC Applications A.21-01-003 and A.24-01-001

Williams Station Supply Criticality and PFAS Vulnerability

Loss of groundwater production due to contamination, including PFAS, would materially reduce SJWC's ability to provide reliable drinking water to its customers and ensure system reliability and resiliency. This risk is particularly evident at Williams Station, where water quality trends have already resulted in several wells being placed on standby. Williams Station represents more than 16% of SJWC's total groundwater supply portfolio and has been a consistent and critical source of water even during droughts over the last 20 years as presented in Figure 8. Yet more than 40% of William Station's capacity is now on standby status due to water quality constraints and if SJWC were to experience another multi-year drought comparable to the 2012–2016 period, the reduced production at Williams Station would have a significant negative impact on system operations, even with customer conservation. Higher pumping during major drought events may also accelerate PFAS concentration upward trends at Williams Station, further limiting the number of wells that can be operated safely. For these reasons, proactively managing PFAS risk at Williams Station is essential to protecting public health while maintaining system reliability,

emergency response capability, and drought resiliency. These findings on the importance of groundwater and Williams Station are also supported by the SFBRWQB and DDW (see Letters of Support in Appendix B and C).[31]

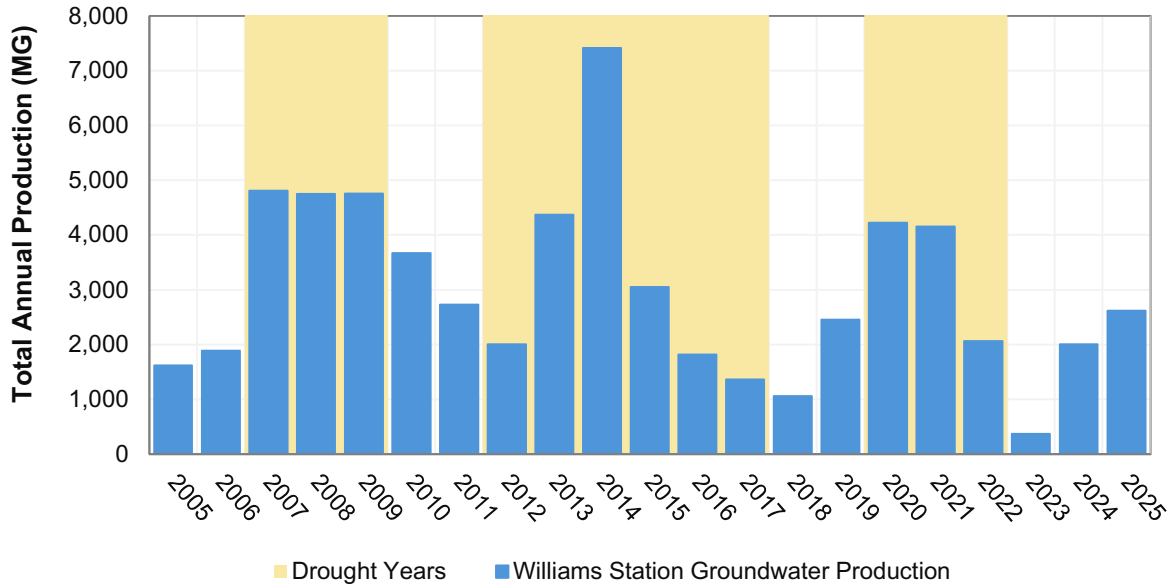


Figure 8. William Station Production History [32]

Alternative Analysis

General Approach

The "*Do Nothing*" alternative assumes no additional treatment or operational modifications at Williams Station and that the system continues to operate as it does today. SJWC quickly determined that this alternative was not in customers' best interest and ruled this out from further consideration. As discussed previously, Williams Station is a critical groundwater production facility, representing a significant share of SJWC's overall groundwater supply portfolio. However, more than 40% of the station's groundwater capacity is currently on standby due to increasing PFAS concentrations, particularly PFOS. Absent proactive measures, it is likely that additional wells will require standby status in the near term, and this risk could be exacerbated during periods of increased pumping, such as in response to reduced Valley Water supplies, major outages, or a multi-year drought. While standby wells may be available for limited emergency operation, SJWC should treat their use as a last resort rather than a routine operational

[31] The SFBRWQCB Letter assumes a total production capacity of 30,500 gpm for Williams Station which is based on a 24 hour run time of all wells.

[32] **Notes:**
(1) During the drought of 2012-2016, SJWC reduce pumping at the request of Valley Water
(2) In 2023, William Station was frequently offline during the Hazen PFAS pilot study

response. Reliance on these wells as a primary strategy could unnecessarily increase customers' exposure to PFAS-related public health risks and reduce operational flexibility when emergency conditions occur.

To address the complex task of developing and evaluating treatment alternatives for Williams Station and identifying the most prudent course of action, SJW engaged Hazen and Sawyer ("Hazen"), a professional engineering firm with specialized expertise in addressing PFAS treatment and mitigation. SJWC established the following goals for Hazen alternative analysis:

1. **PFAS Performance:** Provide treatment system capable of ensuring PFAS concentrations in treated water effluent are at or below 2 ppt
2. **Secondary Contaminants**: Addressed secondary contaminants, specifically iron
3. **Turbidity:** Ensure treated water effluent turbidity remains below one NTU
4. **Recovery:** Achieve a treatment recovery rate greater than 90% over the life of the system to reduce lifecycle cost
5. **Water Quality Compatibility:** Avoid adverse impacts to finished water quality (e.g., increased corrosivity)

To complete this effort, Hazen proposed a structured work plan consisting of stakeholder engagements, technical workshops, pilot testing, development of evaluation criteria, and a formal alternatives analysis. Work began in November 2020 and culminated in a final report and recommended path forward in March 2022.

A copy of Hazen's March 2022 report, including all appendices, is provided in Appendix E. A roadmap summarizing Hazen's original timeline and overall approach is presented in Figure 9.

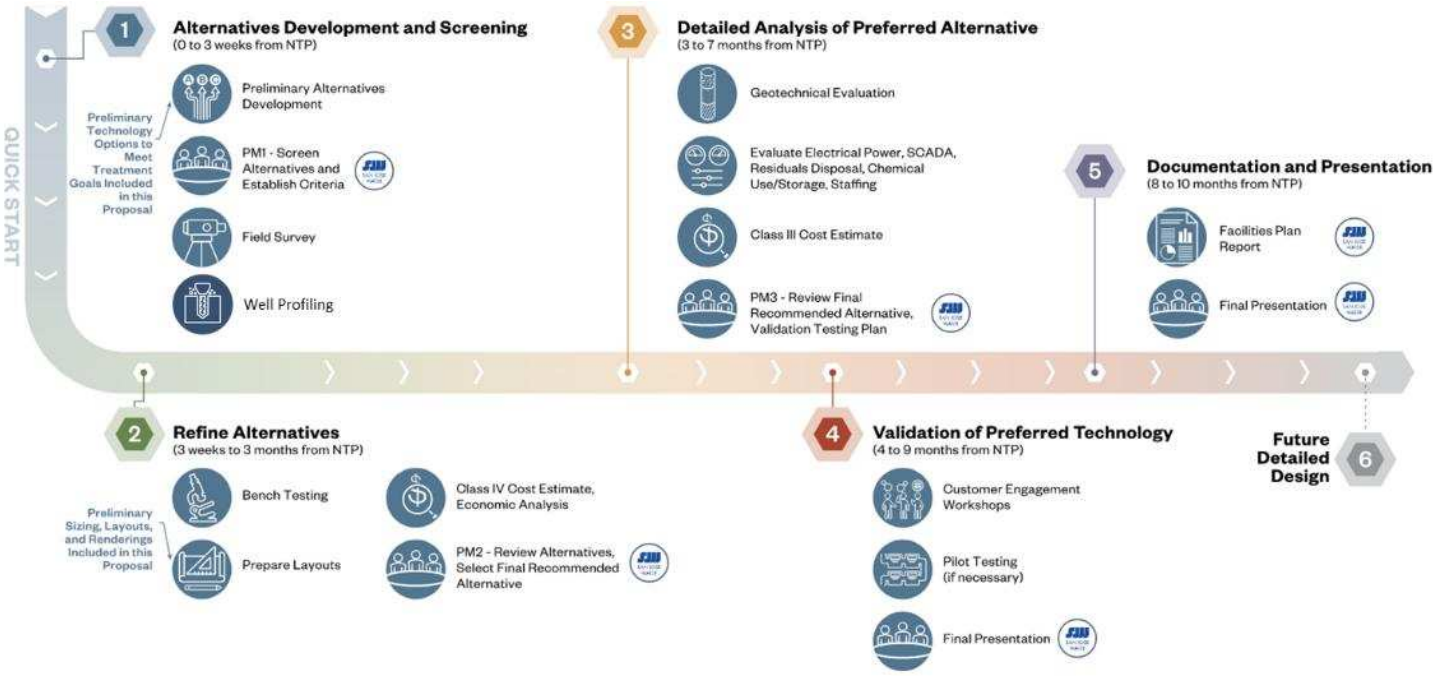


Figure 9. Water Facilities Plan Road Map

Pretreatment Evaluation

Hazen evaluated pretreatment in considerable depth to address sand and turbidity observed in certain wells and to protect downstream PFAS treatment equipment. Pretreatment alternatives included bag filtration, cartridge filtration, self-backwashing strainers, and greensand filtration (which also provides the added benefit of iron removal). Based on bench-scale testing and additional water-quality sampling, Hazen concluded that cartridge filtration represents the simplest and most cost-effective pretreatment option for Williams Station. Cartridge filtration was determined to be sufficient to meet SJWC's turbidity and iron targets and to protect the PFAS treatment vessels from fouling and premature media exhaustion. Accordingly, greensand filtration was not recommended or carried forward as a necessary component of the preferred treatment configuration.[33]

Hardness Reduction Not Carried Forward

Hazen's initial alternatives analysis also evaluated whether adding hardness reduction should be included as a project objective and treatment component. After reviewing the findings, SJWC determined that incorporating hardness reduction would significantly increase both capital and long-term operating costs without providing meaningful public-health benefits. Hardness is a secondary, aesthetic parameter, not a primary health risk, and therefore does not justify the substantial additional investment that would ultimately be borne by customers.

At Williams Station, total dissolved solids (TDS) average approximately 343 mg/L.[34] While this level reflects moderately hard water, it remains within the USEPA's secondary (non-enforceable) guideline of 500 mg/L and does not present a human-health concern.[35] Given these conditions, adding hardness reduction would have required customers to fund a costly treatment process that provides no measurable improvement to drinking water safety.

For these reasons, SJWC elected to remove hardness reduction from the final PFAS treatment plant recommendation. This decision reflects a deliberate effort to control project costs, avoid unnecessary rate impacts, and ensure that customer dollars are focused on addressing the primary health-driven objective of PFAS removal. Accordingly, hardness and the alternatives evaluated by Hazen are not discussed further in this project justification.

PFAS Alternatives Considered

Given the magnitude of the PFAS challenge at Williams Station, the potential treatment flow range (approximately 14 – 20 MGD), and SJWC's responsibility to perform due diligence and implement a cost-effective, reliable solution in customers' best interest, Hazen evaluated a broad range of treatment alternatives and system configurations. In total, Hazen assessed: (1) four pretreatment alternatives, (2)

[33] Hazen, *Revised Facilities Plan for Williams Station, PFAS Treatment and Softening Facilities* (Mar 2022), pg. 33
[34] WQTS, *Bench-Scale Testing of PFAS Removal from SJWC's W2 Well Water* (2021), pg. A-4
[35] USEPA, *Secondary Drinking Water standards* (2025). https://www.epa.gov/sdwa/secondary-drinking-water-standards-guidance-nuisance-chemicals

four PFAS treatment technologies, and (3) four pumping and storage configurations. After selecting ion exchange (IX) as the preferred PFAS treatment approach, Hazen also pilot tested four different IX resins and evaluated two alternative IX facility layouts at the station in greater detail.

For purposes of this project justification, the discussion below is limited to the primary PFAS treatment technologies evaluated by Hazen. The alternatives are presented assuming cartridge filtration as pretreatment and excluding hardness treatment from the project scope, as discussed above. Additional details are provided in Hazen's March 2022 report (see Appendix E for full report).

Accordingly, each PFAS treatment option is presented assuming cartridge filtration upstream of the primary PFAS process, including the following configurations:

1. **Granular Activated Carbon (GAC)**
2. **Ion Exchange (IX) resin**
3. **Fluoro-Sorb® adsorptive media**
4. **Nanofiltration / Reverse Osmosis (NF/RO)**

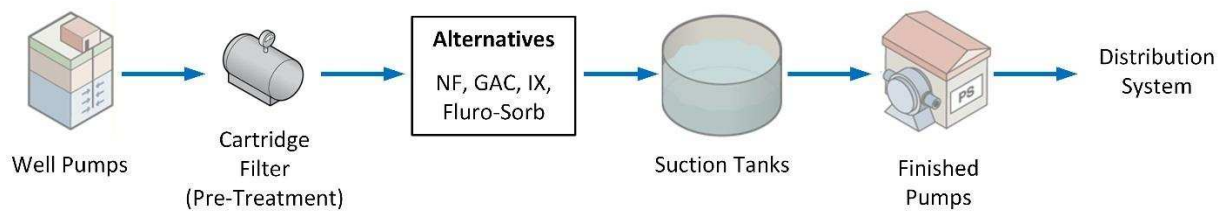


Figure 10. Simplified Overview of Alternatives & Approach Considered for Williams Station PFAS Treatment

Alternative A - Granular Activated Carbon

Granular activated carbon (GAC) PFAS treatment is accomplished by passing source water through a bed of adsorptive GAC media with a high internal surface area. As PFAS impacted water flows through the media bed, PFAS constituents adsorb to the carbon surface until the media approaches exhaustion (i.e., the bed reaches its adsorption capacity for the constituents of concern). Once exhausted, the GAC media must be replaced. Periodic backwashing may also be required to address headloss associated with sediment accumulation.

Operationally, GAC is relatively simple and typically requires the most attention during backwash events and media replacement activities. Depending on the level of automation, GAC systems can also have comparatively modest electrical, controls, and instrumentation requirements. However, for equivalent treatment flows, GAC generally requires a larger footprint than other PFAS treatment technologies because it operates at lower hydraulic loading rates. While GAC media costs are typically lower than IX resin, the overall capital cost can be higher due to the larger number and size of vessels required. GAC is generally effective at removing long-chain PFAS constituents but may be less effective for certain short-chain PFAS.



Figure 11. Example GAC Vessels

Hazen performed bench-scale testing to estimate PFAS removal performance and media changeout frequency for GAC, IX resins, and an alternative sorbent media (Fluoro-Sorb®). Based on these results, Hazen concluded that GAC would achieve the lowest bed volumes to exhaustion and would therefore require more frequent media replacement and/or a greater number of vessels to meet the performance objectives. Although GAC can have relatively lower routine O&M complexity, the projected vessel count and changeout frequency resulted in a materially higher lifecycle cost compared to IX and Fluoro-Sorb. Accordingly, GAC was not carried forward for further evaluation.

Alternative B - Fluoro-Sorb®

Fluoro-Sorb® (FS) media is a new media available today for the treatment of PFAS. FS treatment is accomplished similar to GAC, as PFAS contaminants are adsorbed by the media as the source water passes through the media bed. Bench testing for SJWC and pilot testing for Orange County Water District had shown promising removal of both short and long chain PFAS with this method. Footprint, burden on operations, and truck traffic were expected to be similar to that of IX treatment since the media has a similar hydraulic loading rate as IX and needs to be replaced when it is exhausted. Also similar to IX treatment, hydraulic losses through the treatment trains are expected to be higher than those of GAC treatment.

During bench testing and the initial alternatives evaluation for Williams Station, FS was considered a viable alternative to ion exchange (IX) because it had comparable design requirements, including similar empty bed contact time (EBCT) targets (approximately 2–3 minutes) and hydraulic loading rate (HLR) limits (approximately 16 gpm/ft^2). However, just prior to pilot testing, the FS vendor reported observations of media compaction and rapid headloss buildup at higher HLRs and recommended limiting the design HLR to 9.5 gpm/ft^2. Hazen incorporated this revised recommendation into the pilot program.

The reduced HLR materially affected facility sizing and lifecycle cost. Specifically, reducing the design HLR from 16 gpm/ft² to 9.5 gpm/ft² increased the required number of lead-lag vessel pairs from 9 to 14, increasing the footprint and capital cost and, in turn, affecting the lifecycle cost comparison.



Figure 12. Example Fluoro-Sorb® Vessels

As documented in Section 3.1 of Hazen's report, Hazen compared estimated lifecycle costs for a 10,000 gpm system operating at an annual average flow of 6.24 MGD. While FS was projected to have lower O&M costs, the increased capital cost associated with the lower HLR resulted in IX being the lower-cost alternative over the life of the system. In addition to the cost advantage, IX is a well-established PFAS treatment technology that is generally easier to permit and does not require backwashing. For these reasons, SJWC selected IX as the preferred PFAS treatment technology over FS.[36]

Alternative C - Nanofiltration

Nanofiltration (NF) treats PFAS using semi-permeable membranes that reject PFAS constituents, which are then concentrated in a brine (concentrate) stream for disposal. NF are capable of removing both long- and short-chain PFAS and, relative to media-based systems (e.g., GAC or IX/FS), membrane elements typically require less frequent replacement than adsorption media or resin changeouts. NF systems generally require a higher degree of automation and have higher energy demands than other PFAS treatment technologies due to the operating pressures required to drive flow through the membranes. Under the NF configuration evaluated by Hazen, permeate would then pass through a decarbonator to remove carbon dioxide and raise pH, which reduces the amount of sodium hydroxide required for final pH adjustment.

Despite these advantages, Hazen identified several significant limitations for NF system at Williams Station, including recovery, brine management, and operational flexibility. First, NF produces a PFAS-laden concentrate stream that must be disposed, typically to the sanitary sewer. While PFAS discharge to the sewer may not be restricted under current requirements, future regulatory developments could

[36] Hazen, *Revised Facilities Plan for Williams Station, PFAS Treatment and Softening Facilities* (Mar 2022), pg. 139

impose additional limitations or require further treatment of membrane concentrate prior to discharge, increasing cost and operational complexity. Second, recovery was projected to be the lowest among the alternatives evaluated (approximately 91%), because the full flow must pass through the membrane process and scaling projections indicated it would be difficult to achieve recoveries greater than 91% for the NF configuration. Lower recovery increases the volume of concentrate requiring disposal and increases the amount of groundwater production needed to deliver the same treated-water volume, which in turn increases groundwater production and sewer disposal costs. Finally, Hazen noted that NF may offer less operational flexibility for deployment at other SJWC well sites because membrane performance and pretreatment requirements can vary significantly with source-water chemistry, including hardness levels and the specific PFAS profile.



Figure 13. Example of NF Skid

Overall, while NF was projected to have a comparatively lower initial capital cost, it had materially higher operating costs driven by energy usage, concentrate disposal, and increased water losses relative to adsorption-based alternatives. [37] The multi-criteria decision analysis also considered additional factors such as operational burden and complexity and customer impacts. Based on these combined considerations, Hazen and SJWC did not carry forward the NF alternative for PFAS treatment at Williams Station. [38]

Alternative D - Ion Exchange

Ion exchange (IX) treatment for PFAS is accomplished by passing PFAS-impacted source water through vessels containing synthetic resin beads. As water flows through the resin bed, PFAS constituents are selectively adsorbed and/or exchanged onto the resin, displacing benign ions associated with the resin media. The vessels are sized to provide sufficient resin depth and EBCT to achieve effective PFAS removal. For PFAS applications, the IX resin is typically single-use (non-regenerable); once the resin is exhausted, it is removed and replaced. Because the resin is not regenerated, routine backwashing associated with media regeneration is generally not required.

IX PFAS treatment shares several operational advantages with GAC, including relatively low operational complexity and, depending on the level of automation, comparatively modest electrical, controls, and instrumentation requirements. Unlike GAC, IX also provides effective removal of both long-chain and

[37] *Id.*, pg. 59
[38] *Id.*, pg. 68

short-chain PFAS, and it can typically operate at higher hydraulic loading rates. These characteristics reduce the overall footprint for a given design flow relative to GAC.



Figure 14. Example Ion Exchange Resin Vessel

Key considerations for IX include headloss and source-water quality interactions. The tighter and more uniform resin bed can produce higher hydraulic losses through the treatment trains compared to GAC, which may affect available well-pump capacity and may require evaluation of pressure ratings and hydraulic performance of upstream and downstream equipment. In addition, IX resin can remove other constituents present in the source water (co-contaminants), which may compete for resin capacity and reduce PFAS run times depending on water quality. Finally, IX resin unit costs are typically higher than GAC media, which can increase operations and maintenance (O&M) costs driven primarily by resin replacement and disposal.

Ultimately based on the multi-decision criteria considering capital cost, operations & maintenance, permitting, complexity, and resilience, among others, IX PFAS treatment was determined to be the most optimum technology for Williams Station and the best long-term solution for customers.[39]

Recommended Alternative

Based on Hazen's alternatives evaluation and multi-criteria ranking, Ion Exchange was selected as the preferred long-term PFAS treatment approach for Williams Station. Under this recommended concept, source water is treated through pretreatment to manage sand, silt, and turbidity and protect downstream processes, followed by a 20,000 gpm rated IX based treatment train that addresses both water quality objectives (include removal of iron) and PFAS removal, with pH/corrosion considerations incorporated into the overall process configuration. IX PFAS treatment offers effective removal of short chain PFAS contaminants, and a higher hydraulic loading capability compared to GAC which leads to smaller overall treatment footprints. The smaller treatment footprint of the facility lends itself to greater applicability at other SJWC locations that will require treatment in the future, allowing for a uniformity of PFAS treatment through the system. A conceptual process flow for this alternative is presented in Figure 15.

Hazen's detailed assessment of the selected alternative (including treatment headloss/hydraulics, pumping and break tank considerations, residuals handling and sanitary sewer disposal, electrical power requirements, chemical storage/consumption, staffing requirements, and SCADA/controls) is provided in Chapter 5 of the report. Pilot study methods and performance results supporting the technology selection

[39] *Id.*, pg. 68

are documented in Chapters 6 and 7, and the August 2022 update summarizes key regulatory-driven revisions and reevaluated GAC and IX scenario parameters, layouts, and cost impacts.

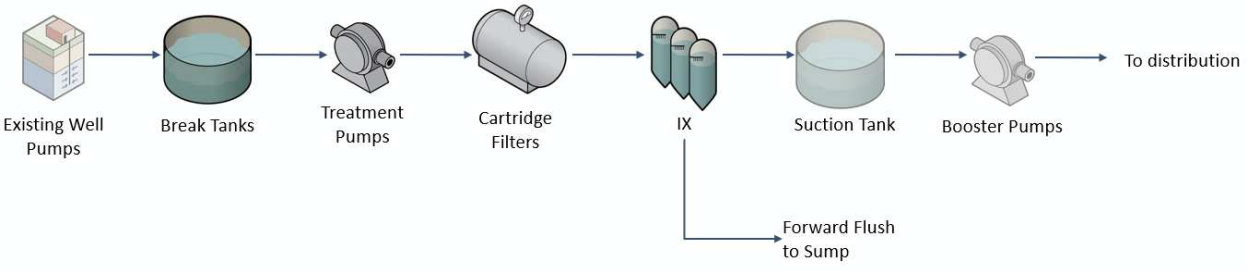


Figure 15. Conceptual Process Flow Diagram for IX Treatment

Final PFAS Design

Following completion of Hazen's alternatives analysis, SJWC issued a request for proposals (RFP) to four major engineering design firms to perform final design of the PFAS treatment facilities at Williams Station. After multiple rounds of proposal review and interviews, SJWC selected CDM Smith as the best-value firm based on overall responsiveness, relevant PFAS treatment experience, technical approach, and proposed cost. SJWC issued CDM Smith a Notice to Proceed (NTP) on May 1, 2023. Final design was completed in January 2025. A summary of the key design components is provided in Table 4, and the final treatment system layout is shown in Figures 16 to 20. This final design and layout of the PFAS treatment plant for Williams has received strong support from the SFBRWQCB and DDW (see Support Letters in Appendix B and C).

Additional key civil drawing details are included in Appendix F. A full set of final design drawings for the Williams Station PFAS Treatment Project is available from SJWC upon request.

Table 4. Design Criteria of Williams PFAS Station

Parameter	Units	Criteria
Design Flows		
Minimum Flow	GPM	3,000
Maximum Plant Capacity	GPM	20,000
Raw Water Tanks		
Number	EA	2
Type	-	Welded Steel
Maximum Volume (each)	GAL	249,900
Diameter	FT	45
Side Shell Height	FT	24
Design / Max Overflow Rate (each)	GPM	20,000
IX Booster Pumps		
Number	-	7 (6 Duty, 1 Standby)
Type	-	Vertical Turbine

Parameter	Units	Criteria
Capacity (each)	GPM	3,334
Total Head	FT	210
Motor Horsepower	HP	250
Drive	-	VFD
IX Pre-Treatment		
Type	-	Cartridge Filtration
No. of Filter Housing	EA	5 (4 Duty, 1 Standby)
Cartridge Filter Element Diameter	IN	6
Cartridge Filter Element Lenth	IN	40
No. Cartridge Filter Elements per Vessel	EA	36
Loading Rate (n)	GPM/10"	27.8
Loading Rate (n-1)	GPM/10"	34.7
Inlet/Outlet Connection	IN	24
Filtration Rating	MICRONS	5
Clean Filter Differential Pressure	PSI	3
Terminal Differential Pressure	PSI	15
Vessel Orientation	-	Horizontal
IX Treatment System		
Type	-	Series Lead / Lag
No. of Vessel Pairs	EA	14 (13 Duty, 1 Standby)
No. of Vessel	EA	28
Vessel Diameter	FT	12
Straight Side Shell Height	FT	5
Approx. Overall System Height	FT	16
Vessel Pressure Rating	PSI	125
Bed Depth	FT	4.7
Resin Volume (each)	CF	530
Empty Bed Contact Time	MIN	5.0
Hydraulic Loading Rate	GPM/FT2	13.6
Service Flow Rate	GPM/FT2	3.0
Clean Bed Differential Pressure	PSI	28
Terminal Differential Pressure	PSI	35
Process Drain Pumps		
Type	-	Submersible
Number	EA	2 (Lead / Lag)
Capacity (each)	GPM	1,500
Total Head	FT	37
Motor Horsepower	HP	30
Drive	-	VFD

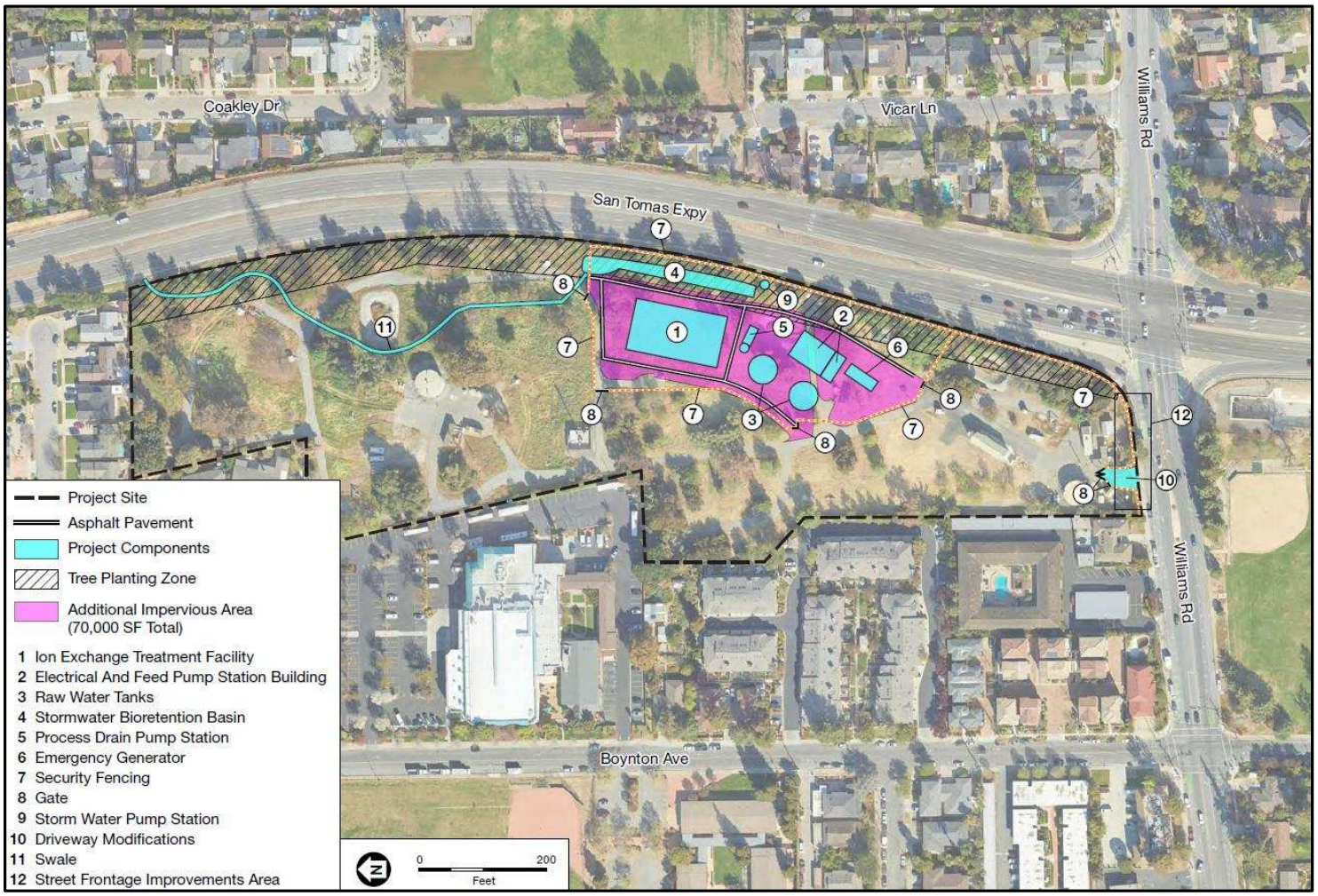


Figure 16. Schematic of PFAS Treatment Plant Improvement Plan

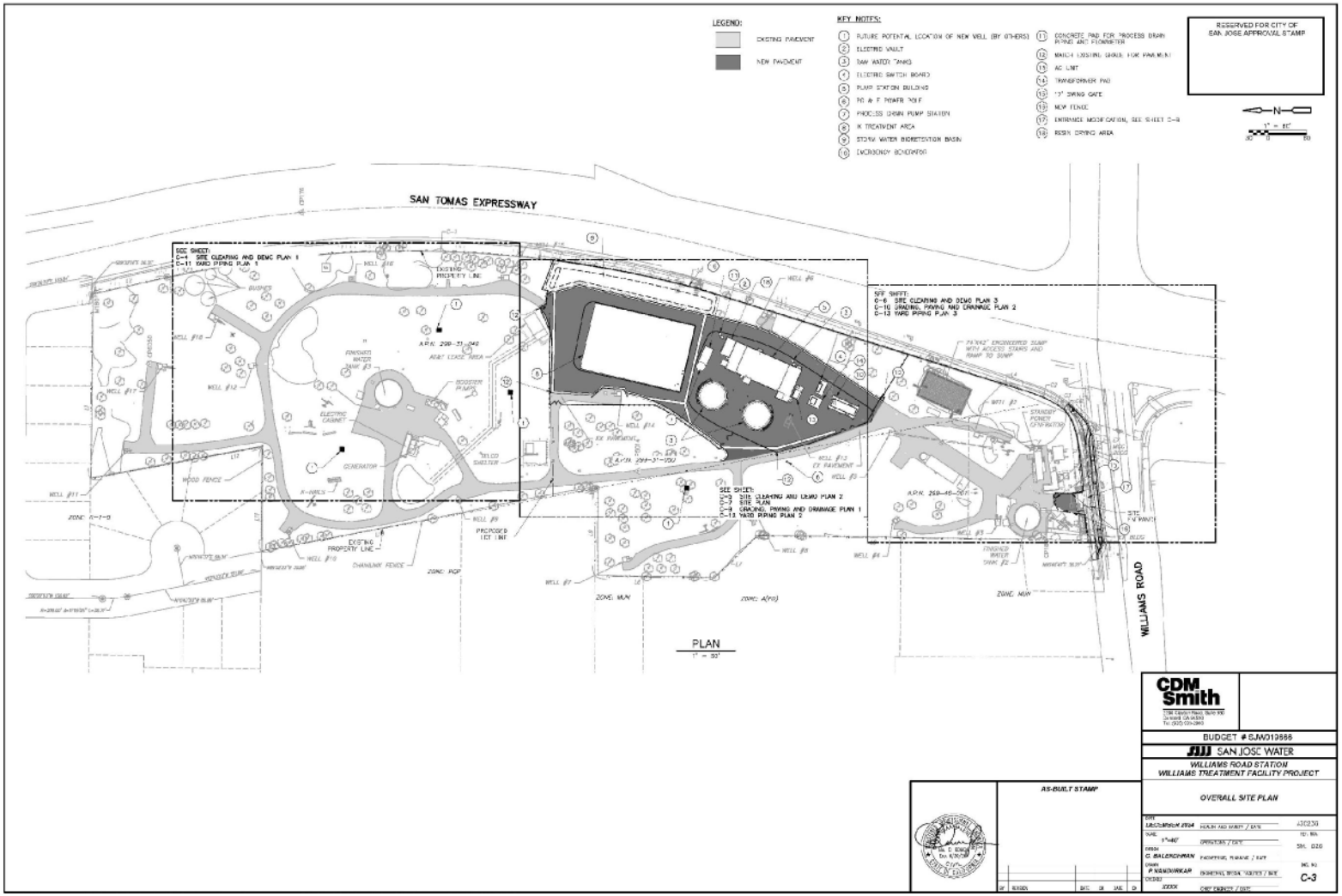


Figure 17. Final Design of Williams Station and Layout of PFAS Treatment Project

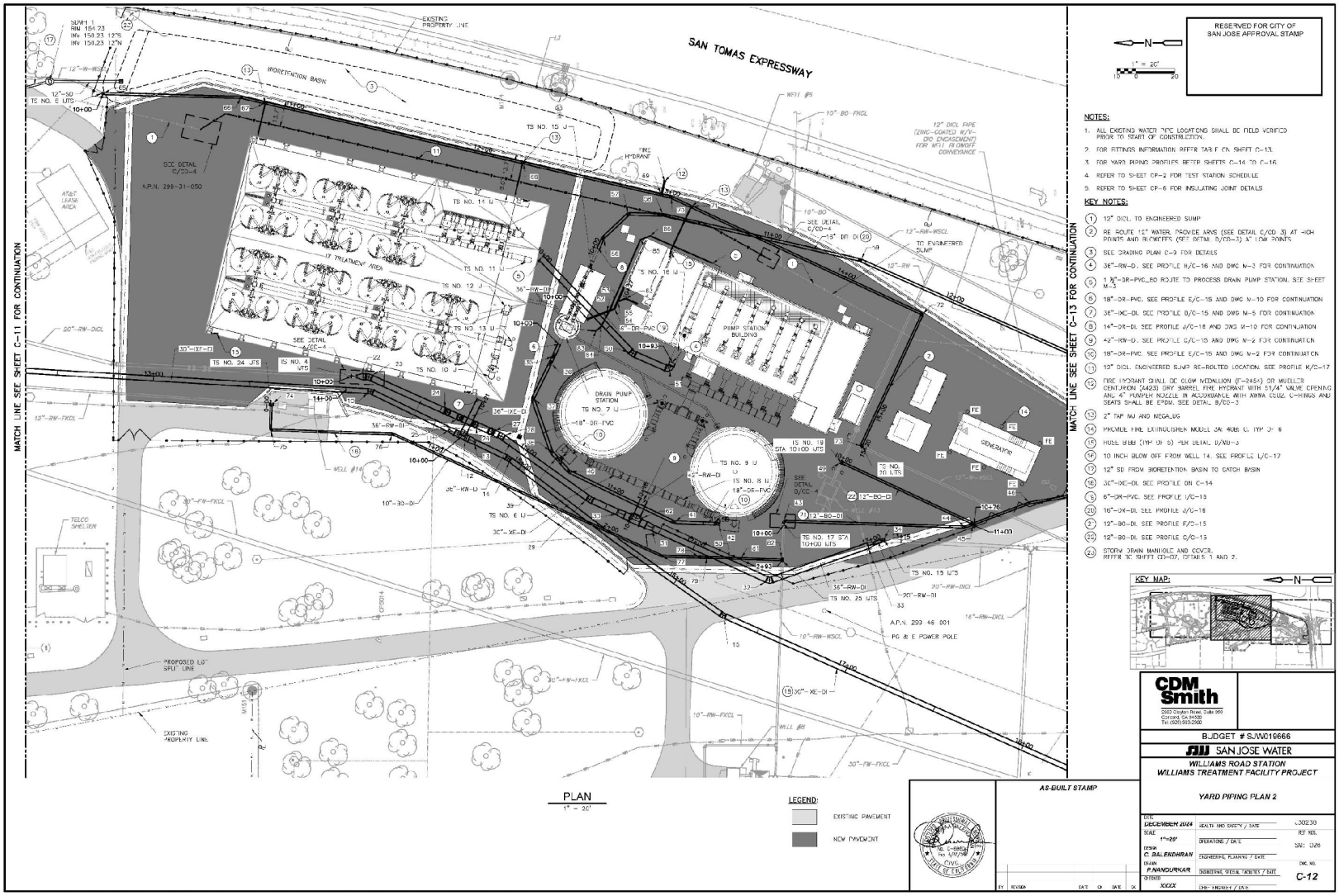


Figure 18. Piping and Detailed Layout of PFAS IX System at Williams Station

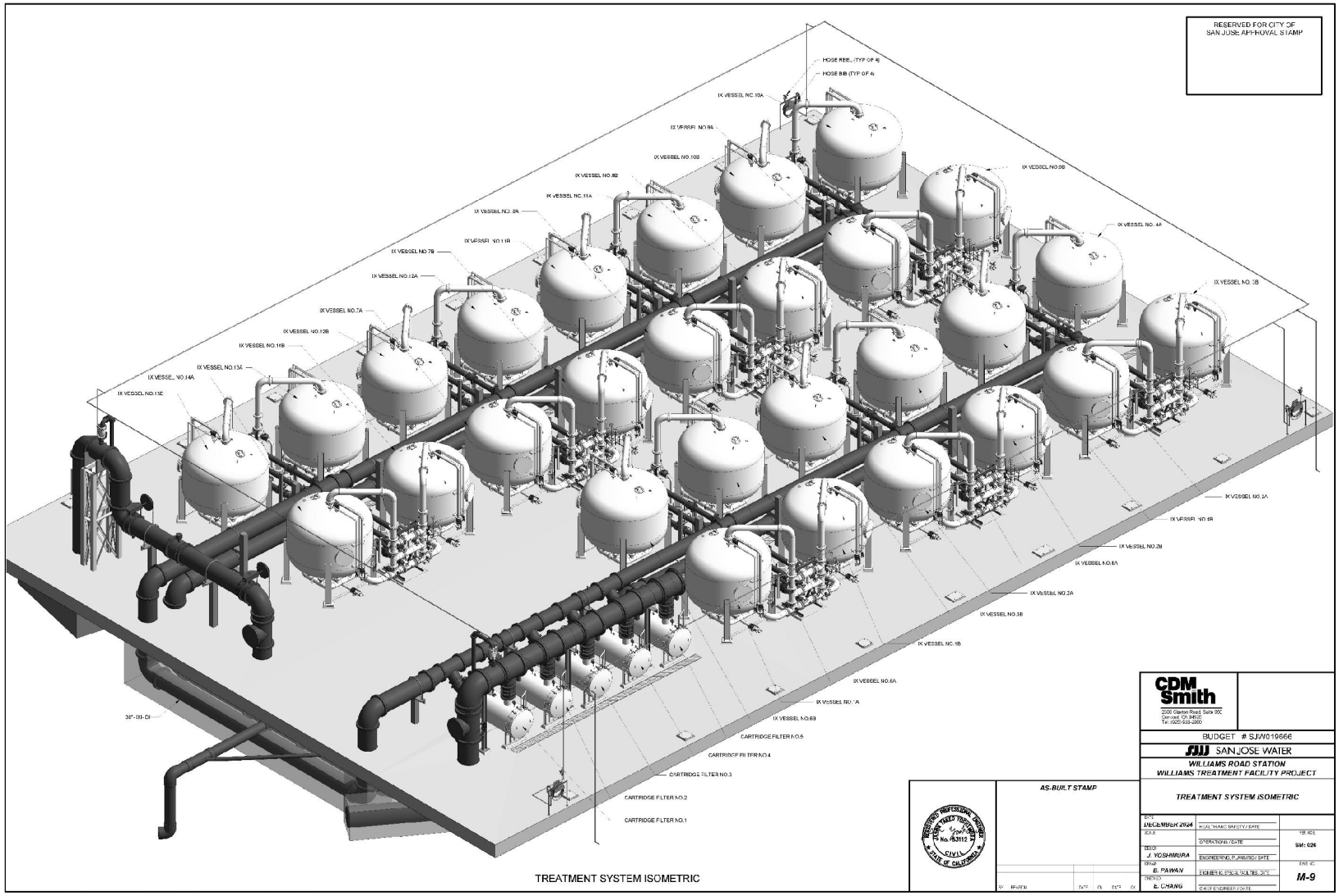


Figure 19. Isometric View of PFAS IX Vessels and Configuration at Williams Station

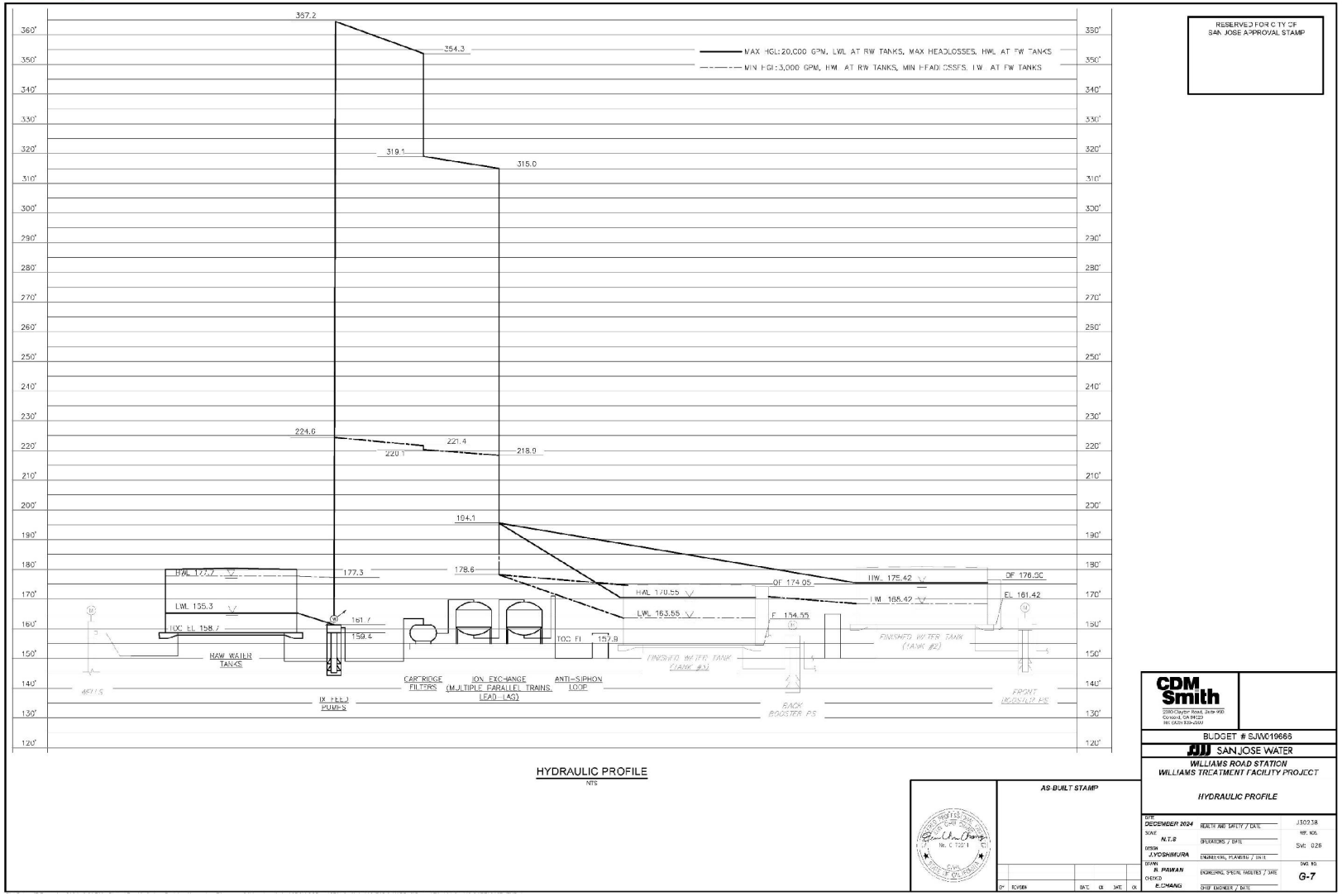


Figure 20. Hydraulic Profile of PFAS IX System at Williams Station

Scheduling

Design for the Williams Station PFAS Treatment Project was completed in early 2025, and construction permitting is expected to be finalized in 2026. While minor permitting and DDW review will still continue after construction begins to validate performance, these activities will not delay project initiation. Pending CPUC approval in 2026, SJW plans to release the project for bidding in the fourth quarter of 2026 to secure competitive pricing and ensure the best value for customers. Construction is scheduled to span beyond three years (2027–2030), including schedule float for risk allowance, culminating in a fully operational PFAS treatment plant at Williams Station by Q2 of 2030. For a more detailed chart of tasks and schedule please see Appendix G for a Gantt chart updated by CDM Smith as of February 6, 2026.

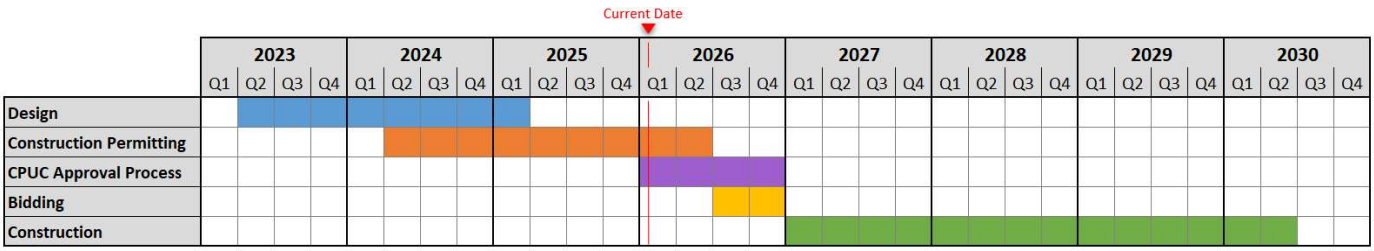


Figure 21. Williams Station PFAS Treatment Project Schedule

Permitting

The following permits were secured or are in the final stages of being secured in order to construct the Williams PFAS Treatment project:

- **California Environmental Quality Act (CEQA)**: Project completed an Initial Study/Mitigated Negative Declaration (IS/MND) and filed a Notice of Completion to circulate the document for public review; CEQA is formally complete only upon City adoption of the MND and filing of a Notice of Determination (NOD).
- **Conditional Use Permit (CUP)**: In the final stages of City of San José approval to authorize PFAS treatment uses and associated buildings at the existing Williams Groundwater Station.
- **Building Permit**: Approved by the City of San José for the electrical building and pump housing; additional on-site inspections will occur during construction to verify code compliance.
- **Driveway Permit**: Approved by the City of San José for modifications to the existing driveway; inspections will be performed during construction to ensure conformance with City standards.
- **Tree Removal Permit**: Requested from the City of San José for removal of trees that conflict with proposed improvements, approval may include replacement/mitigation requirements and pre-removal inspections.
- **Division of Drinking Water (DDW)**: DDW review and approval are required during design, system startup may require modifications to SJWC's potable water permit along with confirmation of treatment performance and monitoring protocols.

- **Bay Area Air Quality Management District (BAAQMD):** A permit is required for the standby generator. This will be approved during construction.

Environmental and Social Justice

SJWC is committed to delivering high-quality water and values to its customers, communities, and environment. SJWC wholeheartedly supports the Commission Environmental and Social Justic (ESJ) Action Plan 2019 and 2022, through which the Commission integrates ESJ considerations in conducting its business. Within SJWC's service area, over 42% of all customers fall within an ESJ community, amounting to over 76,000 services or approximately 427,000 people. To ensure reliability for these communities and all customers in SJWC's service area, the potable water distribution system is configured as an interconnected network of assets and pressure zones working together to wheel water throughout the system and meet customer demand. Interconnection between these pressure zones ensures capacity and operational flexibility to reliably meet customers' water demand and local fire flow protection needs, even in the face of natural disasters, drought, power outages, and other system emergencies (e.g., main break or equipment failure). This network of pressure zones is therefore critical to providing a safe and dependable water supply to all customers. Moreover, any station improvements made within one part of the system not only increases the reliability and quality of the specific zones the improvement primarily serves, but also in all adjacent connected zones within the larger SJWC service area.

This project supports the California Public Utilities Commission ESJ Action Plan goals, providing ESJ communities access to improved high-quality water by removing PFAS compounds from SJWC's groundwater supplies. Within Cox Zone specifically, which is served by Williams Station, 23% of the services (i.e., 4,415 services or approximately 22,400 people) are considered part of an ESJ community. As a result, the improvements presented herein will directly improve service and/or reliability to these ESJ community customers, as well as all other SJWC customers within the service area. Because groundwater supplies from Williams Station may be used elsewhere in the distribution system, many additional customers will benefit from the IX treatment system and improved water quality.

Operational Expenses

At a planned capacity of 20,000-gpm, the Williams Station PFAS Treatment Project is expected to become the second-largest ion-exchange PFAS facility in the United States when it enters service in 2029. [40] Given the scale of operations, SJWC anticipates incremental impacts to staffing and ongoing O&M expenses. These costs are discussed below and presented in 2026 dollars but will not come into full effect until the plant is fully operational in 2030.

CDM has determined that the new treatment facility will be classified as a Class T4 water treatment plant in accordance with Title 22 § 64413.1, primarily due to the overall size, process complexity, and

[40] Current largest is a 25 MGD IX Plant in Yorba Linda as of January 2026
https://www.acwa.com/innovation/nations-largest-ion-exchange-pfas-treatment-facility-begins-operation-in-yorba-linda/

operational requirements of the facility. Both CDM and Hazen have recommended the addition of two full-time, state-certified T4 water treatment operators to adequately support the day-to-day operation and management of the plant (see Appendix E, H, and I). In alignment with these recommendations and to ensure reliable staffing for continuous operations, SJWC has included two certified T4 operators in its proposed staffing plan.

Based on a planned average daily production capacity of 7.0 MGD (approximately 5,000 gpm), and considering the associated energy demands, filter replacement needs, and other operational components, CDM conducted a comprehensive Operation and Maintenance (O&M) cost analysis which is summarized in Table 5 below. The detailed O&M expense estimate is provided in Appendix I. All costs are presented in 2026 dollars.

Table 5. Projected Williams PFAS Treatment Plant Operational Expense

Expense	Annual Cost
Power – IX Feeding Pumping	$406,193
Power – Process Drain Pumping	$6,666
Power – Ancillary (building, HVAC, Lighting)	$22,326
Cartridge Filter Replacements	$94,500
IX Resin Replacements	$1,003,021
Analytical Lab Sampling & Reporting	$235,644
Labor	$485,400
Total Annual O&M Expense	**$2,254,000 per year**
Total Cost Per Acre-Feet[1]	**$287 / AF**
Total Cost per Million Gallon[1]	**$882 / MG**

Note:
(1) Assuming average daily production of 7.0 MGD (see Appendix I for details)

Capital Budget

A summary of the Capital Improvement Program (CIP) budget is provided in Table 6, derived from an Opinion of Probable Construction Costs (OPCC) prepared by CDM Smith's certified cost estimating professionals. The complete OPCC is provided in Appendix J. These estimates reflect current market conditions at the time of filing, however, they **do not** include potential tariff related surcharges, given the uncertainty and continuously evolving federal trade policy anticipated this project's three-year construction window. In light of this uncertainty, SJWC has included a prudent 5% contingency to address this, as well other unknown or unforeseen risks, consistent with current industry standard practices. If tariff levels or related supply chain conditions materially change, actual construction costs could exceed current estimates despite this contingency.

The total project costs presented below also incorporate all expenditures to date (as of January 14, 2026), including $3.459 million in consultant design fees, permitting activities, and SJW labor. [41]

Table 6. Capital Improvement Budget

Conceptual Cost Estimate	
Project Number	Index # 6122
Project Name	Williams Station PFAS Treatment
Recommendation	Install an Ion Exchange PFAS Treatment Facility
Item	**Estimated Amount**
Contract Cost	$39,547,200
Material Cost	$75,452,800
Company Labor	$1,316,800
Design & Construction Management	$14,704,600
Permits and Fees	$684,600
Contingencies (5%)	$6,585,600
Overhead (13%)	$17,977,900
Total Estimated Project Cost (2026 Dollars)	**$156,269,500**
Total Estimated Project Cost (2030 Dollars)	**$175,882,700**

NOTE: Assume 3.0% escalation rate per year

[41] Total capital spend to date does not include AFUDC or Overhead

Appendix A
Statement of Qualifications

SAN JOSE WATER COMPANY

STATEMENT OF QUALIFICATION
SUZANNE DELORENZO

My name is Suzanne DeLorenzo. My business address is 1221A South Bascom Avenue, San Jose, California 95128.

I am employed by San Jose Water Company and have served as Director of Water Quality since March 21, 2022. In this role, I am responsible for managing personnel, programs, and equipment related to water quality monitoring, distribution system water quality, flushing, cross-connection control, and regulatory compliance for an investor-owned public water utility. These responsibilities include ensuring compliance with applicable state and federal drinking water regulations and protecting public health.

Prior to joining San Jose Water Company, I served as Water Quality and Laboratory Supervisor at Passaic Valley Water Commission in Little Falls, New Jersey from 2020 to 2022. Before that, I was the Water Quality and Conservation Manager at Clackamas River Water in Clackamas, Oregon from 2011 to 2020. In these positions, I was responsible for drinking water quality monitoring, laboratory operations, regulatory compliance, and public health protection.

I hold a Doctor of Philosophy in Environmental Science and Engineering from Oregon Health & Science University. I also earned a Master of Science in Biomedical Science from the University of Medicine and Dentistry of New Jersey and a Bachelor of Science in Biology from Monmouth University.

I have not previously submitted testimony before the California Public Utilities Commission.

SAN JOSE WATER COMPANY

STATEMENT OF QUALIFICATIONS
KATELINE LIN

My name is Kateline Lin, and my business address is 1265 South Bascom Avenue, San Jose, California 95128.

For more than 8 years, my work at San Jose Water Company (SJWC) has centered on planning, asset management, leak detection, and capital budgeting. In my current role as Engineering Unit Manager, Planning, I manage the annual Capital Improvement Program (CIP) budget to ensure infrastructure investments are optimized across cost, level of service, and system risk.

A significant portion of my responsibilities involve leading the development of CIP budgets and the planning, approval, and execution of projects. I oversee the development of infrastructure master plans which inform SJWC's capital improvement strategies and include risk analyses, asset rankings, and system optimization efforts. I also lead the development of major water supply and demand planning documents, including the Urban Water Management Plan, Water Supply Assessments, and Water Loss Audits. In addition, I oversee a range of special capital projects, including solar and energy storage installations, fleet electrification, water loss reduction initiatives, and feasibility studies for alternative water supply sources.

My educational background includes a Bachelor of Science in Civil Engineering and a Master of Science in Environmental Engineering and Science from Stanford University. I am also a licensed Civil Engineer in California and a certified Project Management Professional.

Over the course of my career, I have prepared documentation for three General Rate Case applications and the Advanced Metering Infrastructure application before the California Public Utilities Commission. Significant components of the capital budget, project and program justifications, and enterprise asset management plan submitted as the Capital Exhibit were prepared by me or with my review.

Appendix B

San Francisco Bay Regional Water Quality Control Board Letter **Regional Water Board Support for SJWC Construction of Williams Station PFAS Treatment Project** (dated January 28, 2026)

San Francisco Bay Regional Water Quality Control Board

January 28, 2026

California Public Utilities Commission
Attn: President Alice Reynolds and Commissioners
505 Van Ness Avenue
San Francisco, CA 94102

SUBJECT: Regional Water Board Support for San Jose Water's Construction of Williams Station PFAS Treatment Project

President Reynolds and Commissioners,

The San Jose Water Company (San Jose Water) is proposing to construct a treatment facility to address per- and polyfluoroalkyl substances (PFAS) contamination in public drinking water supply wells at its Williams Station in the Santa Clara Groundwater Subbasin. I understand that San Jose Water is submitting an Advice Letter to the California Public Utilities Commission (CPUC) for approval of this project.

I want to convey San Francisco Bay Regional Water Quality Control Board's wholehearted support for this project. The project aligns with our mission to preserve, enhance, and restore the quality of California's water resources and drinking water for the protection of the environment, public health, and all beneficial uses, and to ensure proper water resource allocation and efficient use, for the benefit of present and future generations. The project is also consistent with the State of California's Human Right to Water policy that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes (State Water Board Resolution No. 2016-0010). We are dedicated to a single vision: abundant clean water for human uses and environmental protection to sustain California's future.

Regional Water Board staff is collaborating with San Jose Water to confront PFAS contamination in the Santa Clara Groundwater Subbasin, a critical local source of drinking water for over one million residents in in the metropolitan San Jose area. Without PFAS treatment, this source of supply water will not meet the drinking water standards, which could threaten drinking water supplies especially during droughts.

San Jose Water relies on its groundwater supplies to maintain a high level of service to its customers and ensure supply resiliency against weather-related and other significant man-made or natural disasters. Groundwater accounts for approximately 40% of San Jose Water's supply. The Williams Station has the greatest well production capacity within San Jose Water's groundwater infrastructure system, with 15 wells able to produce a total of 30,500 gallons per minute (gpm). However, 6 of the 15 wells are

currently on standby status, making them available for potable use only in emergencies, to help manage PFAS-related risks while maintaining system reliability. San Jose Water has been proactively monitoring for the presence of PFAS compounds since 2019 and has recorded increasing concentrations of PFAS in supply wells at Williams Station in recent years. Maintaining safe operation of this station is important to protect public health and to support operational reliability, including during outages and emergency conditions. It is critical to construct a PFAS treatment facility at Williams Station to provide drinking water that meets water quality objectives and supports the water demand.

San Jose Water has completed the design of the PFAS treatment facility at Williams Station. The project includes pretreatment (cartridge filtration) and a full-scale ion exchange PFAS treatment system with a maximum plant capacity of 20,000 gpm. The construction of the PFAS treatment facility at Williams Station will allow San Jose Water to deliver a safe and reliable water supply to the community.

In consideration of the project's goals and attributes, we concur with San Jose Water's plan and want to facilitate construction of this PFAS treatment facility for the groundwater basin. This project represents a proactive measure to manage PFAS impacts in an important groundwater source and to support compliance planning under the evolving state and federal PFAS requirements. We are confident in San Jose Water's ability to effectively implement the project and appreciate their efforts to incorporate Regional Water Board input throughout the process. We encourage CPUC to support San Jose Water's Williams Station PFAS Treatment Project.

Sincerely,

Eileen M. White

Digitally signed by Eileen M. White
Date: 2026.01.28 15:07:58 -08'00'

Water Boards

Eileen M. White, P.E.
Executive Officer

cc:
Van Tsang, District Engineer, California Division of Drinking Water
Tanya Moniz-Witten, President, San Jose Water Company
Jake Walsh, Vice President of Engineering, San Jose Water Company
Scott Hoffman, Manager of Property & Permit Services, San Jose Water Company
Suzanne DeLorenzo, Director of Water Quality, San Jose Water Company

Appendix C

State Water Resource Control Board, Division of Drinking Water

Division of Drinking Water Support for SJWC Williams Road Station PFAS Treatment Facility Project (dated February 26, 2026)

State Water Resources Control Board
Division of Drinking Water

February 26, 2026

System No. 4310011
San Jose Water

California Public Utilities Commission
drawateral@cpuc.ca.gov

DIVISION OF DRINKING WATER SUPPORT FOR SAN JOSE WATER WILLIAMS ROAD STATION PFAS TREATMENT FACILITY PROJECT

The State Water Resources Control Board, Division of Drinking Water (Division) supports the construction and operation of the proposed ion exchange treatment facility at San Jose Water's Williams Road Station. The Division has reviewed and approved the 100% design plans for the proposed treatment facility.

Williams Road Station is a high production facility at the heart of the San Jose Water's geographic distribution area that serves as a critical point of supply of local groundwater. The public drinking water supply wells at the Williams Road Station have been demonstrated to have per- and polyfluoroalkyl substances (PFAS) above the drinking water notification levels established by the Division and the maximum contaminant levels (MCL) established by U.S. EPA in 2024. Multiple other San Jose Water well fields have also shown levels of PFAS above these levels.

The timeline for rule implementation provided by U.S. EPA will require San Jose Water to comply with the established federal MCLs for PFAS by 2029. Failure to treat non-compliant sources would require the removal of these sources from service.

Given the widespread detection of these compounds throughout the San Jose Water groundwater supply network, currently established regulatory limits and timelines, and the apparent trajectory of increasing detection and identified impacts, the Division generally supports the development of treatment capacity to effectively remove PFAS from San Jose Water's groundwater supply. Further, given the critical nature of the Williams Road Station in San Jose Water's supply portfolio, the Division supports the prioritization of the construction and operation of the proposed ion exchange treatment facility at San Jose Water's Williams Road Station.

If you have any questions regarding this matter, please contact me at (510) 620-3602 or Dr. Rory Klinger, Water Resource Control Engineer at (510) 412-4685.

Sincerely,

Van Tsang
Digitally signed by Van Tsang
Date: 2026.02.26 08:40:48 -08'00'

Van Tsang, P.E.
District Engineer
Santa Clara District
Division of Drinking Water
State Water Resources Control Board

cc: Santa Clara County Department of Environmental Health
(via email: dehdrinkingwater@cep.sccgov.org)

Public Advocates Office, California Public Utilities Commission
(via email: drawateral@cpuc.ca.gov)

Richard Rauschmeier, California Public Utilities Commission
(via email: richard.rauschmeier@cpuc.ca.gov)

Bruce DeBerry, California Public Utilities Commission
(via email: bruce.deberry@cpuc.ca.gov)

James Booth, California Public Utilities Commission
(via email: james.boothe@cpuc.ca.gov)

Colby Sneed, San Jose Water
(via email: colby.sneed@sjwater.com)

Suzanne DeLorenzo, San Jose Water
(via email: suzanne.delorenzo@sjwater.com)

Joshua Karpel, San Jose Water
(via email: joshua.karpel@sjwater.com)

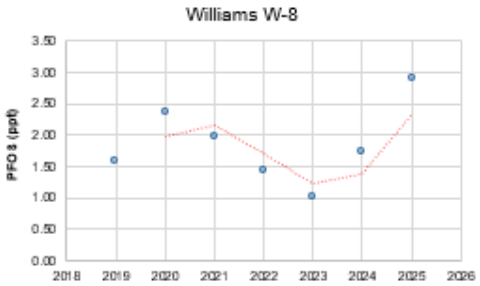
Carlos Ramos, San Jose Water
(via email: carlos.ramos@sjwater.com)

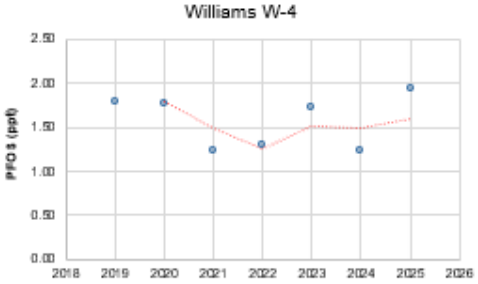
Stephanie Vogel, San Jose Water
(via email: stephanie.vogel@sjwater.com)

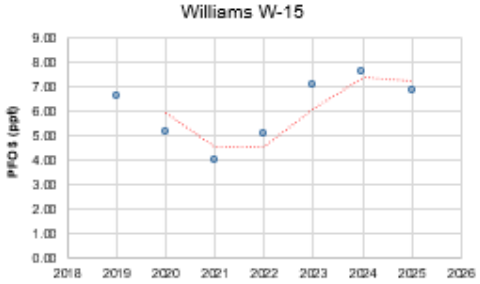
Appendix D

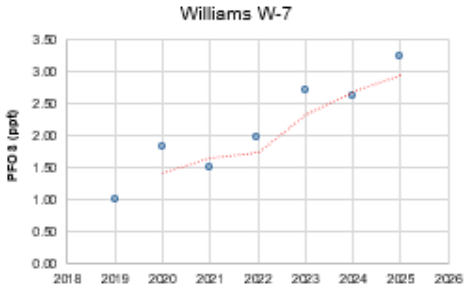
Historical Water Quality Analysis of Williams Station Wells
12-Month Average Data and 2-Month Moving Average Trends

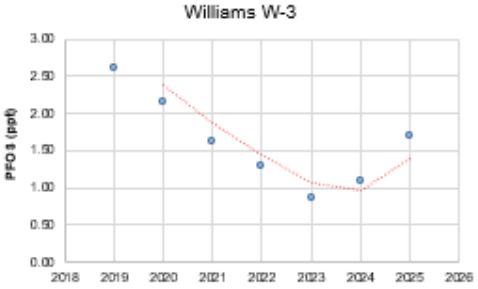
PFOS (Perfluorooctane Sulfonic Acid)

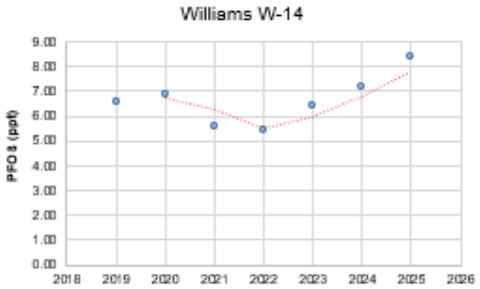


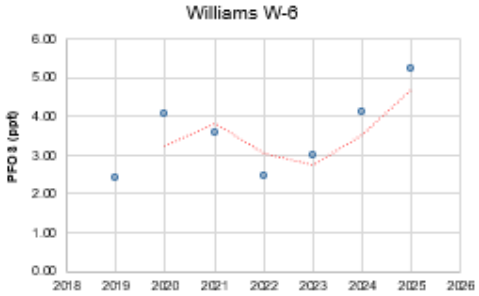


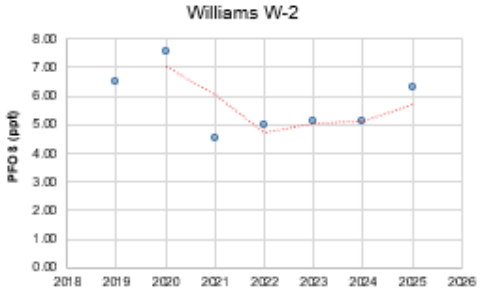


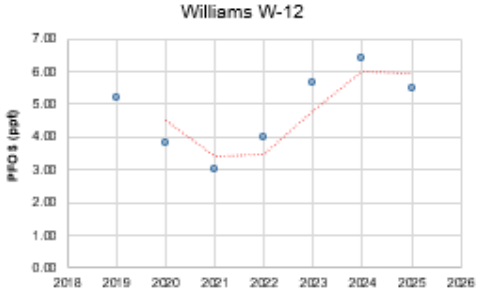


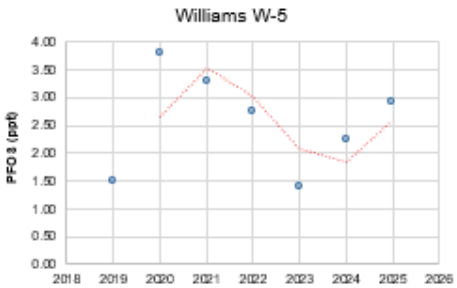


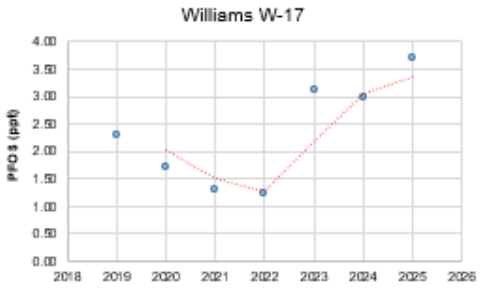


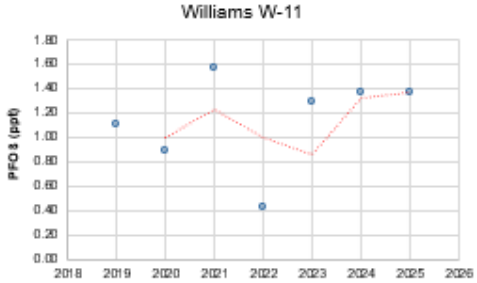


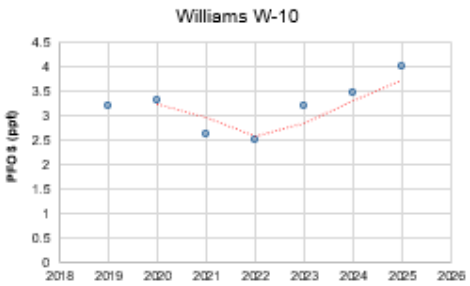




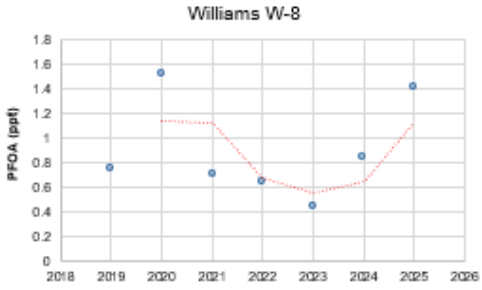


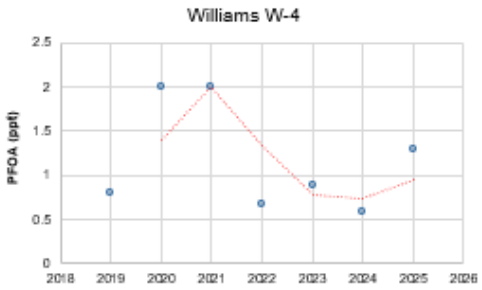


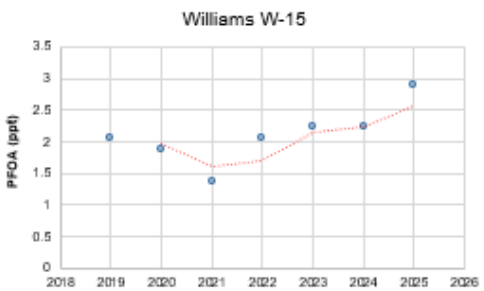


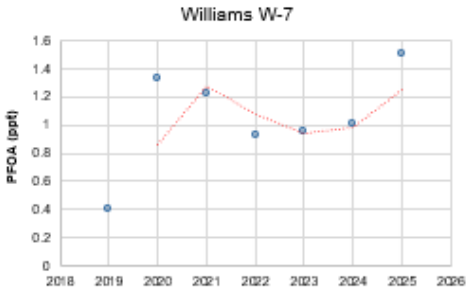


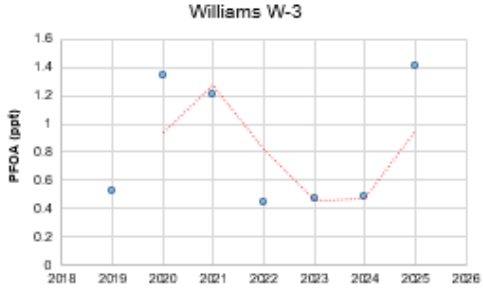
PFOA (Perfluorooctanoic Acid)

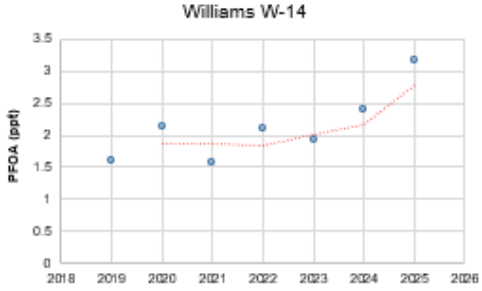


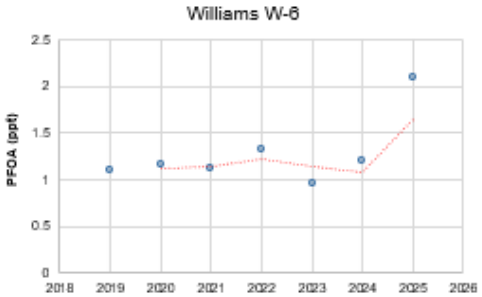


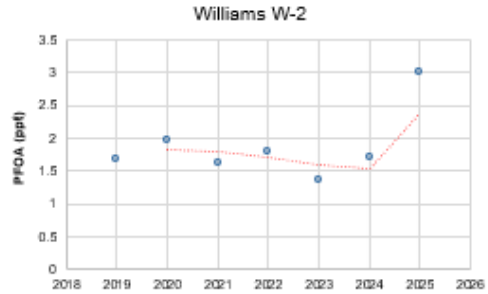


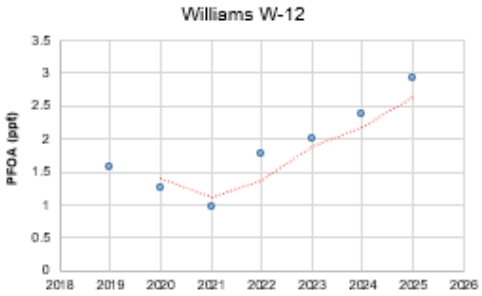


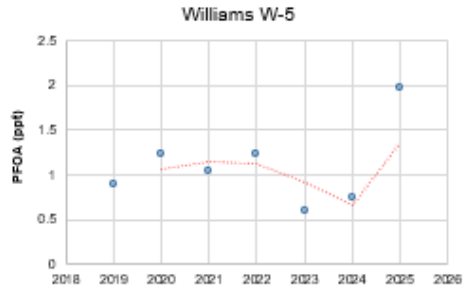


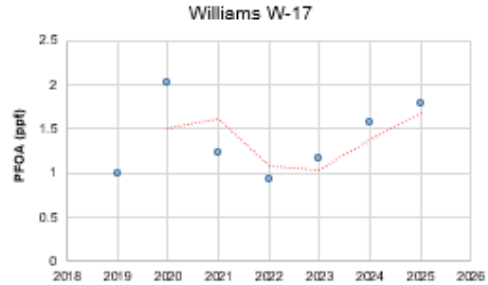


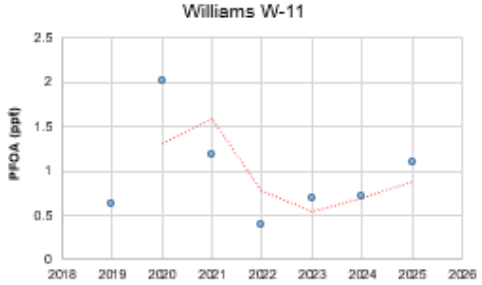


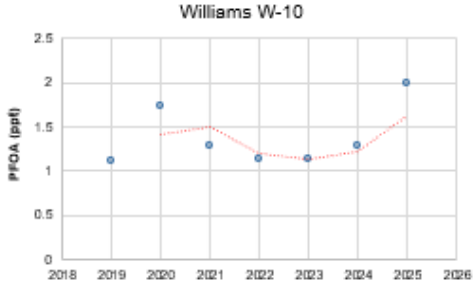




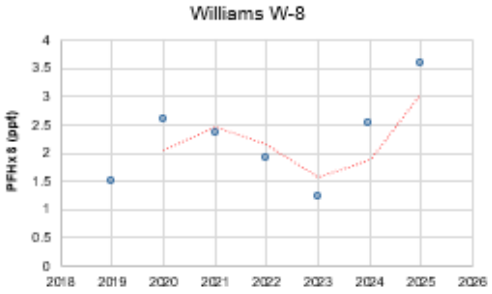


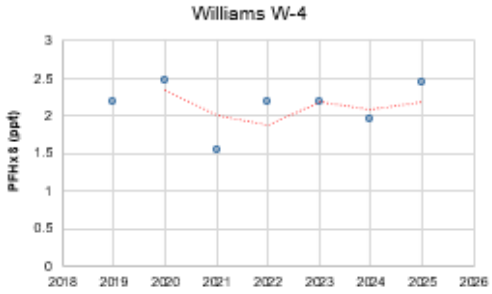


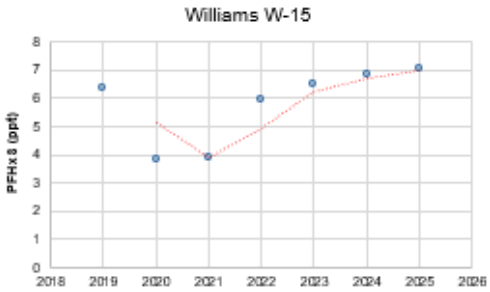


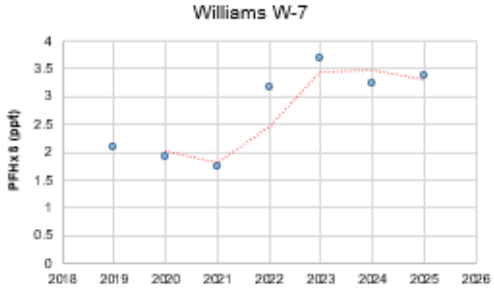


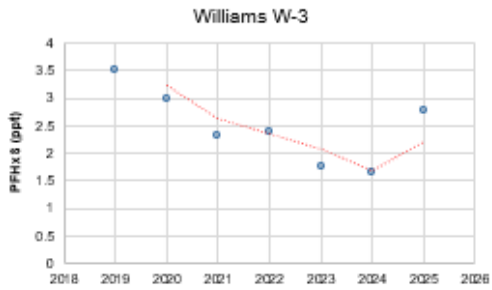
PFHxS (Perfluorohexanesulfonic Acid)

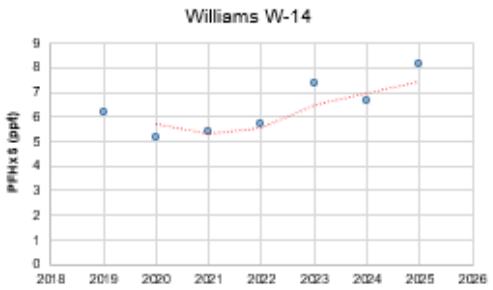


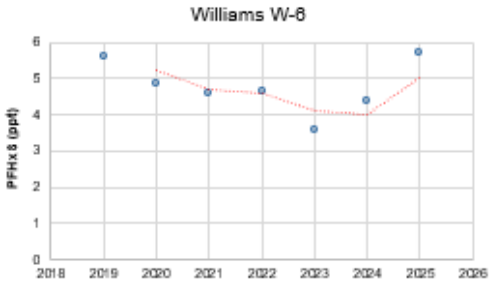


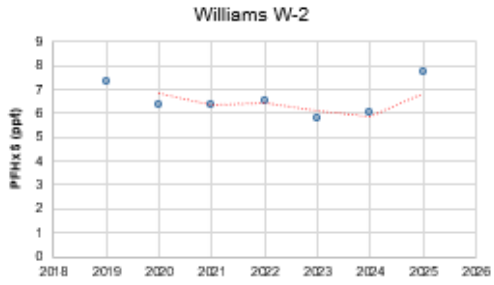


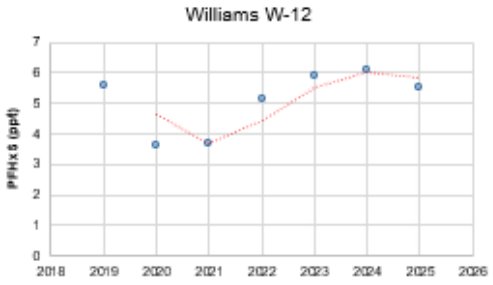


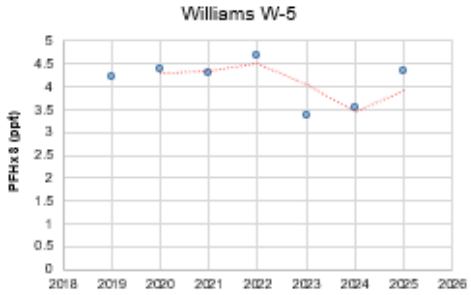


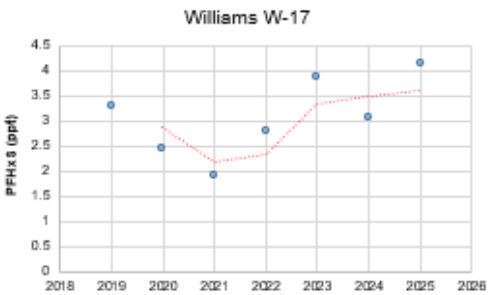


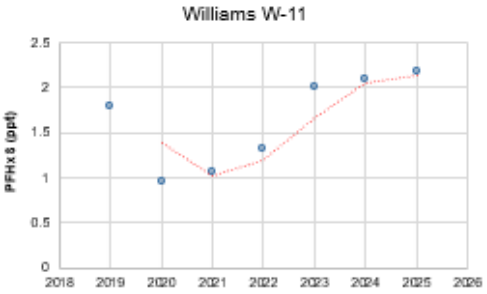


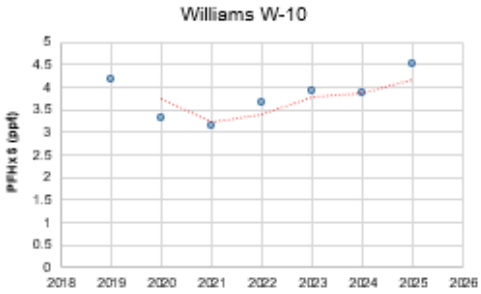












Appendix E

Facilities Plan for Williams Station PFAS Treatment and Softening Facilities (March 2022) Hazen Project No. 20177-000



Facilities Plan for Williams Station

PFAS Treatment and Softening Facilities
Hazen Project No. 20177-000
March 21, 2022

Table of Contents

1. Introduction and Evaluation Process Overview 8
1.1 Project Goals 8
1.2 Alternatives Evaluation Process Overview 8
1.3 Summary of Capacities and Water Quality Concerns 11
2. Alternatives Screening 13
2.1 Screening Criteria 13
2.2 Pretreatment 13
2.3 Softening 17
2.4 PFAS Removal 24
3. Bench Testing Results 27
3.1 RSSCTs and Recirculating Isotherms 27
3.2 Pretreatment Testing 31
4. Alternatives Evaluation 41
4.1 Alternatives Development 41
4.2 Evaluation Criteria 55
4.3 Preliminary Capital, O&M, and Lifecycle Costs 55
4.4 Alternatives Scoring and Ranking 63
5. Detailed Assessment of Selected Alternative 69
5.1 Treatment System Headloss and Hydraulics 69
5.2 Number of Systems and Pumping Alternatives 71
5.3 Break Tank Sizing 87
5.4 Residuals Handling and Sanitary Sewer Disposal 87
5.5 Electrical Power Requirements 87
5.6 Chemical Storage and Consumption 89
5.7 Staffing Requirements 90
5.8 SCADA and Controls 91
6. Pilot Study Testing and Results 93
6.1 Pilot Testing Plan 93
6.2 Pilot Setup 103
6.3 Observations from Loading of PFAS Media 107
6.4 Startup and Sloughing Analysis 108
6.5 Softening and PFAS Removal Efficacy 119

6.6 Softening Operation and Results 125
6.7 pH Adjustment and Corrosion Indices 132
6.8 Swelling, Headloss, and Hydraulic Loading Rate 136
7. Refined Technology Overview 139
7.1 Comparison of IX and FS 139
7.2 Conceptual Design 140
7.3 Capital, O&M, and Lifecycle Costs 147
7.4 Estimated Construction Schedule 152

List of Appendices

Appendix A: RSSCT and Recirculating Isotherm Bench Testing Report
Appendix B: Geotechnical Report
Appendix C: Site Survey
Appendix D: Meeting Slides

List of Tables

Table 1-1. Well Information 11
Table 1-2. Booster Pump Capacities 11
Table 1-3. Water Quality Issues in Standby Wells 12
Table 2-1. Summary of Screening for Pretreatment Technologies 17
Table 2-2. Summary of Screening for Softening Technologies 24
Table 2-3. Summary of Screening for PFAS Removal Technologies 27
Table 3-1. PFAS Occurrence in Well #2 Compared to Regulatory Limits 28
Table 3-2. Estimated Bed Volumes to Breakthrough 29
Table 3-3. Summary of Pretreatment Test Plan 31
Table 3-4. Wells Sampled During Initial Testing (Feb 16) 32
Table 3-5. Wells Sampled During Additional Testing (May 5) 32
Table 4-1. Summary of Treatment Processes in Each Alternative 41
Table 4-2. Preliminary Alternative Capital Cost Estimates 57
Table 4-3. Capital Cost Assumptions 58
Table 4-4. Summary of Preliminary O&M Cost ($/MG) 58
Table 4-5. Water Loss by Unit Process 59
Table 4-6. Preliminary Lifecycle Cost Comparison 62
Table 4-7. Summary of Alternatives Scoring 65
Table 5-1. Conceptual Pumping Options Advantages and Disadvantages 74
Table 5-2. Comparison of Electrical Requirements for Options 2 and 3 85
Table 5-3. Cost Comparison of Options 2 and 3 86
Table 5-4. Comparison of Pumping Options 2 and 3 86
Table 5-5. Break Tank Sizing, Goals, and Construction Cost Estimate 87
Table 5-6. Chemical Storage Volume, Storage Tank Sizes, and Frequency of Deliveries 90
Table 5-7. Anticipated O&M Tasks and Frequency 91
Table 6-1. Pilot Testing Objectives 93
Table 6-2. WAC Softening Initial Operation Conditions 94
Table 6-3. Ion Exchange/Fluoro-sorb Initial Operation Conditions 95
Table 6-4. Summary of Pilot Operation 99
Table 6-5. Sampling and Analysis Frequency 101
Table 6-6. Volume Produced and Time for Startup and Sloughing Sampling 102
Table 6-7. Sodium Hydroxide Dose at Different Blend Ratios Required to Raise pH of Softened Water 134
Table 6-8. Corrosivity Indices Evaluated During Pilot Study 135

Table 7-5. Post-Pilot Capital Cost Assumptions 148
Table 7-6. Alternatives Evaluation, Pre-Pilot, and Post-Pilot O&M Cost Summary 148
Table 7-7. Preliminary and Revised Chemical Dosages Summary 149
Table 7-8. Analytical O&M Cost Assumptions 150
Table 7-9. Preliminary and Revised Lifecycle Cost Comparison 152

List of Figures

Figure 1-1. Alternatives Evaluation Process with SJW feedback During Progress Meetings 8
Figure 1-2. Approach to Evaluation Criteria, Weighting, and Scoring 9
Figure 1-3. Project Roadmap 10
Figure 2-1. Bag Filter Housing and Elements 14
Figure 2-2. Cartridge Filter Housing and Elements 15
Figure 2-3. Self-Backwashing Strainer (Source: Amiad Water Systems) 16
Figure 2-4. Greensand Filtration Process (Source: Loprest) 16
Figure 2-5. Calcium and Magnesium Solubility 18
Figure 2-6. Calcium and Magnesium Hardness Fraction 19
Figure 2-7. Lime Softening Process 19
Figure 2-8. Lime Softening Treatment Footprint 20
Figure 2-9. Pellet Softening Process (Farahmand, et al) 21
Figure 2-10. Softening and Regeneration with Na or K Process (Source: Skipton, et al) 22
Figure 2-11. GAC Treatment Train 25
Figure 2-12. NF/RO Treatment Skid 26
Figure 3-1. Estimated BV at Changeout (left) and Cost in $/MG (right) based on PFOS 30
Figure 3-2. Estimated Lifecycle Cost of GAC, IX, and FS Including Project Costs 30
Figure 3-3. Cumulative Probability Plots of Time Between Runs 32
Figure 3-4. Particle Size Distribution and TDS Loading in Wells 4 (top) and 18 (bottom) 34
Figure 3-5. Silt Density Index Results 35
Figure 3-6. Turbidity (top) and TSS (bottom) Results (February 16) 36
Figure 3-7. Unfiltered Turbidity Results (May 5) 37
Figure 3-8. 5 µm Filtered Turbidity Results (May 5) 37
Figure 3-9. 10 µm Filtered Turbidity Results (May 5) 38
Figure 3-10. Total (top) and Dissolved (bottom) Iron Results (Feb 16) 39
Figure 3-11. Total (top) and Filtered (bottom) Iron Results (May 5) 40
Figure 4-1. Simplified PFD of Source, Pretreatment, and Finished Water Pumping 41
Figure 4-2. Sewer Lines in the Vicinity of Williams Station 42
Figure 4-3. Simplified PFD for Alternative 1: Nanofiltration 42
Figure 4-4. Process Flow Diagram for Alternative 1: Nanofiltration 44
Figure 4-5. Site Layout for Alternative 1: Nanofiltration 45
Figure 4-6. Simplified PFD for Alternative 2: Sidestream RO, PFAS IX/FS 46
Figure 4-7. Process Flow Diagram for Alternative 2: Sidestream RO, PFAS IX/FS 47
Figure 4-8. Site Layout for Alternative 2: Sidestream RO, PFAS IX/FS 48
Figure 4-9. Simplified PFD for Alternative 3: Pellet Softening, PFAS IX/FS 49
Figure 4-10. Process Flow Diagram for Alternative 3: Pellet Softening, PFAS IX/FS 50
Figure 4-11. Site Layout for Alternative 3: Pellet Softening, PFAS IX/FS 51

Figure 4-12. Simplified PFD for Alternative 4: Acid Regen IX Softening, PFAS IX/FS 52
Figure 4-13. Process Flow Diagram for Alternative 4: Acid Regen IX Softening, PFAS IX/FS 53
Figure 4-14. Site Layout for Alternative 4: Acid Regen IX Softening, PFAS IX/FS 54
Figure 4-15. Evaluation Criteria and Relative Weighting 55
Figure 4-16. Summary of Preliminary O&M Cost by Alternative 60
Figure 4-17. O&M Cost by Alternative (including Valley Water Fees, 2029 rates) 61
Figure 4-18. Total Cost of Water Including O&M and Debt Service (Excluding Base VW Fees) 63
Figure 4-19. Radar Plot Summarizing Scoring for Qualitative Criteria 64
Figure 4-20. Alternatives Ranking 68
Figure 5-1. Treatment Schematic for Softening (orange) and PFAS-only Treatment Stream (green) 69
Figure 5-2. Cumulative Headloss from Softening Stream (left) and PFAS-only Treatment Stream (right) 70
Figure 5-3. Well Efficiency Before and After Treatment 71
Figure 5-4. Existing System Schematic 72
Figure 5-5. Existing System Piped Connections Layout 73
Figure 5-6. Option 1A Pumping Schematic 75
Figure 5-7. Option 1B Pumping Schematic 75
Figure 5-8. Option 4A Pumping Schematic 76
Figure 5-9. Option 4B Pumping Schematic 76
Figure 5-10. Option 2A Pumping Schematic 78
Figure 5-11. Option 2B Pumping Schematic 78
Figure 5-12. Option 2A Conceptual Site Layout 79
Figure 5-13. Option 2B Conceptual Site Layout 80
Figure 5-14. Option 3A Pumping Schematic 82
Figure 5-15. Option 3B Pumping Schematic 82
Figure 5-16. Option 3A Conceptual Site Layout 83
Figure 5-17. Option 3B Conceptual Site Layout 84
Figure 5-18. Front and Back MCC Existing Electrical Demands 88
Figure 5-19. Estimated New Electrical Loads 88
Figure 5-20. Chemical Feed Locations and Purpose 89
Figure 6-1. Conceptual Process Flow Diagram for Pilot Study 94
Figure 6-2. WAC Pilot Unit (source: Purolite) 96
Figure 6-3. WAC Pilot Schematic 96
Figure 6-4. Example PFAS Pilot Unit with 2-in and 3-in Columns (source: Purolite) 97
Figure 6-5. Schematic of PFAS Pilot Unit (source: Purolite) 97
Figure 6-6. Schematic of Liqui-Cel™ EXF decarbonator (source: 3M) 98
Figure 6-7. Conceptual Pilot Process Flow Diagram with Sampling Locations 100
Figure 6-8. Acid Waste Tank, Hydrochloric Acid Totes, and Covered Softening Skid at Williams Station 104
Figure 6-9. WAC IX Softening Skid 104
Figure 6-10. Decarbonator Skid Setup 105
Figure 6-11. PFAS IX/FS Skid 106
Figure 6-12. Covered PFAS IX/FS Skid 106

Figure 6-13. Slurrying of IX Resin During Loading 107
Figure 6-14. Air-Bound FS Media Being Washed out During Backwash 108
Figure 6-15. Detects < 10% of MCL, NL, or HAL 110
Figure 6-16. Detects > 10% of a Regulatory Level or No Concentration for Comparison 111
Figure 6-17. Phase 1 Sloughing Analysis of Regulated Constituents 113
Figure 6-18. Phase 1 Sloughing Analysis of Unregulated Constituents 114
Figure 6-19. Phase 2 Sloughing Analysis of Regulated Constituents off PFAS Media 115
Figure 6-20. Phase 2 Sloughing Analysis of Unregulated Constituents off PFAS Media 116
Figure 6-21. Phase 2 Sloughing Analysis of Unregulated Constituents off PFAS Media (cont.) 117
Figure 6-22. Phase 2 Sloughing Analysis of WAC Resins 118
Figure 6-23. Example Softened Water Hardness Readings 119
Figure 6-24. Total Hardness Concentrations of Raw Water and Softened Water Over Time 120
Figure 6-25. Calcium Hardness Concentrations of Raw Water and Softened Water Over Time 120
Figure 6-26. Magnesium Hardness Concentrations of Raw Water and Softened Water Over Time 121
Figure 6-27. Influent and Effluent Concentrations of Regulated PFAS 122
Figure 6-28. Unregulated PFAS with Effluent Concentrations Below the Detection Limit 123
Figure 6-29. Unregulated PFAS with Effluent Concentrations below the Detection Limit, Field Blank Detects 124
Figure 6-30. Conceptual WAC Breakthrough Curve 125
Figure 6-31. Conceptual Diagram of Hardness Removal and Alkalinity Consumption During WAC IX 126
Figure 6-32. ResinTech Effluent Hardness vs. Bed Volumes 127
Figure 6-33. Purolite WAC Effluent Hardness vs. Bed Volumes 127
Figure 6-34. Online pH Analyzer and pH Grab Sample Comparison 128
Figure 6-35. Effluent pH vs. Bed Volumes for ResinTech Resin 129
Figure 6-36. Effluent pH vs. Bed Volumes for Purolite Resin 129
Figure 6-37. Online Conductivity Analyzer and Conductivity Grab Sample Comparison 130
Figure 6-38. Effluent Conductivity vs. Bed Volumes for ResinTech WAC 131
Figure 6-39. Effluent Conductivity vs. Bed Volumes for Purolite WAC 131
Figure 6-40. Sodium Hydroxide Dose Required to Reach pH 7.2 in ResinTech effluent (A) Post-Regen and (B) Pre-Breakthrough, and Purolite effluent (C) Post-Regen and (D) Pre-Breakthrough. 133
Figure 6-41. Sodium hydroxide Dose Required to Raise pH to 7.2 in Softened Water vs. After Decarbonation 134
Figure 6-42. Estimated Sodium Concentration Under Baseline Conditions and at Different Sodium hydroxide Doses 135
Figure 6-43. Raw Water, Blended Water, and Blended Water with Decarbonation CCPP 136
Figure 6-44. Observed WAC Resin Swelling 137
Figure 6-45. Headloss vs. Hydraulic Loading Rate for PFAS Media 137
Figure 6-46. Softening Performance of ResinTech Resin at Various HLR 138
Figure 7-1. Lifecycle Cost Estimate Comparison of IX and FS 139
Figure 7-2. Simplified Process Flow Diagram Pre-Pilot (top) vs. Post-Pilot (bottom) 140

Figure 7-3. Post-Pilot PFD 141
Figure 7-4. Boring Locations 144
Figure 7-5. Post-Pilot Site Layout 146
Figure 7-6. Anticipated O&M Cost Breakdown Comparison ($/MG) 151
Figure 7-7. Estimated Construction Schedule 153

List of Acronyms

Abbreviation	Definition
BV	bed volumes
FS	Fluoro-sorb
GAC	granular activated carbon
HCF	hundred cubic feet
IX	ion exchange
kBV	thousand bed volumes
MCL	maximum contaminant level
MG	million gallons
MGD	million gallons per day
MRL	minimum reporting level
NF	Nanofiltration
NSF	National Sanitation Foundation
NTU	Nephelometric turbidity unit
PFAS	per- and polyfluoroalkyls substances
PFD	process flow diagram
PM	progress meeting
RL	response level
RO	reverse osmosis
RSSCT	rapid small-scale column test
SDI	silt density index
SJW	San Jose Water Company

Abbreviation	Definition
SMCL	secondary maximum contaminant level
TSS	total suspended solids
WAC	weak acid cation exchange
WQTS	Water Quality & Treatment Solutions, Inc.

1. Introduction and Evaluation Process Overview

1.1 Project Goals

San Jose Water Company (SJW) initiated this project to address per- and polyfluoroalkyl substances (PFAS), iron, turbidity, and hardness at Williams Station. The project involves development of a facilities plan for Williams station that includes a 14 MGD treatment system capable of meeting the following objectives:

1. PFAS compounds below the 2 parts per trillion (ppt) minimum reporting level (MRL)
2. Hardness below 100 mg/L as $CaCO_3$, consistent with surface water sources in SJW's distribution system
3. Iron below 10% of the secondary maximum contaminant level (SMCL), or < 0.03 mg/L
4. Finished water turbidity of < 1 nephelometric turbidity units (NTU)
5. Recovery of > 90% of water treated over the life of the treatment system
6. Treatment must not cause adverse impacts to water quality (e.g., increasing corrosivity or concentrations of sodium or potassium)

1.2 Alternatives Evaluation Process Overview

The process for evaluating alternatives is summarized in Figure 1-1 and Figure 1-2, with the overall project roadmap provided in Figure 1-3. Following the kick-off meeting, Hazen conducted a high-level assessment to screen numerous technologies. This assessment was presented in Progress Meeting 1 (PM 1), and used to identify the pretreatment, softening, and PFAS-removal technologies that would be evaluated. PM 1 was also used to establish evaluation criteria and their relative importance. Criteria and weighting were further refined by SJW prior to PM 2. The alternatives evaluation and ranking was presented in PM 2, which was used to select the Final Recommended Alternative. This selected alternative will be evaluated in greater detail prior to PM 3.

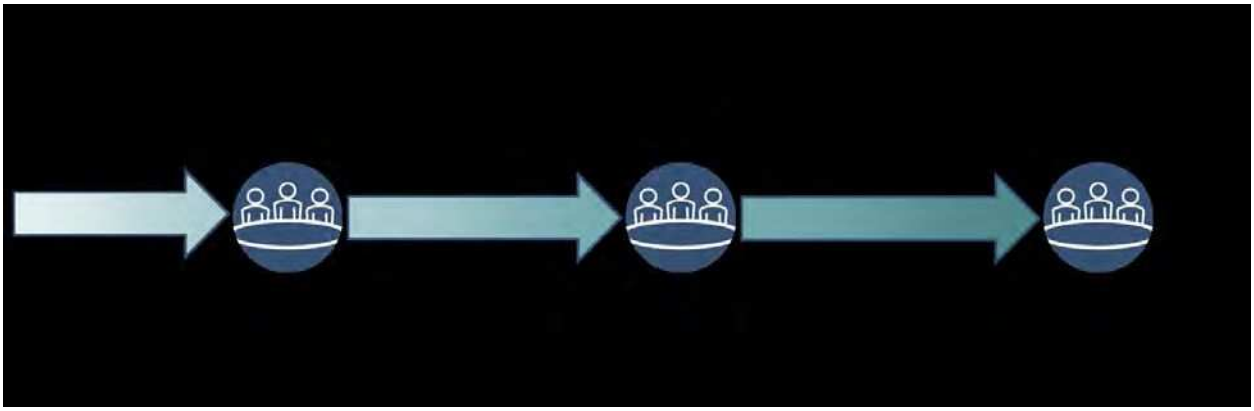


Figure 1-1. Alternatives Evaluation Process with SJW feedback During Progress Meetings



Figure 1-2. Approach to Evaluation Criteria, Weighting, and Scoring

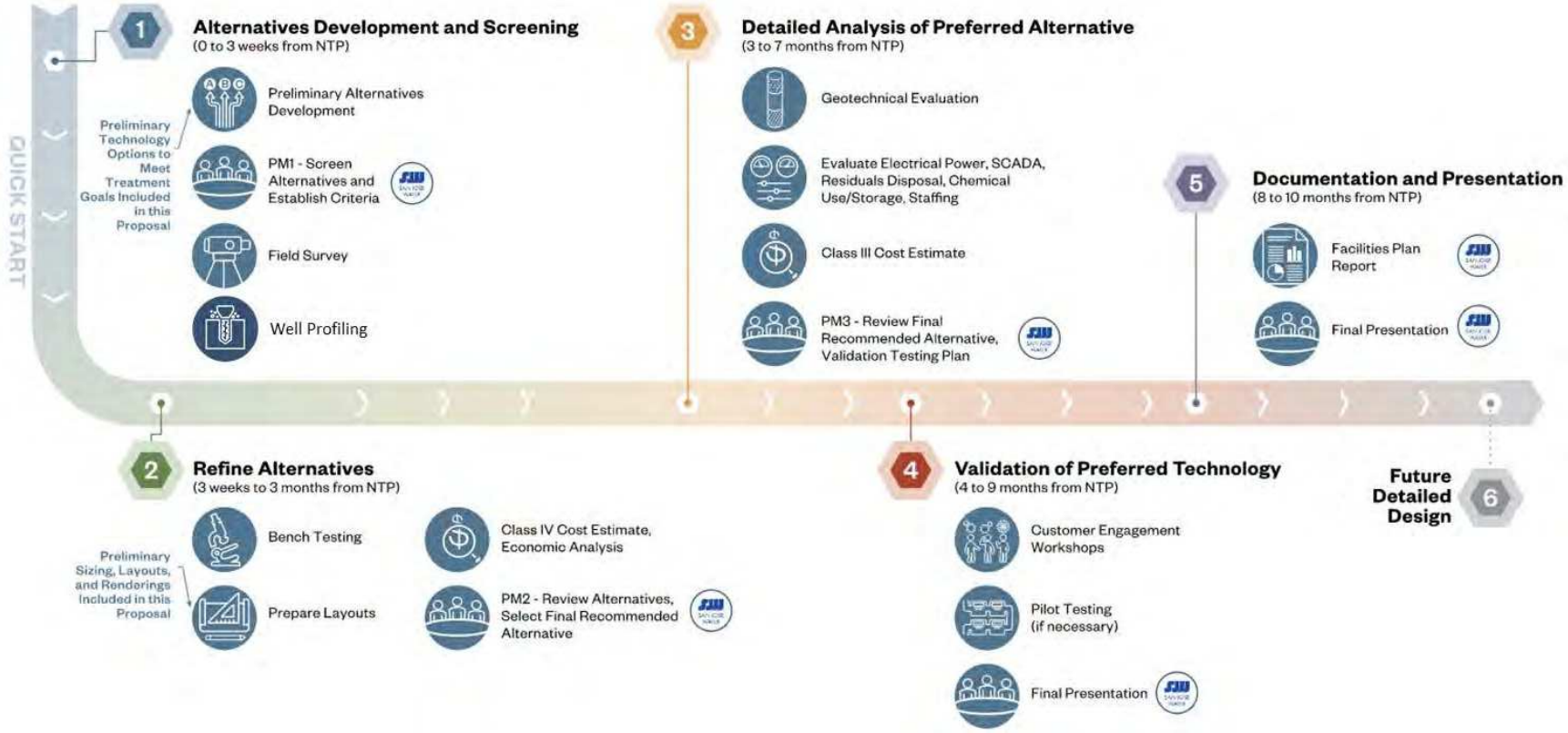


Figure 1-3. Project Roadmap

1.3 Summary of Capacities and Water Quality Concerns

Williams Station has 15 wells that are either active or in standby, along with six booster pumps. Capacities and other relevant information for the wells and booster stations are summarized in Table 1-1 and Table 1-2. Water quality issues impacting individual wells are summarized in Table 1-3.

Table 1-1. Well Information

Well Number	Well					Pump Type	Motor HP
	Status	Year Installed	Type	Design Cap. (gpm)	Current Cap. (gpm)		
2	Standby	1951	Cable Tool	1700	1868	Vertical Turbine	150
3	Active	1954	Cable Tool	1640	1446	Vertical Turbine	150
4	Standby	1956	Cable Tool	1400	1522	Vertical Turbine	125
5	Active	1957	Cable Tool	1640	1556	Vertical Turbine	150
6	Active	1958	Cable Tool	2300	2630	Vertical Turbine	250
7	Active	1959	Cable Tool	1685	1738	Vertical Turbine	150
8	Active	1960	Cable Tool	1600	1794	Vertical Turbine	150
10	Active	1961	Cable Tool	2140	2099	Submersible	200
11	Active	1961	Cable Tool	2000	2045	Submersible	200
12	Active	1961	Cable Tool	2000	2020	Vertical Turbine	200
13	Standby	1961	Cable Tool	2300	1490	Vertical Turbine	200
14	Standby	1962	Cable Tool	2350	2667	Vertical Turbine	200
15	Standby	1962	Cable Tool	2400	2382	Vertical Turbine	200
17	Active	2013	Rotary	2000	2335	Submersible	200
18	Standby	2013	Rotary	2000	2120	Vertical Turbine	200

Table 1-2. Booster Pump Capacities

Booster Pump Number	Design Capacity (gpm)	Current Capacity (gpm)
B5	3500	3160
B6	3560	3630
B7	3600	3470
B8	3300	3480
B9	3500	3240
B10	3350	3700

Table 1-3. Water Quality Issues in Standby Wells

Well Number	Issue of Concern	Compliance Sample Detected Concentration Prior to Standby Status	Date Placed on Standby Status
2	PFOS	0.0072 ug/L	10/21/2019
4	Iron	*	12/2/2014
13	Iron	2100 ug/L	7/23/2019
14	PFOS	0.0066 ug/L	12/23/2019
15	PFOS	0.0082 ug/L	10/21/2019
18	Turbidity	**	3/12/2020

* No single sample result incited the status change to standby. Statistical results from the most recent ten samples obtained from 12/19/2017 through 2/27/2020 are minimum 110 ug/L, maximum 390 ug/L, average 215 ug/L, median 200 ug/L.

** Turbidity grab samples, with results as high as 30 NTU, were observed, therefore compliance samples were not taken. SJW does not collect compliance samples until turbidity runs below 5 NTU (target of 1 NTU) as measured by a Hach 2100q in the field. Wells are blown off to waste for several days in attempts to meet these targets before compliance sample collection is cancelled. No formal well rehabilitation has been conducted. Well 18 was run to blow-off from 8-60 hours on seven instances over the course of one month to attempt to reduce turbidity.

2. Alternatives Screening

2.1 Screening Criteria

The following screening criteria below was established during the project kick-off meeting. These criteria were then used to screen different technologies for their effectiveness during PM 1.

- **Technology Readiness:** full-scale facilities are either permitted or currently in operation
- **Footprint:** the selected technology must fit within the existing footprint at Williams Station, with minimal site modifications (e.g., well and pipeline relocation)
- **Burden on Operations:** the system must be able to be operated remotely, with a few visits per week by operations staff
- **Softening:** achieve a finished water hardness of approximately 100 mg/L as $CaCO_3$
- **Truck Traffic:** infrequent trucking, avoiding additional truck traffic on a daily basis
- **Removal of Co-Contaminants:** meets stated treatment objectives (i.e., does not need to remove a broad range of additional contaminants)

2.2 Pretreatment

Pretreatment technologies considered included bag filtration, cartridge filtration, self-backwashing strainers, and greensand filtration.

2.2.1 Bag Filtration

Bag filtration accomplishes removal of sand and silt by capturing it on cloth bag elements as water is hydraulically pushed through the housing where the cloth bags sit. The bag retains particles that are larger than the nominal pore size of the bag. Bag filters require replacement as sand and silt particles accumulates on the bag surface over time. Filter bags are available in a variety of pore sizes that allow for selection of a product that provides adequate protection for the water quality required but minimizes changeouts. Bag filter housings typically hold a small number of bags, which allows for quick changeouts of bags when they are clogged. This technology only accomplishes surficial filtration, which leads to bags being clogged faster cartridge filters of the same pore size, requiring changeouts more often. Additionally, bag replacements are usually proprietary and specific to the housing being used, which can pose challenges in procurement of bags for changeouts. Another challenge found in procurement of bag filters is the limited options of NSF61-certified products available in the market. Figure 3-1 provides a visual example of a typical bag filter housing unit and bag filter elements.



Figure 2-1. Bag Filter Housing and Elements

2.2.2 Cartridge Filtration

Similar to bag filtration, cartridge filtration removes sand and silt as water flows through filter elements placed inside a housing. Cartridge filter elements can be made of different materials and have different lengths, radii, and pore sizes for different applications and water quality. These elements typically provide larger surface area for filtration compared to bag filters due to depth filtration; therefore, these elements clog less often and require less changeouts over time for larger flow applications. Cartridge filter changeouts typically take a longer time to exchange as the housings hold more elements for equal design flow conditions compared to bag filters. However, more cartridge filters per housing do allow for smaller overall footprint of the overall system. Cartridge filters are more often non-proprietary and are generally interchangeable between different manufacturer housing units thus simplifying procurement. Figure 3-2provides a visual example of a cartridge filter housing unit and cartridge filter elements.



Figure 2-2. Cartridge Filter Housing and Elements

2.2.3 Self-Backwashing Strainers

Self-backwashing strainers capture sand and silt in water as it flows through a porous screen mesh inside a housing unit. The sand and silt are captured and stored in the housing units and periodically go through a backwash cycle to clear the accumulated sediments inside the unit. This pretreatment option produces a continuous backwash stream that requires disposal, which reduces recovery of overall design flow. Although this pretreatment option does not require a cartridge or bag filter changeouts, which are operational burdens, these strainers do have more mechanical and electrical components, which increase their capital costs and O&M complexity compared to bag and cartridge filtration. Additionally, filtering particles smaller than 10 micron is a challenge for self-backwashing strainers. Figure 3-3 provides an example of the process and mechanical components of a typical self-backwashing strainer.

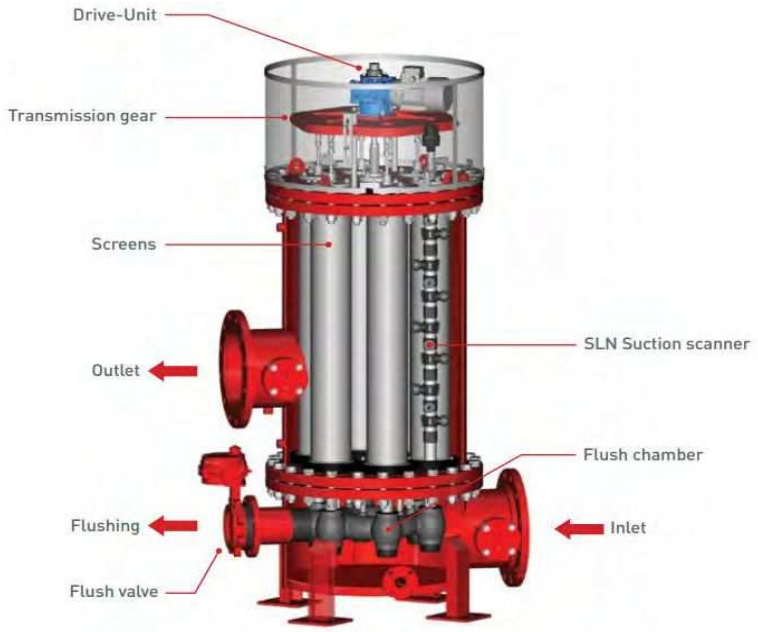


Figure 2-3. Self-Backwashing Strainer (Source: Amiad Water Systems)

2.2.4 Greensand Filtration

Greensand filtration provides removal of dissolved iron and manganese in water by use of a catalytic manganese oxide media (e.g., greensand). This technology requires addition of an oxidant chemical, typically sodium hypochlorite, before the filter to regenerate the media following successful removal of the iron and manganese. The solids created in the conversion are removed by the filter and the filter requires periodic backwashing to restore capacity. The backwash waste stream produced may be partially recovered and the remaining flow needs to be disposed of, and reducing recovery. Greensand filtration vessels also have a large footprint and may require subsequent treatment like cartridge filters to remove particulates smaller than 10 micron. A visual example of a multi-cell greensand filtration vessel is provided on Figure 3-4.

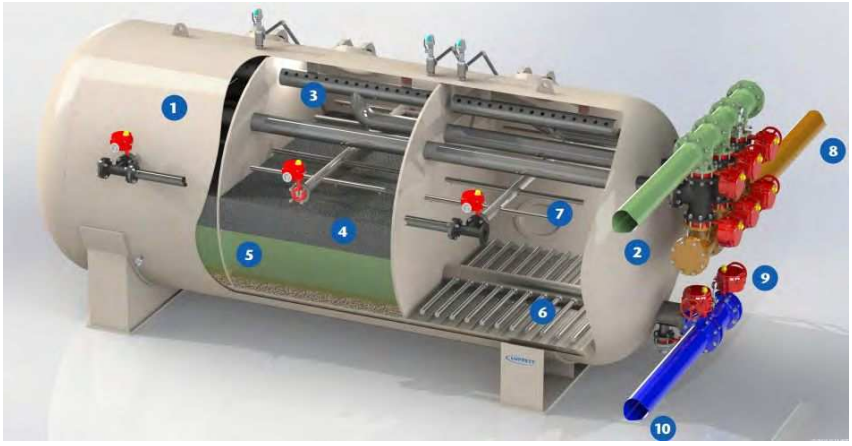


Figure 2-4. Greensand Filtration Process (Source: Loprest)

2.2.5 Pretreatment Screening Summary

After screening the pretreatment options, SJW and Hazen agreed that all four options were effective enough to be included for further evaluation. As the summary of the screening in Table 3-1 shows, none of the pretreatment options considered had fatal flaws or enough negative effectiveness concerns to eliminate the technology for further evaluation. It should be noted that greensand filtration was considered to be neutral in meeting three different criteria, but this technology is the best known to treat dissolved iron, which the other options would not be able to remove.

Table 2-1. Summary of Screening for Pretreatment Technologies

Criterion	Bag Filtration	Cartridge Filtration	Self-BW Strainers	Greensand Filtration
Technology Readiness	⇧	⇧	⇧	⇧
Footprint	⇧	⇧	⇧	⇔
Burden on Operations	⇧	⇧	⇧	⇔
Truck Traffic	⇧	⇧	⇧	⇧
Removal of Co-Contaminants	⇔	⇔	⇔	⇔
Iron < 0.03 mg/L	?	?	?	⇧
Turbidity < 1 NTU	⇧	⇧	⇧	⇧
Include in Evaluation?	**Yes**	**Yes**	**Yes**	**Yes**

⇧: positive ⇩: negative ⇔: neutral ⊗: fatal flaw (eliminate technology)

?: requires further investigation

2.3 Softening

Softening technologies considered included lime softening, pellet softening, ion exchange (Na or K regeneration), ion exchange (acid regeneration), nanofiltration or reverse osmosis, and pH adjustment or polyphosphate addition.

2.3.1 Calcium and Magnesium Hardness

Historical hardness data was plotted versus the solubility of calcium (Ca) and magnesium (Mg) hardness in Figure 3-5. The solubility product, K_{sp}, is the concentration of calcium or magnesium multiplied by the concentration of carbonate (in molar concentration). Above the known point of saturation for $CaCO_3$ or $MgCO_3$, these compounds are oversaturated and may precipitate. The data shows that both calcium and magnesium hardness found in the source water is well above the solubility limits, and precipitation of the Ca and Mg is expected to occur causing scaling. Solubility of calcium and magnesium hardness is

reduced as temperature increases (e.g., in water heaters or dishwashers); therefore, Ca and Mg would precipitate more easily.

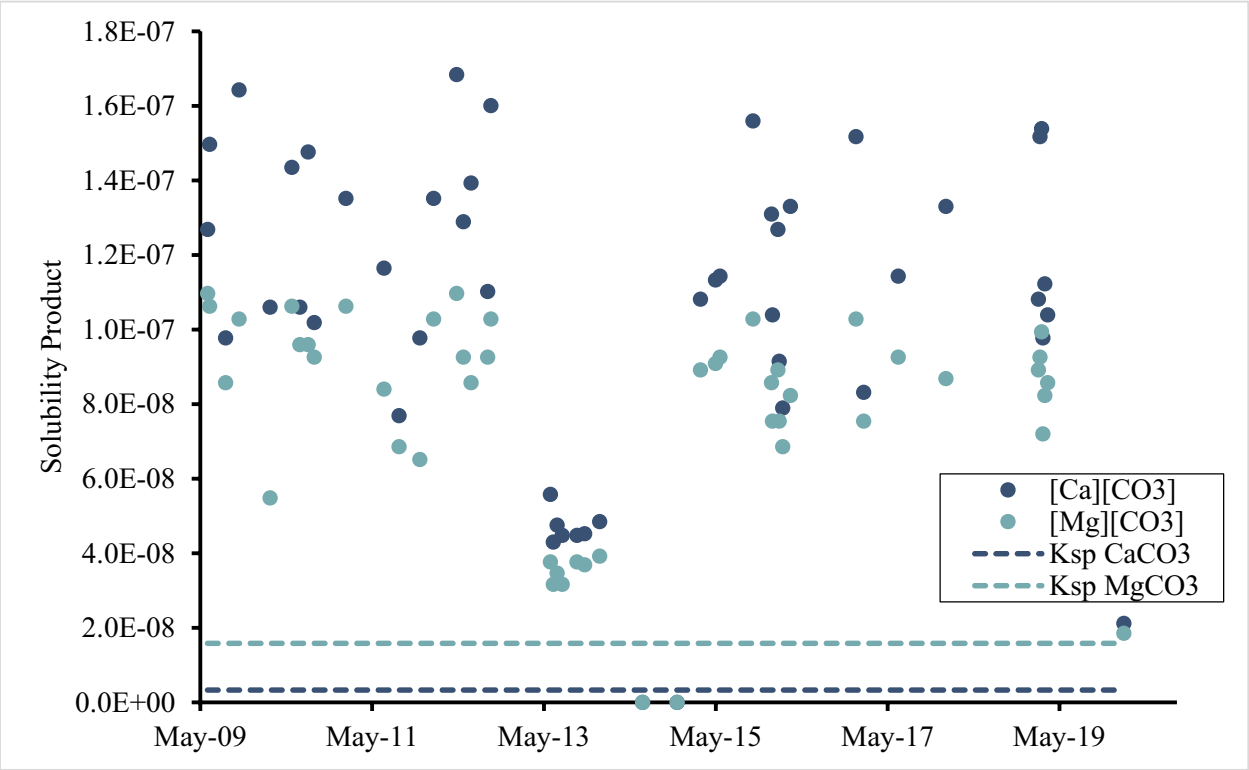


Figure 2-5. Calcium and Magnesium Solubility

Additionally, as Figure 3-6 shows, the proportion of calcium hardness found in the source water is only slightly more than half of the total hardness recorded. Therefore, a softening technology that primarily addresses calcium hardness will only address part of the scaling issues with hard water.

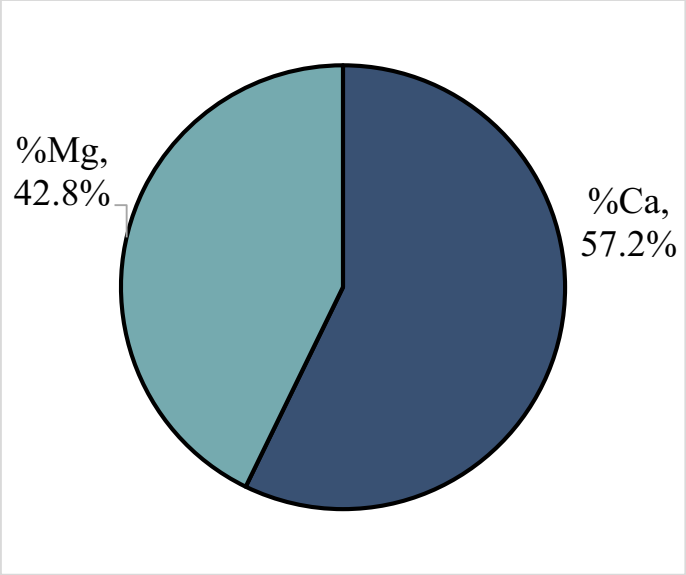


Figure 2-6. Calcium and Magnesium Hardness Fraction

2.3.2 Lime Softening

Lime softening is the process of adding lime or soda ash to the process stream to raise the pH of the water and thus leading to the precipitation of calcium and magnesium hardness. The precipitate is collected and removed in large contact basins, and re-stabilization of the pH of the process stream is then accomplished through addition of carbon dioxide. The residuals collected from the contact basins must be treated and dewatered by a mechanical process or through on-site lagoons before disposal off site. Figure 3-7 below provides a simplified representation of the lime softening process.

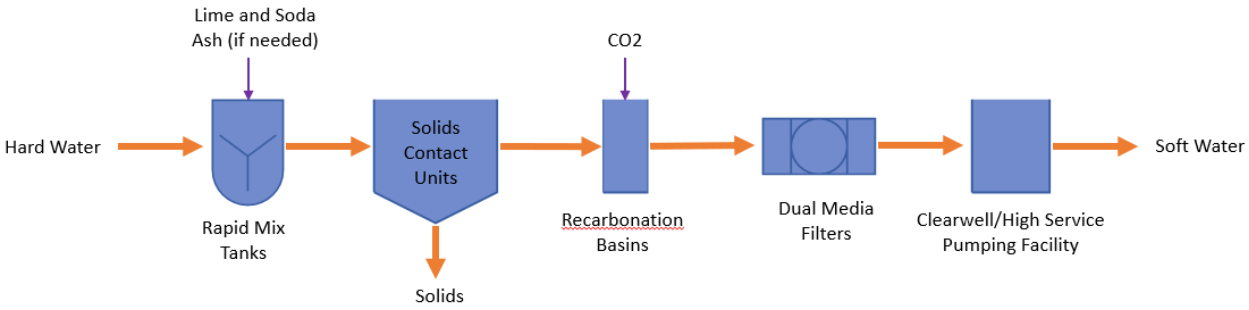


Figure 2-7. Lime Softening Process

A benefit of lime softening is that this technology is widely available and widely used in the field of water municipalities. Additionally, lime softening also removes some turbidity in the source water in the process of the precipitation of hardness elements. A major drawback of this technology is the large footprint required for all equipment and facilities. Figure 3-8 presents a preliminary footprint for a 10,000

GPM lime softening plant. Other disadvantages of lime softening include the need for full time trained staff to operate and maintain the plant, and the need to modify chemical and lime feeds when hardness or process flows change. High chemical doses required for this method along with residual solids needed to be disposed off-site are expected to cause frequent truck traffic.



Figure 2-8. Lime Softening Treatment Footprint

2.3.3 Pellet Softening

Pellet softening is achieved by adding an alkaline chemical like sodium hydroxide, lime wash, or sodium carbonate into the reactor vessel to increase the pH of the influent hard water and causing crystallization of the hardness ions. A fine sand feed is also added into the reactor to allow for a surface for the ions to crystallize on and accumulate, thus creating pellets. As the pellets grow larger and denser, they will fall to the bottom of the reactor where they will be periodically removed and disposed of. Figure 3-9 shows a simplified process of pellet formation within and removal from the reactor.

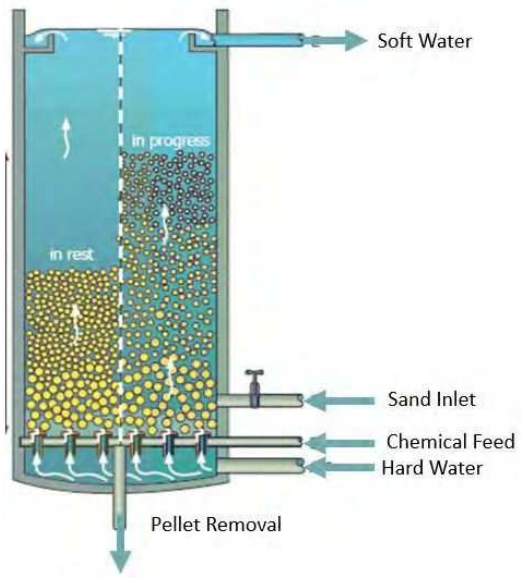


Figure 2-9. Pellet Softening Process (Farahmand, et al[1])

Pellet softening has a much smaller footprint requirement due to achievable high loading rates of the reactors and less facilities needed to accomplish the process. Having less facilities also provides future flexibility for expansion and simple integration with an existing system. A major drawback to this softening technology is the potential of increasing sodium levels in the process water depending on what catalyst chemical is used to create the crystallization. In addition, this softening system can only reduce hardness to approximately 120 mg/L, which is just above the hardness goal set by the screening criteria. Similar to lime softening, dealing with the chemical feeds and waste handling creates some burdens on operation, and also would lead to an increase in truck traffic on the site.

2.3.4 Ion Exchange (Na or K Regeneration)

Ion exchange softening with Na or K regeneration is accomplished in media vessels filled with media that is loaded with loosely attached, positively charged sodium or potassium ions. As the source water loaded with positively charged Ca and Mg hardness ions passes through the resin filled vessel, the hardness ions are exchanged with the Na or K ions on the resin, thus capturing the hardness ions on the resin and releasing Na or K ions into the softened water. The resin can then be regenerated by flushing it with a brine solution containing Na or K ions so that it can continue to remove hardness in the source water. A visual example of the softening and regeneration process is presented in Figure 3-10 below.

[1] FARAHMAND, A. ; GIFANI, N. ; FARIVAR, M (2012): Hybrid RO and Softening Birjand Water Treatment Plant. Toossab Consulting Engineers Co.; ISA Water and Wastewater Industries : https://isawaterwastewater.com/wp-content/uploads/2012/07/WWAC2012_Farahmand-Gifany-Farivar_Hybrid-RO-softening_paper.pdf

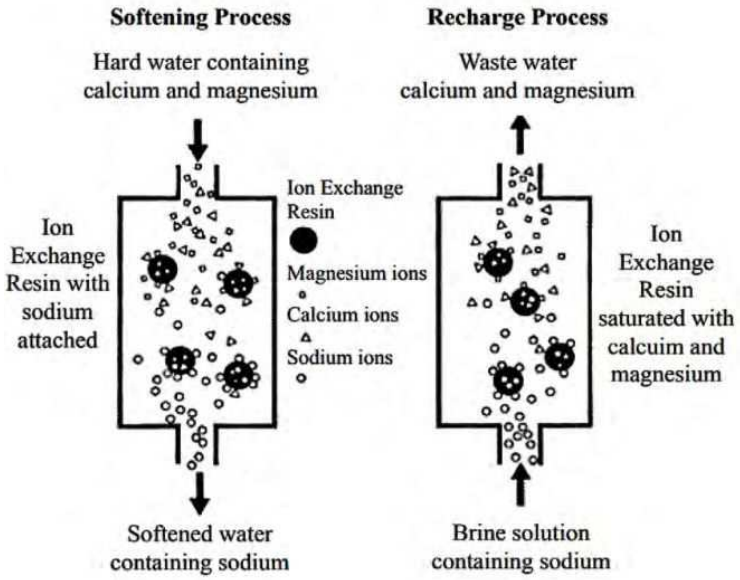


Figure 2-10. Softening and Regeneration with Na or K Process (Source: Skipton, et al[2])

[3]This technology has many strengths that allow it to meet many of the set screening criteria. Ion exchange softening systems are fully automatic and their operation is not highly impacted by changes in flow or hardness in the source water; therefore, burden on operations is low. These systems have a small footprint, are readily used in the municipality field, and can remove other constituents found in the source water, like iron and manganese. Removal of other constituents can also be considered a weakness, as these constituents will foul the resin and reduce its hardness removal abilities. Other drawbacks of this technology are the increase of sodium or potassium concentrations in the source water after softening and the large discharge of brine waste created from the regeneration solution.

2.3.5 Weak Acid Cation Ion Exchange (Acid Regeneration)

Ion exchange softening with weak acid regeneration uses the same methods for the removal of hardness ions as those described in Section 3.3.4, but is different in the way the resin removal capacity is regenerated. In this method, a hydrogen ion loaded solution is used to drive off the Ca and Mg ions and create new charged sites on the resin for further softening. This process requires a side stream blend downstream of the softening process to re-stabilize the pH in the effluent stream. Vendor's estimate that the regeneration waste stream will have a pH between 5.5 - 6.

Along with less concerns with the brine disposal compared to Na or K regeneration, this method of softening also prevents increases in sodium levels the treated effluent stream. Additionally, co-contaminants like scale forming anions and some dissolved iron can also be removed with this treatment

---

[2] SKIPTON, S.O. ; DVORAK, B.I. ; NIEMEYER, M.N. (2008): Drinking Water Treatment: Water Softening (Ion Exchange). University of Nebraska Lincoln: https://extensionpublications.unl.edu/assets/pdf/g1491.pdf

technology. This method of softening is not commonly used in municipal applications; however, media used for this method is NSF 61 certified and used widely in other applications like bottling plants. This technology also requires a larger footprint that softening with Na/K regeneration in part because of reported swelling of the media that occurs during the regeneration with acid and also other treatment components needed for this process. Media swelling was tested during subsequent pilot testing.

2.3.6 Nanofiltration or Reverse Osmosis

Softening through nanofiltration (NF) or reverse osmosis (RO) is accomplished as source water is pumped under pressure through semi-permeable membranes and the hardness ions are rejected by the membranes. The results are a softened permeate stream with a low pH and brine stream of rejected hardness ions and other contaminants. Adding antiscalant chemicals to the process feed or other forms of pretreatment are required prior to the membranes to avoid fouling or scaling that causes reduced efficiency of the membranes. Additionally, proper stabilization or blending of the permeate stream must be performed to avoid corrosivity.

NF and RO are effective options for water softening and removal of other organic and inorganic compounds, like PFAS, that can be found in the source water. If monitored properly, these membranes can last a long time and require little maintenance, although some challenges in operation can be faced during turndown periods. NF and RO also face recovery challenges; however, these challenges can be mediated through having multiple stages and reducing waste produced. Even when recovery is improved, the constant brine waste stream produced in this process can be a challenge at some sites due to discharge capacity or brine quality. NF and RO softening have multiple challenges to consider, but these treatment options are widely used in municipalities and solutions to many of these challenges have been studied and applied.

2.3.7 pH Adjustment or Polyphosphate Addition

pH adjustment or addition of polyphosphates to treated water before distribution are not necessarily water softening solutions as they do not physically reduce the water hardness, but they can minimize scaling in some applications. These types of treatment consist of addition of a chemical to the treated water before distribution that inhibit the growth of scale in customer appliances and distribution pipes. This process requires a chemical storage tank and metering pumps to dose the chemical so the footprints needed are small, operation is simple, and they have low capital and operational costs. Challenges with this approach include potential improper corrosion control for lead with a decrease in pH, breakdown of polyphosphates in the distribution system at water ages greater than 3 days, and potential mobilization of existing beneficial scale in the distribution system. Lastly, depending on the chemicals being used, an increase in sodium levels in the treated water could occur.

2.3.8 Softening Screening Summary

Table 3-2 below provides a summary of the screening performed on the softening alternatives presented in the above sections. Based on the screening criteria set for the softening technology, San Jose Water and Hazen determined that lime softening, regenerable IX (Na or K), and pH adjustment or polyphosphate addition were not appropriate to include in further evaluation as they had fatal flaws with meeting some

of the screening criteria. It should be noted that although the technologies selected to be evaluated had some negative screening points and some require further investigation, these options were considered to have acceptable performance in comparison to those not selected.

Table 2-2. Summary of Screening for Softening Technologies

Criterion	Lime Softening	Pellet Softening	Regen. IX (Na or K)	Regen. IX (acid/base)	NF/RO	pH adjust. or poly-P
Technology Readiness	⇧	⇧	⇧	⇩	⇧	⇧
Footprint	⊗	⇧	⇧	⇔	⇧	⇧
Burden on Operations	⊗	⇩	⇧	⇧	⇔	⇧
Truck Traffic	⇩	⇔	⇧	⇧	⇧	⇧
Removal of Co-Contaminants	⇧	⇔	⇧	⇧	⇧	⇔
Hardness < 100 mg/L	⇧	⇩	⇧	⇧	⇧	⊗
Recovery > 90%	⇧	⇧	⇧	⇧	⇔	⇧
No Increase in Na, K, or Corrosivity	⇧	?	⊗	?	⇔	⇩
Include in Evaluation?	**No**	**Yes**	**No**	**Yes**	**Yes**	**No**

⇧: positive ⇩: negative ⇔: neutral ⊗: fatal flaw (eliminate technology)

?: requires further investigation

2.4 PFAS Removal

PFAS removal technologies considered included granular activated carbon media, ion exchange resin, Flourosorb resin, and NF/RO.

2.4.1 Granular Activated Carbon

GAC PFAS treatment is accomplished through depth filtration of source water through a bed of adsorptive granular activated carbon media that has a high surface area onto which contaminants adhere. As the PFAS contaminated water passes through the GAC media bed, the contaminants are adsorbed to the surface of the media until the media is exhausted and has reached its adsorption capacity for the contaminant of concern. When the media is exhausted, it must be replaced with fresh media. Backwashing may be necessary at times due to headloss buildup from sediment.

GAC treatment has low operational complexity, needing most attention during infrequent backwash events or media replacements. Depending on preferred levels of automation, GAC treatment also typically has limited electrical and instrumentation requirements. Compared to other PFAS treatment options, GAC treatment typically requires a large footprint as it offers lower hydraulic loading rates for the same design flows. GAC media cost tends to be lower than IX resin media but capital cost is higher. Although GAC media is effective in removing long chain PFAS constituents, it faces a challenge in removal of short chain PFAS, which can be an issue if high levels of these chains are found in the source water. Figure 3-11 provides a visual of GAC media vessels, which are very similar to the vessels used in IX and Fluorosorb treatment.



Figure 2-11. GAC Treatment Train

2.4.2 Ion Exchange

Similar to the ion exchange softening process, ion exchange treatment for PFAS is accomplished as PFAS contaminated water passes through the IX resin and the unwanted PFAS ions are exchanged with innocuous ions from the resin beads and captured on the resin beads' surface. IX vessels need to be filled with enough depth to accomplish appropriate contact time between the water and the resin for effective PFAS removal. IX resin used for PFAS removal is not regenerable like those used for softening, so no operational backwashing is required.

IX PFAS treatment has strengths similar to GAC in regards to operational complexity, limited electrical and instrumentation components, and effective removal of long chain PFAS contaminants. Additionally, IX PFAS treatment also offers effective removal of short chain PFAS contaminants, and a higher hydraulic loading capability compared to GAC which leads to smaller overall treatment footprints. A major challenge of IX PFAS treatment is the hydraulic loss through the treatment trains due to the tighter and more uniform nature of the resin beds compared to GAC media beds. Higher hydraulic losses through

the treatment can impact well pump capacities and pressure ratings of other treatment equipment in the process. IX resin also removes co-contaminants in the source water aside from PFAS, which can create some issues in regard to competition for exchange with innocuous ions with PFAS ions. Additionally, IX resin unit market prices are typically more expensive than that of GAC media which raises O&M costs.

2.4.3 Fluoro-Sorb

Fluoro-Sorb media is a new media being piloted and studied for the treatment of PFAS. Fluoro-Sorb treatment is accomplished similar to GAC, as PFAS contaminants are adsorbed by the media as the source water passes through the media bed. Bench testing for SJW and pilot testing for Orange County Water District have shown promising removal of both short and long chain PFAS with this method. Footprint, burden on operations, and truck traffic is expected to be similar to that of IX treatment since the media has a similar hydraulic loading rate as IX and needs to be replaced when it is exhausted. Also similar to IX treatment, hydraulic losses through the treatment trains are expected to be higher than those of GAC treatment.

2.4.4 Nanofiltration or Reverse Osmosis

The process of PFAS treatment using nanofiltration or reverse osmosis functions the same as it does for softening and is explained in Section 3.3.6. The semi-permeable membranes reject the PFAS compounds, which are disposed in the brine stream. These technologies are known to remove both long and short chain PFAS compounds, and typically require less frequent replacements of membranes compared to the exchanges of media or resin seen in GAC and IX PFAS treatment. NF and RO require more automation than other PFAS treatments and typically have higher energy costs as well. Figure 3-12 shows an example of an NF/RO treatment skid.



Figure 2-12. NF/RO Treatment Skid

2.4.5 PFAS Removal Screening Summary

All of the technologies included in the PFAS removal screening were considered valid for further evaluation. A summary of the screening decisions made for PFAS removal technologies is presented in Table 3-3 . GAC, IX, and FS were also considered for bench-scale testing to compare their effectiveness in removing PFAS as discussed in Section 2.

Table 2-3. Summary of Screening for PFAS Removal Technologies

Criterion	GAC	IX	FS	NF/RO
Technology Readiness	⇧	⇧	⇩	⇧
Footprint	⇔	⇧	⇧	⇧
Burden on Operations	⇧	⇧	⇧	⇔
Truck Traffic	⇧	⇧	⇧	⇧
Removal of Co-Contaminants	⇧	⇔	⇔	⇧
All PFAS Compounds < MRL	⇩	⇔	⇔	⇧
Recovery > 90%	⇧	⇧	⇧	⇔
No Increase in Na, K, or Corrosivity	⇧	⇧	⇧	⇔
Include in Evaluation?	**Yes**	**Yes**	**Yes**	**Yes**

⇧: positive ⇩: negative ⇔: neutral ⊗: fatal flaw (eliminate technology)

?: requires further investigation

3. Bench Testing Results

3.1 RSSCTs and Recirculating Isotherms

Bench testing was conducted to estimate removal of PFAS and changeout frequency for granular activated carbon (GAC), ion exchange (IX) resins, and an alternative sorbent, Fluorosorb (FS). A detailed report on describing bench testing was prepared by Water Quality & Treatment Solutions, Inc. (WQTS) and is included in Appendix A. This section provides a brief summary of the results and implications for treatment selection.

Table summarizes occurrence of PFAS in Well #2 along with MRL and relevant regulatory concentrations. This includes California notification levels (NLs) and response levels (RLs) for PFOA, PFOS, and PFBS. NLs and RLs have not been developed for PFHxS, PFNA, or PFHpA at the time of this report. Based on the information in Table , we can infer that PFOS would likely be the PFAS compound of greatest public health concern. An estimate of bed volumes to breakthrough for each media type is shown in Table . PFNA had comparable time to breakthrough as PFOS in GAC, longer time to breakthrough in IX, and both compounds were below detection after 300,000 bed volumes (BV) using

FS. For these reasons, **PFOS was selected for estimating media life and associated changeout frequencies and costs**.

Table 3-1. PFAS Occurrence in Well #2 Compared to Regulatory Limits

PFAS Compound	Average Well #2 Conc. (ng/L)	MRL (ng/L)	CA NL (ng/L)	CA RL (ng/L)
PFOA	1.8	2	5.1	10
PFOS	7.1	2	6.5	40
PFBS	2.2	2	500	5,000
PFHxS	6.9	2	N/A	N/A
PFNA	4.2	2	N/A	N/A
PFHpA	0.7	2	N/A	N/A

Table 3-2. Estimated Bed Volumes to Breakthrough

Product	EBCT, minutes	kBVs to 2 ng/L	kBVs to 50% Breakthrough
GAC	7.5 / vessel (8.75 kBV /Month)	PFOS: ~200 kBVs	N/A
		PFHxS: ~150 kBVs	
		PFBS: ~120 to 200 kBVs	
		PFNA: ~200 kBVs	
Fluoro-Sorb-200	2.0 / vessel (22 kBV / Month)	PFOS: >300 kBVs	N/A
		PFHxS: >300 kBVs	
		PFBS: >300 kBVs	
		PFNA: >300 kBVs	
Evoqua's PSR2+ Resin	2.0 / vessel	N/A	PFOS: 160 – 420 kBVs
			PFHxS: 190 – 410 kBVs
			PFBS: 180 – 340 kBVs
			PFNA: 110 – 340 kBVs
Purolite's PFA694E Resin	2.0 / vessel	N/A	PFOS: 400 – 750 kBVs
			PFHxS: 330 – 620 kBVs
			PFBS: 400 – 590 kBVs
			PFNA: 570 – 1,100 kBVs

Estimated BV to breakthrough and associated media replacement costs are shown in Figure -1. Boxes represent uncertainty in estimated BV to breakthrough. IX boxes correspond to the range in Table 3-2, GAC includes the estimated BV (~200 kBVs) ± 20%, and for FS the maximum run + 50%. GAC was estimated to have the shortest BV to breakthrough, but the lowest media replacement cost in $/MG given the low cost of media ($61/ft^3). IX and FS had higher media costs at $290/ft^3 and $145/ft^3, respectively. These result in costs of media changeout that are higher than for GAC, although the lower bound for FS could not be determined given that the tests could not be run to breakthrough due to lack of sample.

Despite lower O&M cost for GAC, it is also important to consider the difference in capital cost. GAC requires a higher empty bed contact time (EBCT), 7.5-10 min in the lead vessel, compared to IX and FS: 2-3 min. GAC also has a lower surface loading rate, limited to 8-10 gpm/ft^2, compared with up to 18 gpm/ft^2 for IX and FS. GAC thus requires 10 lead-lag vessel pairs compared to 6 pairs for IX and FS. Despite the lower O&M cost for GAC, IX or FS would be expected to have a lower lifecycle cost (see Figure 3-2). For this reason, **subsequent designs and cost estimates assumed either IX or FS would be used for alternatives that include adsorptive media**. It should be noted that this assumes that FS and IX have the same HLR, which was revised by the vendor later in the study.

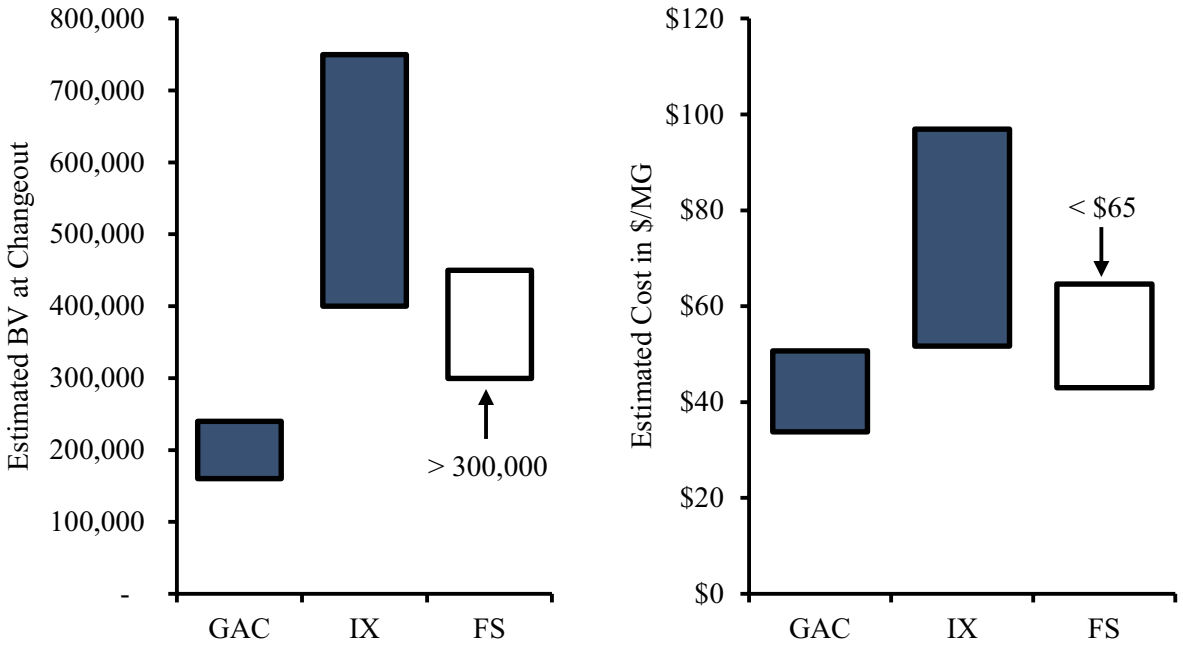
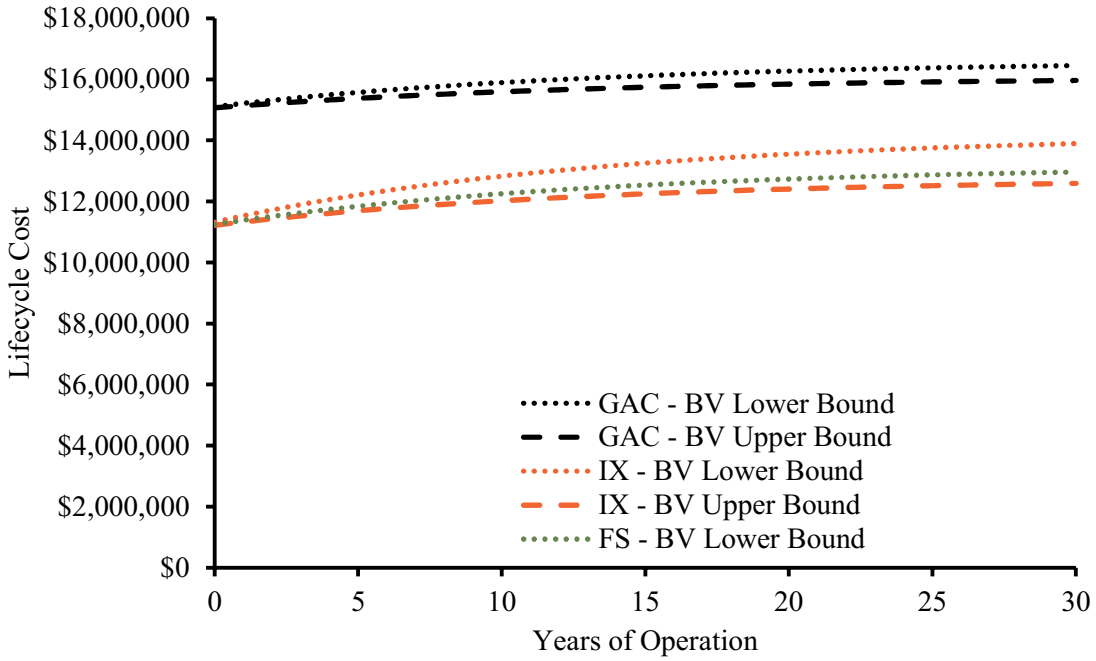


Figure 3-1. Estimated BV at Changeout (left) and Cost in $/MG (right) based on PFOS



*Includes a discount rate of 7.64% on media replacement

Figure 3-2. Estimated Lifecycle Cost of GAC, IX, and FS Including Project Costs

3.2 Pretreatment Testing

3.2.1 Pretreatment Methods

Pretreatment testing was conducted to quantify the presence of potential foulants in the source water. The first round of testing was conducted on February 16, 2021, with additional data collected on May 5, 2021. At each well site on February 16, the following parameters were measured during the first hour of well operation: silt density index (SDI), total and dissolved iron (unfiltered and filtered), sand levels using the Rossum sand tester, total suspended solids (TSS), turbidity (unfiltered and filtered), and particle size distribution. Table 2-3 lists the parameters' target measurement or sampling times after well startup and whether the parameter was measured in the field or by an analytical lab. One (1)-gallon samples were collected in Cubitainers at the frequency listed below. SDI was tested using well pressure. On May 5, data was collected for turbidity and iron in unfiltered, 5 µm filtered, and 10 µm filtered samples. Iron samples from May 5 were analyzed with a lower reporting limit (0.01 mg/L) than those tested on February 16 (0.1 mg/L).

Table 3-3. Summary of Pretreatment Test Plan

Sampling Date	Parameter	Sampling/Measurement Times Post Well-Startup	Analysis Type
February 16	SDI	0, 5, 10, 15, and 30 min	Field
	Iron	Same as SDI, unfiltered and filtered	Analytical lab
	Sand level	0-5, 5-10, 10-20, 20-30, 30-40 min	Field
	TSS	0, 5, 10, 15, and 30 min	Analytical Lab
	Turbidity	0, 5, 10, 15, 30, and 45 min	Field
	Particle Size Distribution	0, 5, 10, 15, and 30 min	Analytical Lab
May 5	Turbidity	0, 5, 10, 15, and 30 min (unfiltered, 5 µm filtered, 10 µm filtered)	Field
	Iron	0, 5, 10, 15, and 30 min (unfiltered, 5 µm filtered, 10 µm filtered)	Analytical Lab

Wells 4 and 13 were offline at the time of sampling due to iron, and Well 18 was offline due to turbidity and sanding. Over the most recent compliance period, Well 4 had iron between 0.11 and 0.39 mg/L with an average of 0.22 mg/L. Although Well 13's most recent iron concentration was higher at 2.1 mg/L, Well 4 had a higher average iron concentration and more consistently produced elevated iron concentrations. For this reason, Wells 4 and 18 were sampled to target wells with elevated iron and turbidity, respectively.

The sampled wells and the time offline prior to sampling are summarized in Tables 2-4 and 2-5. The offline durations were selected based on well operations data from Williams Station between March 1st and May 31st of 2020 (see Figure 6). Wells 4 and 18 were also sampled given their elevated iron and turbidity as discussed above, and these wells were sampled as permitted following preparation (i.e., flushing) of these wells by SJW staff.

Table 3-4. Wells Sampled During Initial Testing (Feb 16)

Test Well	Time Offline
Well 8	1.2 hour
Well 5	4 hours
Well 17	8.8 hours
Well 4	167.2 hours
Well 18	161.8 hours

Table 3-5. Wells Sampled During Additional Testing (May 5)

Test Well	Time Offline
Well 10	1.2 hours
Well 11	1.3 hours
Well 6	3.7 hours
Well 5	5.5 hours
Well 4	2.5 hours
Well 18	4.3 hours

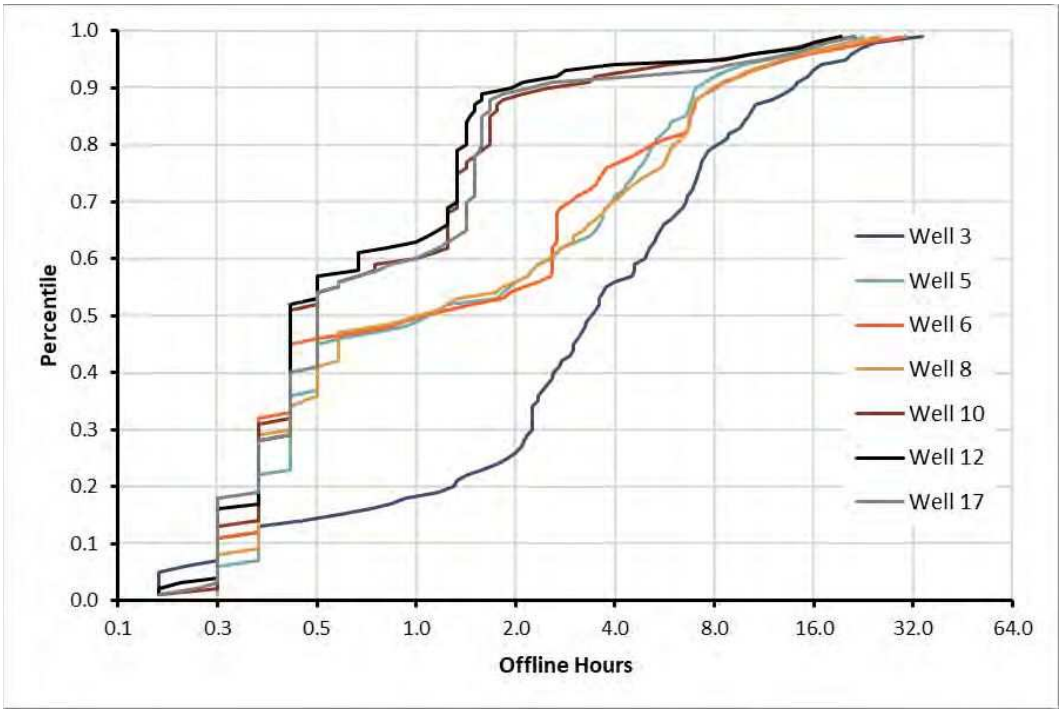


Figure 3-3. Cumulative Probability Plots of Time Between Runs

3.2.2 Pretreatment Results

To assess the effectiveness of existing sand separators, as well as to estimate removal by cartridge filters and self-backwashing strainers, particle size distribution data were collected. The product of particle size distribution at TSS (i.e., quantity and size distribution) for Wells 4 and 18 is shown in Figure 2-4. Regardless of run time, most of the particles produced by the wells were smaller than the ~70 µm cutoff for sand separators. This indicates that most of the solids would need to be removed by either self-backwashing strainers or cartridge filters. The 5 µm cartridge filters needed to protect high-pressure membranes and IX or FS media would remove most of the solids produced by the wells. These results also demonstrate that solids concentrations decrease significantly at longer run times.

SDI can be used as a surrogate for membrane fouling potential. Figure 2-5 shows SDI results over time. After 15 minutes of run time, all wells tested with the exception of Well 18 had an SDI of less than 4. These results suggest that membrane fouling potential decreases with run time and blowing off wells for 15 minutes at initial startup could be effective in reducing membrane fouling. This finding is supported by turbidity and TSS data (Figures 2-6, 2-7, 2-8, and 2-9). TSS was below detection in all wells except Wells 11 and 18 after 15 minutes of runtime. In the second sampling event, Well 11 turned off and started up again after the 15 minute sample was taken, resulting in higher than expected turbidity at the 30 min sample point.

Iron data shown in Figure 2-10 demonstrates that iron concentrations also decreased by over an order of magnitude within 15 minutes for wells with iron above the 0.1 mg/L reporting limit. These data also showed that iron was primarily present in particulate form, where the dissolved fraction was defined as passing through a 0.45 µm filter. However, given that the detection limit of 0.1 mg/L was greater than SJW's goal of 0.03 mg/L, **initial designs prior to receiving May 5 results were conducted assuming that greensand filtration would be required**.

The results from additional iron sampling on May 5, conducted with a reporting limit of 0.01 mg/L, indicated that greensand would not be needed to meet SJW's iron goal (see Figure 2-11). For active wells (i.e., excluding W-4 and W-18), all unfiltered samples were below SJW's iron goal within 5 minutes of startup. This indicates that for most wells, no iron treatment would be required. For W-4 with 5 µm filtration, iron was reduced below the 0.03 mg/L goal within 5 min of well operation. W-18 samples with 5 µm filtration were between the SMCL (0.3 mg/L) and SJW's goal (0.03 mg/L) in all samples, with 10- and 30-min samples only slightly above the iron goal. Iron reductions in W-18 by cartridge filtration were between 81 and 97% with a median of 96%, indicating most of the iron in W-18 was in particulate form and was well removed by cartridge filtration. Planned redevelopment of W-18, along with blending from additional wells, provides further confidence in meeting SJW's water quality goals. **Based on the additional sampling, it was concluded that SJW's turbidity and iron water quality targets could be met by cartridge filtration, and that greensand filtration would not be necessary.**

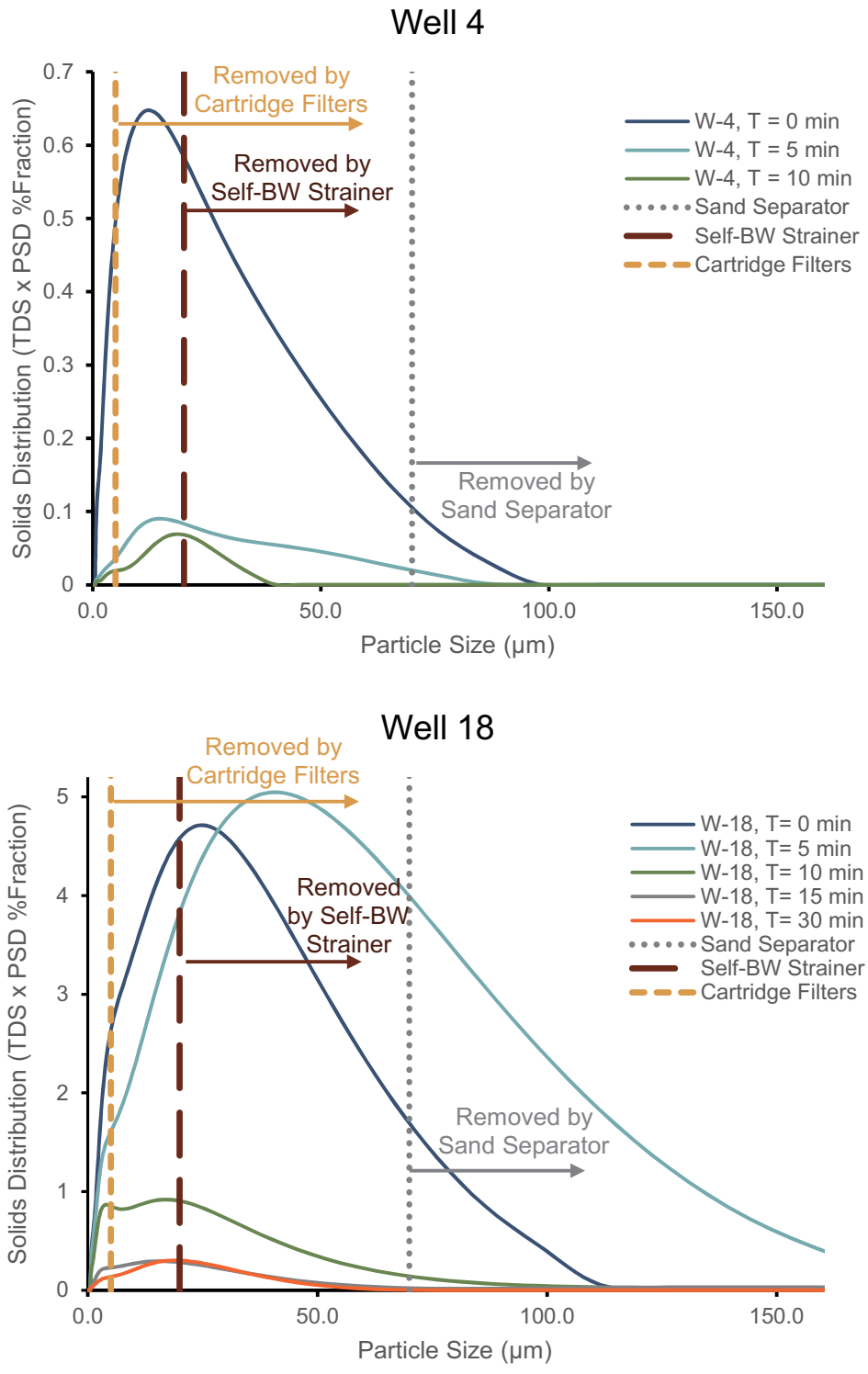


Figure 3-4. Particle Size Distribution and TDS Loading in Wells 4 (top) and 18 (bottom)

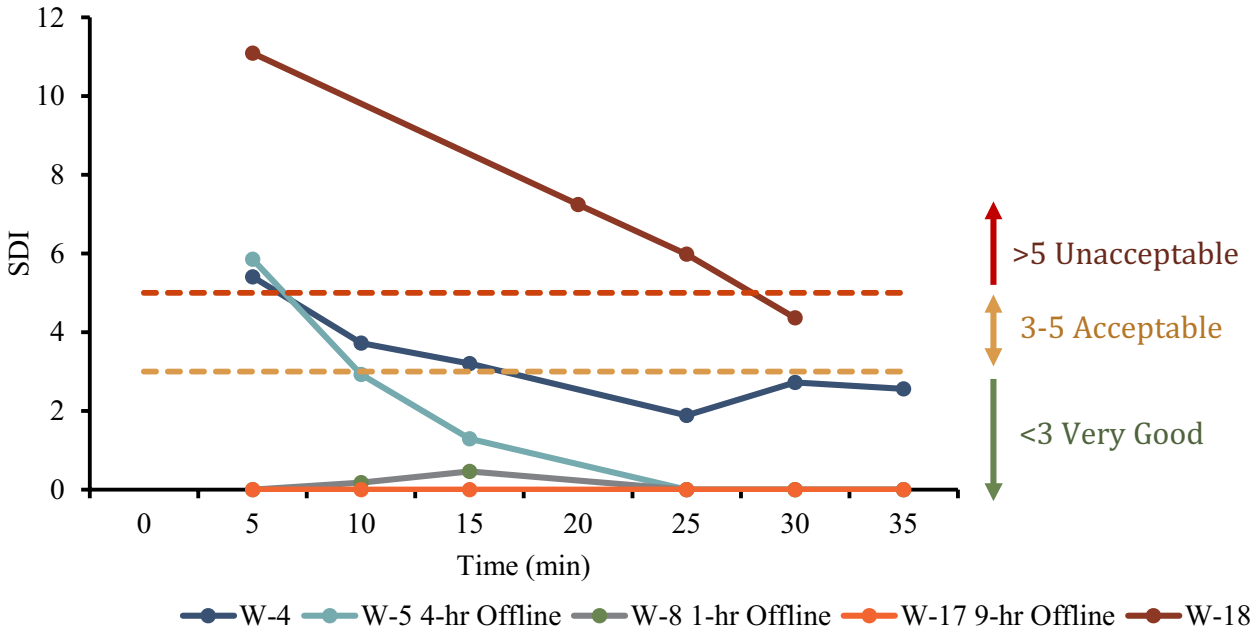


Figure 3-5. Silt Density Index Results

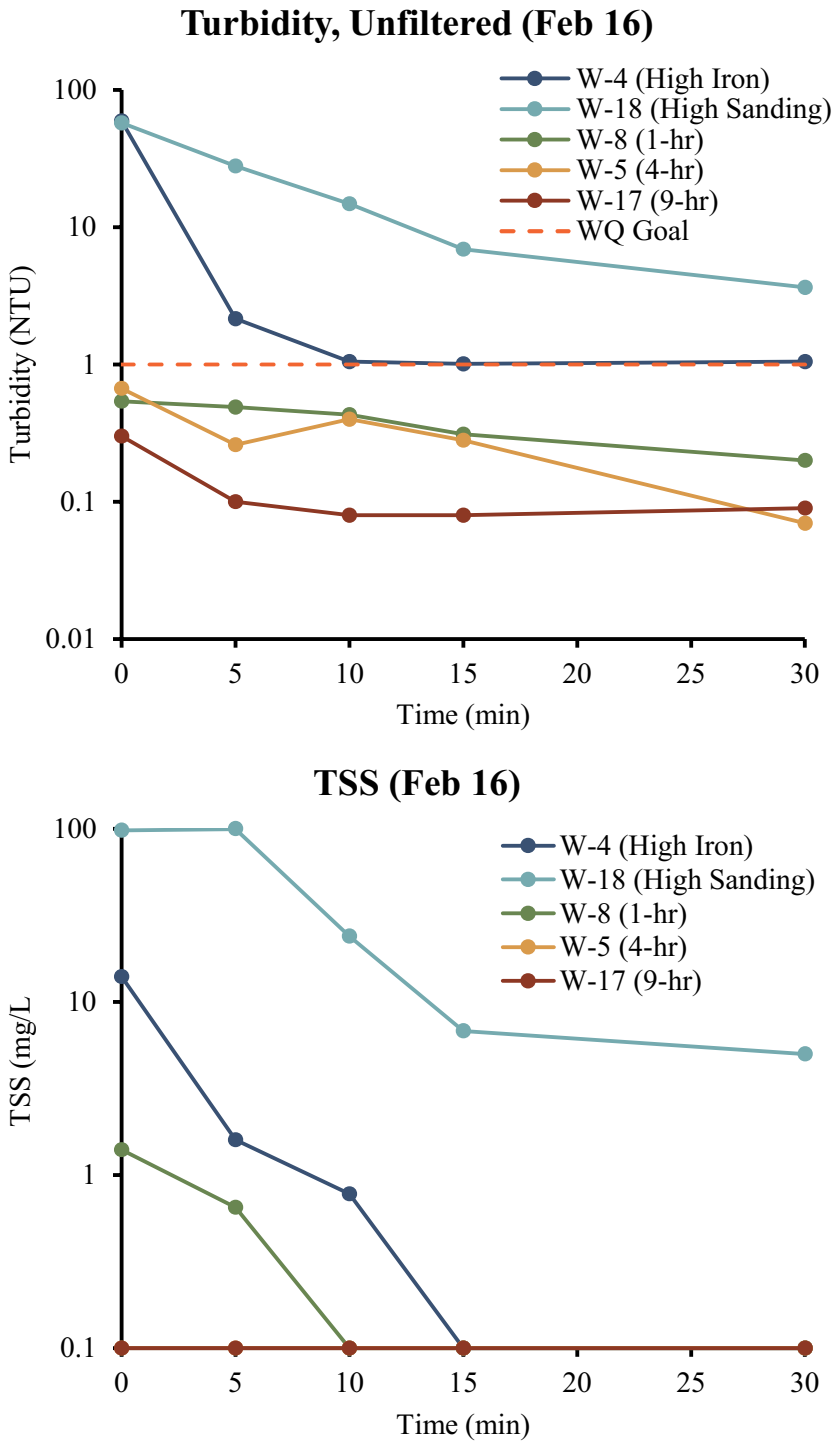


Figure 3-6. Turbidity (top) and TSS (bottom) Results (February 16)

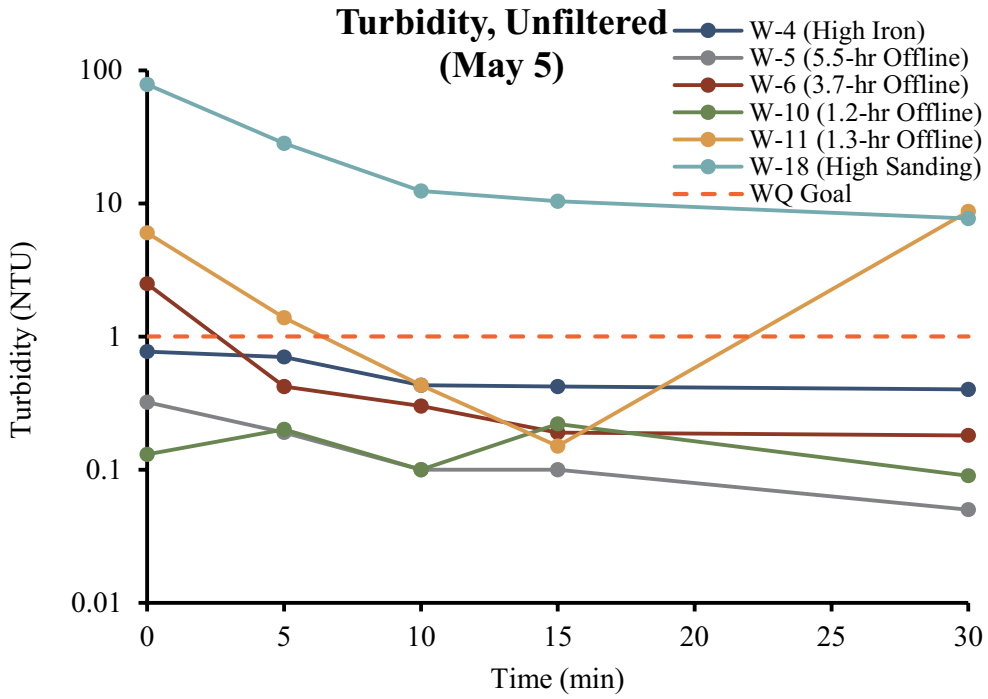


Figure 3-7. Unfiltered Turbidity Results (May 5)

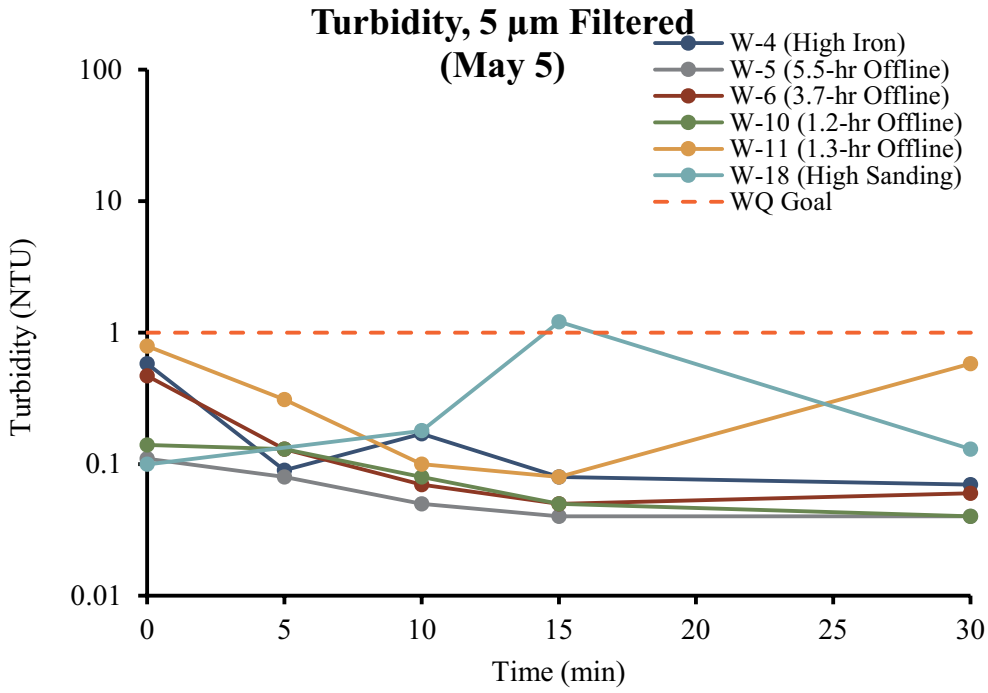


Figure 3-8. 5 µm Filtered Turbidity Results (May 5)

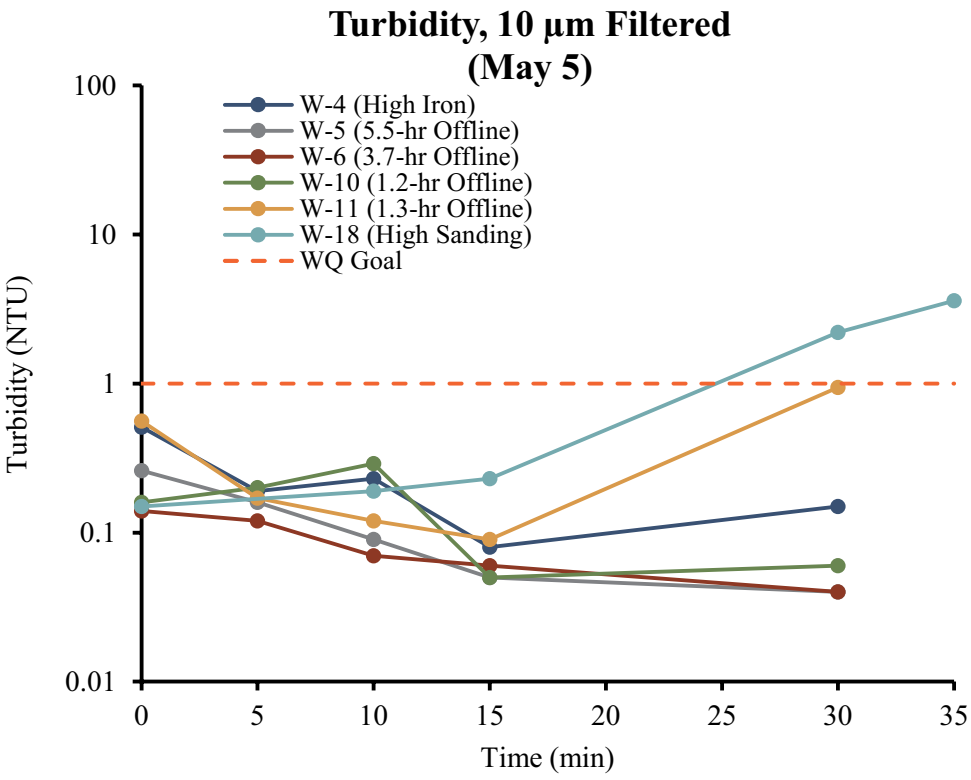


Figure 3-9. 10 µm Filtered Turbidity Results (May 5)

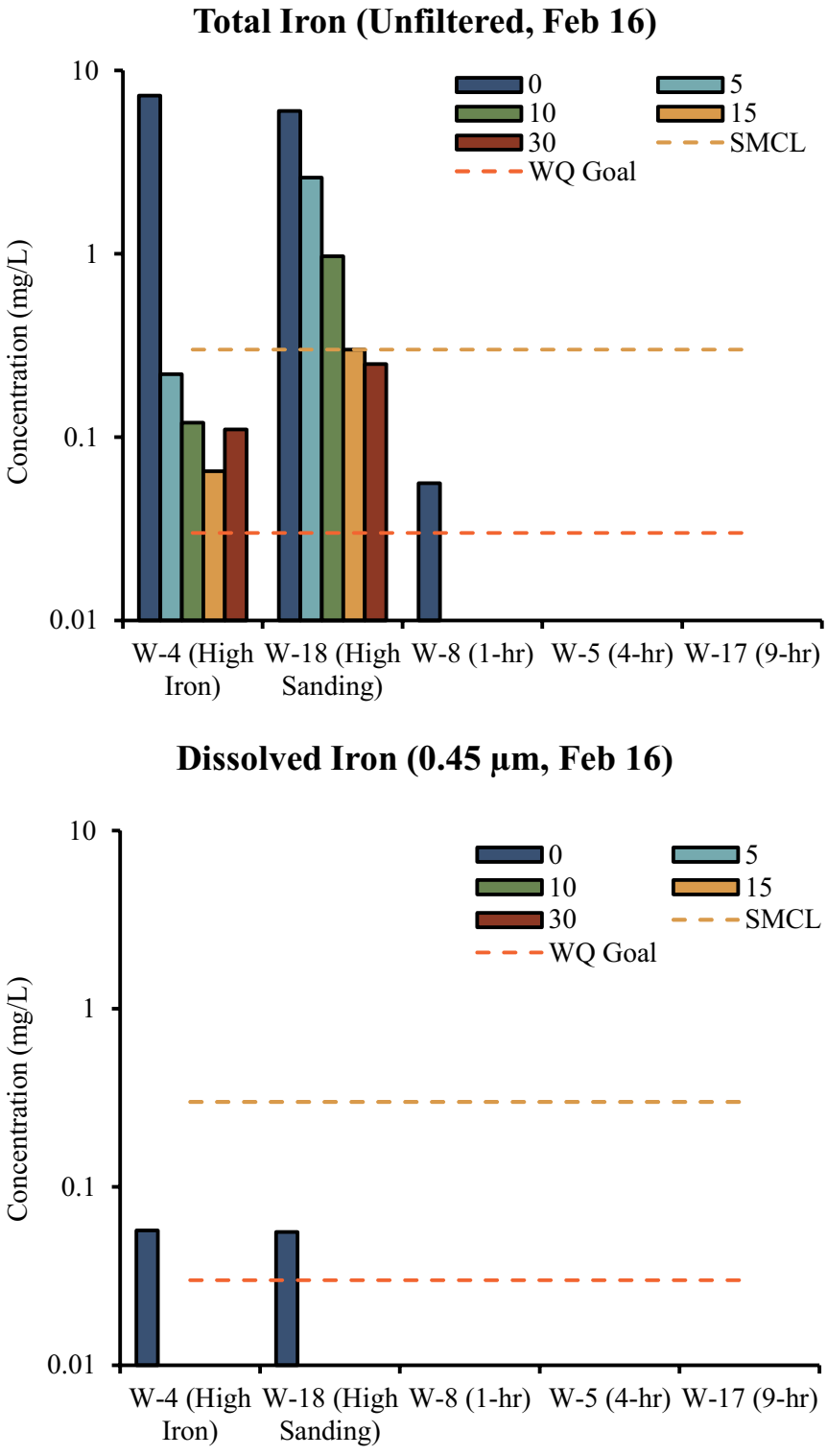


Figure 3-10. Total (top) and Dissolved (bottom) Iron Results (Feb 16)

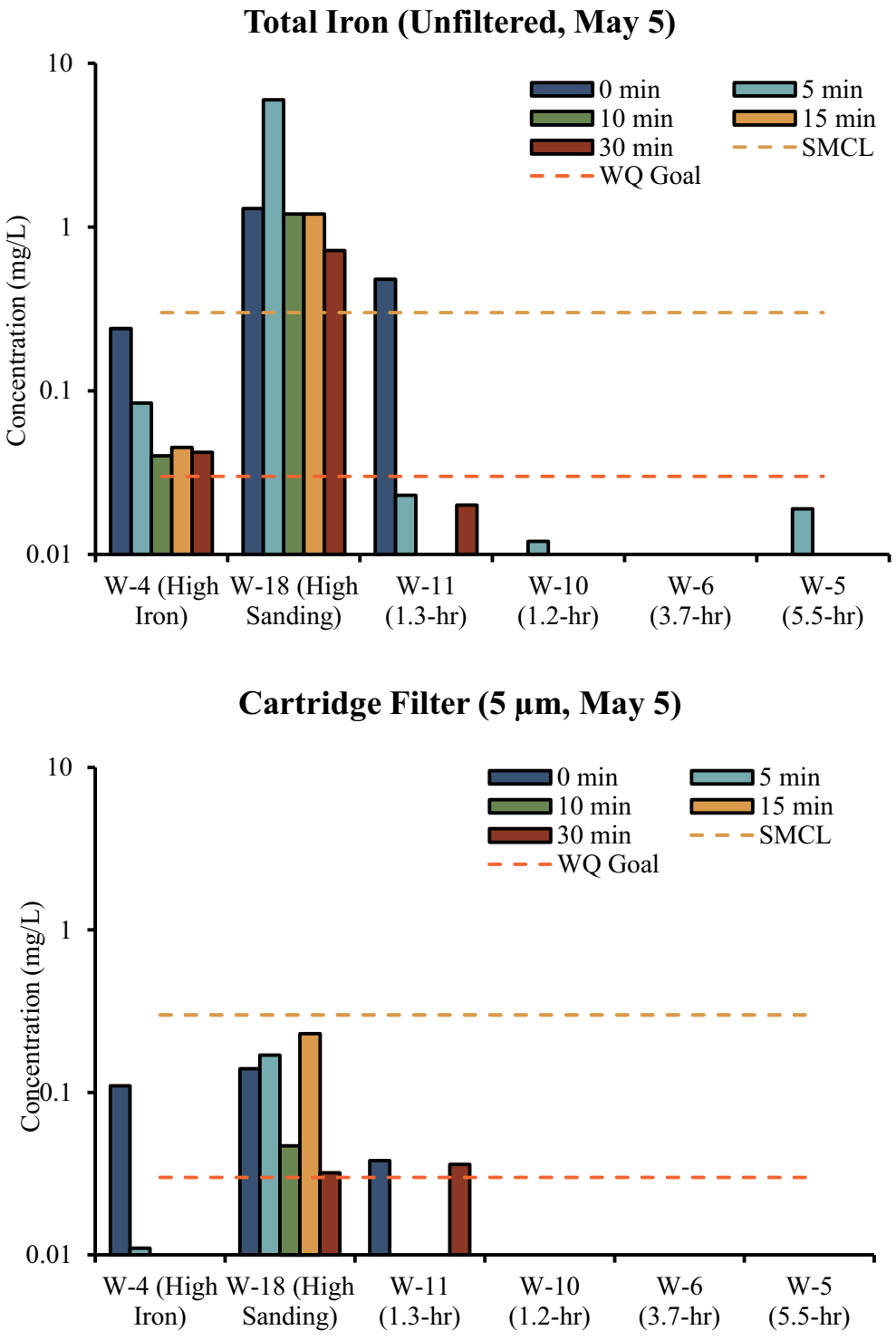


Figure 3-11. Total (top) and Filtered (bottom) Iron Results (May 5)

4. Alternatives Evaluation

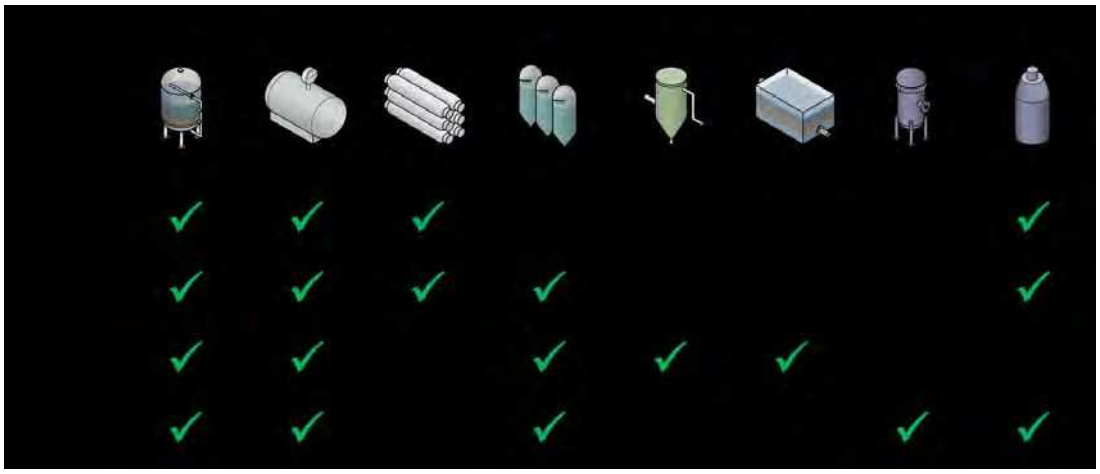
4.1 Alternatives Development

Four alternatives were developed to meet the project water quality objectives. All alternatives had the same source, greensand pretreatment, and finished water pumping, with alternative treatment processes at the location shown in Figure 4-1. The processes included in each alternative are summarized in Table 4-1. The following subsections will discuss each alternative in greater detail.



Figure 4-1. Simplified PFD of Source, Pretreatment, and Finished Water Pumping

Table 4-1. Summary of Treatment Processes in Each Alternative



As noted in Section 2.2.4, Greensand filtration pretreatment requires an oxidant chemical, in this case, sodium hypochlorite (OSG), to regenerate the Greensand media following successful removal of iron and manganese. The introduction of sodium hypochlorite upstream of any of the alternatives can degrade the efficacy of PFAS and softening treatment. To protect the IX media and NF/RO membranes, adding sodium bisulfite downstream of the cartridge filters and upstream of the treatment would be required. Sodium bisulfite would quench any residual chlorine from the upstream addition of sodium hypochlorite.

All of the alternatives considered require a liquid stream discharge to sanitary sewer. The City of San Jose was contacted regarding sanitary sewer capacity in the area. Hazen requested capacities for two mains shown in Figure 4-2: 36-inch Main crossing San Thomas Expy at Williams Rd (DPW-SSGM-0000024829) and a 27” Main along Boynton Ave (DPW-SSGM-0000041391). The City determined that

based on their modeling results, both lines have the capacity to handle an additional 1,000 gpm. This indicates that sanitary sewer discharge is unlikely to be limiting for any of the alternatives provided that SJW's goal of 90% recovery is met for a 14 MGD system.



Figure 4-2. Sewer Lines in the Vicinity of Williams Station

4.1.1 Alternative 1: Nanofiltration

Alternative 1, NF removes polyvalent cations that cause hardness as well as PFAS in a single step. A simplified process flow diagram (PFD) of this approach is shown in Figure 4-3. The full process stream would pass through cartridge filters to reduce fouling on the downstream NF membranes. Following NF, membrane permeate would flow through a decarbonator to raise pH by removing carbon dioxide, thereby reducing the amount of sodium hydroxide required to raise pH. A detailed PFD, including chemical feeds and waste produced, is included in Figure 4-4. Figure 4-5 provides a preliminary site layout.

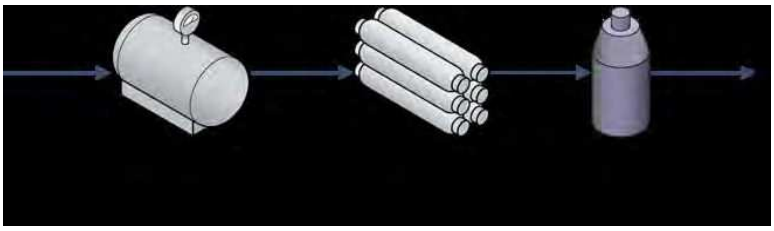


Figure 4-3. Simplified PFD for Alternative 1: Nanofiltration

A key advantage of Alternative 1 is that hardness and PFAS are removed in a single process, simplifying operation relative to the other alternatives. The common use of NF membranes is anticipated to result in straightforward permitting of the process.

The disadvantages of this alternative include low recovery, PFAS-laden brine, and limited flexibility for use at other sites. Recovery is the lowest for this alternative (91%) because the full flow passes through the membrane process. Scaling projections indicated that it would be difficult to achieve >91% recovery with NF or RO systems. As detailed in the O&M cost discussion (Section 4.3.2), the high cost of groundwater and sewer disposal increase the cost of low recovery alternatives. Membrane processes also produce PFAS-laden brine. While there is currently no restriction on discharge of PFAS to the sanitary sewer, future regulatory developments may require additional PFAS treatment for membrane concentrate prior to sewer discharge. The NF process is also more difficult to tailor to water quality at other SJW well sites that may have differing hardness concentrations and PFAS treatment needs.

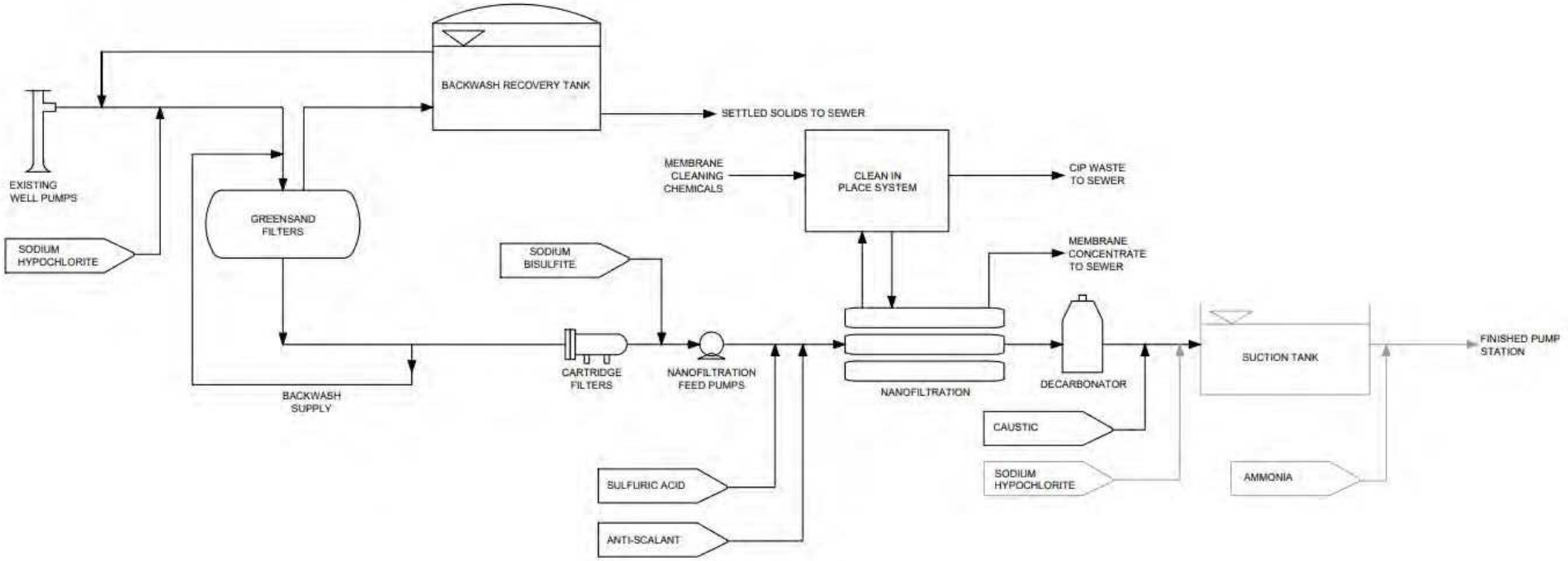


Figure 4-4. Process Flow Diagram for Alternative 1: Nanofiltration

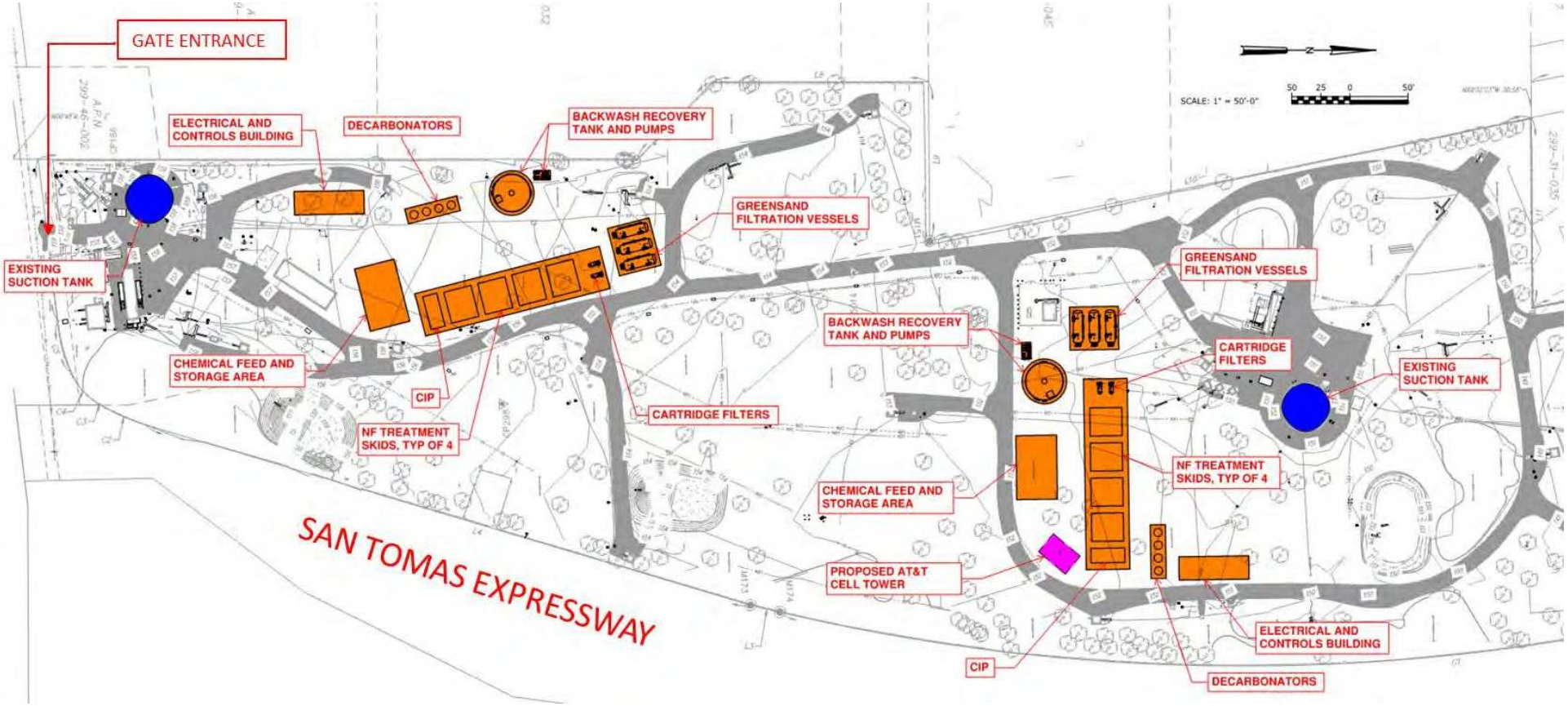


Figure 4-5. Site Layout for Alternative 1: Nanofiltration

4.1.2 Alternative 2: Sidestream RO, PFAS IX/FS

Alternative 2, sidestream RO with PFAS IX/FS, removes hardness and PFAS through a portion of the flow using RO and treats an RO bypass stream with either IX or FS to remove PFAS. A simplified PFD of this alternative is shown in Figure 4-6. The full process stream would pass through 5 µm cartridge filters to reduce fouling on the RO membranes as well as IX or FS resin. Following RO, membrane permeate would flow through a decarbonator to raise pH by removing carbon dioxide, thereby reducing the amount of sodium hydroxide required to raise pH. The decarbonated RO permeate would then blend with the IX/FS effluent on the bypass stream. A detailed PFD, including chemical feeds and waste produced, is included in Figure 4-7. Figure 4-8 provides a preliminary site layout.

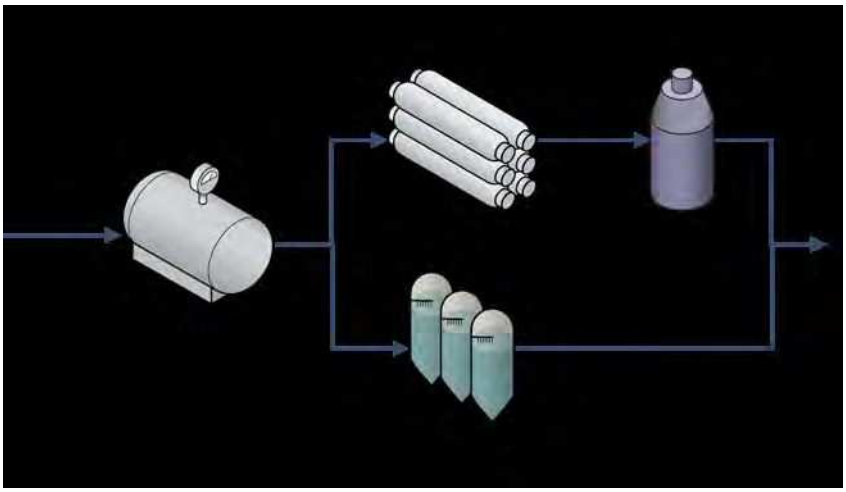


Figure 4-6. Simplified PFD for Alternative 2: Sidestream RO, PFAS IX/FS

Advantages of Alternative 2 include higher recovery than Alternative 1, straightforward permitting, and ability to tailor design to water quality at different sites. Recovery is higher in Option 2 than Option 1 because only 60% of the flow goes to RO, while the other 40% goes to IX/FS. This means that only 60% of the flow produces concentrate, leading to an overall recovery of 94%. The frequent use of RO and PFAS IX in the state suggests that permitting for this process should be straightforward. Finally, this process could be adapted to different SJW wellfields where sizing of the RO portion would be determined based local hardness levels (e.g., higher hardness waters would have higher RO fractions).

The disadvantages of this alternative include the second lowest recovery, PFAS-laden brine, and larger number of complex processes. The 94% recovery is the second lowest of the alternatives considered and is limited by scaling. As detailed in the O&M cost discussion (Section 4.3.2), the high cost of groundwater and sewer disposal increase the cost of low recovery alternatives. Membrane processes also produce PFAS-laden brine. While there is currently no restriction on discharge of PFAS to the sanitary sewer, future regulatory developments may require additional PFAS treatment for membrane concentrate prior to sewer discharge. Finally, the combination of RO and IX or FS would be operationally complex.

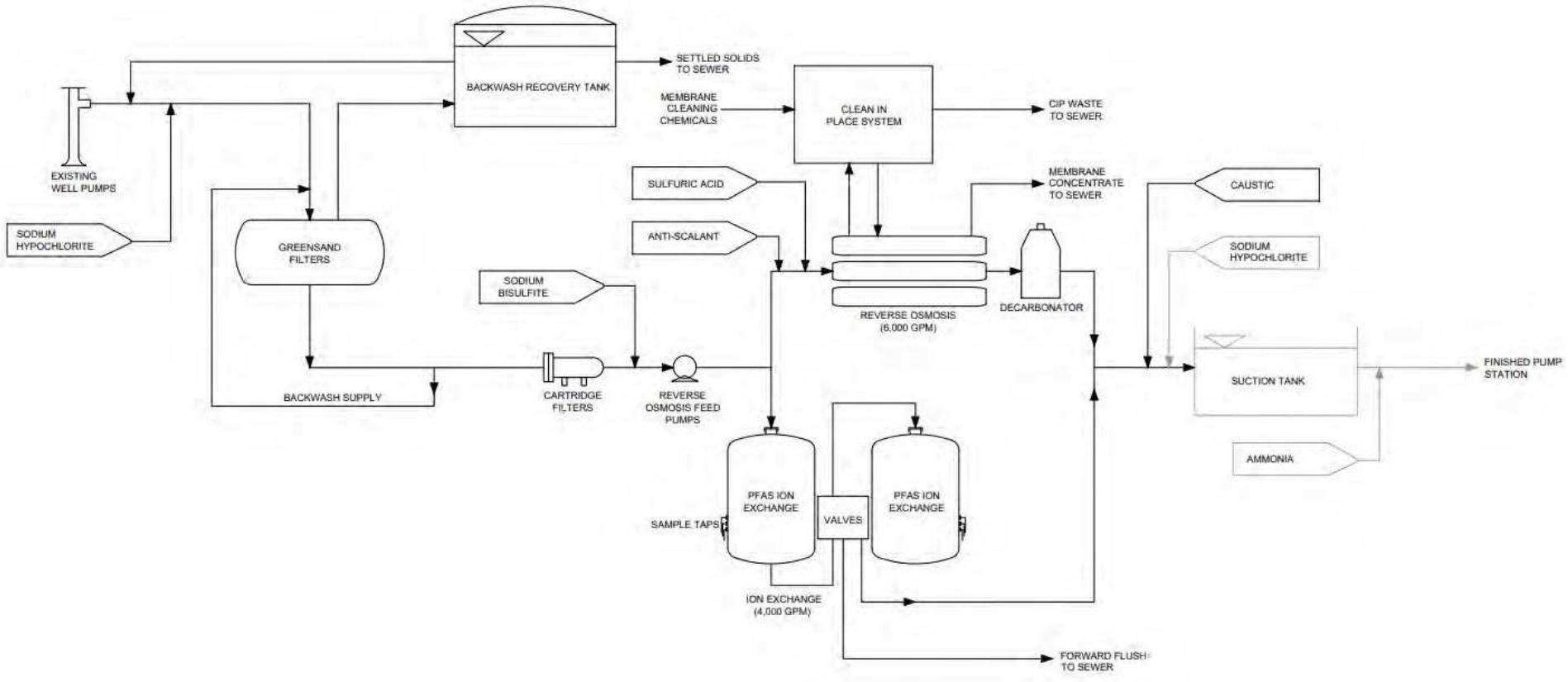


Figure 4-7. Process Flow Diagram for Alternative 2: Sidestream RO, PFAS IX/FS

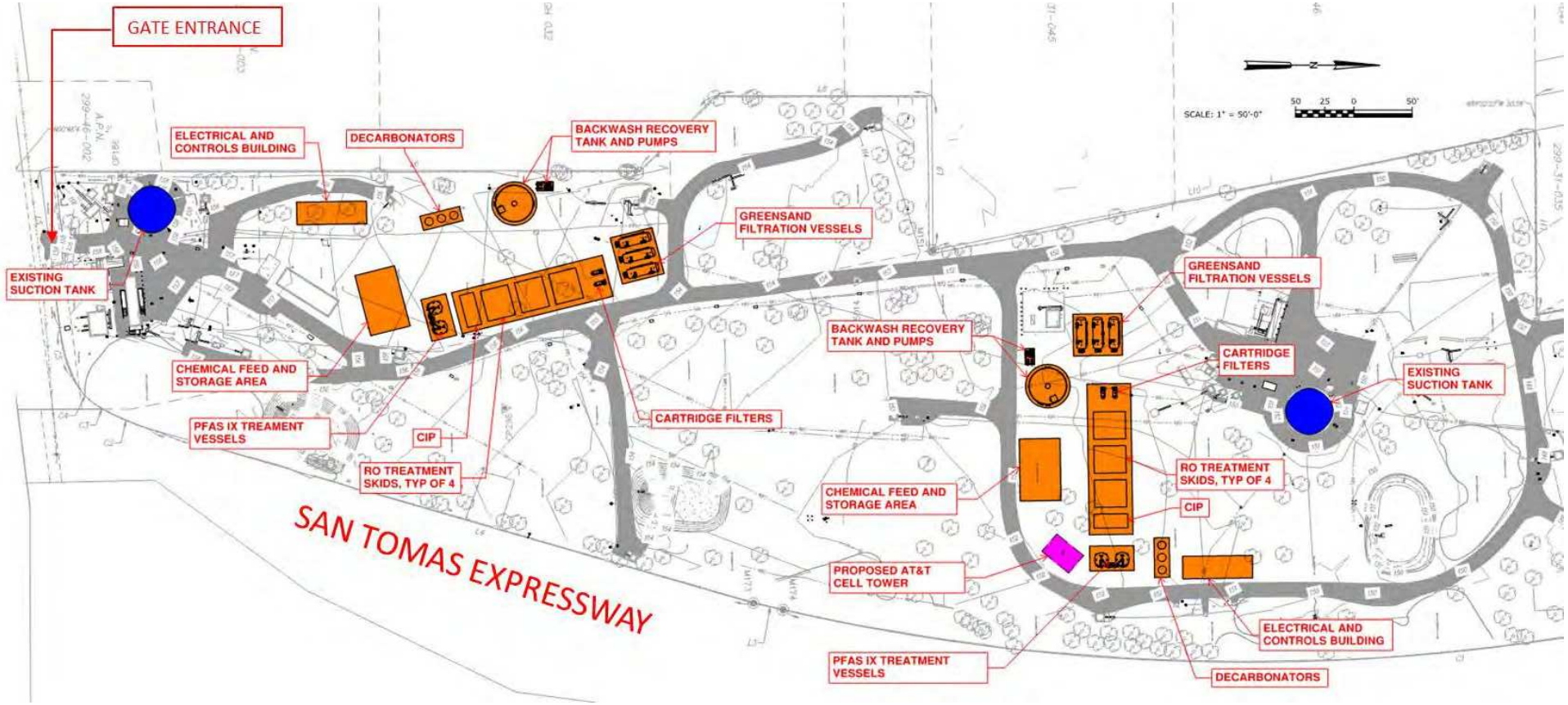


Figure 4-8. Site Layout for Alternative 2: Sidestream RO, PFAS IX/FS

4.1.3 Alternative 3: Pellet Softening, PFAS IX/FS

Alternative 3, pellet softening with PFAS IX/FS, removes hardness and PFAS sequentially. A simplified PFD of this alternative is shown in Figure 4-6. A detailed PFD, including chemical feeds and waste produced, is included in Figure 4-7. Figure 4-8 provides a preliminary site layout. The first stage in the process is pellet softening. Upstream of the pellet reactor, a sand catalyst and lime are fed at doses of approximately 30 mg/L and 190 mg/L, respectively. This high dose of lime is needed to raise the pH to 10.5 in order to meet the target hardness of 100 mg/L as $CaCO_3$. Doses of sand and lime, combined with calcium and magnesium in the source water, would result in the production of approximately 15,000 pounds per day of solids. If sodium hydroxide were used, 160 mg/L of sodium hydroxide (as dry chemical) would be required, resulting in higher than acceptable sodium or potassium in the finished. For this reason, the process requires the use of lime.

When lime is used, carryover turbidity from the pellet softener can be over 20 NTU. This high concentration of carryover solids would rapidly foul cartridge filters and therefore media filters, which can be backwashed, are required downstream of the pellet reactor. Filter effluent would then be captured in a small filter clearwell and pumped through cartridge filters and IX/FS.

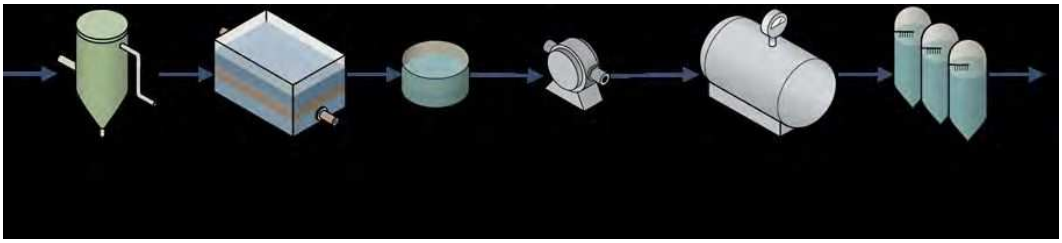


Figure 4-9. Simplified PFD for Alternative 3: Pellet Softening, PFAS IX/FS

Advantages of Alternative 3 include the highest recovery of the four alternatives and the ability to phase the project. Recovery for Alternative 3 is expected to be approximately 98%, significantly higher than Alternatives 1 and 2. Also, SJW could choose to phase the construction, addressing either hardness or PFAS individually.

The disadvantages of this alternative include that it is operationally intensive, requires high chemical use and solids production, and has limited applicability to other sites. The process would be operationally intensive given the number of processes, high feeds and residuals production, and process control requirements. Pellet reactors are most effective when run at near steady state operation, and changing flows would require taking reactors online and offline, including maintenance flushing when taking reactors out of service. Given these operation considerations, the station would likely need to be manned during operation, which would require more personnel. High chemical dose and solids production will also require frequent chemical deliveries and solids hauling, resulting in more operational coordination by SJW in addition to neighborhood impacts from trucking. Finally, other well sites operated by SJW have significantly higher hardness, and it is unlikely that this process would be cost effective at sites with higher hardness.

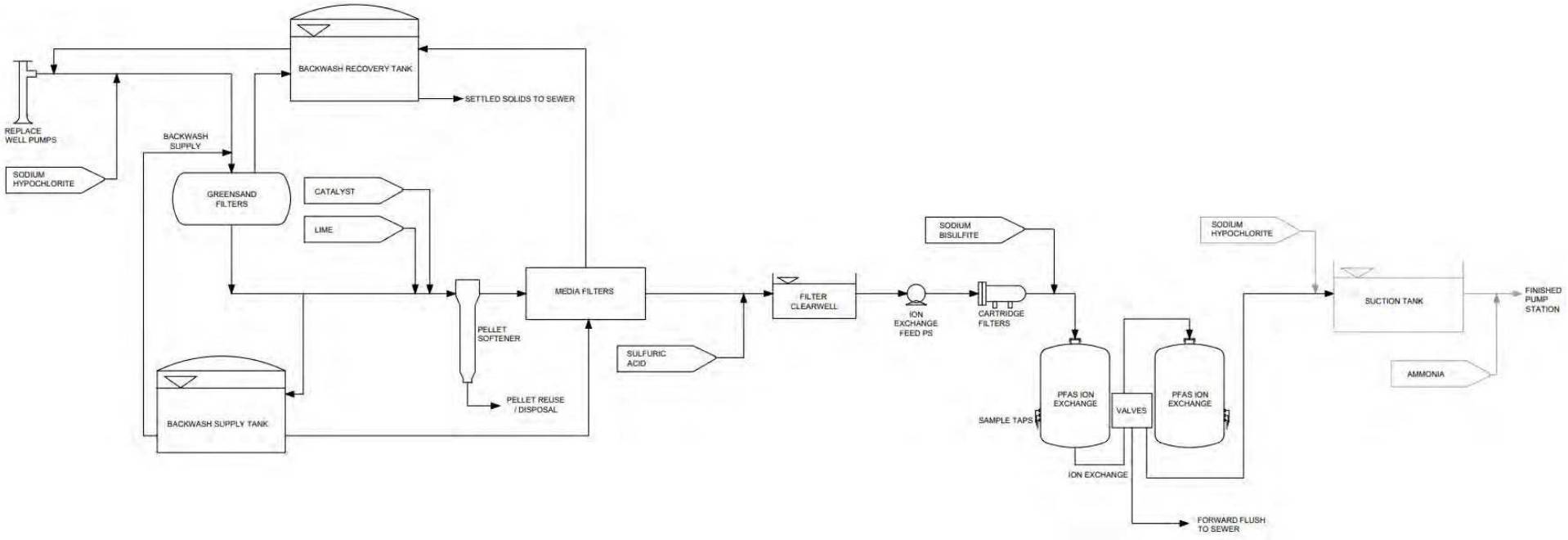


Figure 4-10. Process Flow Diagram for Alternative 3: Pellet Softening, PFAS IX/FS

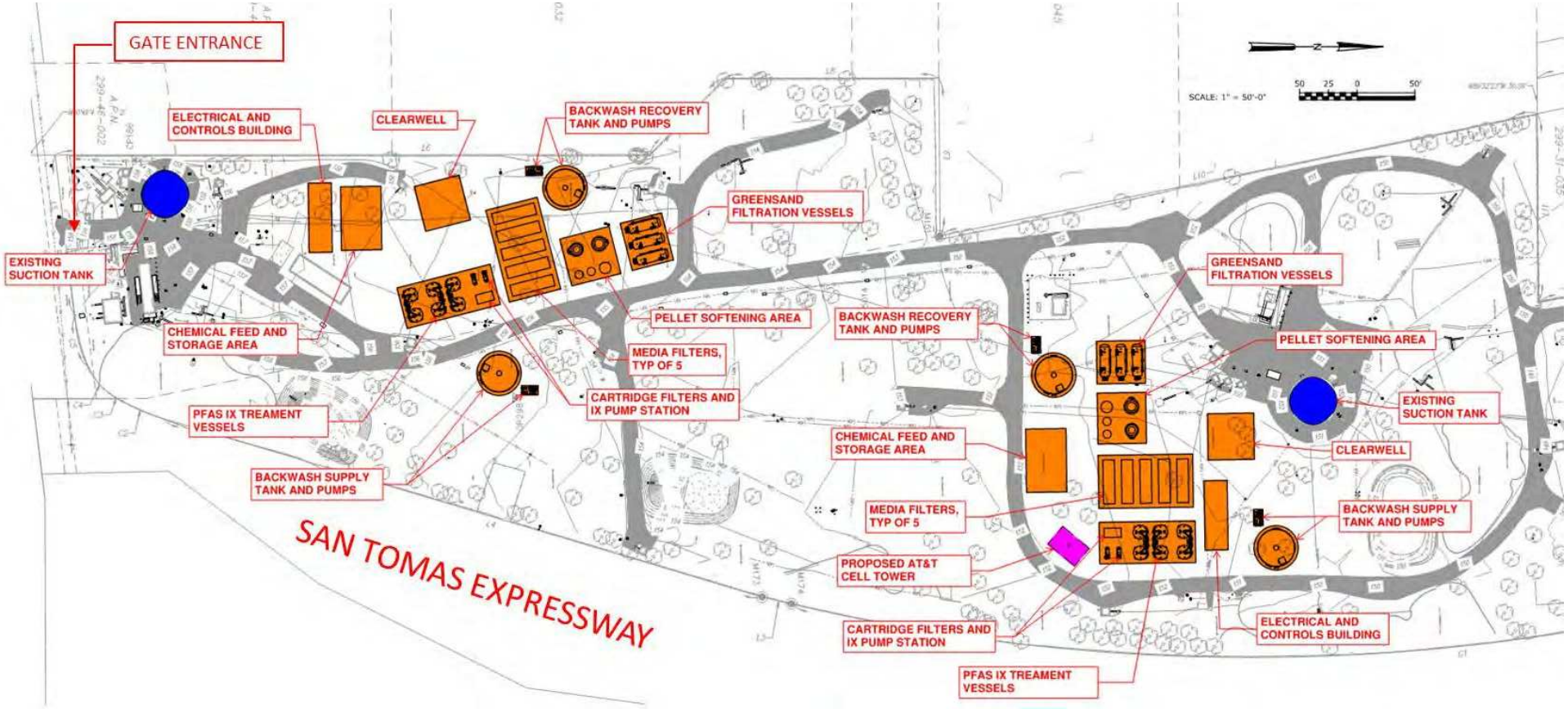


Figure 4-11. Site Layout for Alternative 3: Pellet Softening, PFAS IX/FS

4.1.4 Alternative 4: Acid Regen IX Softening, PFAS IX/FS

Alternative 4, acid regen IX with PFAS IX/FS, hardness associated is removed through weak acid cation exchange (WAC) and PFAS is removed through either IX or FS. Because WAC would remove hardness below the target of 100 mg/L as $CaCO_3$, a sidestream would not be softened and blended with the softened water flow. A simplified PFD of this alternative is shown in Figure 4-12. A detailed PFD, including chemical feeds and waste produced, is included in Figure 4-13. Figure 4-14 provides a preliminary site layout.

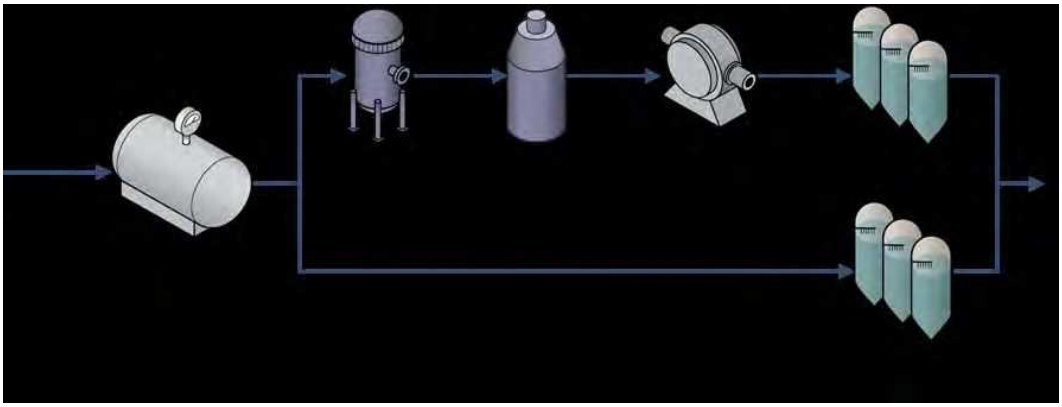


Figure 4-12. Simplified PFD for Alternative 4: Acid Regen IX Softening, PFAS IX/FS

Advantages of Alternative 4 include the second highest recovery of the four alternatives, the ability to phase the project, and tailorability to site-specific water quality. Recovery for Alternative 4 is expected to be approximately 97%, significantly higher than Alternatives 1 and 2. Also, SJW could choose to phase the construction, addressing either hardness or PFAS individually. Another advantage is that the process is applicable to other sites, where the fraction of flow through the unsoftened sidestream would be adjusted based on source water hardness (e.g., higher hardness, smaller sidestream).

The disadvantages of this alternative are the high chemical dose and DDW permitting timeline. The use of HCl for regenerating the WAC resin is the most significant cost driver for O&M (see Section 4.3.2). Permitting would be the most challenging for this alternative due to the uncommon use of WAC in municipal softening applications. Although the resins and vessels are NSF 61 certified, most applications of this technology are in the industrial or food and beverage markets.

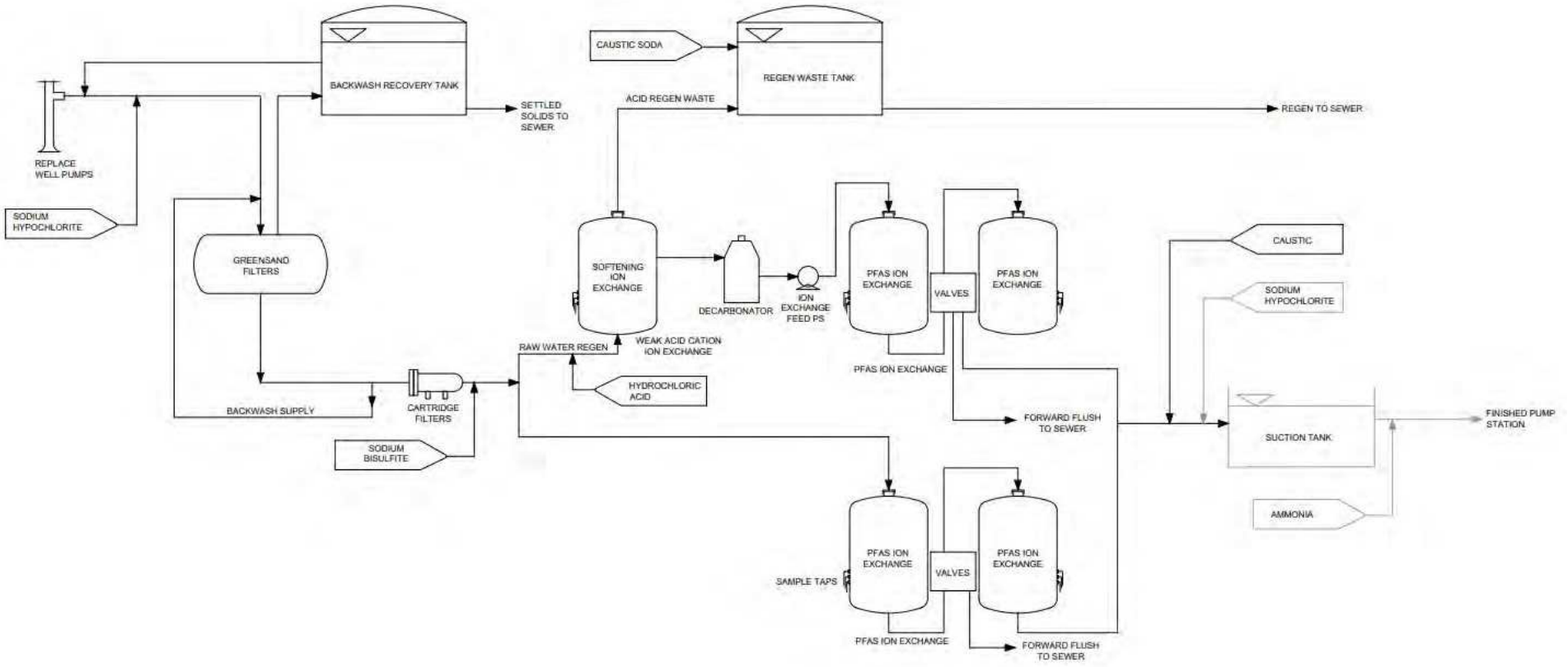


Figure 4-13. Process Flow Diagram for Alternative 4: Acid Regen IX Softening, PFAS IX/FS

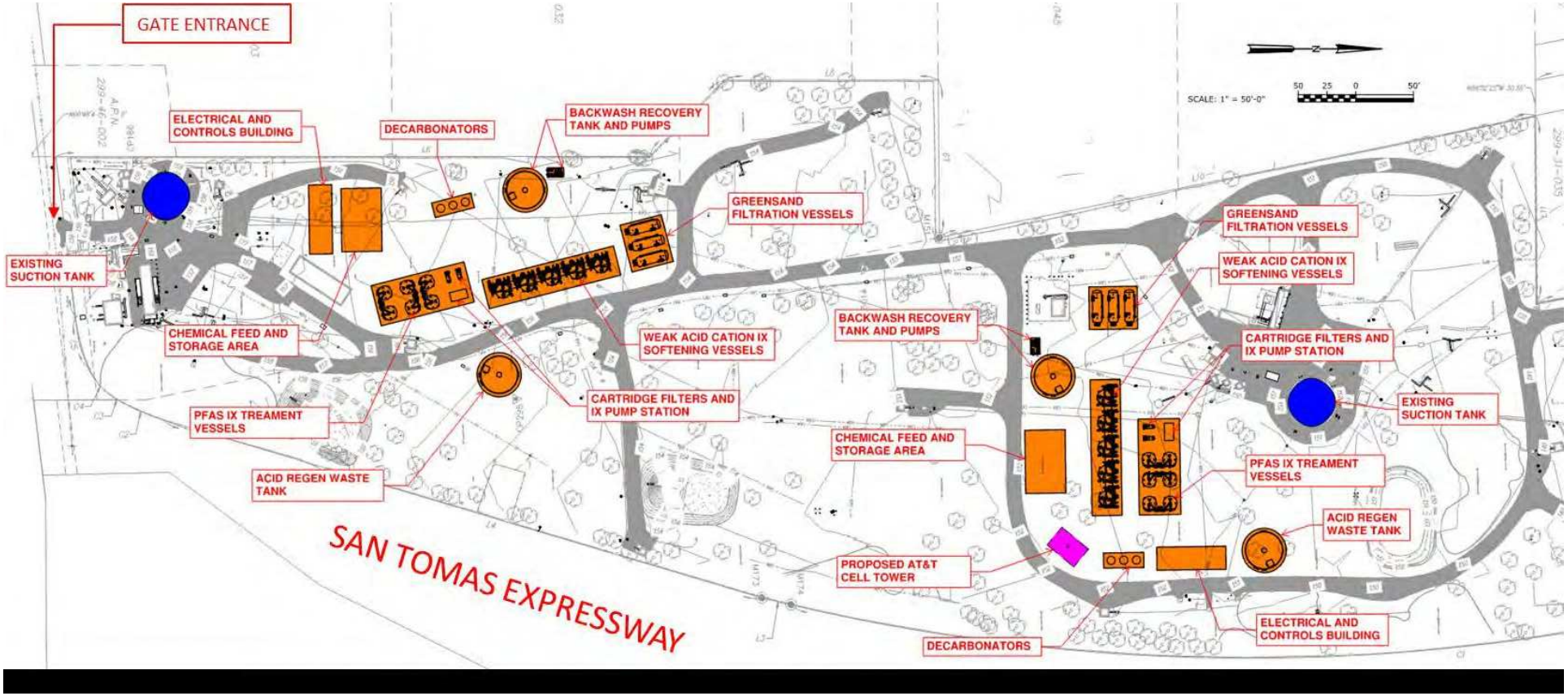


Figure 4-14. Site Layout for Alternative 4: Acid Regen IX Softening, PFAS IX/FS

4.2 Evaluation Criteria

The evaluation criteria, along with their relative weighting, are shown in Figure 4-15. These evaluation criteria were developed as described in Section 1.2, with weightings determined by SJW staff survey responses. The five highest-ranked criteria were Customer Satisfaction, Neighborhood Aesthetics, Operations Burden & Complexity, Health & Safety, and O&M Cost. The scoring of these criteria is described in Section 0.

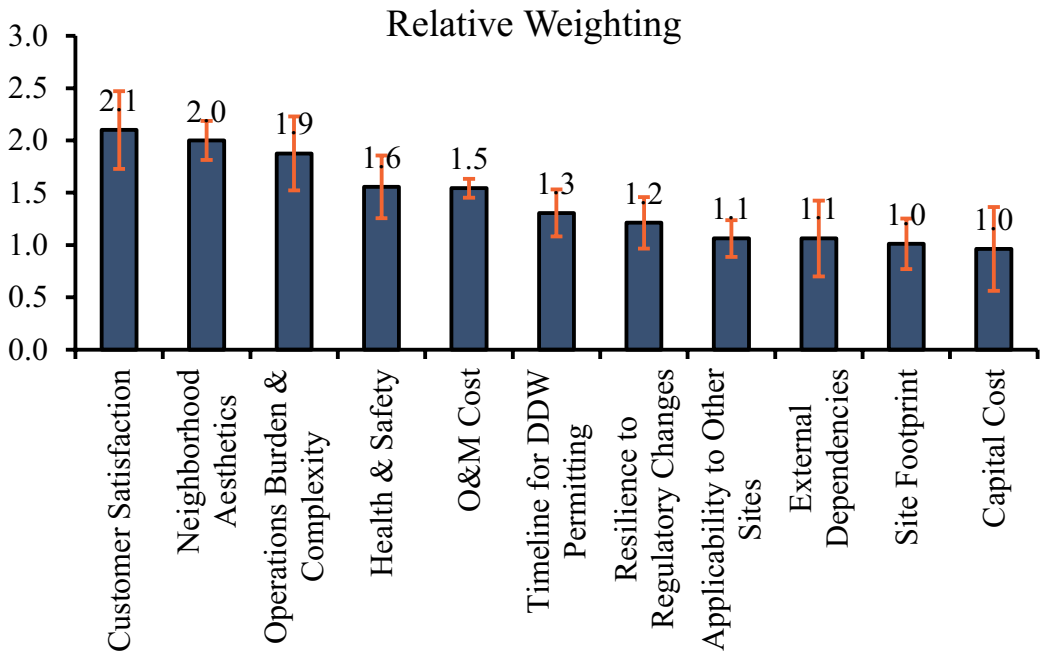


Figure 4-15. Evaluation Criteria and Relative Weighting

4.3 Preliminary Capital, O&M, and Lifecycle Costs

This section provides estimates of preliminary capital, O&M, and lifecycle costs. O&M and lifecycle costs are based on an annual average flow of 6.24 MGD, which was calculated based on booster station totalizers provided between August 2017 and 2020.

4.3.1 Preliminary Capital Cost

Capital costs for each system are summarized in Table 4-2, with associated assumptions documented in Table 4-3. The estimate is considered to be an AACE Class 4 level. Class 4 has a typical accuracy range of -30% on the low side and +50% on the high side. A 30% design contingency has been added to the estimate based on current status of design documents, the nature of the project, and the estimate classification.

The lowest capital cost alternative was Alternative 1 (NF) at $47 million, followed by Alternative 4 (Acid-Regen Softening and PFAS IX) at $49 million. However, the capital costs for all alternatives were relatively similar, within ~25%.

Table 4-2. Preliminary Alternative Capital Cost Estimates

Description	Alternative 1 NF	Alternative 2 RO / IX	Alternative 3 Pellet & IX	Alternative 4 Acid Regen & IX
Demolition	$200,000	$200,000	$200,000	$200,000
Greensand Filter	$4,000,000	$4,000,000	$4,000,000	$4,000,000
Feed Pump Station	$500,000	$500,000	$0	$0
Cartridge Filters	$1,200,000	$1,200,000	$1,200,000	$1,200,000
Nanofiltration	$20,100,000	$0	$0	$0
Nanofiltration Building	$2,300,000	$0	$0	$0
Reverse Osmosis	$0	$21,500,000	$0	$0
PFAS Ion Exchange	$0	$5,400,000	$11,100,000	$11,100,000
Pellet Softener	$0	$0	$13,700,000	$0
Media Filter	$0	$0	$7,500,000	$0
Filter Clearwell	$0	$0	$1,000,000	$0
IX Feed Pump Station	$0	$0	$500,000	$300,000
Weak Acid Cation IX	$0	$0	$0	$13,100,000
Decarbonator	$2,400,000	$1,900,000	$0	$1,900,000
Electrical Building	$500,000	$500,000	$500,000	$500,000
Site Work	$700,000	$700,000	$800,000	$700,000
Yard Piping	$1,300,000	$1,400,000	$1,500,000	$1,500,000
Electrical and Instrumentation	$2,900,000	$3,200,000	$3,800,000	$3,000,000
PROBABLE CONSTRUCTION COST	**$36,100,000**	**$40,500,000**	**$45,800,000**	**$37,500,000**
Project Costs (Design & ESDC, PM, CM, Legal)	$10,900,000	$12,200,000	$13,800,000	$11,300,000
PROBABLE PROJECT COST	**$47,000,000**	**$52,700,000**	**$59,600,000**	**$48,800,000**

Table 4-3. Capital Cost Assumptions

Assumption	Percentage
Portion of work performed by Subcontractor	20%
Subcontractor Overhead and Profit	25%
Contractor Mark-up on Subcontractor work	5%
Contractor Overhead	10%
Contractor Profit	10%
Escalation at 3% annually	6%
Bond and Insurance	3%
Contingency	30%
Project Costs (Design & ESDC, PM, CM, Legal)	30%

4.3.2 Preliminary O&M Cost

Table 4-4 provides a summary of preliminary O&M costs broken down into six categories: chemical costs, media / consumable replacement, additional Valley Water fees, electricity, sewer disposal fees, and solids disposal.

Table 4-4. Summary of Preliminary O&M Cost ($/MG)

	NF	Sidestream RO, IX	Pellet Softening, IX	Acid-Regen IX Softening, IX
Chemical Cost	$92	$76	$616	$538
Media / Consumable Replacement	$128	$122	$109	$109
Additional Valley Water (VW) Fees (2029 rates)	$852	$577	$181	$236
Electricity	$177	$213	$137	$121
Sewer Disposal Fees	$553	$375	$118	$154
Solids Disposal	$0	$0	$0	$0
Total O&M ($/MG)	**$1,802**	**$1,363**	**$1,161**	**$1,158**
Annual O&M ($/yr)	**$4,200,000**	**$3,200,000**	**$2,700,000**	**$2,700,000**

Estimated chemical use and costs was calculated for sodium hypochlorite, sodium bisulfite, sulfuric acid, antiscalant (membrane processes), sodium hydroxide, sand catalyst (pellet softening), lime slurry, hydrochloric acid, and liquid ammonium sulfate (LAS). All alternatives were assumed to have similar

dose of sodium hypochlorite, sodium bisulfite, and LAS. Both membrane alternatives had relatively low chemical costs given the relatively low doses of sulfuric acid, antiscalant, and sodium hydroxide. High doses of lime slurry (190 mg/L) necessary to raise the pH to meet hardness reduction targets resulted in high chemical costs for Alternative 3. For Alternative 4, regeneration of the softening resin required approximately 450 gallons of 32% (20 baume) HCl per million gallon of softening IX flow, resulting in high chemical costs.

Media and consumables were estimated based on the cost of cartridge filters, high pressure membrane elements, and resin replacement. All alternatives were assumed to have similar cartridge filter replacement frequencies: 66 high-capacity filters replaced every 4 months at a cost of $402/element ($35/MG). For the membrane alternatives, high pressure elements were assumed to last for 5 years and have a cost of $550/element. Based on the calculated number of elements per system, this came out to an additional $93/MG for Alternative 1 and $62/MG for Alternative 2. Media replacement was based on the average of IX replacement bounds presented in Section 2.1. For Alternative 2, this came to $25/MG. For Alternatives 3 and 4, this was $74/MG.

Additional Valley Water fees and sewer disposal costs were important cost drivers, particularly for the membrane processes. Valley Water fees and sewer disposal costs result from water loss, which is summarized by unit process in Table 4-5. All processes were assumed to include greensand filtration, which would result in a loss of approximately 0.3% of process water. Recovery in high pressure membrane processes was projected to be approximately 91%, resulting in water loss of 9% for Alternative 1 and 6% for Alternative 2, which has a bypass. Backwashing of media filters downstream of pellet softeners in Alternative 3 was estimated to require 5% of process flow, two thirds of which could be recovered (i.e., 1.7% waste). For Alternative 4, the largest water loss was the regeneration process for softening resin (2.3%). These water losses add costs in two ways. First, Valley Water charges a fee of $4,217/MG for groundwater. This fee is anticipated to increase 9% per year through 2029, resulting in a projected cost of $9,159/MG. At the rates shown in Table 4-5, the cost ranged from $181/MG for Alternative 3 to $852/MG for Alternative 1. Additional groundwater pumping at this rate is required to offset water losses. City of San Jose sanitary sewer fees are made up of an annual capacity charge ($91,799/MGD of capacity) and an O&M rate of $3.028/HCF. Sanitary sewer disposal fees ranged from $118/MG for Alternative 3 to $553/MG for Alternative 1.

Table 4-5. Water Loss by Unit Process

	NF	Sidestream RO, IX	Pellet Softening, IX	Acid-Regen IX Softening, IX
Greensand	0.3%	0.3%	0.3%	0.3%
Concentrate	9.0%	6.0%	0.0%	0.0%
Pellet Underflow	0.0%	0.0%	0.0%	0.0%
Media Filter BW	0.0%	0.0%	1.7%	0.0%
Regen Brine	0.0%	0.0%	0.0%	2.3%
Total	**9.3%**	**6.3%**	**2.0%**	**2.6%**

Pellet softening is the only process that produces solid waste to be hauled offsite. Since the pellets can be beneficially reused, their disposal was assumed to be cost neutral.

The preliminary O&M costs for each alternative are summarized in Figure 4-16. This figure visualizes the information in Table 4-4, demonstrating that costs related to reduced recovery (i.e., additional Valley Water fees and sewer disposal) would be the primary O&M cost drivers for the membrane-based Alternatives 1 and 2. By comparison, chemical costs would be the primary O&M cost driver for precipitative and IX-based softening Alternatives 3 and 4. Although Alternatives 3 and 4 had lower O&M costs that Alternative 1, the treatment O&M costs are much lower than the fees paid to Valley Water (see Figure 4-17). This indicates that the overall difference in cost of different treatment alternatives would be small relative to Valley Water fees, which would apply equally to all alternatives.

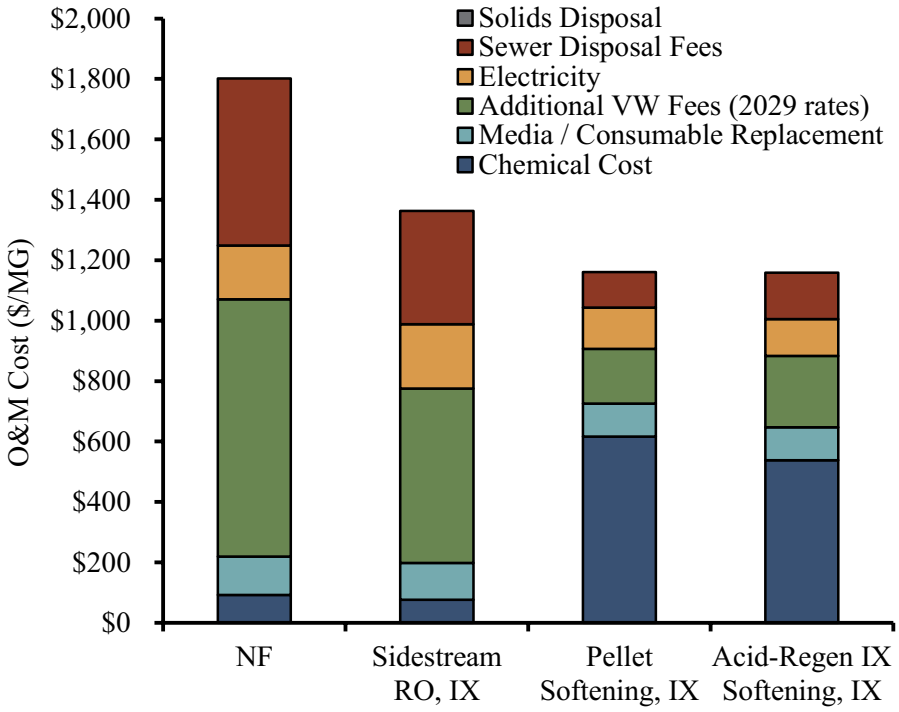


Figure 4-16. Summary of Preliminary O&M Cost by Alternative

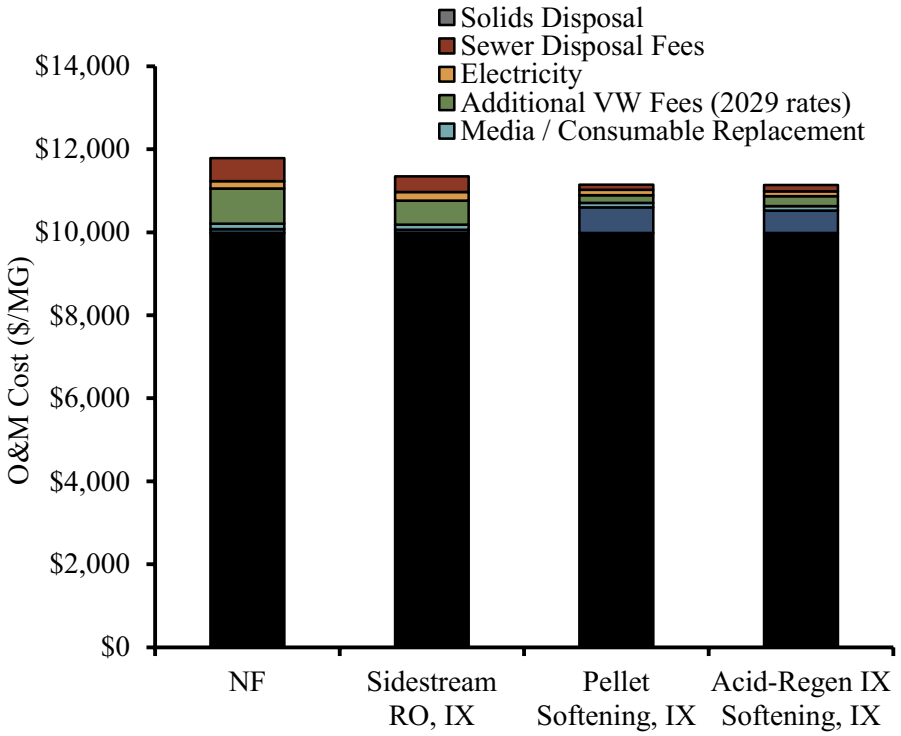


Figure 4-17. O&M Cost by Alternative (including Valley Water Fees, 2029 rates)

4.3.3 Preliminary Lifecycle Cost

A preliminary lifecycle cost analysis was performed based on the following assumptions below. Assumptions for debt ratio and discount rate were provided by SJW based on the utility's approved cost of capital.

- Amortization period: 30 years
- Debt Ratio: 46.72%
- Discount Rate: 7.64%
- Annual O&M Escalation: 2.0%

The results of this analysis are summarized in Table 4-6. Alternative 4, Acid-Regen IX Softening with PFAS IX, was found to have the lowest lifecycle cost at $84.2 million. However, the lifecycle costs for all four alternatives were relatively similar (i.e., within ~20%). The total treatment cost of water on a $/MG basis is shown in Figure 4-18. Alternative 4 has the lowest cost at $1,829/MG, while Alternative 1 has the highest cost at $2,447/MG. This cost excludes the base fee charged by Valley Water ($4,217/MG in 2020 increasing to $9,159 in 2029).

Table 4-6. Preliminary Lifecycle Cost Comparison

	NF	Sidestream RO, IX	Pellet Softening, IX	Acid-Regen IX Softening, IX
O&M				
Annual O&M	$4,200,000	$3,200,000	$2,700,000	$2,700,000
O&M NPV	$59,700,000	$45,500,000	$38,400,000	$38,400,000
Capital				
Project Cost	$47,000,000	$52,700,000	$59,600,000	$48,800,000
Upfront Capital	$25,100,000	$28,100,000	$31,800,000	$26,100,000
Financed Amount	$22,000,000	$24,700,000	$27,900,000	$22,800,000
Debt Service NPV	$19,000,000	$21,300,000	$24,100,000	$19,800,000
Total Capital NPV	$44,100,000	$49,400,000	$55,900,000	$45,800,000
30-Year Lifecycle Cost				
Total Lifecycle NPV	**$103,800,000**	**$94,900,000**	**$94,300,000**	**$84,200,000**

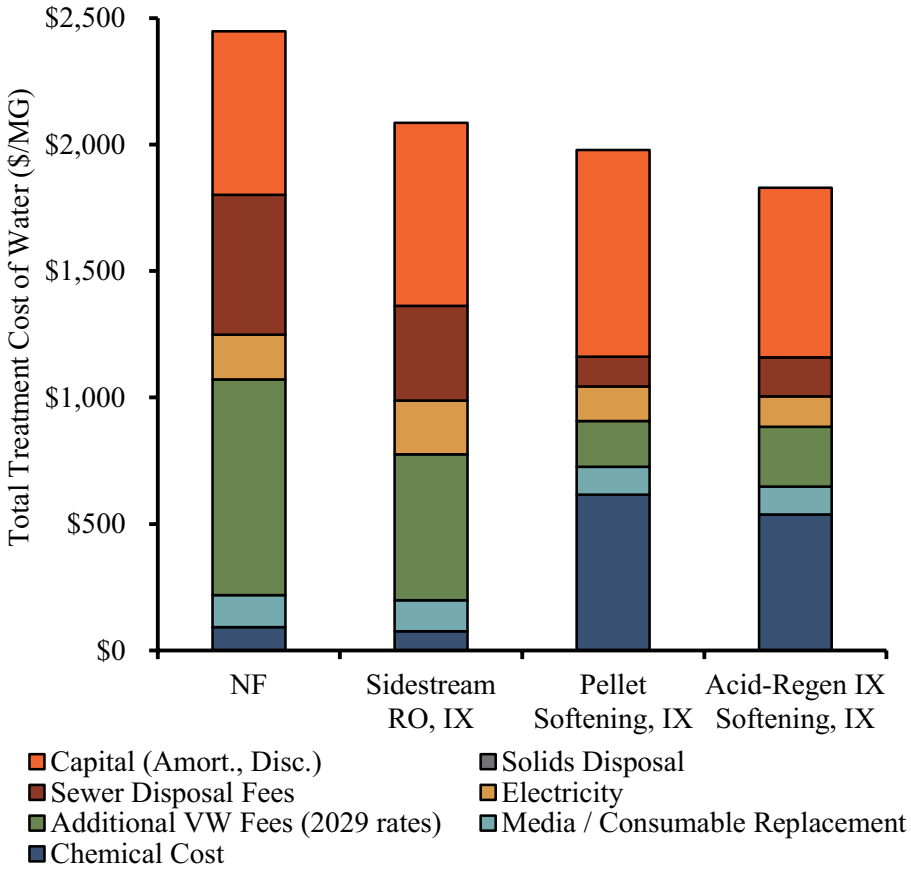


Figure 4-18. Total Cost of Water Including O&M and Debt Service (Excluding Base VW Fees)

4.4 Alternatives Scoring and Ranking

4.4.1 Alternatives Scoring

A summary of alternatives scoring is provided in Table 4-7. Scoring is broken down by the evaluation criteria described in Section 4.2. For qualitative criteria (e.g., Operations Burden and Complexity, Customer Satisfaction), scoring was conducted based on responses to Yes/No questions. Qualitative criteria had a maximum score of 5 and a minimum score of 0. For quantitative criteria (i.e., O&M Cost, Site Footprint, Capital Cost), responses were scaled from 0 to 1.25 times the maximum of the four alternatives, where zero was the most desirable outcome and 1.25*maximum was the least desirable outcome. The factor of 1.25 was added to reduce the spread in scoring; without this factor, the lowest scoring alternative (i.e., largest, most expensive) would have received zero points in scoring.

Figure 4-19 shows a plot summarizing scoring for qualitative criteria. Alternative 4 (Acid-Regen IX Softening with PFAS IX) scored higher than the other alternatives for Operations Burden & Complexity, Neighborhood Dependencies, and Applicability to Other Sites. The membrane-based Alternatives 1 and 2 (NF, Sidestream RO and IX) scored highest for Timeline for DDW Permitting.

The scoring criteria were entered into the Hazen Converge tool for the purpose of ranking alternatives.

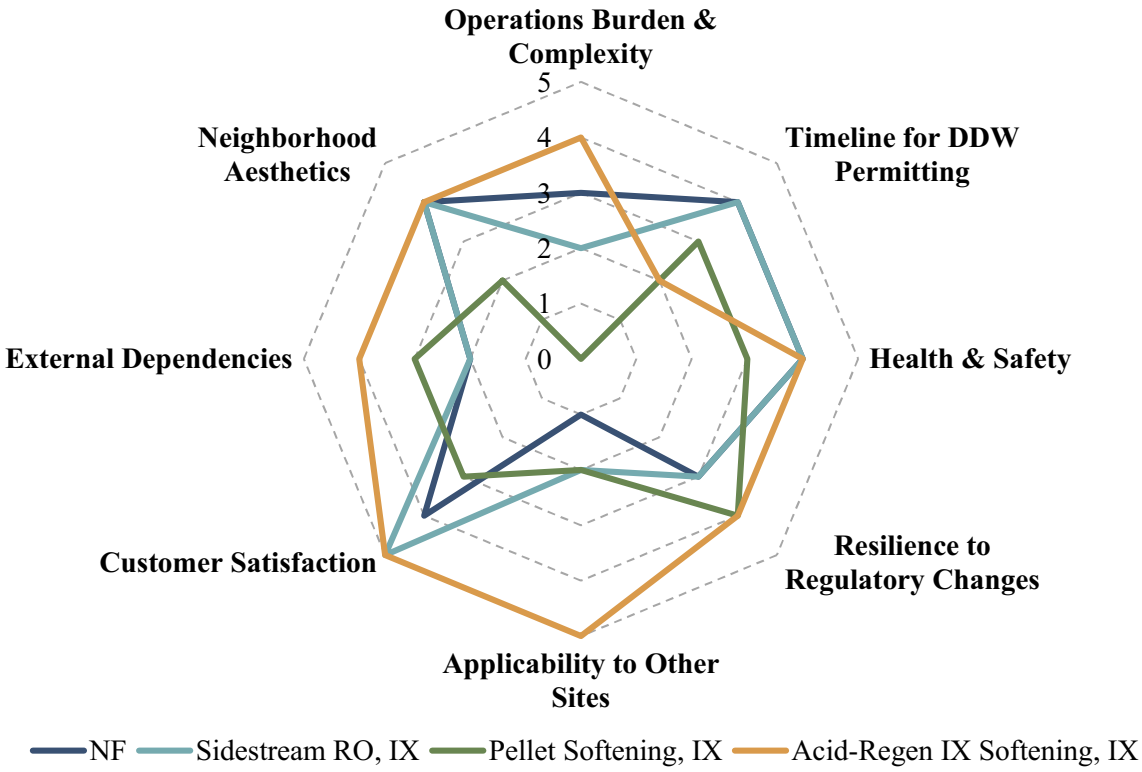


Figure 4-19. Radar Plot Summarizing Scoring for Qualitative Criteria

Table 4-7. Summary of Alternatives Scoring

Criteria	Scoring	NF	Sidestream RO, PFAS IX	Pellet Softening, PFAS IX	Acid-Regen IX Softening, PFAS IX
Operations Burden & Complexity		**3**	**2**	**0**	**4**
High level of line process monitoring required?	Yes = 0, No = 1	0	0	0	1
Requires chemical dose adjustment based on wells in service?	Yes = 0, No = 1	1	1	0	1
Requires daily operator attention?	Yes = 0, No = 1	0	0	0	1
More than 2 unit processes required?	Yes = 0, No = 1	1	0	0	0
Produces solid residuals for handling & disposal?	Yes = 0, No = 1	1	1	0	1
Preliminary O&M Cost ($/MG)[4]	$0 to 1.25* Max(Alt 1-4)	**$1,802**	**$1,363**	**$1,161**	**$1,158**
Timeline for DDW Permitting		**4**	**4**	**3**	**2**
Has technology been deployed at full-scale?	Yes = 1, No = 0	1	1	1	1
All components NSF-61 certified?	Yes = 1, No = 0	1	1	1	1
Commonly permitted in CA?	Yes = 2, No = 0	2	2	1	0
Is piloting valuable to determine design criteria?	Yes = 0, No = 1	0	0	0	0
Health & Safety		**4**	**4**	**3**	**4**
Applied chemicals have NFPA health rating ≥ 3?	Yes = 0, No = 1	0	0	0	0
Applied chemicals have NFPA health rating = 4?	Yes = 0, No = 1	1	1	1	1
Operating pressure above 150 psi?	Yes = 0, No = 1	1	1	1	1
Requires working at heights above 6 ft?	Yes = 0, No = 1	1	1	0	1
Requires routine work near an engulfment hazard or open confined space?	Yes = 0, No = 1	1	1	1	1

[4] Costs were refined in subsequent sections.

Criteria	Scoring	NF	Sidestream RO, PFAS IX	Pellet Softening, PFAS IX	Acid-Regen IX Softening, PFAS IX
Resilience to Regulatory Changes		**3**	**3**	**4**	**4**
Effective for short-chain PFAS?	Yes = 2, No = 0	2	2	2	2
Broadly effective for additional micro-constituents?	Yes = 1, No = 0	1	1	0	0
Generates PFAS-laden brine?	Yes = 0, No = 2	0	0	2	2
Site Footprint (ft^2)	0 to 1.25* Max(Alt 1-4)	**54,000**	**49,000**	**65,000**	**50,000**
Applicability to Other Sites		**1**	**2**	**2**	**5**
Able to treat higher hardness at other sites to 100 mg/L?	Yes = 1, No = 0	1	1	0	1
Able to efficiently address a range of constituent concentrations (iron/TSS, hardness, PFAS)?	Yes = 1, No = 0	0	1	1	1
Compatible with wellhead treatment?	Yes = 1, No = 0	0	0	0	1
Wide range of process turndown?	Yes = 1, No = 0	0	0	0	1
Recovery >95%?	Yes = 1, No = 0	0	0	1	1
Customer Satisfaction		**4**	**5**	**3**	**5**
Meets 0.03 mg/L iron target?	Yes = 1, No = 0	1	1	1	1
Reduces hardness by 50%?	Yes = 1, No = 0	1	1	1	1
Consistently meets 100 mg/L hardness goal?	Yes = 1, No = 0	1	1	0	1
Removes Mg hardness?	Yes = 1, No = 0	1	1	0	1
Potential for oversoftening?	Yes = 0, No = 1	0	1	1	1
External Dependencies		**2**	**2**	**3**	**4**
Is there a sanitary sewer discharge?	Yes = 0, No = 1	0	0	0	0
Sanitary sewer discharge includes concentrated PFAS?	Yes = 0, No = 1	0	0	1	1
Is frequent solids hauling required?	Yes = 0, No = 1	1	1	0	1
Energy-intensive process?	Yes = 0, No = 1	0	0	1	1

Criteria	Scoring	NF	Sidestream RO, PFAS IX	Pellet Softening, PFAS IX	Acid-Regen IX Softening, PFAS IX
Proprietary process equipment that excludes competition?	Yes = 0, No = 1	1	1	1	1
Preliminary Capital Cost (Project Cost)[5]	$0 to 1.25* Max(Alt 1-4)	**$47,000,000**	**$52,700,000**	**$59,600,000**	**$48,800,000**
Neighborhood Aesthetics		**4**	**4**	**2**	**4**
Increase in chemical deliveries?	Yes = 0, No = 1	0	0	0	0
Equipment over 20 ft tall?	Yes = 0, No = 1	1	1	0	1
Frequent solids hauling?	Yes = 0, No = 1	1	1	0	1
Anticipated odor?	Yes = 0, No = 1	1	1	1	1
Increased dust or noise during operation?	Yes = 0, No = 1	1	1	1	1

[5] Costs were refined in subsequent sections.

4.4.2 Alternatives Ranking Results

The alternatives ranking was conducted using Hazen Converge, a multi-criteria Decision Tool. This Excel-based tool was used to compute alternative ranking based on the weighting and scoring discussed previously. The results of this ranking are shown in Figure 4-20. Alternative 4 (Acid-Regen Softening IX with PFAS IX) was the highest-ranking alternative followed by Alternative 2 (Sidestream RO with PFAS IX). **These results were presented in PM 2, and SJW chose to move forward with Alternative 4 as the Preferred Alternative.**

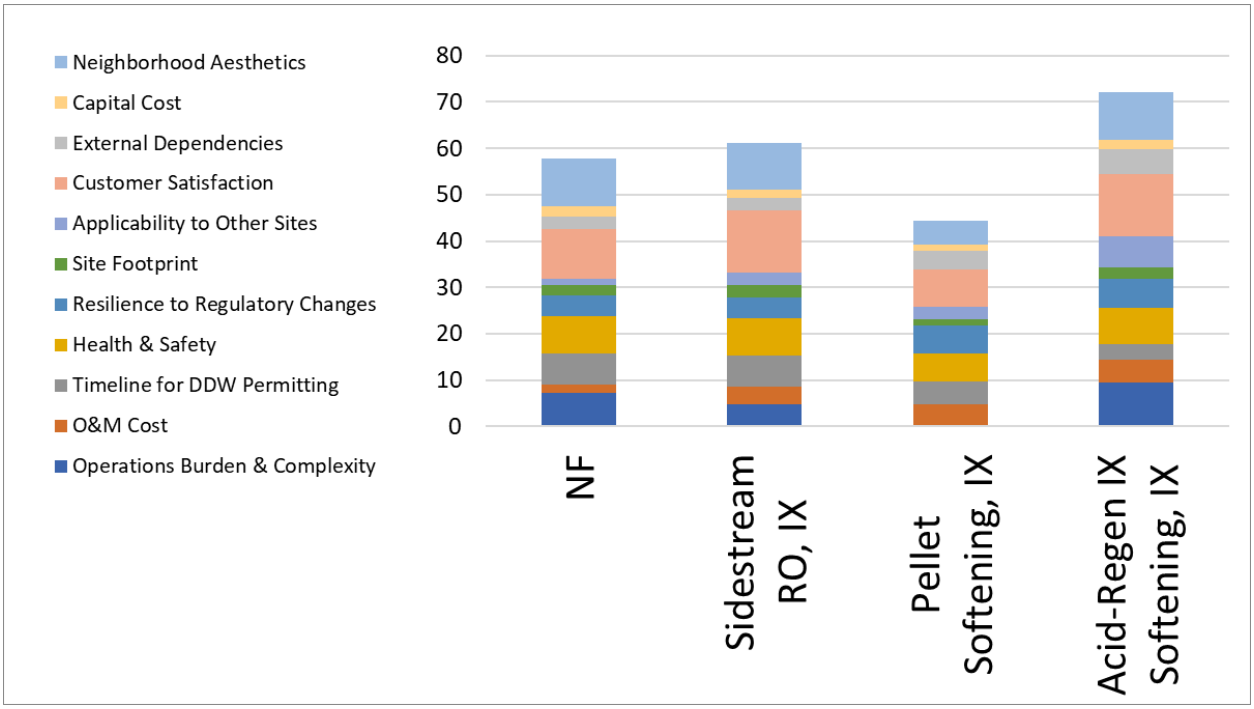


Figure 4-20. Alternatives Ranking

5. Detailed Assessment of Selected Alternative

A detailed assessment was performed for the selected Alternative 4: Acid-Regen IX Softening and IX. This included evaluation of treatment system headloss and hydraulics, pumping alternatives, residuals handling and sanitary sewer disposal, electrical power, chemical storage and consumption, staffing requirements, and SCADA/controls.

5.1 Treatment System Headloss and Hydraulics

Additional headloss is introduced to the existing system through the proposed treatment. Estimates for headloss were based on both clean and dirty (i.e., fouled) conditions. The clean headloss estimates were 2 psi for cartridge filters, 6 psi for WAC IX, and 18 psi for PFAS IX. Fouling was estimated to add another 10 psi to cartridge filters and another 15 psi to PFAS IX. The system breaks head at the decarbonator, which results in 0 psi headloss for the decarbonator. A schematic of the two routes of flow, softening stream and PFAS-only treatment stream, is depicted in Figure 5-1.

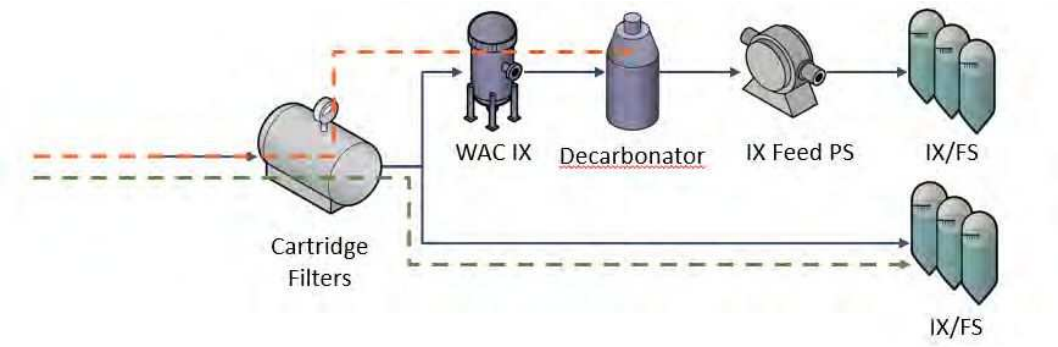


Figure 5-1. Treatment Schematic for Softening (orange) and PFAS-only Treatment Stream (green)

The headloss in the softening stream is the sum of headloss for the cartridge filters, WAC IX, and decarbonator, and the headloss in the PFAS-only treatment stream is the sum of the headloss for the cartridge filters and the PFAS IX/FS. As shown in Figure 5-2, the cumulative headloss in the softening stream is estimated to be 8 psi under clean conditions and 23 psi under dirty conditions, while the cumulative headloss in the PFAS-only treatment stream was estimated to be between 30 and 45 psi.

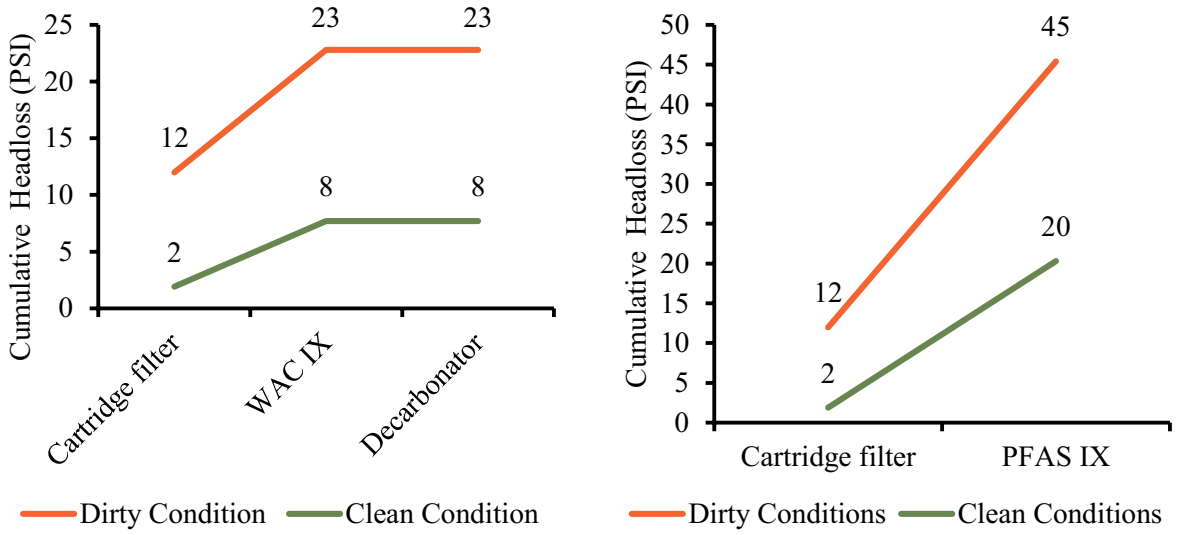


Figure 5-2. Cumulative Headloss from Softening Stream (left) and PFAS-only Treatment Stream (right)

The treatment headloss would reduce well capacity and efficiency, with some wells like W-4 being incapable of pumping against the estimated headloss, as shown in Figure 5-3. The reduced well capacity and efficiency would lead to higher operating costs and possible damage to the well pumps.

Additional stages could potentially be added onto existing well pumps to overcome this additional head. However, the discharge head would need to be increased by approximately 20-30%, exceeding the rated horsepower of many of the existing motors. For this reason, the pumping alternative that increased available head at the well pumps assumed complete replacement of existing pumps and motors.

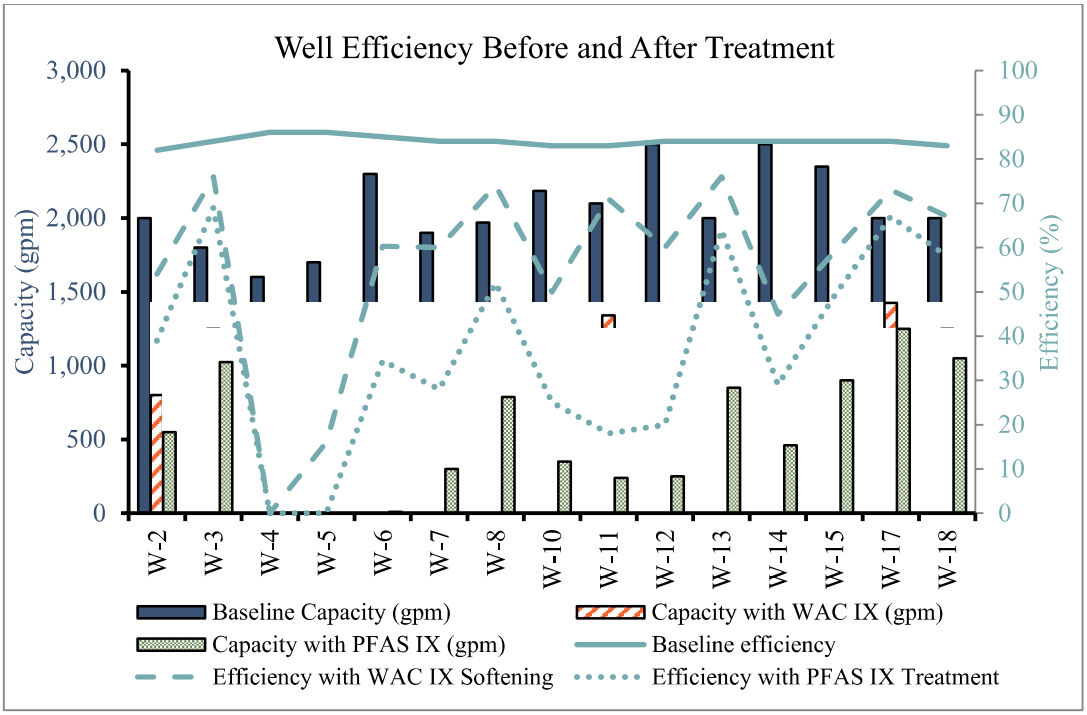


Figure 5-3. Well Efficiency Before and After Treatment

5.2 Number of Systems and Pumping Alternatives

The existing system consists of well pumps, which flow into either the front or back station suction tank. Well pumps 2, 3, 4, 5, 6, 7, 8, and 13 flow into the front station suction tank, and well pumps 10, 11, 14, 15, 17, and 18 flow into the back station suction tank. Both the front and back station suction tanks have three booster pumps to send the water to distribution. The front and back station suction tanks are connected through an intertie that runs across the site. Figure 5-4 depicts a schematic of the existing system, and Figure 5-5 shows the layout of the wells pumps, the piping from well pumps to suction tanks, and the intertie that connects the front and back station suction tanks.

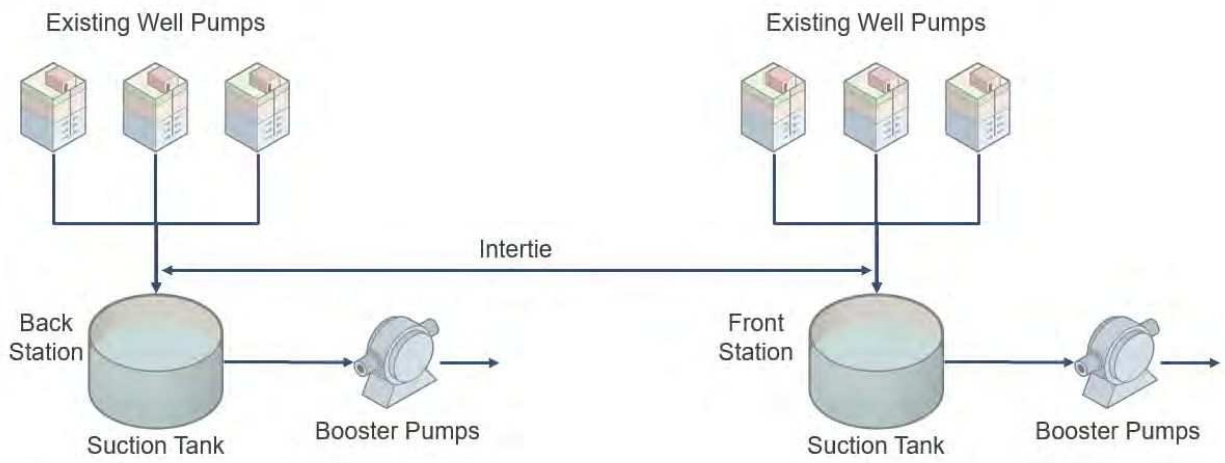


Figure 5-4. Existing System Schematic

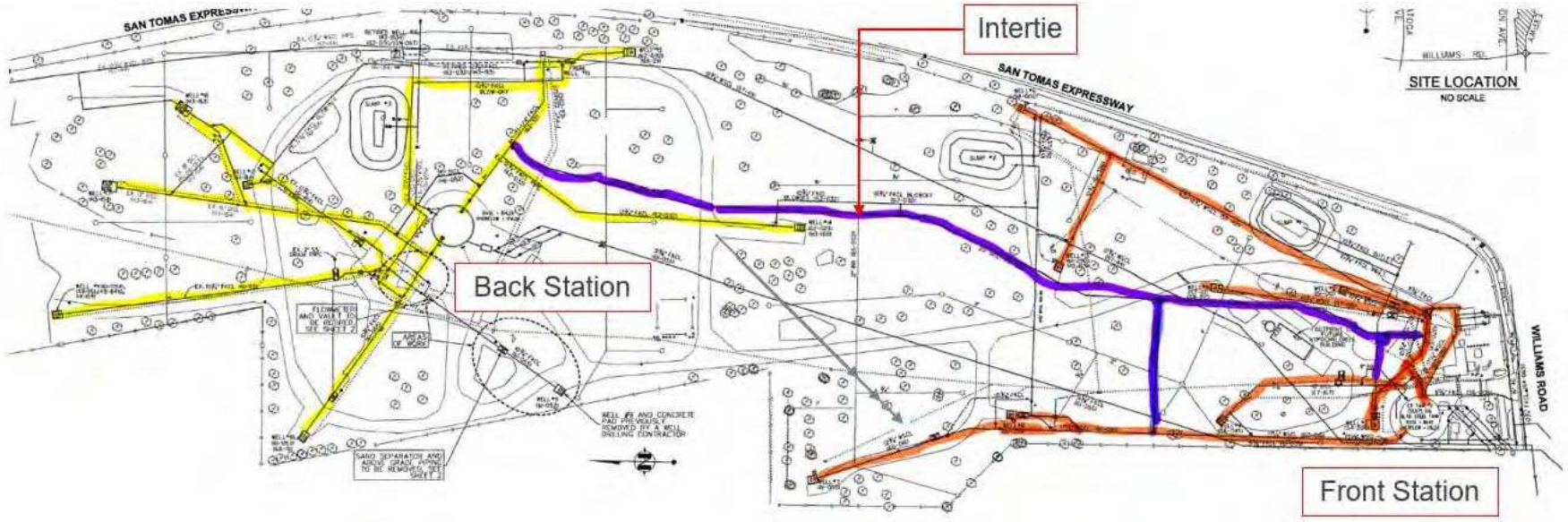


Figure 5-5. Existing System Piped Connections Layout

With the existing site layout and equipment, layout scenarios were developed regarding whether treatment should be centralized, called "Scenario A", or placed at both the front and back stations of Williams station, called "Scenario B". Additionally, several pumping options were identified that would work for both the centralized and front/back scenarios. These conceptual pumping options and their advantages and disadvantages are described in Table 5-1.

Table 5-1. Conceptual Pumping Options Advantages and Disadvantages

Centralized Pumping	Front/Back Pumping	Description	Advantages	Disadvantages
Option 1A	Option 1B	Utilize existing well pumps, suction tank, and booster pumps. Locate treatment after well pumps and before suction tank.	• No changes to existing equipment	• Reduced well capacity and efficiency • Possible damage to well pumps • Higher operating costs due to low efficiency
Option 2A	Option 2B	Replace existing well pumps. Locate treatment after new well pumps and route treated water to existing suction tank. Treated water will be sent to distribution through existing booster pumps.	• Small footprint	• Requires work on all wells at site, likely electrical upgrades • Requires surge tank • More complex controls
Option 3A	Option 3B	Add new suction tank and booster pumps after existing well pumps. Locate treatment after new booster pumps. Treated water will stored in existing suction tank prior to using the existing booster pumps to pump to distribution.	• Simplest controls • Reduces sanding load to treatment system	• Water quality management in break tank • Large footprint
Option 4A	Option 4B	Add in-line booster pumps after existing well pumps and before proposed treatment. Maintain existing suction tank for treated water storage before utilizing existing booster pumps for distribution.	• No changes to existing equipment	• Pump control and pressure surges • Surge tank would be necessary to provide time for booster pumps to adjust

5.2.1 Less Favorable Pumping Options

Options 1 and 4 were considered less favorable options compared with Options 2 and 3 for the reasons that follow.

Option 1 would maintain the existing well pumps, suction tanks, and booster pumps. Treatment would be located between the existing well pumps and the suction tanks. Pumping schematics for Options 1A and 1B are shown in Figure 5-6 and Figure 5-7, respectively.

Option 1 would have the lowest cost since it utilizes all existing equipment onsite. The only capital costs would be from buying the treatment equipment. However, there would be many challenges with this option. As shown in Figure 5-3, reduced well capacity and efficiency with headloss would be introduced by the proposed treatment. The reduction of well capacity and efficiency would lead to possible damage

to the well pumps and higher operating costs due to low efficiency. The challenges identified make Options 1A/1B less favorable in comparison with other pumping options.

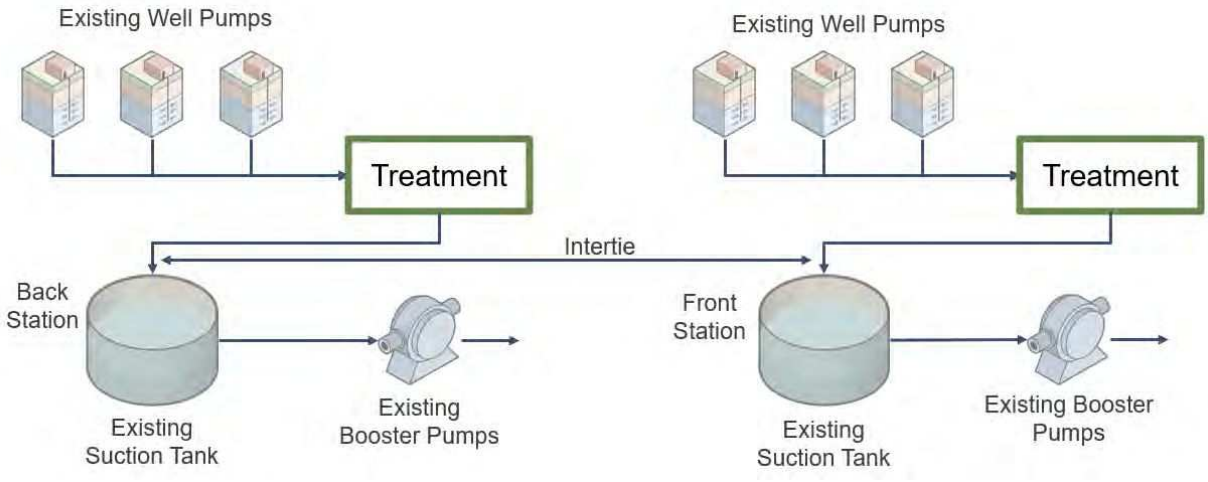


Figure 5-6. Option 1A Pumping Schematic

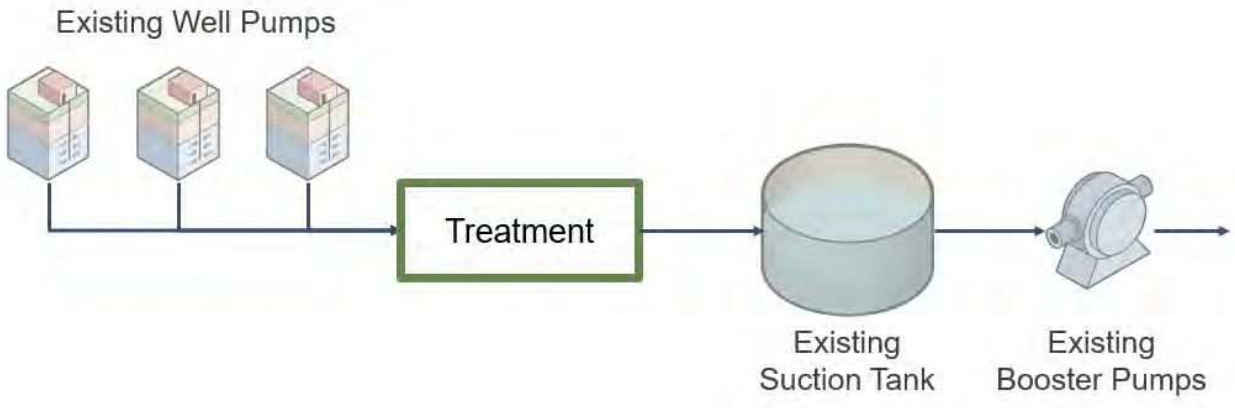


Figure 5-7. Option 1B Pumping Schematic

Option 4 was also considered less favorable compared with other pumping options. Option 4 would add an in-line booster pump between the existing well pumps and the proposed treatment. The existing suction tank would be maintained for treated water storage, and the existing booster pumps would send the treated water to distribution. Pumping schematics for Options 4A and 4B are shown in Figure 5-8 and Figure 5-9, respectively.

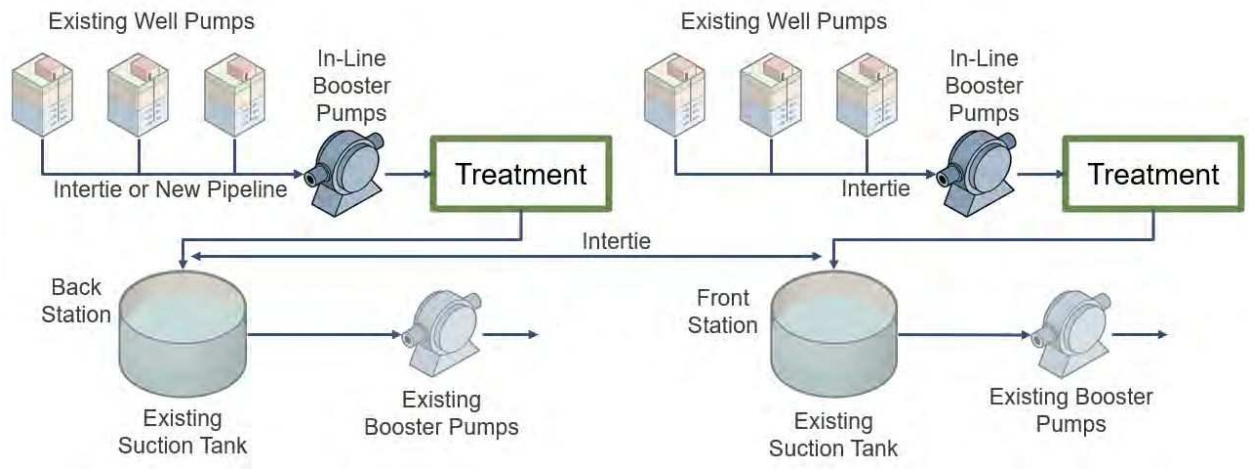


Figure 5-8. Option 4A Pumping Schematic

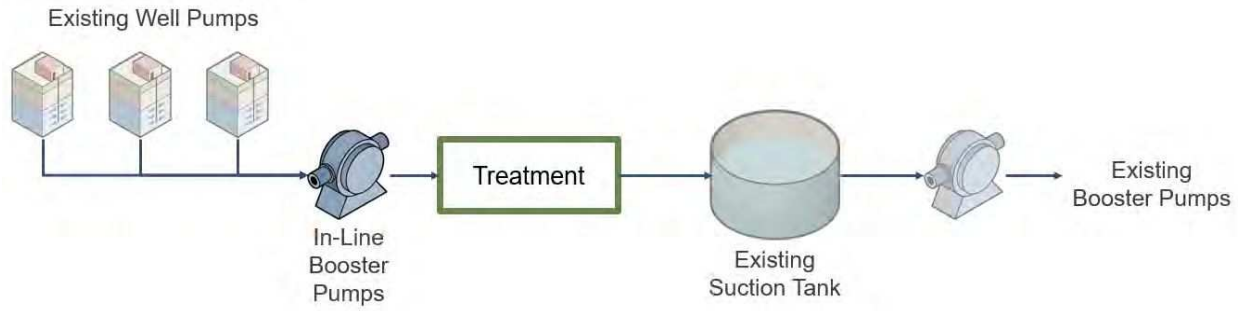


Figure 5-9. Option 4B Pumping Schematic

Option 4 would have many challenges. In-line pressure booster pumps typically have issues with pump control and pressure surges. The existing well pumps have constant speed drives, which results in large, rapid changes in flow when a well starts up or stops. To address this rapid flow change, it would be possible to use slow acting control and waste valves, but these valves can be complicated to operate and maintain and are typically less reliable. Pressure surges and negative pressures can cause the burst or collapse of pipes and treatment vessels and possible damage to well pumps and shafts. Furthermore, pump trips can result in additional pressure surges and an overall system shutdown. It would be possible to add a surge tank on the suction side of the booster pumps to limit the pressure surges and pump control issues. However, surge tanks typically have less storage volume and greater pressure differential compared with a gravity break tank, which is what is located onsite. Additionally, surge tanks cost more than gravity tanks for the same volume. These challenges make Option 4 less favorable than Options 2 and Options 3.

5.2.2 Preferred Pumping Options

Options 2 and 3 were considered to be the most favorable options. After narrowing to these two options, the key decisions for SJW were:

1. Replacing well pumps (Option 2) or adding additional break tanks (Option 3)
2. Locating treatment at the front and back of the station (A) or centralized treatment (B)

Option 2 would replace the existing well pumps with new well pumps but maintain the existing suction tank and booster pumps. Treatment would be located after new well pumps, and the treated water would be routed to the existing suction tank for holding before being sent to distribution with the existing booster pumps. The pumping schematics for Options 2A and 2B are shown in Figure 5-10 and Figure 5-11. The conceptual layouts for Options 2A and 2B are shown in Figure 5-12 and Figure 5-13.

The advantage of Option 2 is that replacing the existing well pumps would result in a smaller footprint compared with Option 3. However, Option 2 would require work on all wells and likely electrical upgrades to the well pumps. Additionally, a surge tank would be required, and more complex controls would be involved.

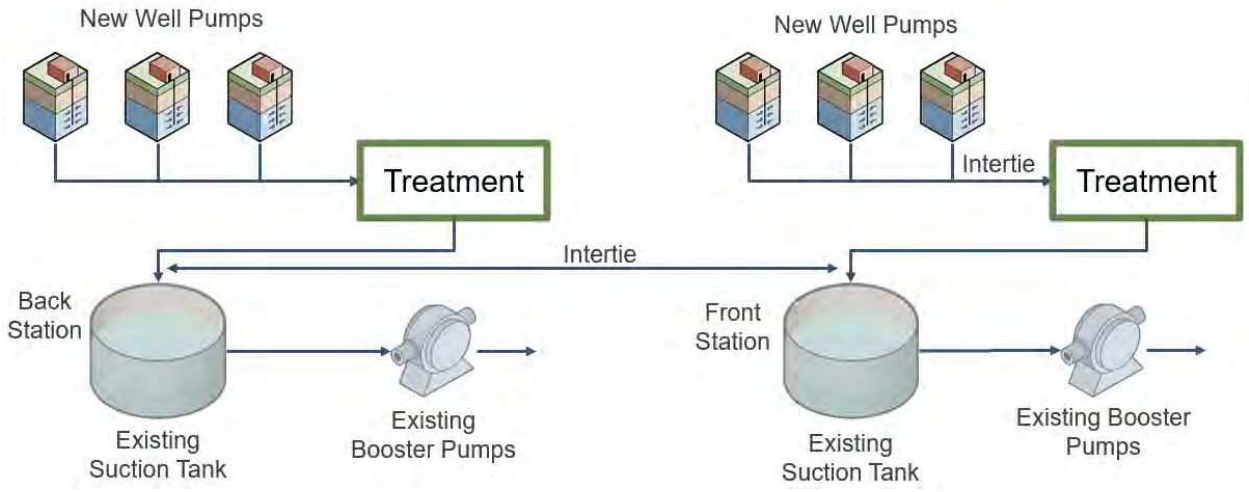


Figure 5-10. Option 2A Pumping Schematic

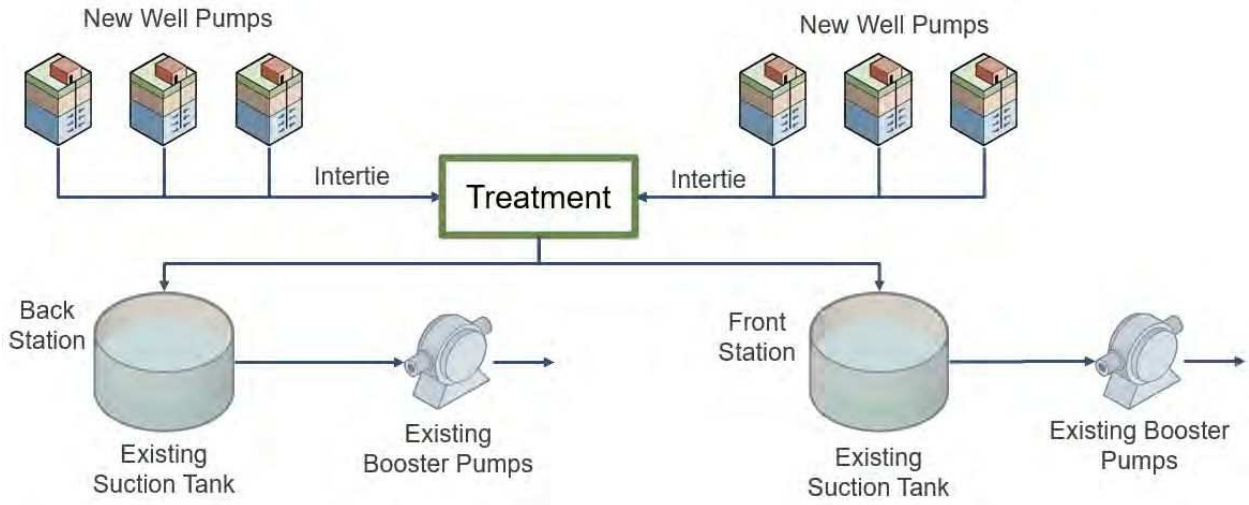


Figure 5-11. Option 2B Pumping Schematic

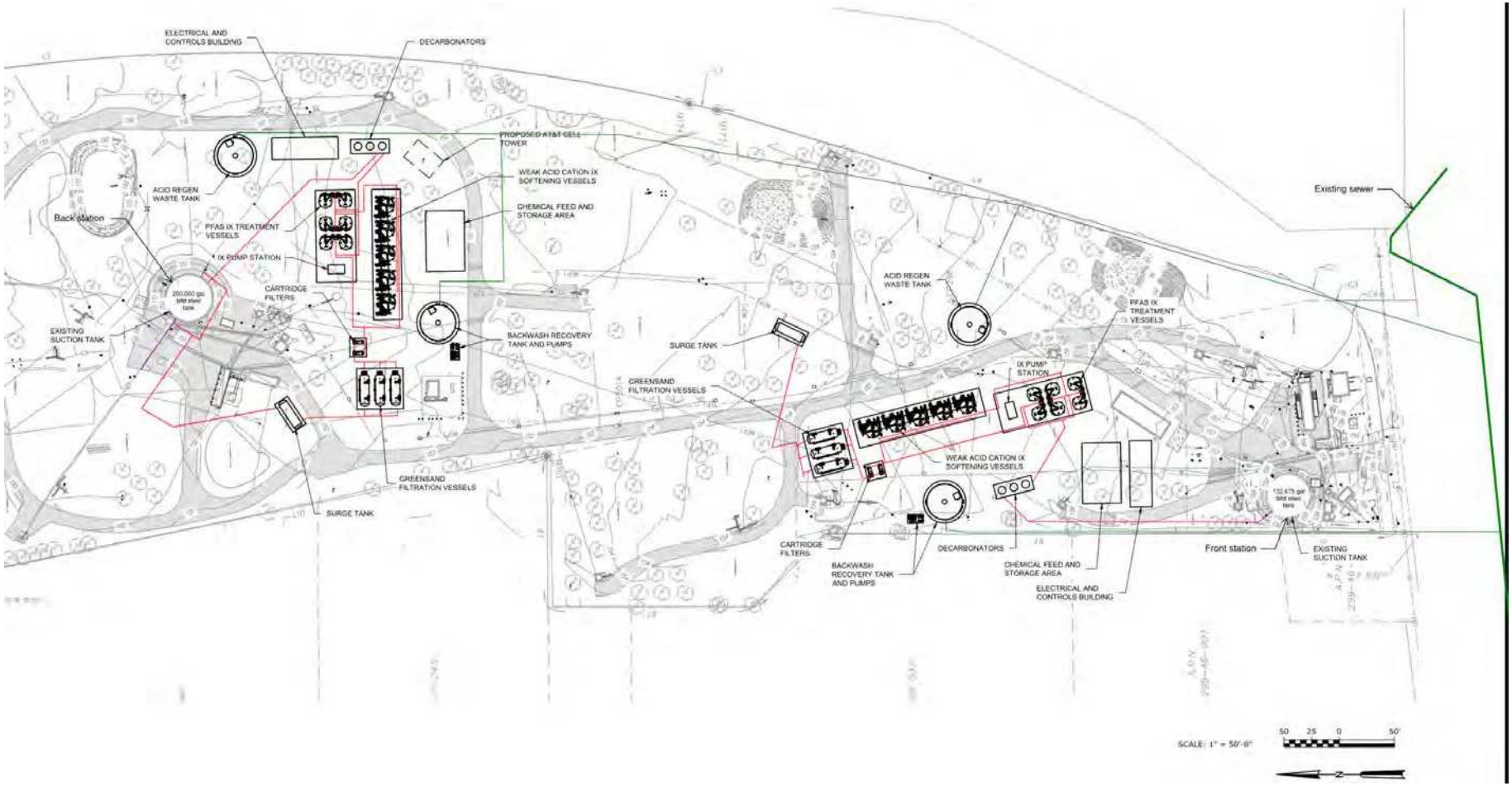


Figure 5-12. Option 2A Conceptual Site Layout

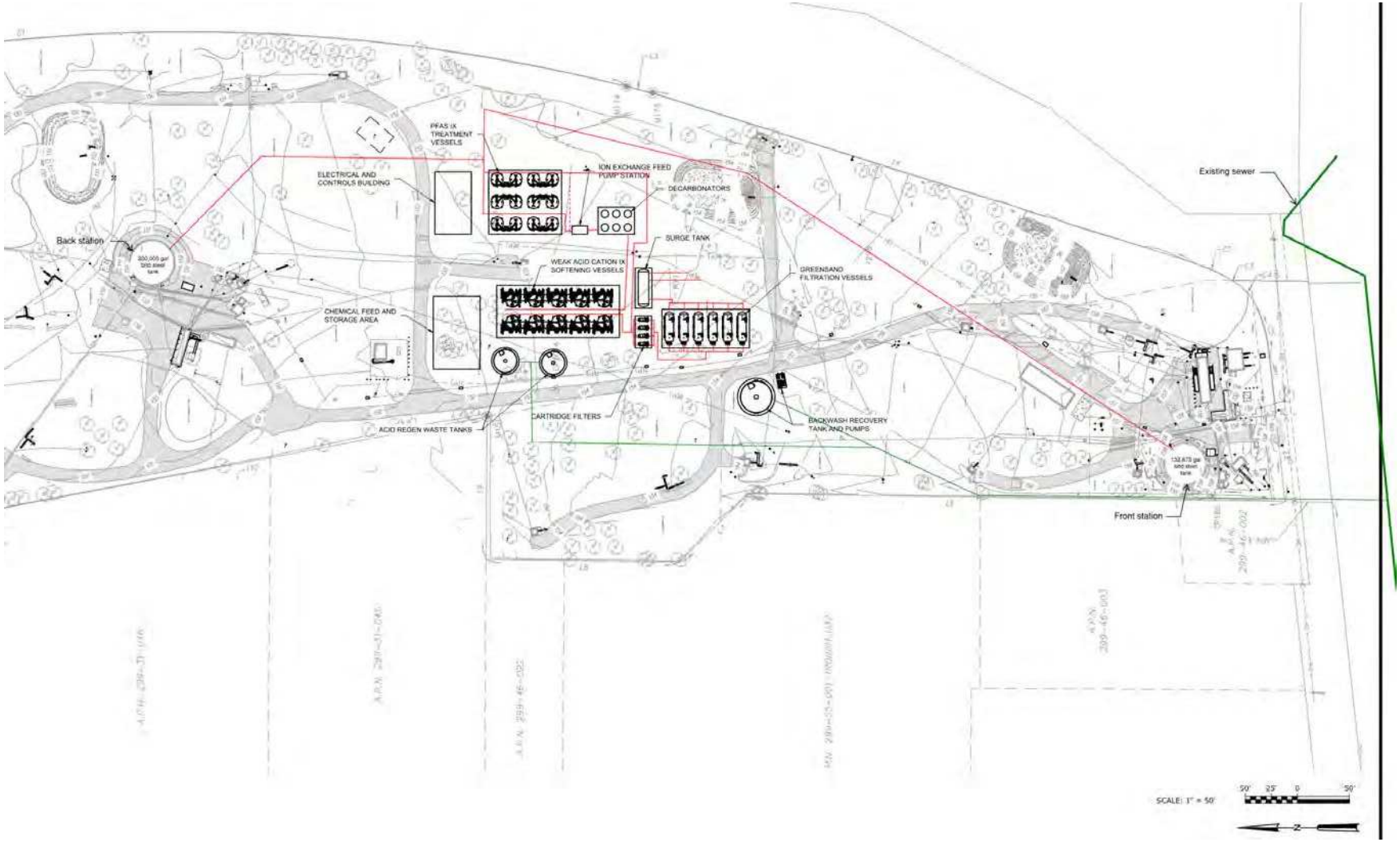


Figure 5-13. Option 2B Conceptual Site Layout

Option 3 would add a new break tank and booster pumps between the existing well pumps and the existing suction tank. The new booster pumps would pump the raw water from the new break tank through treatment. The treated water would be routed to the existing suction tank, and the existing booster pumps would pump the treated water to distribution. Pumping schematics for Option 3A and 3B are shown in Figure 5-14 and Figure 5-15, respectively. Conceptual layouts for Options 3A and 3B are shown in Figure 5-16 and Figure 5-17, respectively.

Option 3 would have the simplest controls and reduce the sanding load to the treatment system due to settling in the new break tank. On the other hand, the new break tank would require water quality management, and the new break tank would have a larger footprint on site compared with Option 2.

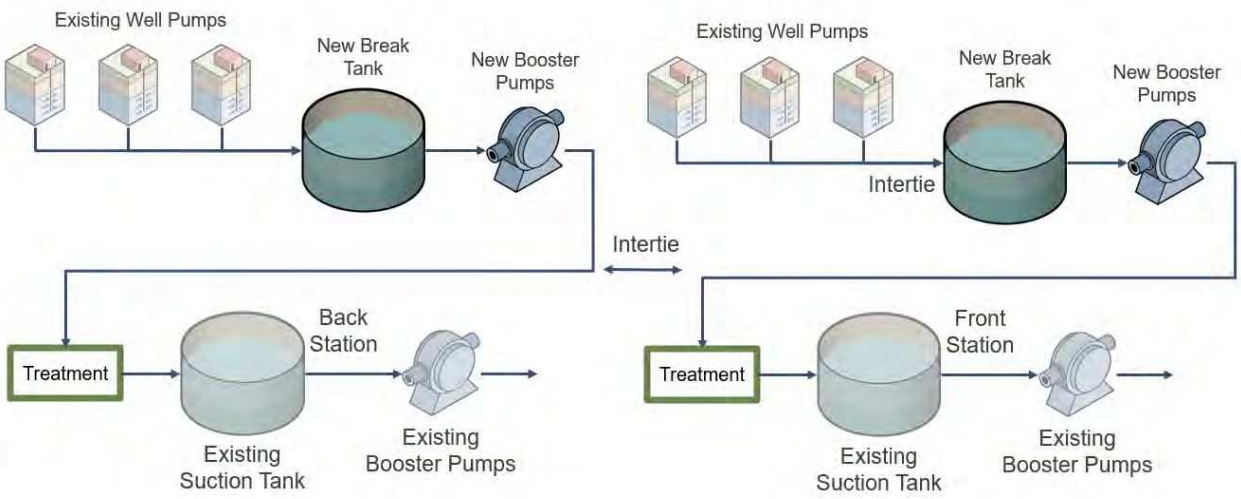


Figure 5-14. Option 3A Pumping Schematic

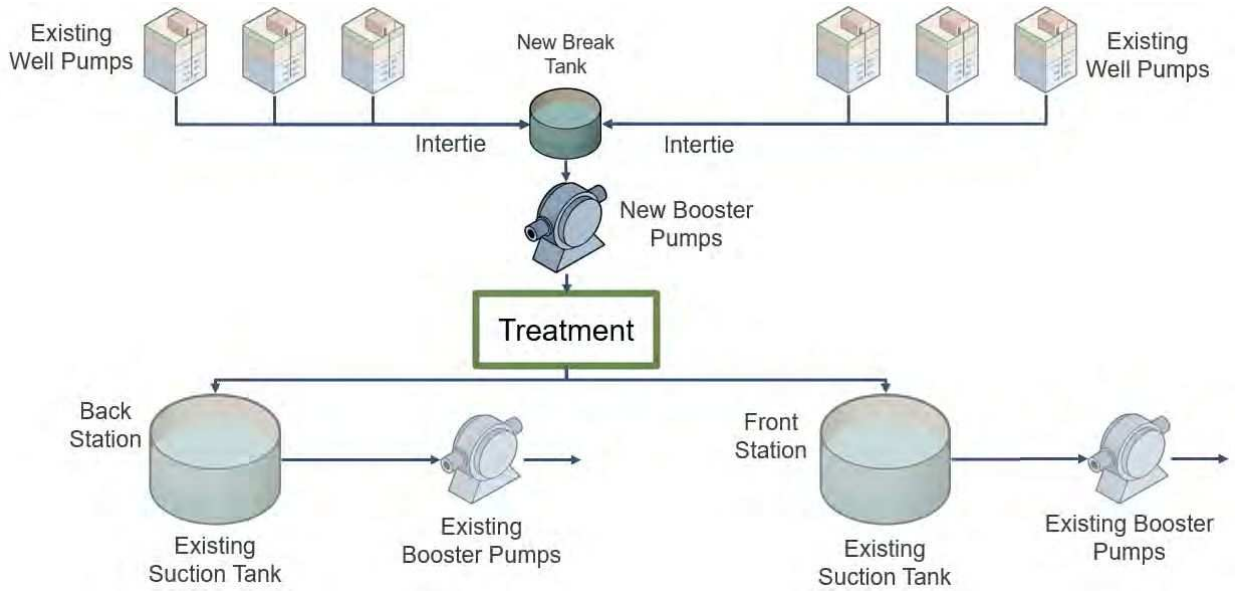


Figure 5-15. Option 3B Pumping Schematic

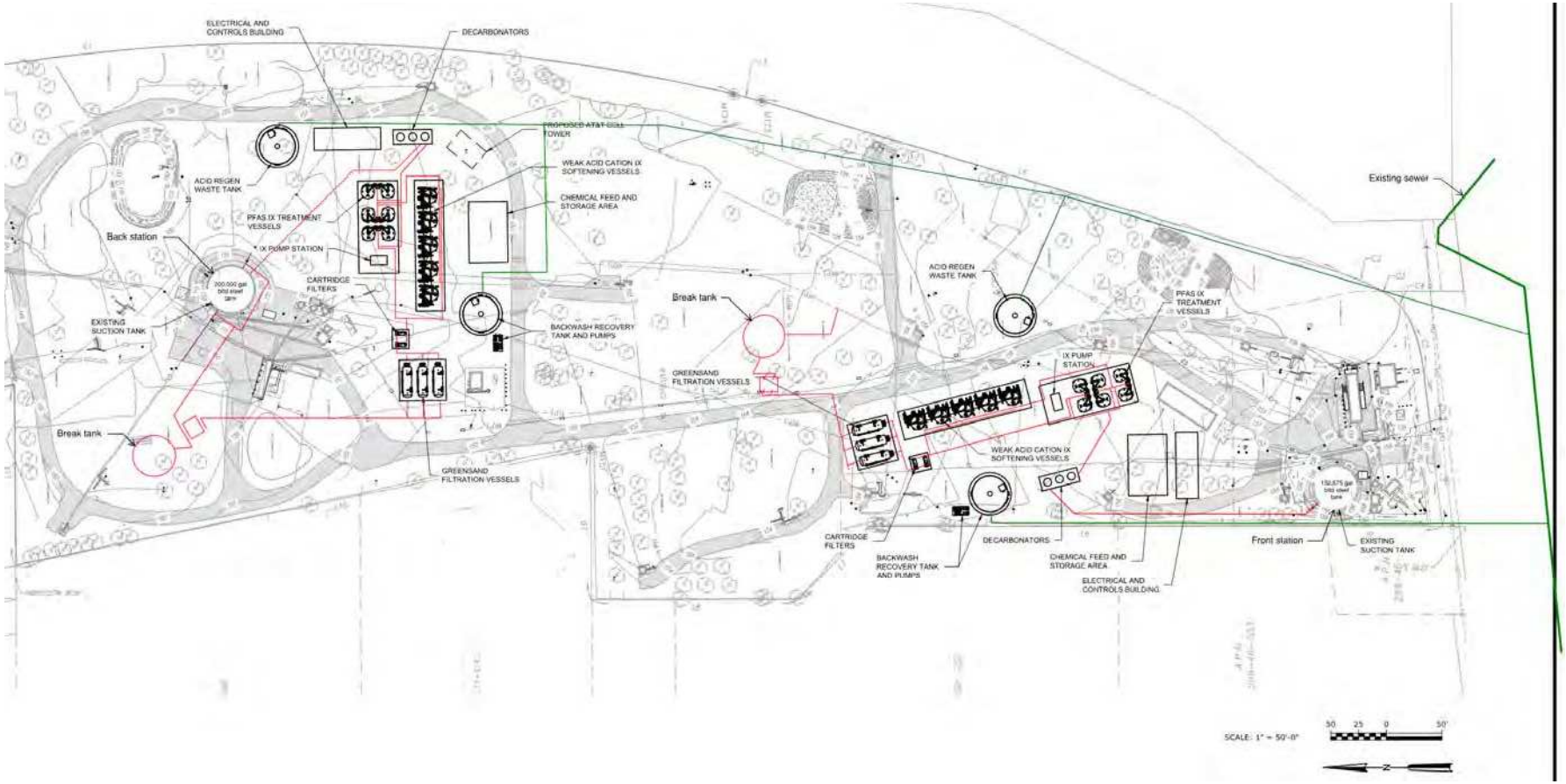


Figure 5-16. Option 3A Conceptual Site Layout

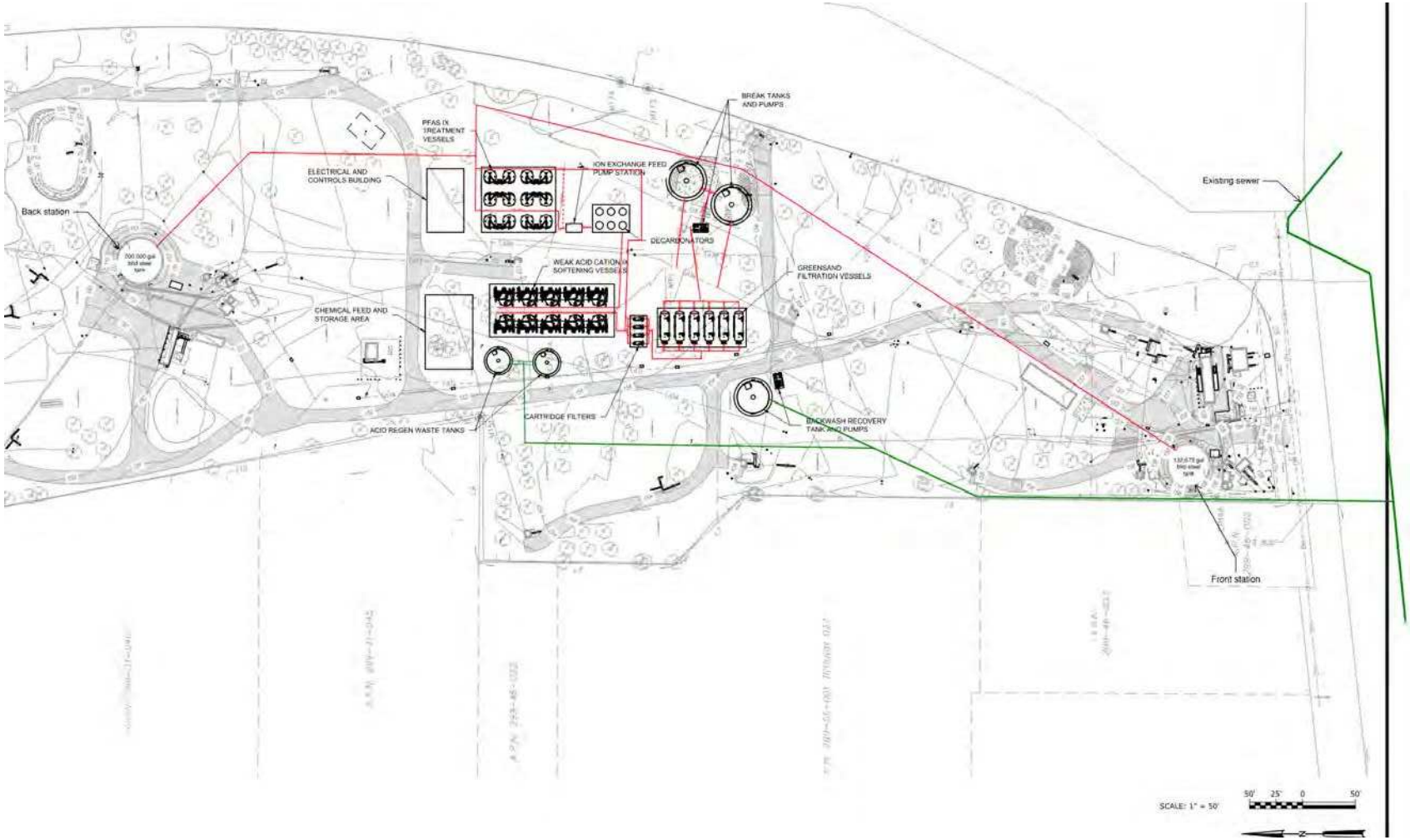


Figure 5-17. Option 3B Conceptual Site Layout

5.2.2.1 Electrical Comparison

The electrical requirements for Options 2 and 3 were investigated and compared. Option 2 would have new electrical loads for the new well pumps in addition to treatment and require an upgrade to the well motor starters and transformers. Further, Option 2 would possibly require an upgrade to the MCC because the back station MCC would reach maximum capacity with the additional electrical loads. Option 2 would need to consider a generator upgrade.

In comparison, the new loads for the station using Option 3 would be from the booster pumps and treatment. The transformers may need to be upgraded; however, further investigation would be required to understand the exact loads and if loads could be split across transformers. Like Option 2, Option 3 may require a generator upgrade. A summary of these electrical requirement comparisons can be found in Table 5-2.

Table 5-2. Comparison of Electrical Requirements for Options 2 and 3

	Option 2	Option 3
New Loads	New Motors Treatment	Booster Pumps Treatment
Upgrade Well Motor Starters	**Required**	Not Required
Upgrade MCCs	**May be required**[1]	Not Required
Upgrade Transformers	**Required**	**May be Required**[2]
Generator Upgrade	**Consider**	**Consider**

1. Back MCC will reach max capacity
2. May be sufficient when loads are refined and/or work if loads are split across transformers

5.2.2.2 Cost Estimate Comparison

The estimated probable construction and project costs for dual and centralized treatment for Options 2 and 3 are shown in Table 5-3. As depicted in Table 5-3, the most cost-effective treatment configuration is centralized treatment with Option 3 pumping. Option 2 would be significantly more expensive ($17.1M or $17.7M) compared to Option 3 ($8.1M or $6.3M).

Table 5-3. Cost Comparison of Options 2 and 3

	Opt. 2 – New Pumps and Motors		Opt. 3 – New Break Tank and Booster PS	
	A Dual (Front/Back) Treatment	B Centralized Treatment	A Dual (Front/Back) Treatment	B Centralized Treatment
Well Pumps	$8,800,000	$8,800,000	$0	$0
Booster Pump	$0	$0	$2,600,000	$1,300,000
Hydropneumatic Tank	$900,000	$500,000	$0	$0
Break Tank	$0	$0	$1,200,000	$1,200,000
Yard Piping	$2,500,000	$3,400,000	$1,800,000	$1,800,000
Electrical and Instrumentation	$900,000	$900,000	$600,000	$500,000
PROBABLE CONSTUCTION COST	**$13,100,000**	**$13,600,000**	**$6,200,000**	**$4,800,000**
Project Costs (Design & ESDC, PM, CM, Legal)	$4,000,000	$4,100,000	$1,900,000	$1,500,000
PROBABLE PROJECT COST	**$17,100,000**	**$17,700,000**	**$8,100,000**	**$6,300,000**

5.2.2.3 Summary of Pumping Options

An overall comparison of pumping Options 2 and 3 is summarized in Table 5-4. With the estimated lower project cost, single system to operate, maintain, and monitor, and electrical and controls simplicity, **SJW selected centralized treatment with new break tanks and booster pump station (Option 3B) to further develop the selected alternative.**

Table 5-4. Comparison of Pumping Options 2 and 3

	Opt. 2 – New Pumps and Motors		Opt. 3 – New Break Tank and Booster PS	
	A Dual (Front/Back) Treatment	B Centralized Treatment	A Dual (Front/Back) Treatment	B Centralized Treatment
O&M				
- Number of Systems	⇔	⇧	⇔	⇧
- Equip. Maintenance	⇔	⇧	⇔	⇔
Water Quality				
- Monitoring Locations	⇔	⇧	⇔	⇧
- Break Tank WQ	⇧	⇧	⇔	⇔
Cost	⇩	⇩	⇔	⇧
Electrical	⇔	⇔	⇧	⇧
Controls / Surge	⇔	⇔	⇧	⇧

5.3 Break Tank Sizing

The decision to further develop centralized treatment with new break tanks and booster pumps necessitated discussion on break tank sizing. Two break tanks were selected so that one tank could be serviced and cleaned while the other one remained operational. Larger diameter tanks provide more time for settling sand and iron precipitates. Potential break tank sizes, volumes, hydraulic residence time (HRT), design goals, and construction cost estimates are shown in Table 5-5 for comparison. SJW selected two 32-ft diameter break tanks for the refined design to allow for more operational flexibility.

Table 5-5. Break Tank Sizing, Goals, and Construction Cost Estimate

Break Tank Size	Total Volume (gallons)	HRT at Design Flow (min)	Design Goal	Construction Cost Estimate
(2) 18-ft	50,000	5 min	Flow attenuation	$1.2M
(2) 32-ft	180,000	18 min	Solids removal, iron oxidation	$1.8M
(2) 40-ft	250,000	25 min	Solids removal, iron oxidation	$2.2M

5.4 Residuals Handling and Sanitary Sewer Disposal

Treatment residuals sources that would require handling and disposal include the acid regenerant and the IX or FS media.

The WAC IX regeneration process would occur after an estimated 1.1 MG of water is softened (excludes PFAS-only treatment stream). The regeneration of each WAC IX vessel is expected to produce 37,400 gallons of acid regenerant waste. Of the 37,400 gallons of acid regenerant waste, 36,900 gallons will be water and 500 gallons will be 20 Baumé (°Bé) HCl used for the WAC IX regeneration. The acid regenerant waste was estimated have a pH of about 5 and high concentrations of calcium, magnesium, and chlorine.

The IX or FS media is usually provided as a turnkey service by the vendor, with purchase of a batch including disposal. Disposal typically includes incineration or thermal destruct and landfilling. In the case of FS, the media is noncombustible, so reactivation or thermal destruct of sorbed PFAS may occur first. There is a possibility that future disposal costs will rise if spent IX or FS media becomes classified as hazardous waste.

5.5 Electrical Power Requirements

To understand the limits of the existing motor control centers (MCC) in the front and back station, the team investigated the existing electrical load capacities. The existing front MCC has a generator sized for 118% of demand and has a spare capacity of 622 kVA/748 A. The existing back MCC has a generator sized for 46% of demand and does not have any spare capacity. Demands for both the front and back MCC are shown in Figure 5-18.

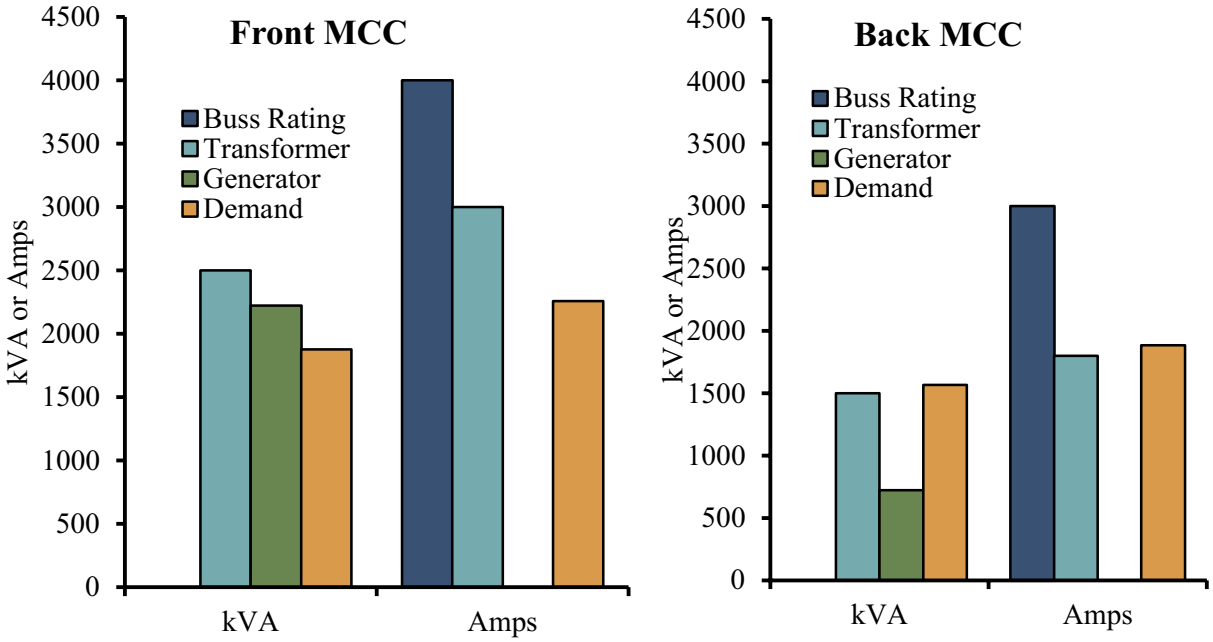


Figure 5-18. Front and Back MCC Existing Electrical Demands

After investigating the existing electrical demands and spare capacity, the new electrical loads from the treatment system were estimated. Booster pumps and IX feed pumps would make up the majority of new electrical loads as shown in Figure 5-19.

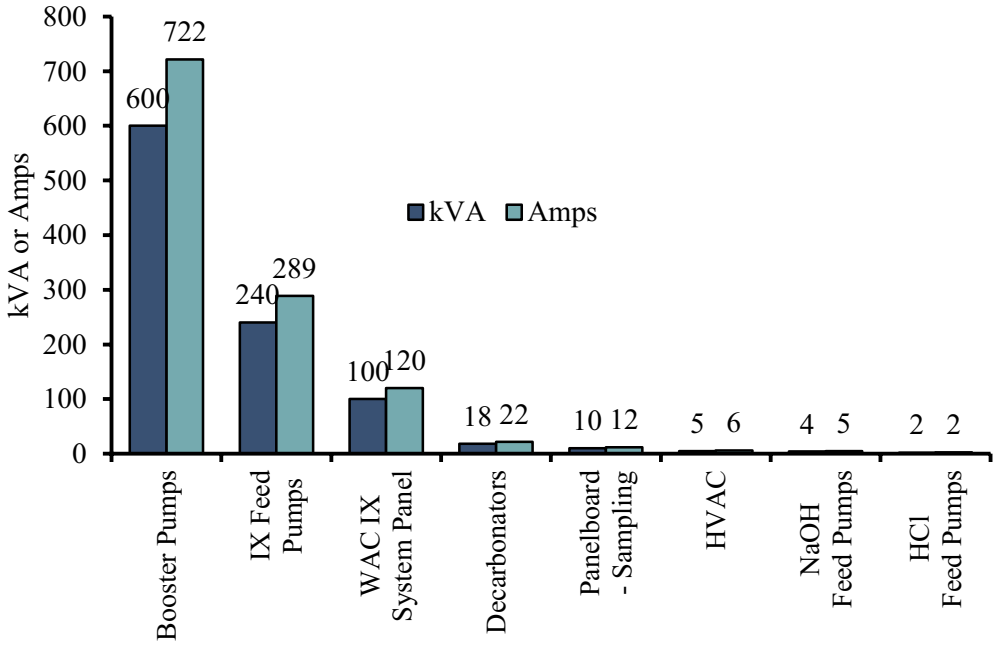


Figure 5-19. Estimated New Electrical Loads

Considering the existing and estimated new electrical loads, the new loads would likely exceed the existing transformer and generator capacity. Based on discussions with SJW, existing loads were calculated based on nameplate information with the stipulation that actual demands may be lower than expected.

As discussed during PM3, SJW prefers to maximize the existing electrical capacity to feed the new treatment plant. The front MCC potentially has spare capacity as the calculated demand shown on the record single line diagram may be conservative. SJW will need to confirm the actual demand on the front MCC with the data logger to get a better sense for the actual demand. If it is found that the front MCC has sufficient spare capacity, a new MCC dedicated to the treatment plant will be sub-fed from the front MCC. The new MCC will be located south of the new treatment plant to minimize the conductor length from the front MCC. If it is found that the front MCC does not have sufficient spare capacity, a dedicated distribution system, including a new PG&E transformer and MCC with a utility metering section, will be installed to support the treatment plant loads. SJW also wants to have a backup generator capable of handling the required new treatment demands at design flow and a buffer of 15-20% for electrical capacity.

5.6 Chemical Storage and Consumption

The chemicals required for this treatment plant include hydrochloric acid and sodium hydroxide. The locations of the chemical feeds and the purpose of each chemical are shown in Figure 5-20.

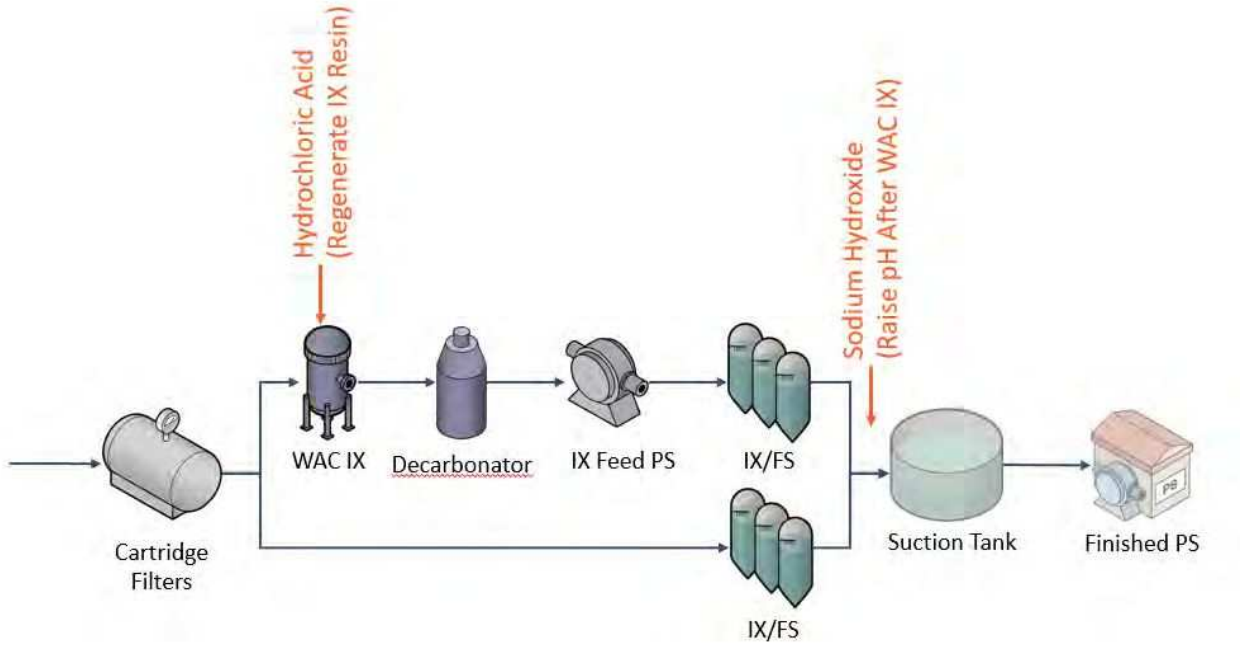


Figure 5-20. Chemical Feed Locations and Purpose

Chemical storage volumes were calculated based on the average flow of 6.24 mgd, and a summary of the storage volume, days of storage, and frequency of deliveries at average and design flow for hydrochloric acid and sodium hydroxide is shown in Table 5-6. In PM3, SJW suggested a design target of seven days

of storage for hydrochloric acid based on the design flow rate. SJW also showed preference toward peristaltic pumps and increasing the size of the storage tanks to decrease the frequency of deliveries. SJW recommended to Hazen to rerun the calculations based on design flow rather than average flow.

Table 5-6. Chemical Storage Volume, Storage Tank Sizes, and Frequency of Deliveries

Design Parameter	Units	Hydrochloric Acid (32%)	Sodium Hydroxide (25%)
Specific Gravity	-	1.16	1.29
Dose (As Dry Chemical)	mg/L	113	5
Use	lb/day	5,881	260
7-Day Storage Volume	gallons	13,300	680
14-Day Storage Volume	gallons	26,600	1,350
30-Day Storage Volume	gallons	56,990	2,900
14-Day Storage Tank Size	-	Four 8,000-gallon tanks (11.9 ft dia. by 11.8 ft)	N/A
30-Day Storage Tank Size	-	Five 12,000-gallon tanks (11.9 ft dia. by 16.3 ft)	One 4,000-gallon tank (7.5 ft dia. by 13.5 ft)
Frequency of Deliveries for 14-Day Storage at Average Flow (6.24 mgd)	-	Two trucks every four days	N/A
Frequency of Deliveries for 30-Day Storage at Average Flow (6.24 mgd)	-	Three trucks every six days	One truck every 41 days
Frequency of Deliveries for 14-Day Storage at Design Flow (14.4 mgd)	-	Two trucks every two days	N/A
Frequency of Deliveries for 30-Day Storage at Design Flow (14.4 mgd)	-	Three trucks every three days	One truck every 18 days

SJW also identified the importance of corrosion control. Many of SJW's pipelines are concrete-lined ductile iron, and they would like to maintain a Langelier Saturation Index (LSI) greater than 1. SJW anticipates that DDW will require a corrosion control study for any new treatment. For this reason, it was decided that information would be collected during pilot testing to enable the calculation of corrosion indices.

5.7 Staffing Requirements

A summary of anticipated O&M duties is shown below in Table 5-7. Based on the design capacity of the plant and the anticipated O&M duties, it was estimated that 1 to 3 full time equivalents (FTEs) are needed. This estimate is a benchmark estimate influenced by the early design stage of the project and the unique PFAS and hardness removal systems, which have limited staffing assessment data available. SJW estimated an annual cost of $200,000 per FTE.

Table 5-7. Anticipated O&M Tasks and Frequency

Pretreatment and Softening		
Task	**Frequency**	**Comments**
Break tank cleaning	Every five years	
Booster pump calibration	Monthly	
Greensand changeouts	Every 10 years	Dependent on water quality
Cartridge filter replacements	Every four to six months	Varies depending on water quality and filters used
WAC resin changeouts	Every five to seven years	
Decarbonator blowers testing	Monthly	
PFAS Treatment		
Task	**Frequency**	**Comments**
IX resin changeouts	One vessel every two months	Lead in a lead-lag pair
Resin profiling	Monthly	
Media trap check	Every two weeks	
IX feed pumps calibration	Monthly	
Chemical Systems		
Task	**Frequency**	**Comments**
Hydrochloric acid dosing pumps calibration	Monthly	
Hydrochloric acid delivery	Monthly or bi-weekly	
Sodium hydroxide dosing pumps calibration	Monthly	
Sodium hydroxide delivery	Monthly or bi-weekly	
Online Analytical Systems		
Task	**Frequency**	**Comments**
Verification	Daily	
Calibration	Monthly	
Cleaning	Every three months	
Testing	Monthly	
General Tasks		
Task	**Frequency**	**Comments**
Process/equipment integrity	Daily	
Equipment/building review	Daily	
Process inspection – filling out site logs	Daily	
Sampling and analysis	Daily	
Operation lock out tag out	Monthly	
Process review (SCADA)	Daily	
Shift reporting	Daily	
Admin/reporting	Weekly	

5.8 SCADA and Controls

The existing facilities contain Programmable Logic Controllers (PLCs), which communicate with SJW's off-site SCADA system. New PLCs will be required for monitoring and controls of the new treatment process, regardless of the alternative selected, as described in Section 4. During preliminary design, the model/make of the existing PLCs should be evaluated to determine feasibility of reusing the existing PLC Cabinets. The new PLCs will likely be desired to be the same manufacturer and compatible with the existing PLCs and should communicate via the same communication protocol. During preliminary design, conversations with SJW are recommended to determine if an on-site SCADA system is desired.

At a minimum, the new PLC cabinets are recommended to be provided with an Operator Interface Terminal (OIT) to facilitate controls of the process area.

6. Pilot Study Testing and Results

6.1 Pilot Testing Plan

Pilot testing was conducted to validate the efficacy of the selected technology and further refine design assumptions. The pilot testing plan was developed based on feedback from DDW during a meeting held on May 14, 2021.

6.1.1 Objectives

The objectives of the pilot study are summarized in Table 6-1 . IX and FS media were not intended to be run to breakthrough given that breakthrough was estimated to require over 12-24 months of operation (see Section 3.1). Testing of IX and FS was instead focused on initial leaching of contaminants and sloughing of contaminants, which was of concern to DDW due to observations of nitrate sloughing from GAC.

Table 6-1. Pilot Testing Objectives

WAC Softening	PFAS IX/FS
• Leaching of constituents at startup • Potential sloughing of contaminants after vessels are offline and restarted • Performance/design parameters o Bed volumes to hardness breakthrough, differences in effluent species (Mg, Ca) o Headloss across resin o Acid doses to regenerate resin o Resin swelling o Effluent pH, pH after bypass blend • Residuals handling o pH of diluted regenerant (if neutralization required for sewer disposal)	• Leaching of constituents at startup • Potential sloughing of contaminants after vessels are offline and restarted • Performance/design parameters o Backwash or forward flush of fines o Headloss across media at different flow rates o Media expansion during backwash/fluffing o Media compaction during operation • Will NOT be testing to breakthrough due to 1-2 year expected life of resin. Resin life to be evaluated through bench testing.

6.1.2 Conceptual Process Flow Diagram

The conceptual pilot process flow diagram (PFD) is shown in Figure 6-1. The source water was collected downstream of the Well 12 sand separator from a 1-inch hose bib. To understand how each treatment technology operates individually and in tandem with other processes, testing occurred in two phases over the course of four weeks total. Phase 1 (Weeks 1 & 2) operated the WAC softening and PFAS IX/FS treatment in parallel, while Phase 2 (Weeks 3 & 4) operated the WAC softening and PFAS IX/FS treatment in series.

For Phase 1, the raw water was routed in parallel to the WAC feed pump and the IX/FS feed pump. The raw water was pumped from the feed pumps through cartridge filters and into WAC and IX/FS skids. The WAC softening process generated acid regenerant waste, which was collected in a tank before being trucked offsite for disposal. The pH of the regenerant waste was unknown but was hypothesized to be less than pH 2. The WAC softening effluent routed to a decarbonator before discharging to a sump. The effluent from the IX/FS skid also discharged to a sump.

For Phase 2, effluent from the decarbonator was fed to the IX/FS feed pump, with excess flow going to the sump. The IX/FS feed pump provided water to the IX/FS skid and the effluent was discharged to the sump.

Backflow preventers were used downstream of each feed pump.

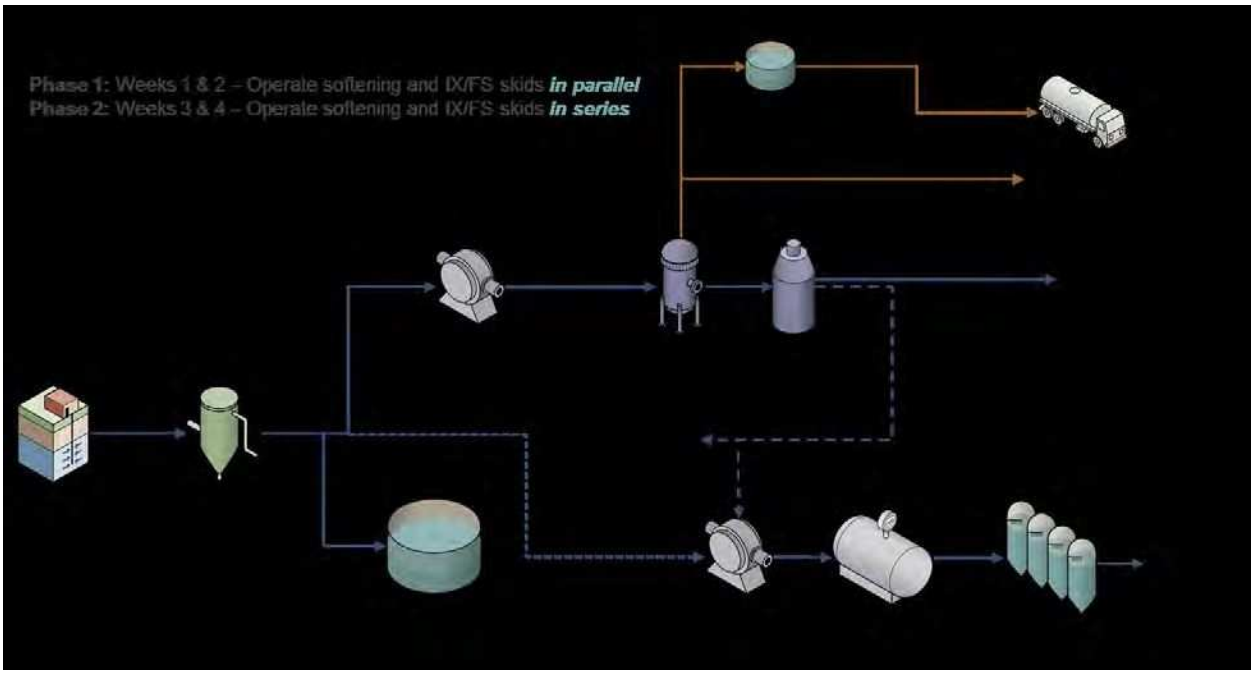


Figure 6-1. Conceptual Process Flow Diagram for Pilot Study

The following subsections describe the sizing and flow rates for the WAC softening and IX/FS columns. Hydraulic loading rates (HLRs) and empty bed contact times (EBCTs) were selected based on discussions with vendors, experience in other pilot tests, and the goal of avoiding bed shifting at high HLRs, which can cause short-circuiting.

6.1.3 WAC Softening

The WAC softening process was set up with two columns in parallel – one column filled with Purolite SSTC104 resin, and the other column filled with the ResinTech WACMP resin. The total flow rate was 3.8 gpm, and the bed and column conditions are outlined in Table 6-2.

Table 6-2. WAC Softening Initial Operation Conditions

Parameter	Purolite	ResinTech
Resin Name	SSTC104	WACMP
Diameter (in.)	6	6
HLR (gpm/ft^2)	9.4	9.4
EBCT (min)	2.7	2.7
Flow (gpm)	1.9	1.9
Bed Height (in.)	40	40

Testing targeted performance of the resins, such as bed volumes to breakthrough and differences in effluent species, along with physical parameters like resin swelling, headloss, and bed expansion during backwash. Testing was also used to determine acid doses for regeneration. When the columns were reconfigured to operate in series with the IX/FS skid in Phase 2, testing investigated the impact of pH change on the testing objectives.

6.1.4 PFAS IX/FS

The PFAS IX/FS was set up with two IX and two FS columns in parallel. The IX resins tested were Purolite PFA 694E and DOWEX PSR2+. The FS media tested were Fluoro-sorb (FS) 200 and 400. The flow rate was 1.08 gpm, and the bed and column conditions are outlined in Table 6-3.

Table 6-3. Ion Exchange/Fluoro-sorb Initial Operation Conditions

Parameter	PFA 694E	PSR2+	FS 200	FS 400
Diameter (in.)	2	2	2	2
HLR (gpm/ft^2)	15	15	9.5	9.5
EBCT (min)	2.0	2.0	2.0	2.0
Flow (gpm)	0.33	0.33	0.21	0.21
Bed Height (in)	48	48	30.5	30.5

Testing verified removal of PFAS, although the media were not tested to breakthrough. Testing also characterized leaching of constituents at start up, determined if media sloughs contaminants after vessels are offline and restarted, measured headloss across media, and measured media compaction during operation. In Phase 2, testing continued to evaluate the previously listed goals and identify impacts of upstream softening on PFAS IX/FS operation.

6.1.5 Description of Pilot Systems

Pictures and schematics for the WAC pilot are shown in Figure 6-2 and Figure 6-3, and for the PFAS pilot unit in Figure 6-4 and Figure 6-5 (note that the skid shown in Figure 6-4 has 2-in and 3-in columns, while the SJW pilot had only 2-in columns).

Pilot testing of forced draft decarbonators, which are the most common type of decarbonator used in drinking water applications, is not commonly performed due to reliability of modeling for CO_2 removal and pH projections. This results in limited availability of pilot equipment. Available pilot equipment was typically oversized, had been previously used in non-potable applications, and required 480V power. For these reasons, a Liqui-Cel™ unit was selected. Figure 6-6 shows a schematic of the Liqui-Cel™ unit that was used for decarbonation. Liqui-Cel™ decarbonators are commonly used in high-purity water applications and operate by passing water through a gas transfer membrane that is selectively permeable to carbon dioxide, and then moves carbon dioxide away from the surface using a sweep gas (either atmospheric air or compressed nitrogen). In addition to meeting pilot-scale needs for decarbonator testing, use of the Liqui-Cel™ also allowed SJW to test an alternative to force draft decarbonation that does not break head.



Figure 6-2. WAC Pilot Unit (source: Purolite)

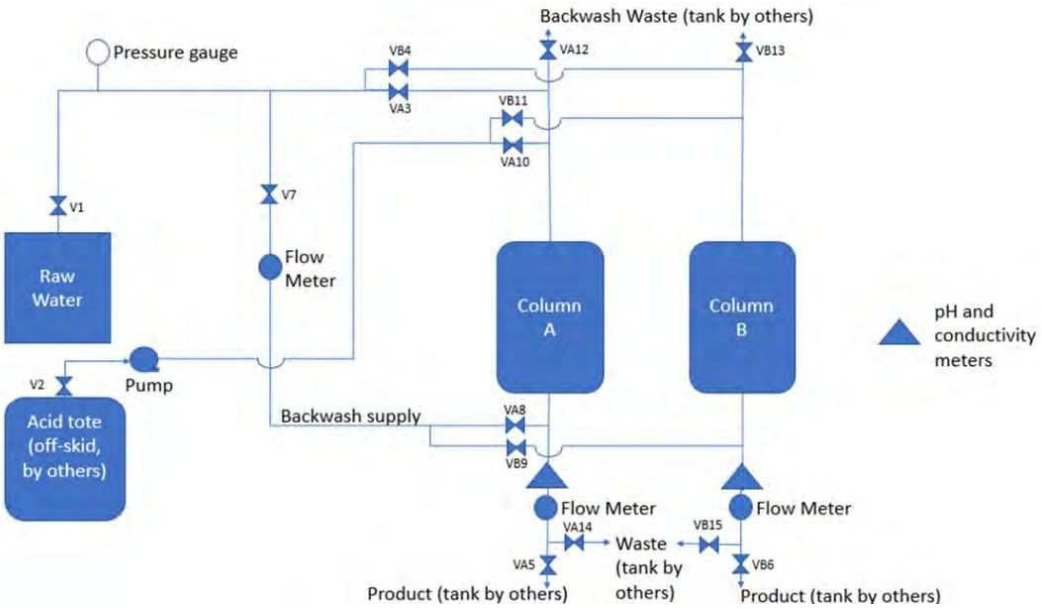


Figure 6-3. WAC Pilot Schematic



Figure 6-4. Example PFAS Pilot Unit with 2-in and 3-in Columns (source: Purolite)

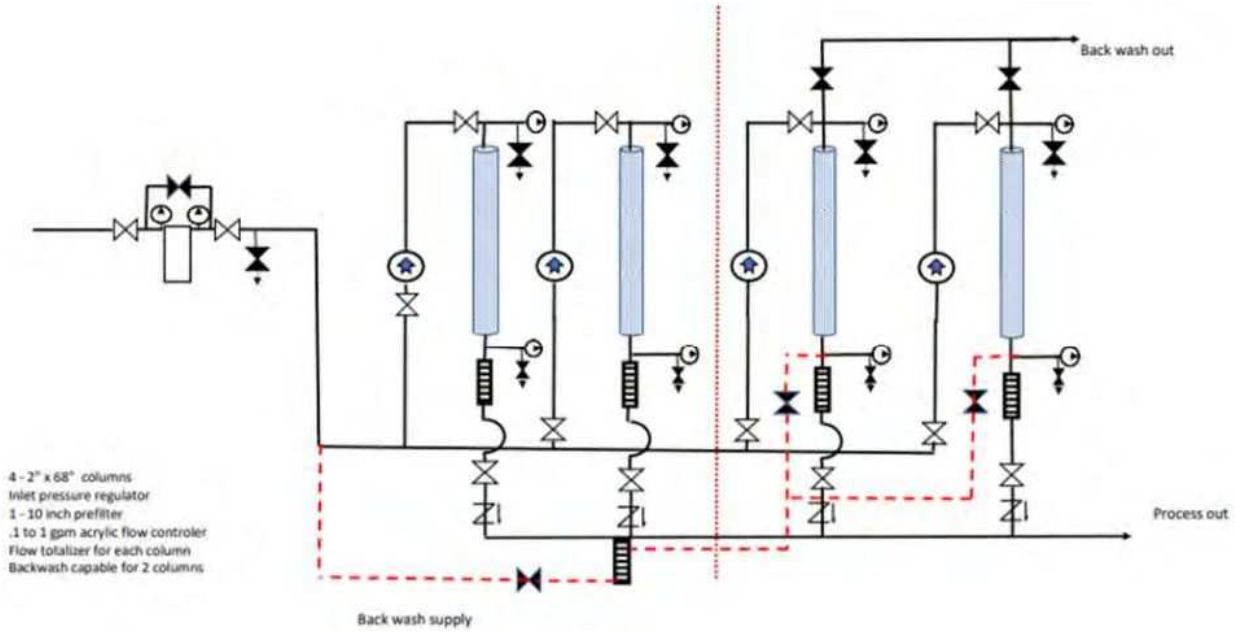


Figure 6-5. Schematic of PFAS Pilot Unit (source: Purolite)

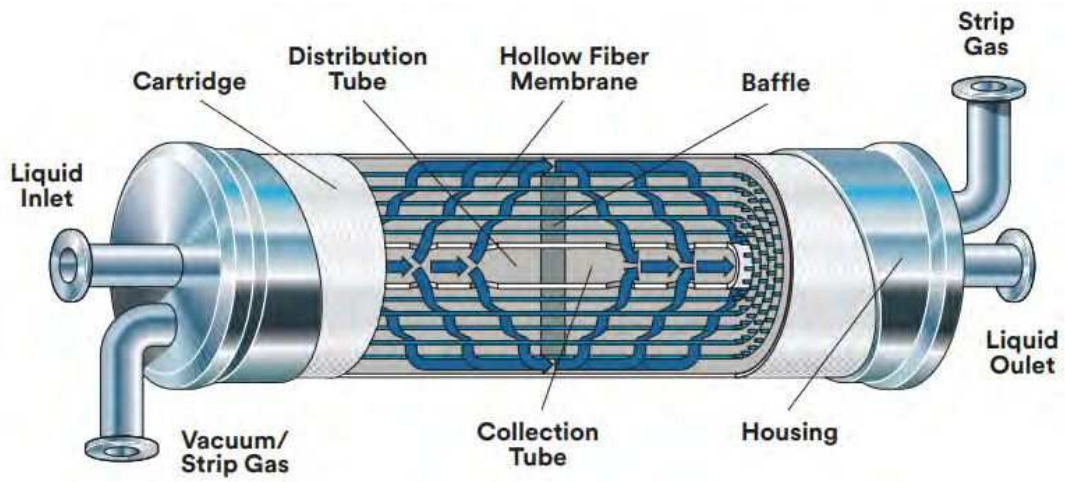


Figure 6-6. Schematic of Liqui-Cel™ EXF decarbonator (source: 3M)

6.1.6 Pilot Operation

Table 6-4 provides a summary of pilot operation. Upon initial startup (Monday Week 1), WAC, IX, and FS were sampled to identify leaching from each material. During the rest of Phase 1, WAC was operated, regenerated, and sampled during weekdays, with continuous loading of IX and FS. The IX/FS skid was taken offline starting on Friday morning of Week 2. Following a 72-hour hold (Friday morning to Monday morning), the IX/FS skid was restarted Monday morning and sampled for constituent sloughing. This was the end of Phase 1 (Monday of Week 3).

For Phase 2, WAC and IX/FS skids were operated continuously from Monday afternoon of Week 3 through Friday morning of Week 4, including over the weekend between Weeks 3 and 4. All skids were then taken offline Friday morning of Week 4 to begin a 72-hour hold period. Final testing of WAC and IX/FS sloughing occurred Monday morning of Week 5.

WAC regeneration was performed using hydrochloric acid (HCl). HCl was procured as a 5% solution to avoid on-site dilution. Regeneration using sulfuric acid (H_2SO_4) was also considered. However, the use of sulfuric acid during pilot testing was eliminated for the following reasons:

1. The presence of calcium on the resin, along with sulfate, can form insoluble $CaSO_4$ on the resin surface. If precipitation occurs, the resin may become cemented together in the column, effectively ending the pilot test and damaging the pilot unit.
2. To avoid precipitation, acid would need to be introduced at a low concentration below the $CaSO_4$ solubility limit and the acid concentration increased over time. The use of dilute acid increases the volume of regen waste, thereby complicating waste storage and disposal and increasing cost.
3. The need to produce multiple acid concentrations would likely require on-site site dilution, which presents a safety hazard.

To measure headloss at different flow rates, flow rates through the WAC and PFAS skids were varied on Monday of Week 5 after sampling has been completed.

Table 6-4. Summary of Pilot Operation

WAC Columns:

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Week 1	Phase 1 Operation & Daily Regeneration					Offline	
Week 2	Operation & Daily Regeneration					Offline	
Week 3	Sloughing	Phase 2 Operation & Daily Regeneration					
Week 4	Operation & Daily Regeneration					Offline	
Week 5	Sloughing						

IX/FS Columns:

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Week 1	Phase 1 Operation						
Week 2	Operation					Offline	
Week 3	Sloughing	Phase 2 Operation					
Week 4	Phase 2 Operation					Offline	
Week 5	Sloughing						

Phase 1 - Separate trans (WAC and IX/FS)

Phase 2 - WAC then IX/FS

6.1.7 Sampling Frequency and Analysis

Sampling locations are shown on the conceptual PFD in Figure 6-7, with the parameters to be measured and frequency of analysis shown in Table 6-5. Volume produced and runtime for sampling at startup and sloughing are shown in Table 6-6.

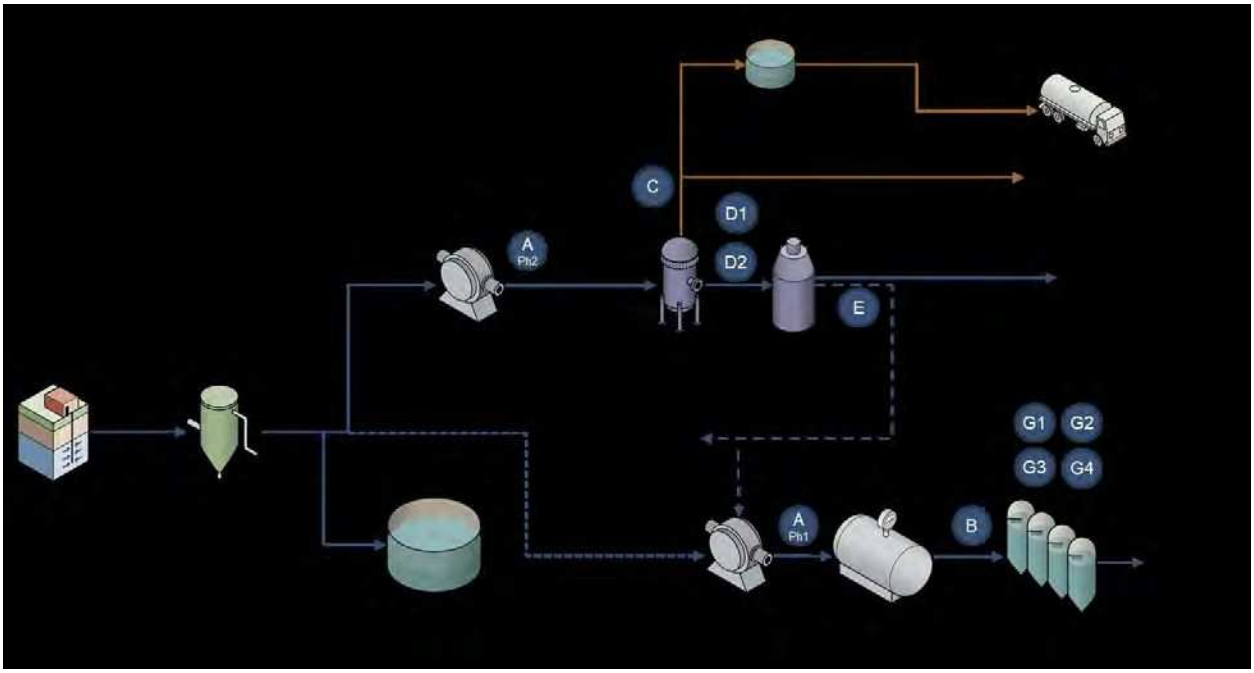


Figure 6-7. Conceptual Pilot Process Flow Diagram with Sampling Locations

Table 6-5. Sampling and Analysis Frequency

	Parameter	Method	A2 Sand Sep. Eff.	B IX Cart. Filt. Eff.	C Acid Regen Waste	D1, D2 WAC Eff.	E Decarb. Eff.	G1-G4 IX/FS Eff.
Special Lab	Nitrosamines (8)	EPA 521	ST	-	-	ST	-	ST
	SVOCs and TICs	EPA 525.2	ST	-	-	ST	-	ST
	VOCs and TICs	EPA 524.2	ST	-	-	ST	-	ST
	Aldehydes/Ketones	EPA 556	ST	-	-	ST	-	ST
Online	Conductivity	SM 2510B	-	-	5R	PR, H2B	-	-
	pH	SM 4500H-B	-	-	5R	PR, H2B	-	-
Field	Alkalinity	Hach 8203	D	D	D	PR, H2B	-	-
	Conductivity	SM 2510B	D	-	-	-	-	-
	Total Hardness	Hach 8213	D	D	-	PR, H2B	-	-
	pH and Temperature	SM 4500H-B	D	D	D	-	H2B	-
	Turbidity	SM 2130B	D	D	-	D	-	D
	Pressure	Field Check	-	D	-	D	-	D
	Flow	Field Check	-	D	-		-	D
Routine Lab	Alkalinity[2]	SM 2320B	D	-	-	D	-	D
	Arsenic	EPA 200.8	W	-	-	W	-	W, S
	Bicarbonate Alkalinity	SM 2320B	D	-	-	D	-	D
	Calcium	EPA 200.7	D	-	-	D	-	D
	Chloride	EPA 300.0	D	-	-	D	-	D
	Chromium, hexavalent[3]	EPA 218.6	W	-	-	W	-	W
	Hardness[1]	Calculation	D	-	-	D	-	D
	Iron	EPA 200.7	D	D	-	D	-	D
	Magnesium	EPA 200.7	D	-	-	D	-	D
	Manganese	EPA 200.8	D	D	-	D	-	D
	Nitrate	EPA 300.0	W	-	-	W	-	W, S
	Perchlorate	EPA 314.0	W	-	-	W	-	W, S
	PFAS[4]	EPA 537.1	T	-	-	T	-	T, S

	Parameter	Method	A2 Sand Sep. Eff.	B IX Cart. Filt. Eff.	C Acid Regen Waste	D1, D2 WAC Eff.	E Decarb. Eff.	G1-G4 IX/FS Eff.
	Silica	EPA 200.7	W	-	-	W	-	W, S
	Sodium	EPA 200.7	D	-	-	D	-	-
	Sulfate	EPA 300.0	D	-	-	D	-	D
	TDS	SM 2540C	D	-	-	D	-	D
	TOC	SM 5310B	W	-	-	W	-	W, S
	Uranium	U - EPA 200.8	W	-	-	W	-	W, S

5R – Every 5 minutes during regeneration
D – Daily
T – Three times per week
W – Once per week
E – End
H2B – Hourly to Breakthrough in the 4 hours leading up to breakthrough (based on conductivity and pH)
PR – Post Regeneration, every 15 minutes for one hour after startup
ST, S – at Startup (ST) and Sloughing (S), which includes after 1, 5, and 10 bed volumes after start
[1] Hardness analysis cost includes calcium and magnesium
[2] Alkalinity analysis cost includes bicarbonate alkalinity
[3] Chromium 6 sample bottles have preservative that has to be used within 30 days
[4] PFAS sample count includes one field blank per day

Table 6-6. Volume Produced and Time for Startup and Sloughing Sampling

Bed Volumes	WAC Volume of Water Treated After Start (L)	IX/FS Volume of Water Treated After Start (L)	WAC Time After Start (min)	IX/FS Time After Start (min)
1	29	2.5	2.7	2
5	147	12.4	21	10
10	293	24.8	42	20

6.1.8 Corrosion Control Analysis

The use of WAC can impact the alkalinity and hardness of the water, which can affect the corrosivity of the water. Potential impacts of treatment on corrosivity were analyzed as follows.

The Tetra Tech Rothberg, Tamburini, and Windsor (RTW) model was used to calculate the calcium carbonate precipitation potential (CCPP), Langelier Saturation Index (LSI), and Larson Ratio (LR) from the water quality data collected in the pilot study. The CCPP, LSI, and LR calculations used the following data collected during testing: temperature, pH, alkalinity, calcium, and ionic strength (monitored by conductivity and TDS), sulfate, and chloride. CCPP and LSI can be useful predictors of the tendency of calcium carbonate to precipitate. Positive CCPP and LSI values are indicative of precipitation rather than dissolution. The CCPP estimates the degree of oversaturation in mg/L as $CaCO_3$ of potential precipitation under equilibrium conditions. The calculations of CCPP, LSI, and LR were conducted each day the data was available.

6.2 Pilot Setup

The pilot equipment was set up close to well 12 and its sand separator. The acid waste tank, 5% hydrochloric acid totes, and WAC softening were set in double containment as shown in Figure 6-8. The softening skid was covered with a tarp when work was not actively being performed. The softening skid uncovered can be seen in Figure 6-9.



Figure 6-8. Acid Waste Tank, Hydrochloric Acid Totes, and Covered Softening Skid at Williams Station



Figure 6-9. WAC IX Softening Skid

The decarbonator skid was mounted on plywood and cinder blocks and located a couple feet outside of the double containment area as shown in Figure 6-10. The decarbonator skid consisted of the Liqui-Cel™ decarbonator, rotameter, liquid trap, 1 hp regenerative blower, air pre-filter, and a sample tap for decarbonator effluent.



Figure 6-10. Decarbonator Skid Setup

The PFAS skid with loaded IX resins and FS media is shown in Figure 6-11. The PFAS IX columns and rotameters were covered in aluminum foil to prevent algal growth and UV damage to the resins and media as shown in Figure 6-12.



Figure 6-11. PFAS IX/FS Skid



Figure 6-12. Covered PFAS IX/FS Skid

6.3 Observations from Loading of PFAS Media

Differences in IX and FS media were observed when loading media into the columns. IX resin was relatively easy to slurry. Per manufacturer's recommendations, resin was added to water and stirred (shown with plastic syringe in Figure 6-13) to create a slurry, which was then poured into the columns. Loading of IX resin was relatively simple, provided that the resin was kept in suspense and quickly poured into the columns.



Figure 6-13. Slurrying of IX Resin During Loading

Loading of the FS media was more challenging. Due to the high density of FS, it could not be slurried and poured into the columns like IX. When loaded dry and water was added on top, "plugs" formed which needed to be broken up to prevent media loss during backwash. Alternating the addition of small volumes of FS and large volumes of water (while draining column effluent) was effective. Some of these challenges may prove unique to pilot testing rather than full-scale operation, but more detailed information from the FS vendor on loading procedures may inform system design. It was also noted that air released from FS media pore spaces formed bubbles, which made media grains buoyant and resulted in some media loss during backwash, particularly for FS 200 (see Figure 6-14).



Figure 6-14. Air-Bound FS Media Being Washed out During Backwash

6.4 Startup and Sloughing Analysis

6.4.1 Startup Sampling

The purpose of startup sampling was to detect release of contaminants from media at startup. Startup samples were collected 1, 5, and 10 bed volumes (BVs) after manufacturer-prescribed procedures. These procedures included 20 BV flush for WAC and PFAS IX resins and 31 minutes of backwash for FS media. Constituents detected included: acetone, naphthalene, methyl ethyl ketone, styrene, chloroform, bromomethane, and toluene. Detects for styrene, chloroform, bromomethane, and toluene were less than 10% of an MCL, NL, or HAL as shown in Figure 6-20. Detects for naphthalene, methyl ethyl ketone, and acetone were greater than 10% of a regulatory level or had no concentration for comparison as depicted in Figure 6-21. Of these, the Purolite WAC resin was the only one to exceed a regulatory concentration, and based on the concentration reducing with increasing BV of flush, naphthalene could be likely be addressed through additional flushing or bringing one WAC vessel on at a time (i.e., blending).

Constituents monitored but not detected included the following:

- Acrylonitrile
- Benzene
- Bromobenzene
- Bromochloromethane
- Bromodichloromethane
- Bromoform
- n-Butylbenzene
- sec-Butylbenzene
- tert-Butylbenzene
- Carbon disulfide
- Carbon tetrachloride
- Chlorobenzene
- Chloroethane

- Chloromethane
- 2-Chlorotoluene
- 4-Chlorotoluene
- Dibromochloromethane
- Dibromomethane
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- Dichlorodifluoromethane
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- 1,1-Dichloroethene
- cis-1,2-Dichloroethene
- trans-1,2-Dichloroethene
- 1,3-Dichloropropene (total)
- 1,2-Dichloropropane
- 1,3-Dichloropropane
- 2,2-Dichloropropane
- 1,1-Dichloropropene
- cis-1,3-Dichloropropene
- trans-1,3-Dichloropropene
- Ethylbenzene
- Hexachlorobutadiene
- Isopropylbenzene
- p-Isopropyltoluene
- Methyl isobutyl ketone
- Methyl tert-butyl ether
- Methylene chloride
- n-Propylbenzene
- 1,1,1,2-Tetrachloroethane
- 1,1,2,2-Tetrachloroethane
- Tetrachloroethene
- 1,2,3-Trichlorobenzene
- 1,2,4-Trichlorobenzene
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- Trichloroethene
- Trichlorofluoromethane
- Trichlorotrifluoroethane
- 1,2,4-Trimethylbenzene
- 1,3,5-Trimethylbenzene
- Vinyl chloride
- m,p-Xylene
- o-Xylene
- Xylenes (total)
- Trihalomethanes (total)

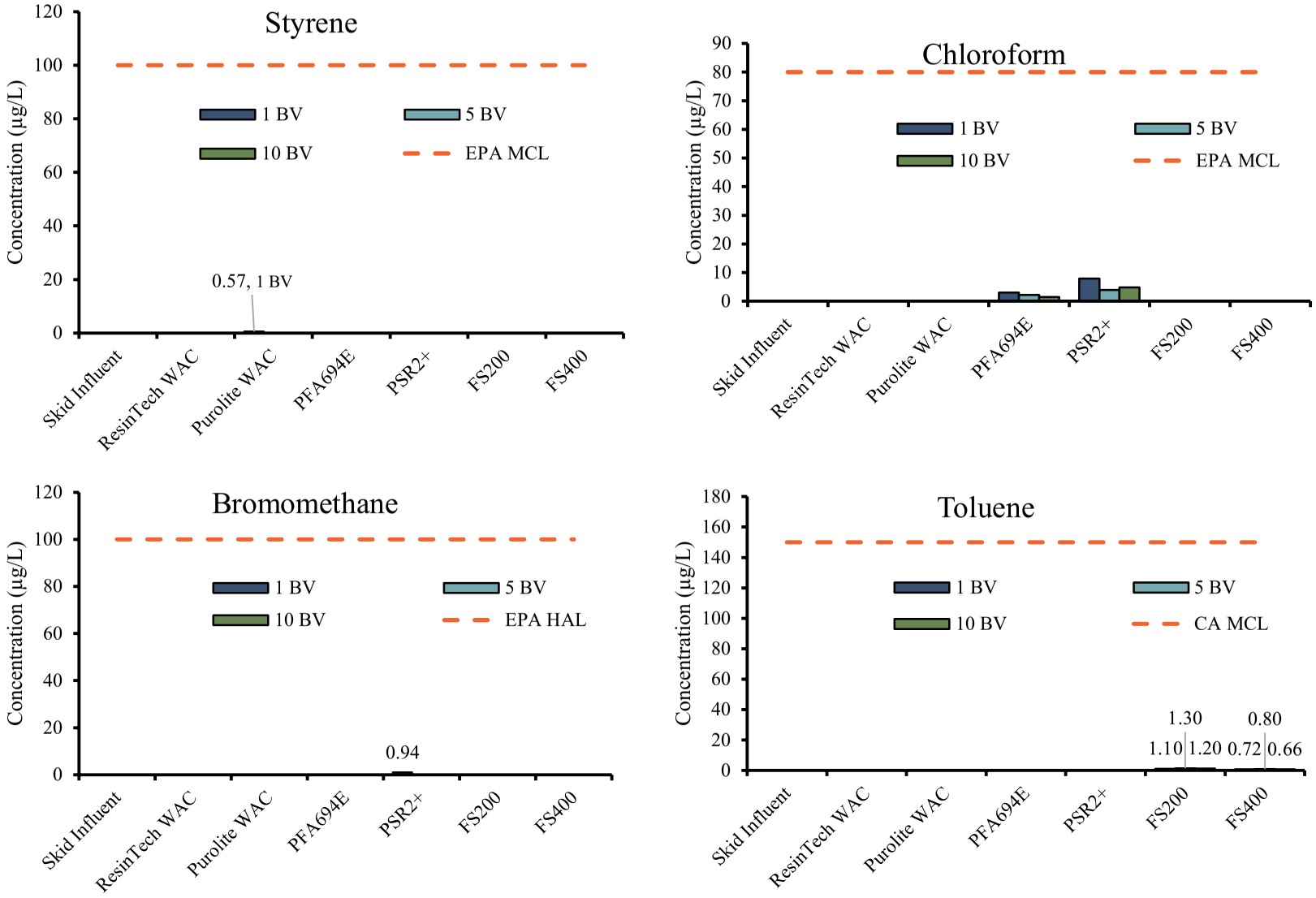


Figure 6-15. Detects < 10% of MCL, NL, or HAL

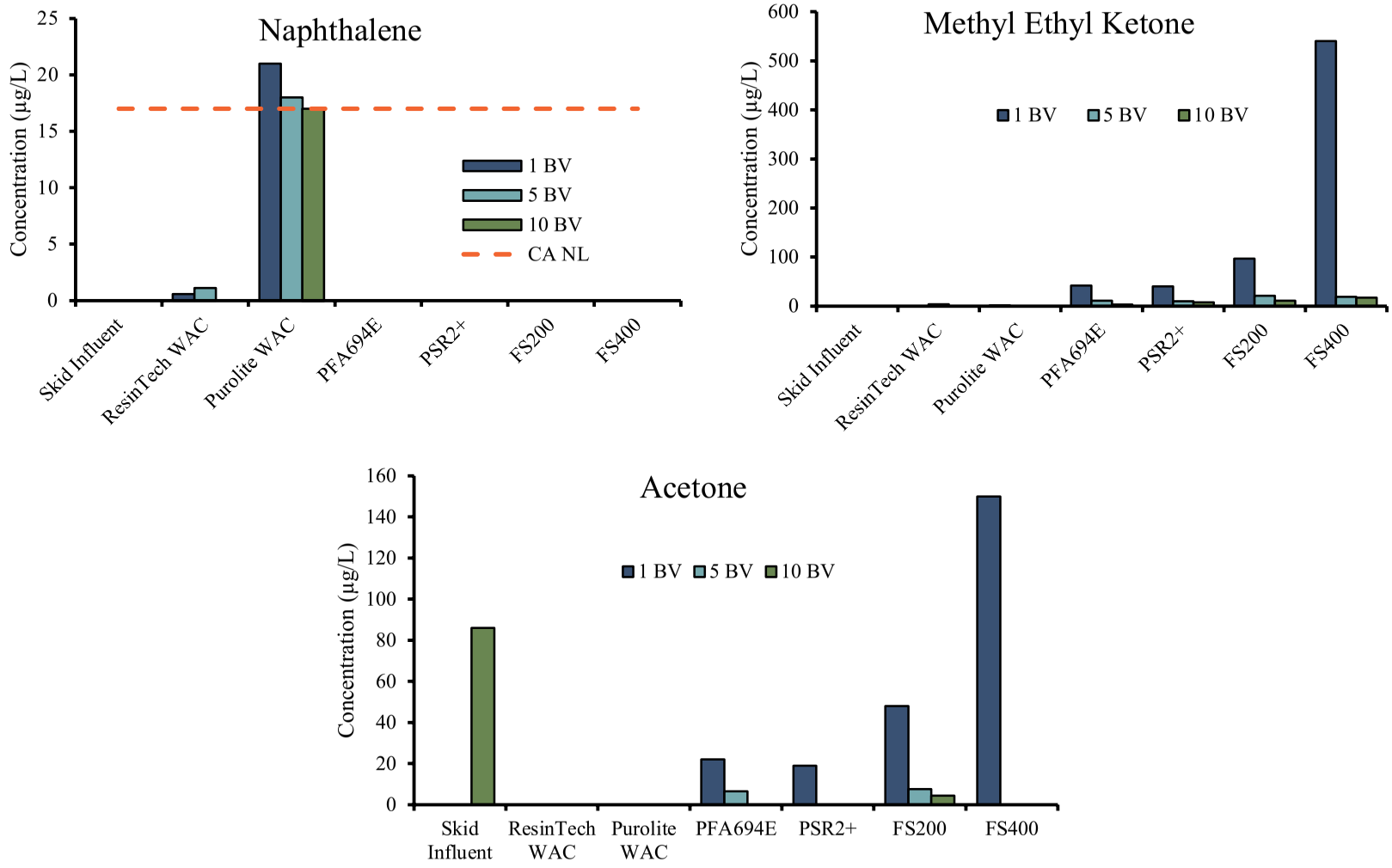


Figure 6-16. Detects > 10% of a Regulatory Level or No Concentration for Comparison

6.4.2 Sloughing Analysis

The purpose of the sloughing analysis was to determine if IX resin or FS media slough weakly sorbed contaminants similar to nitrate peaking observed in GAC. The sloughing analysis was specifically requested by DDW. Similar to the startup sampling procedure, sloughing samples were collected at 1, 5, and 10 BVs after column restart, and sampling occurred during Phase 1 and Phase 2. In Phase 1, sloughing samples were taken from the IX resins and FS media. In Phase 2, sloughing samples were taken from the IX and WAC resins and FS media. The constituents that were analyzed for the IX resins and FS media includes: arsenic, hexavalent chromium, nitrate, perchlorate, PFAS, silica, TOC, and uranium. The constituents that were analyzed for the WAC resins includes: calcium hardness, magnesium hardness, total hardness, alkalinity, strontium, barium, TDS, and TOC.

The sloughing from IX and FS is shown for regulated and unregulated constituents during Phase 1 in Figure 6-15 and Figure 6-16, respectively, and for Phase 2 in Figure 6-17 through Figure 6-19. The sloughing of constituents from WAC resins in Phase 2 is shown in Figure 6-20. **No sloughing of any measured contaminants was observed in either Phase 1 or Phase 2.** This indicates that system restarts are unlikely to produce short-term degradation in water quality, unlike nitrate peaking associated with GAC.

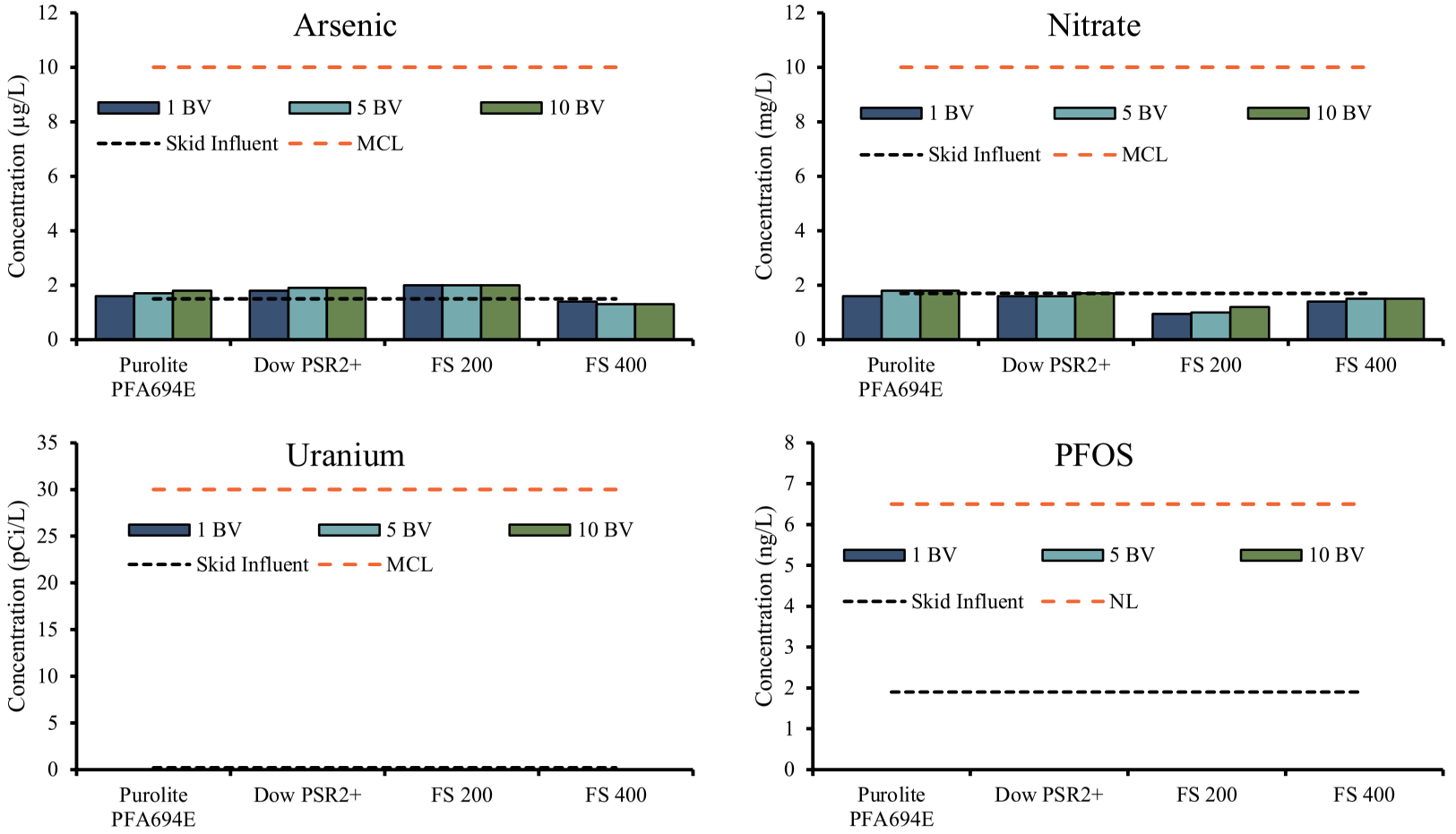


Figure 6-17. Phase 1 Sloughing Analysis of Regulated Constituents

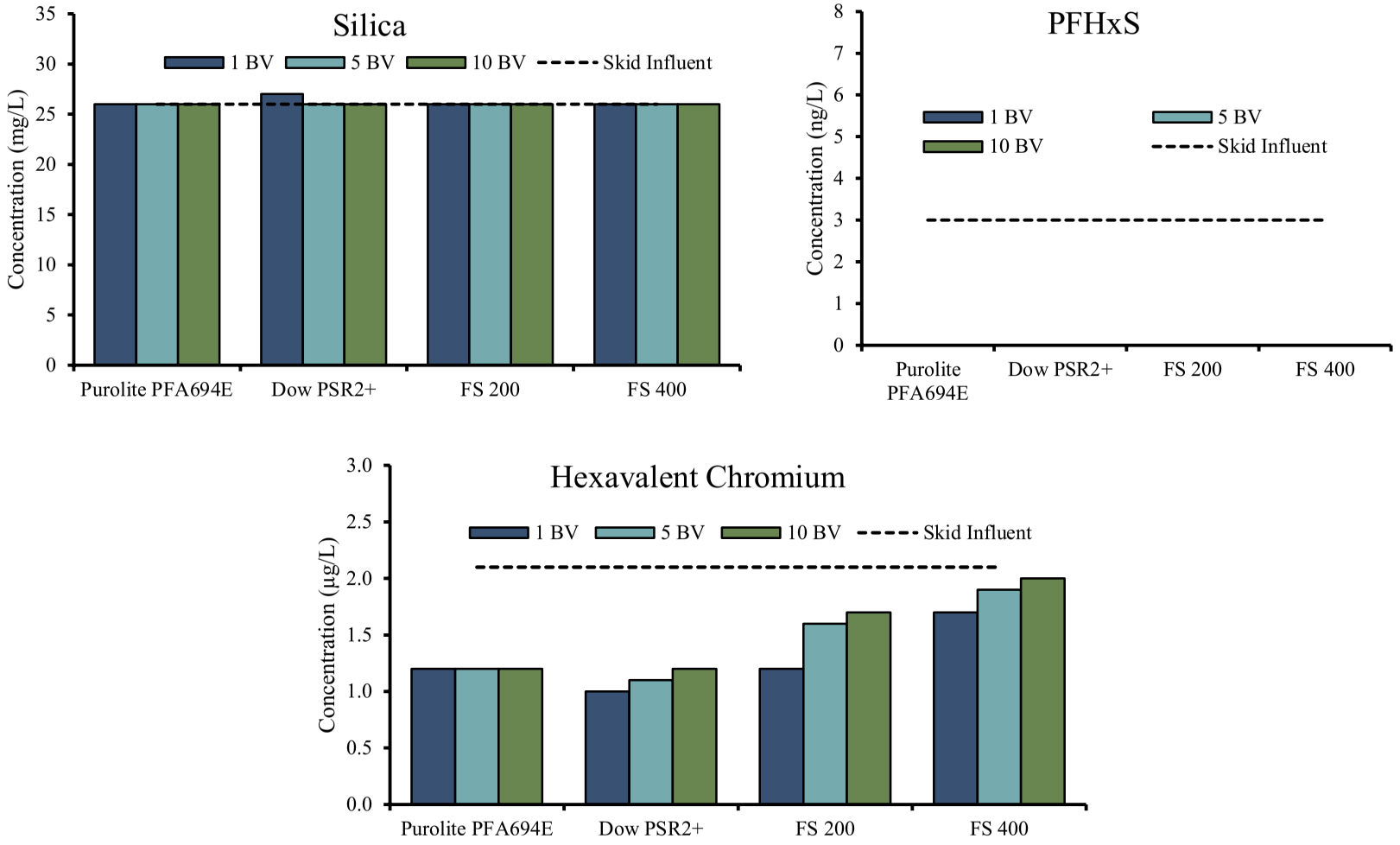


Figure 6-18. Phase 1 Sloughing Analysis of Unregulated Constituents

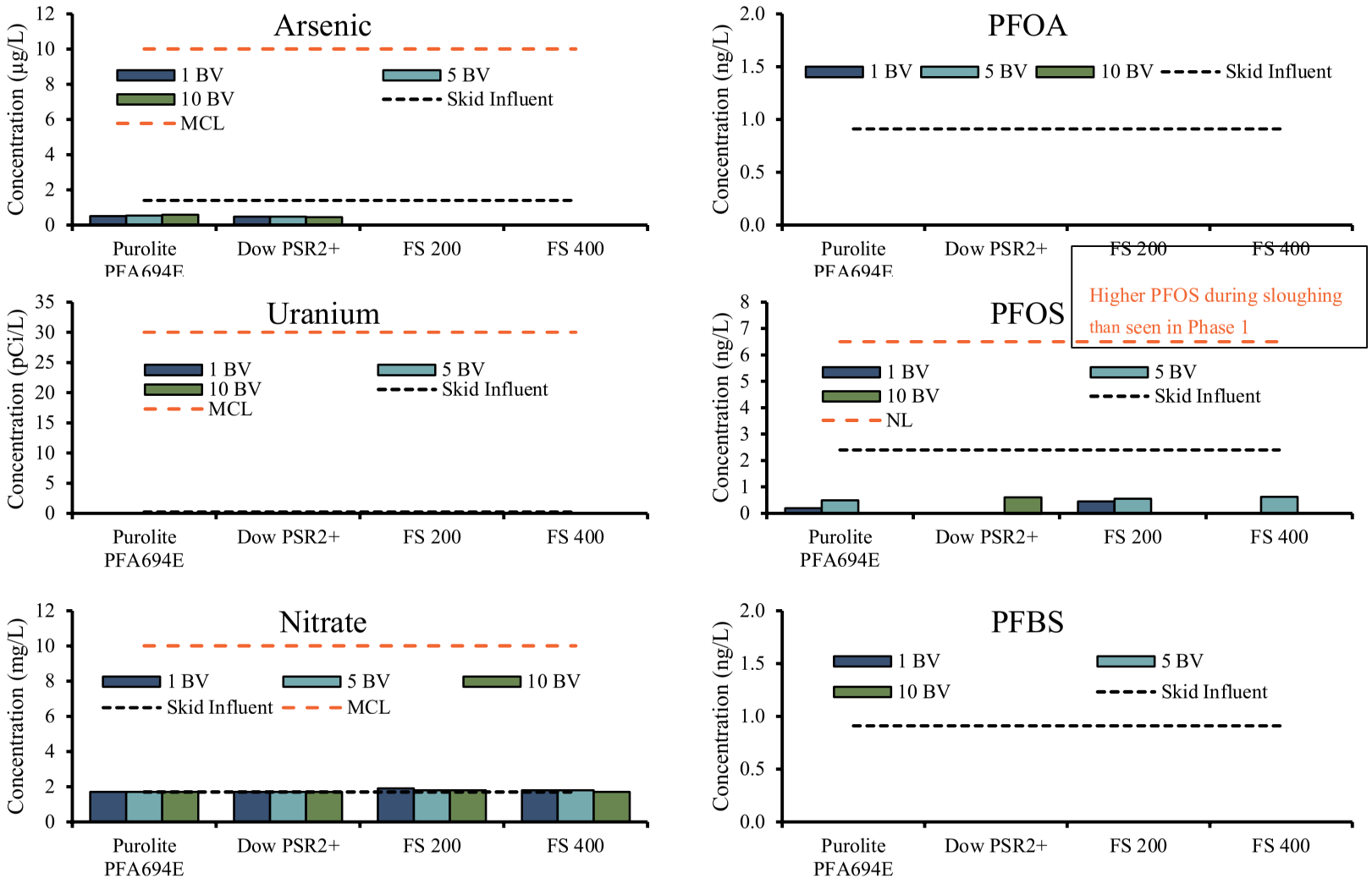


Figure 6-19. Phase 2 Sloughing Analysis of Regulated Constituents off PFAS Media

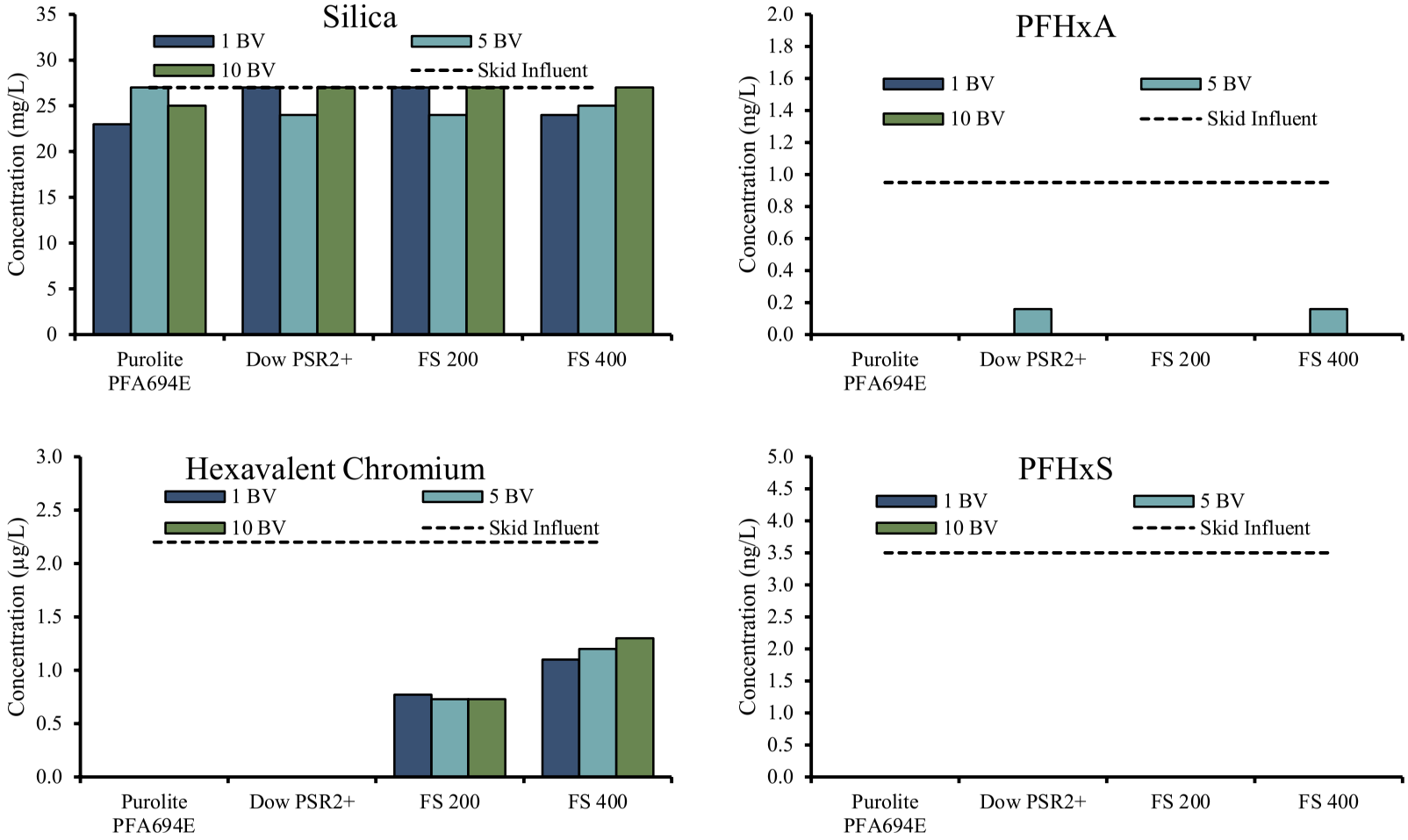


Figure 6-20. Phase 2 Sloughing Analysis of Unregulated Constituents off PFAS Media

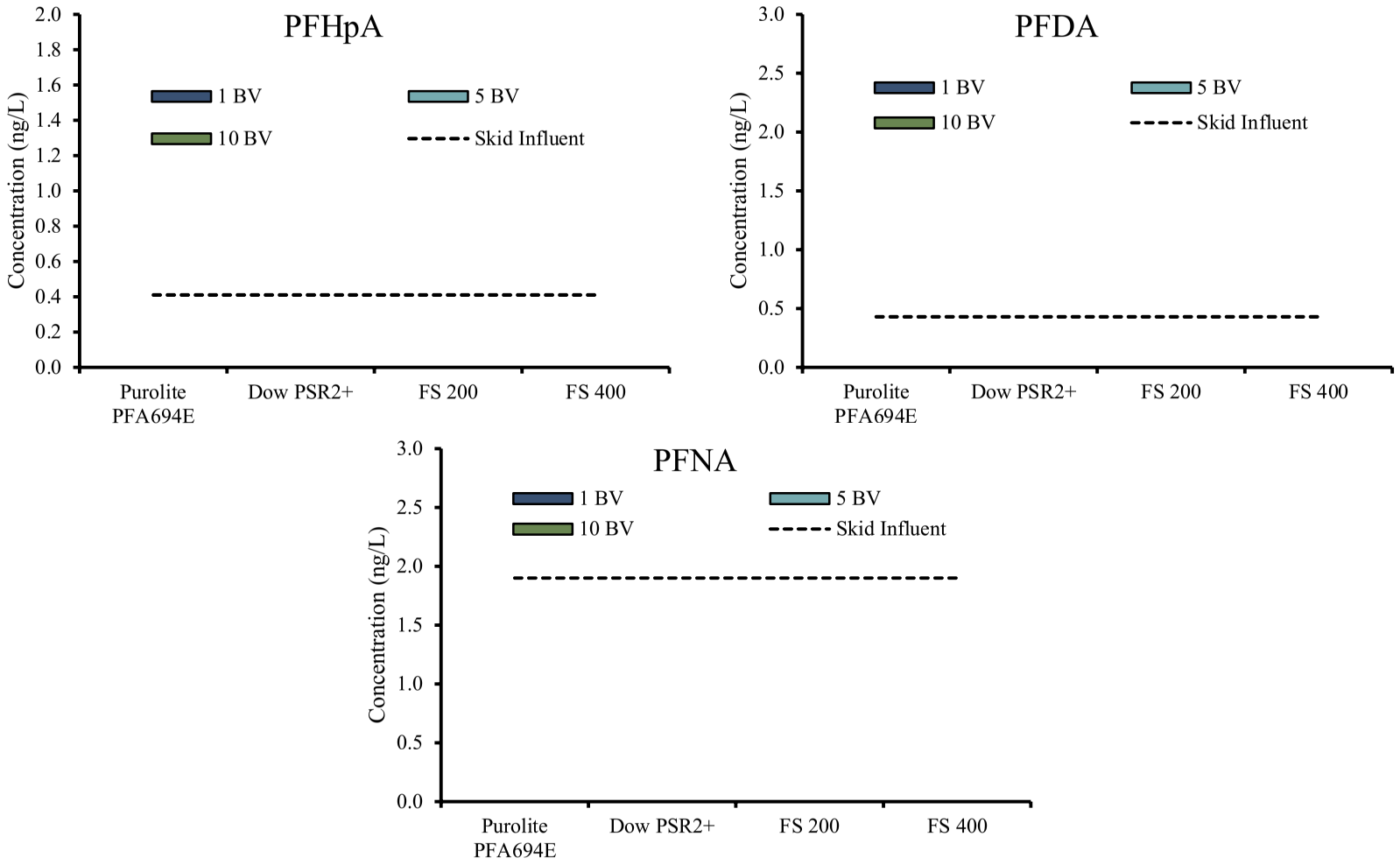


Figure 6-21. Phase 2 Sloughing Analysis of Unregulated Constituents off PFAS Media (cont.)

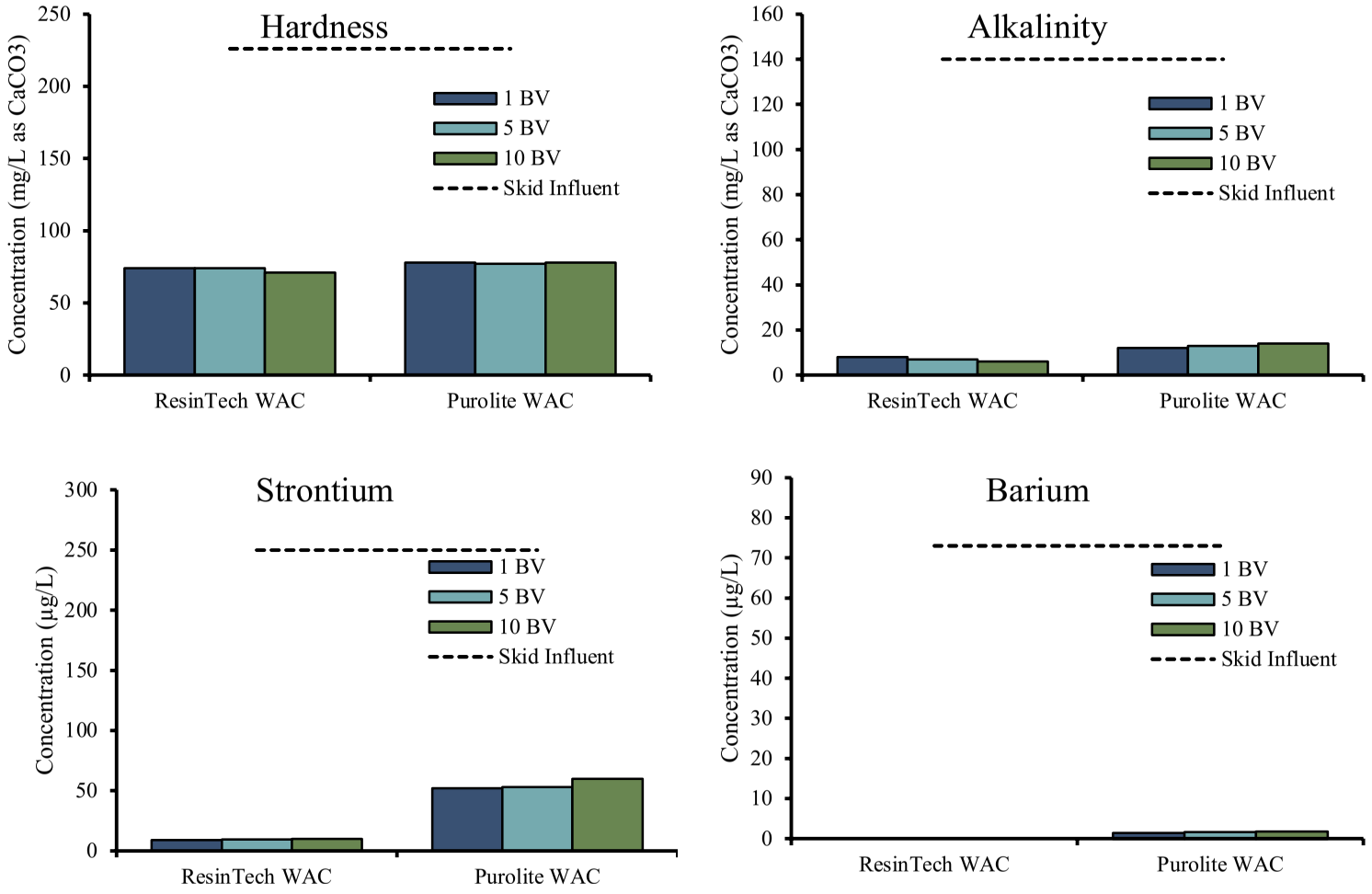


Figure 6-22. Phase 2 Sloughing Analysis of WAC Resins

6.5 Softening and PFAS Removal Efficacy

6.5.1 Softening Efficacy

Figure 6-23 shows one day's results for hardness removal. Both WAC resins tested were capable of reducing hardness to below SJW's target of 100 mg/L as $CaCO_3$. However, it was found that calcium was more readily removed than magnesium. Approximately 50 mg/L hardness remained after regeneration, which was primarily comprised of magnesium.

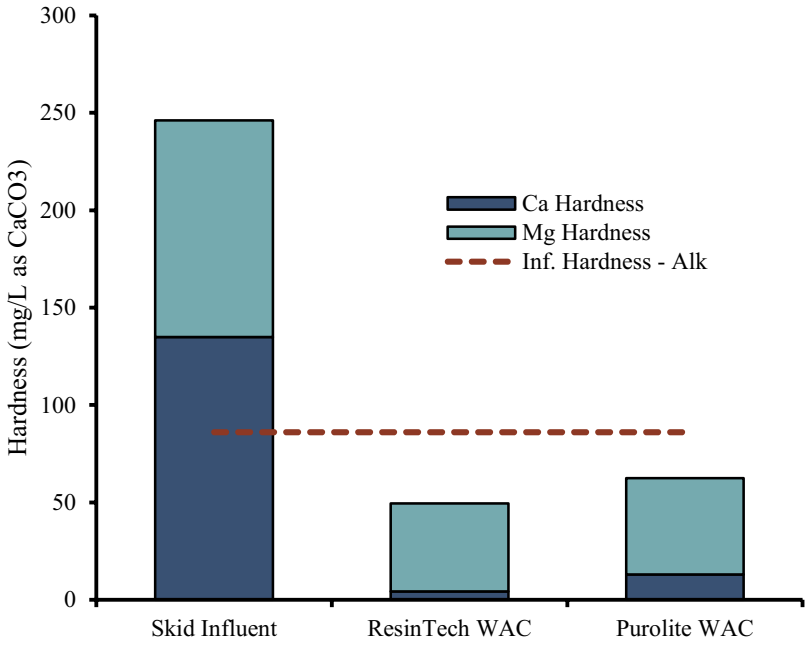


Figure 6-23. Example Softened Water Hardness Readings

Sampling from the WAC columns primarily occurred at the end of a WAC run. Time series of total hardness, calcium hardness, and magnesium hardness of the raw water and softened water over the duration of the pilot can be found in Figure 6-24, Figure 6-25, and Figure 6-26. As shown in the figures below, the ResinTech resin had a higher hardness removal compared to the Purolite resin. The ResinTech resin was generally able to achieve SJW's softening water quality goal of hardness under 100 mg/L as $CaCO_3$.

Prior to piloting, WAC vendors projected post-regen hardness level of approximately 10-15 mg/L as $CaCO_3$. The end of the service cycle was specified as when effluent hardness was equal to influent hardness minus influent alkalinity (70-100 mg/L as $CaCO_3$), which would trigger regeneration. When pilot performance data was shared with vendors, performance projections were revised. The effluent hardness normal operating point, rather than the trigger for regeneration, was expected to equal influent hardness minus alkalinity. This was because WAC was only expected to remove alkalinity-associated hardness. However, Figure 6-21 and Figure 6-22 show greater removals of hardness than theoretically

possible. Vendors were unable to explain better than theoretical performance. One explanation could be that ion exchange continues to occur, albeit less efficiently, at lower pH than expected by vendors.

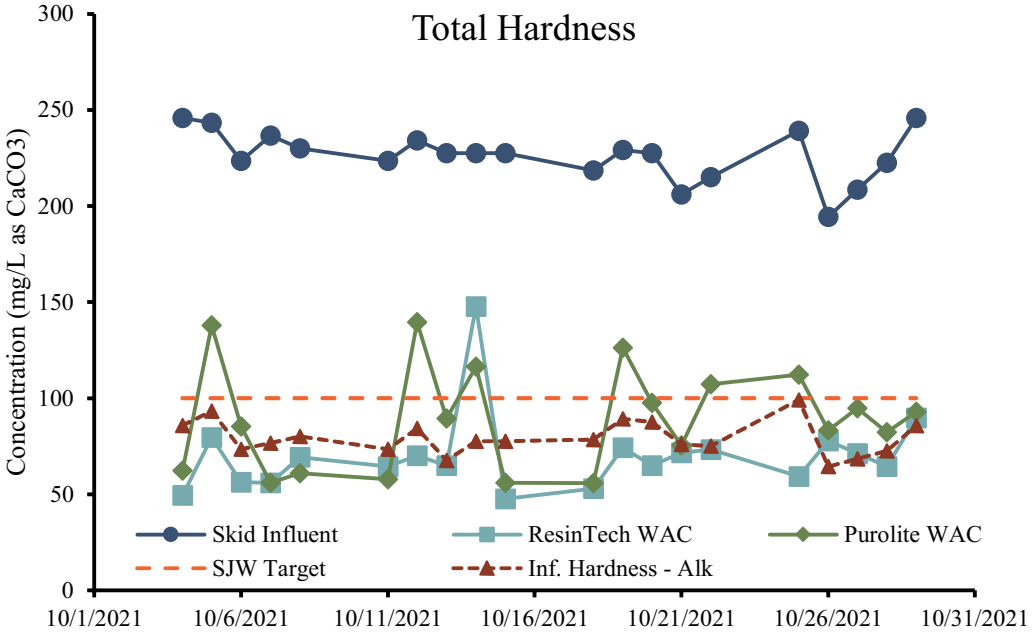


Figure 6-24. Total Hardness Concentrations of Raw Water and Softened Water Over Time

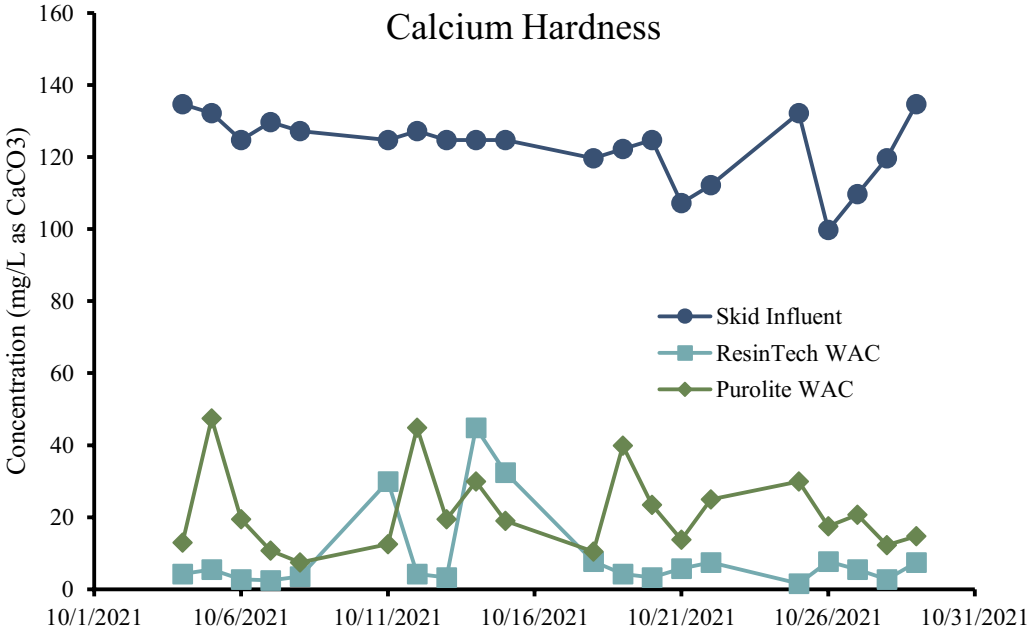


Figure 6-25. Calcium Hardness Concentrations of Raw Water and Softened Water Over Time

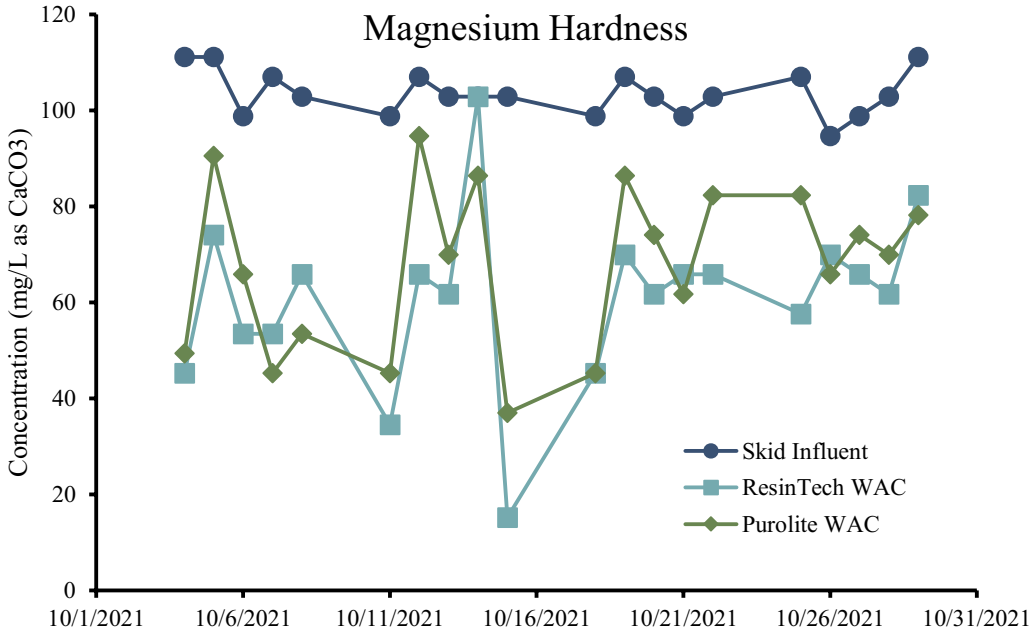


Figure 6-26. Magnesium Hardness Concentrations of Raw Water and Softened Water Over Time

6.5.2 PFAS Removal Efficacy

Influent and effluent concentrations of regulated PFAS (i.e., PFOS, PFOA, PFBS) are shown in Figure 6-27. Effluent concentrations were below the reporting limit, and most were below the detection limit. It should be noted, however, that influent concentrations were also typically below the reporting limit, except for PFOS, concentrations of which were near the reporting limit. This indicates good removal of regulated PFAS by IX and FS, as expected.

Figure 6-28 shows unregulated PFAS with effluent concentrations below the reporting limit, including PFHpA, PFHxS, and PFNA. IX and FS were effective for these constituents similar to the regulated PFAS. There were some unregulated PFAS, including PFDA and PFHxA, for which effluent concentrations exceeded the detection limit but were below the reporting limit (Figure 6-29). It should be noted that PFDA and PFHxA were frequently detected in field blanks, which suggests that effluent concentrations of these constituents may be false positives resulting from sample contamination, lab contamination, or instrument error. SJW also reported detection these constituents in field blanks collected at other sites, providing more evidence that effluent detections may be false positives.

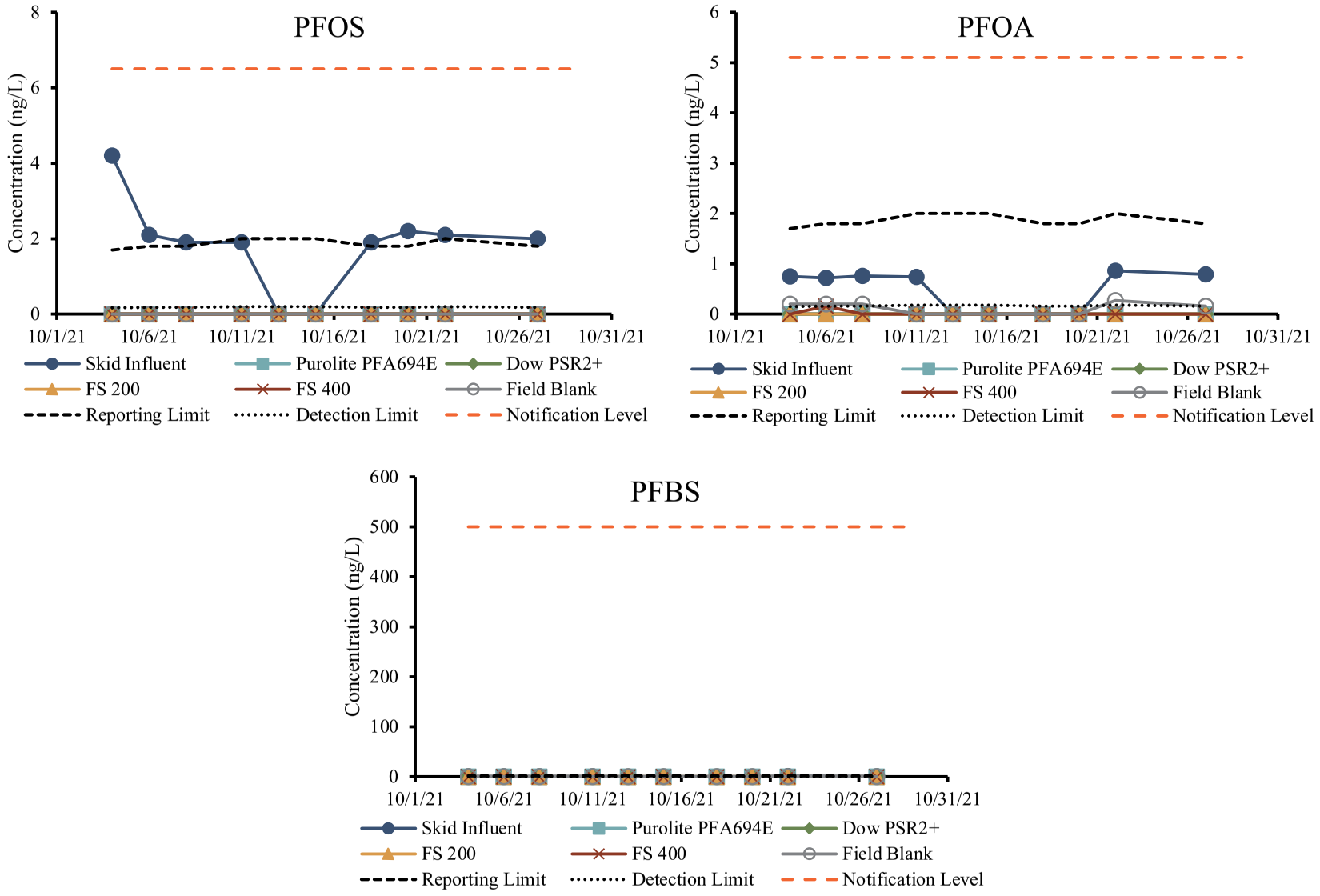


Figure 6-27. Influent and Effluent Concentrations of Regulated PFAS

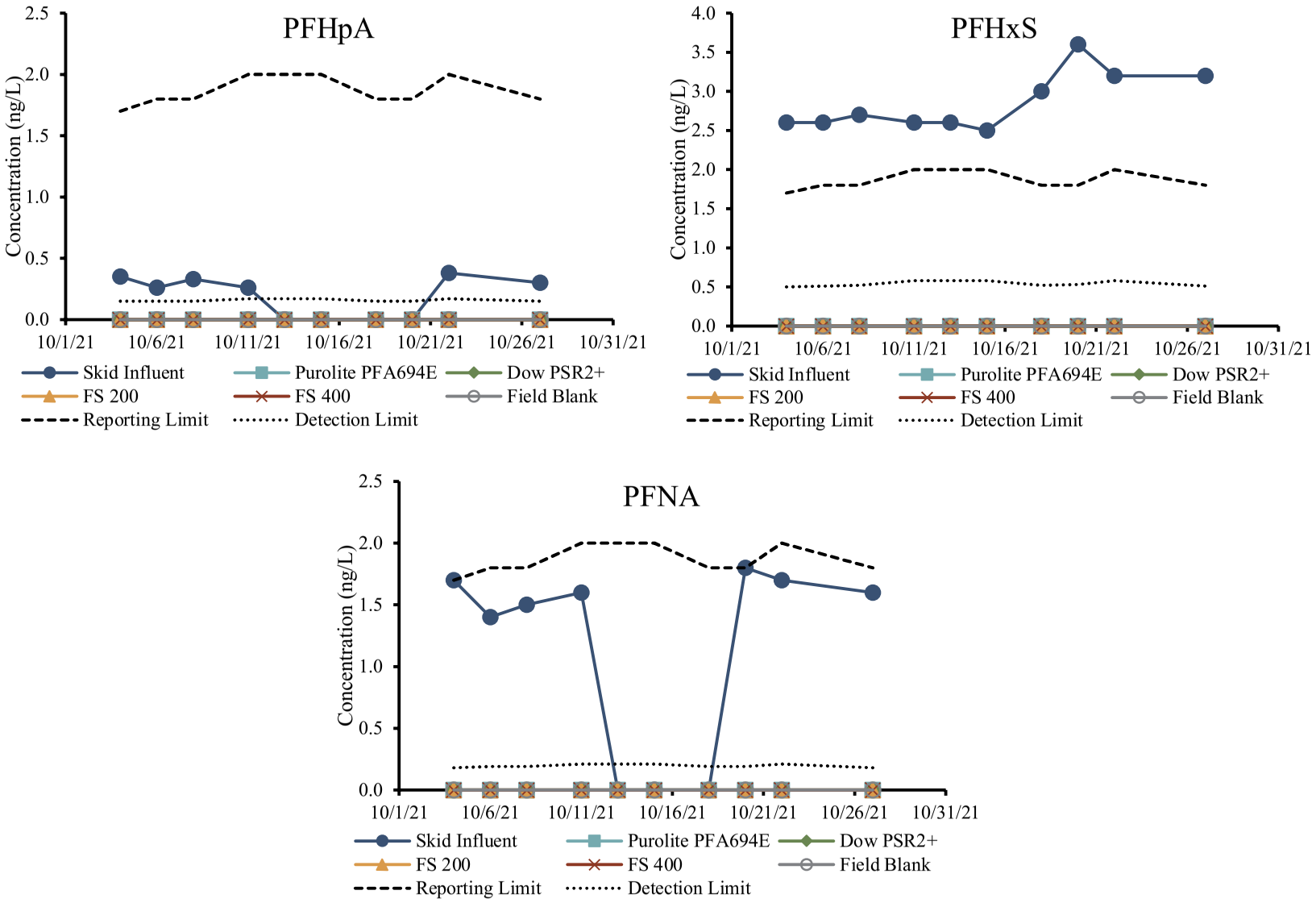


Figure 6-28. Unregulated PFAS with Effluent Concentrations Below the Detection Limit

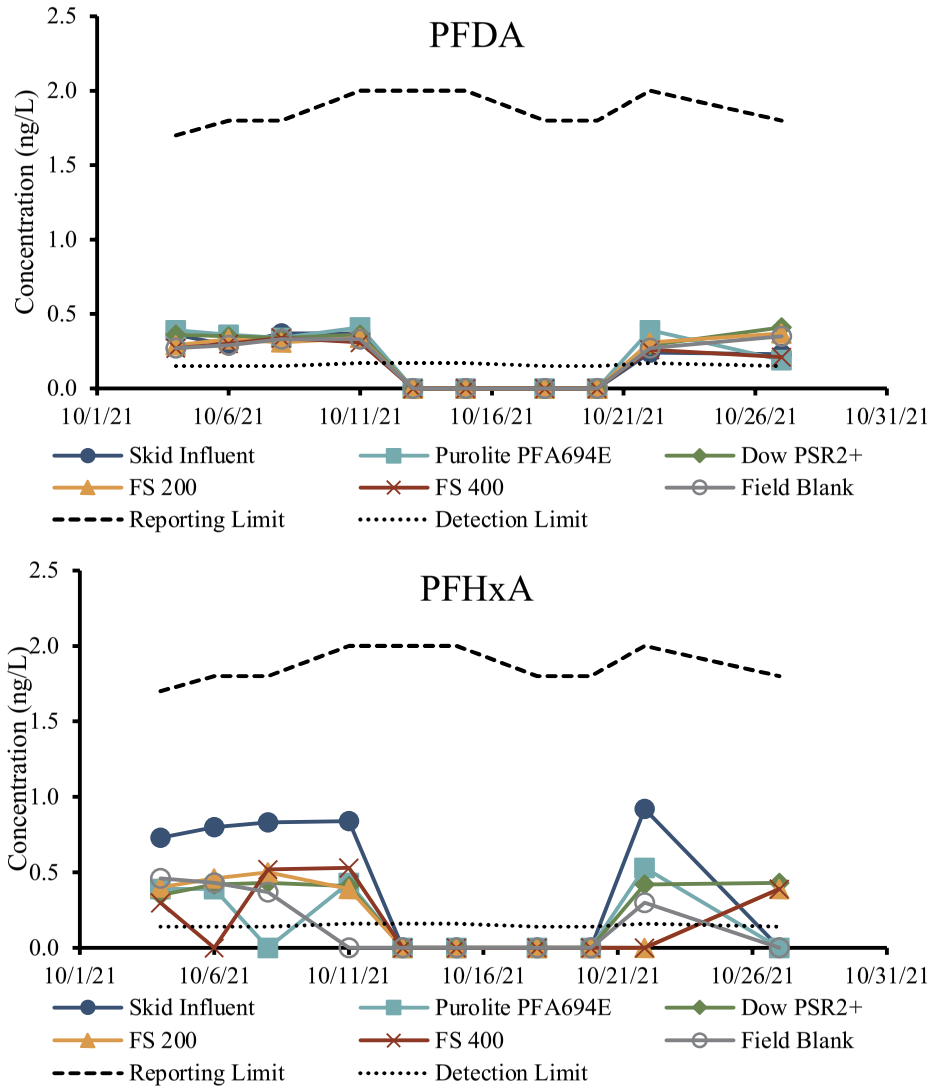


Figure 6-29. Unregulated PFAS with Effluent Concentrations below the Detection Limit, Field Blank Detects

6.6 Softening Operation and Results

A conceptual WAC breakthrough curve is shown in Figure 6-30. At the beginning of the run, effluent pH and hardness are low. An initial increase in pH and hardness is observed, followed by a steady increase, and finally an exponential increase at breakthrough. Through conversations with Purolite, breakthrough was defined as when effluent hardness (in mg/L as $CaCO_3$) exceeded influent alkalinity minus influent hardness (in mg/L as $CaCO_3$). This is because the ion exchange only occurs when localized pH is above approximately pH 6, due to the resin functional groups having a pKa of 4 to 5 [6]. When all alkalinity is consumed, the localized pH decreases below the pKa, and the exchange of Ca^{2+} and Mg^{2+} with H^+ ceases to occur. Based on raw water data, the breakthrough hardness was defined as 60-70 mg/L as $CaCO_3$. When this number is exceeded, it indicates that additional hardness is starting to breakthrough (see right side of curve in Figure 6-30).

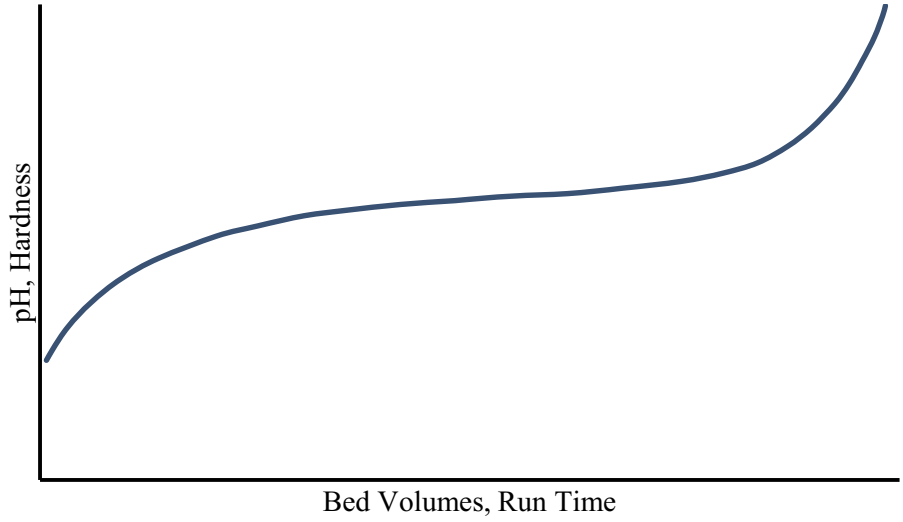


Figure 6-30. Conceptual WAC Breakthrough Curve

Figure 6-31 further illustrates the breakthrough concept. At the beginning of the run, a small fraction of the resin is exhausted, while another fraction (green beads) is actively performing IX. In this section of the column, there is sufficient alkalinity to keep pH in a range where H^+ can be exchanged with Ca^{2+} and Mg^{2+}. As water flows down the column, alkalinity is reduced and pH drops too low for IX to occur (orange beads). At the end of the run, most of the resin is exhausted, while IX as occurring at the bottom of the column. Some hardness begins to break through and effluent alkalinity and pH start to rise. Hardness and pH can thus be used as indicators for regeneration.

[6] Crittenden, J. C., Trussell, R. R., Hand, D. W., Howe, K. J., & Tchobanoglous, G. (2012). *MWH's water treatment: principles and design*. John Wiley & Sons.

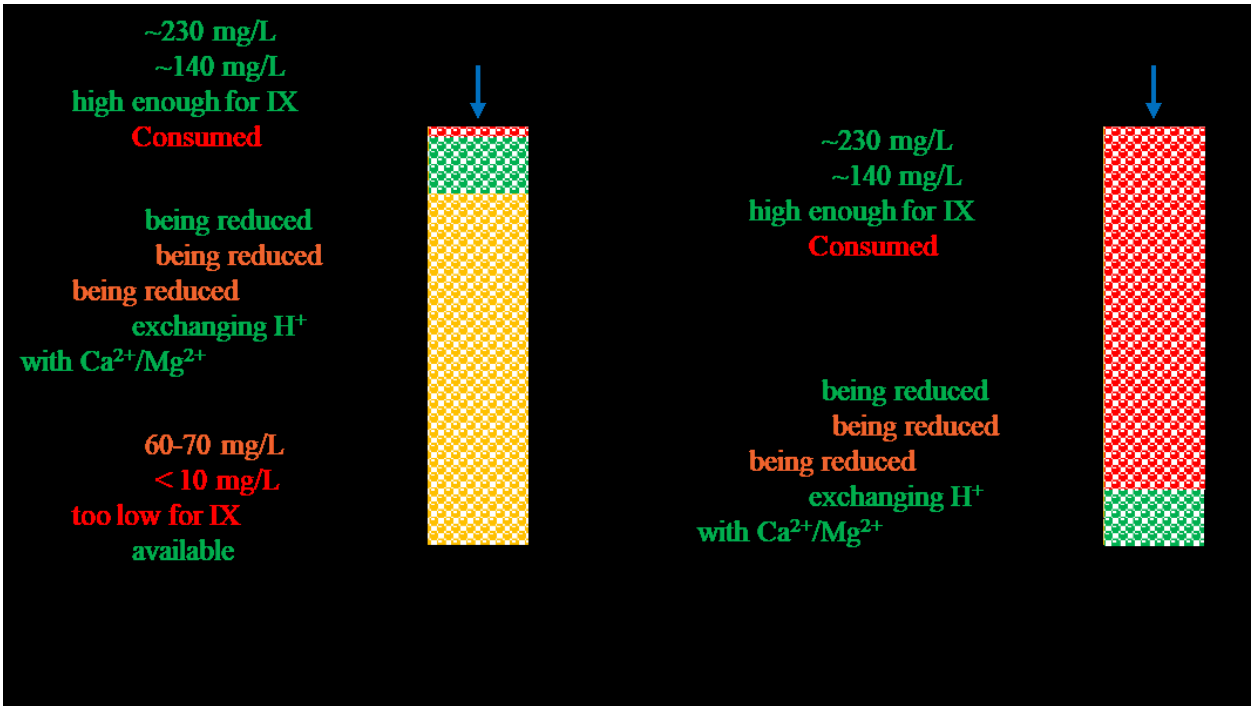


Figure 6-31. Conceptual Diagram of Hardness Removal and Alkalinity Consumption During WAC IX

Due to the length of time it takes to do acid regeneration (i.e., approximately four hours), one of the WAC columns may have been regenerated before or after breakthrough to allow for same day regeneration. On other days, regeneration may have occurred after the target if breakthrough occurred overnight, prior to staff arriving each morning onsite. Effluent hardness, pH, and conductivity were all taken in the field using field sampling equipment and online analyzers to compare the performance of the ResinTech WAC and the Purolite WAC resins.

To account for the different run times described above, the effluent hardness for all WAC runs was compared on the basis of bed volumes of treated water produced. The ResinTech performance is shown in Figure 6-31, and the Purolite resin performance is shown in Figure 6-32. As depicted in Figure 6-31, the ResinTech resin had a low relative initial hardness after regeneration at about 15-25 mg/L as $CaCO_3$, and reached the breakthrough threshold around 550 BV. In comparison, the Purolite resin had a high relative initial hardness at about 40-60 mg/L as $CaCO_3$, and breakthrough occurred around 300 BV as shown in Figure 6-33. When comparing the performance of the resins, **the ResinTech resin performed better than the Purolite resin. The ResinTech resin lasted longer and had higher hardness removal.**

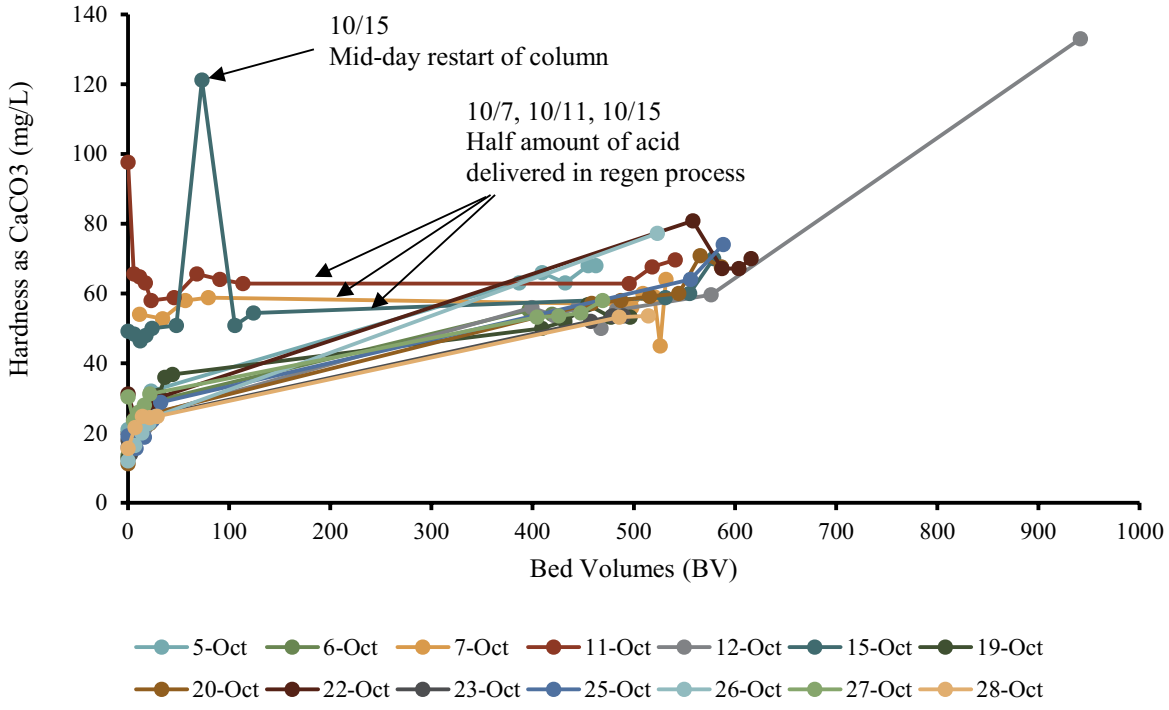


Figure 6-32. ResinTech Effluent Hardness vs. Bed Volumes

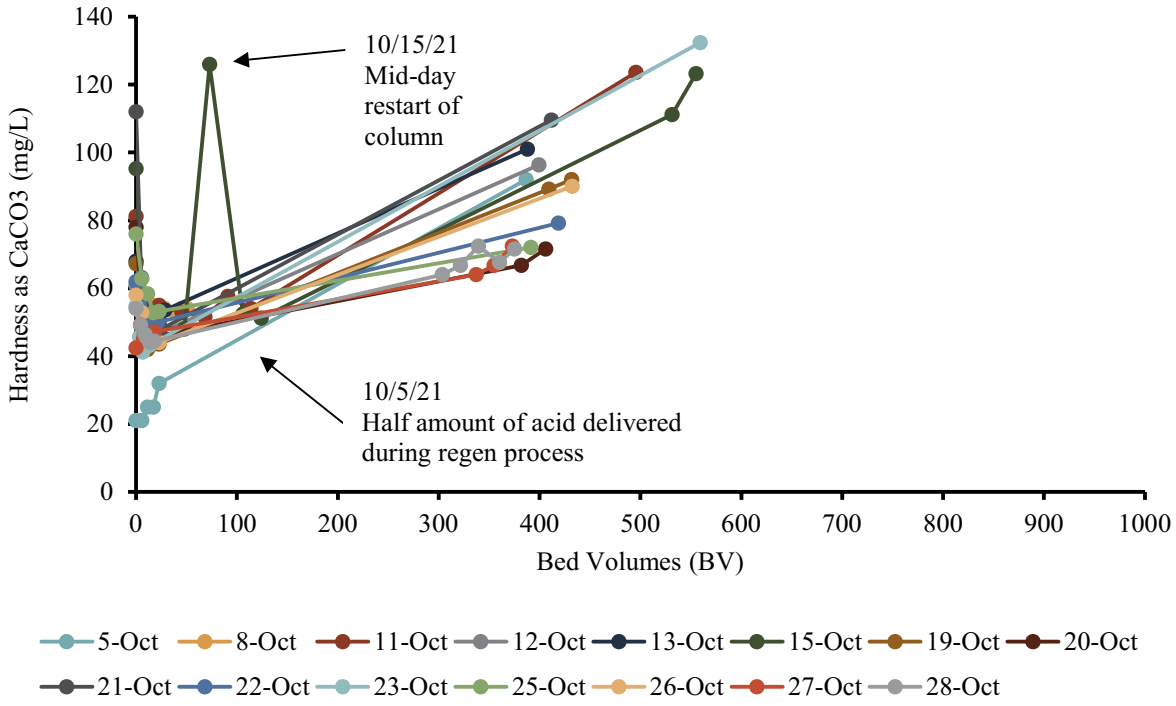


Figure 6-33. Purolite WAC Effluent Hardness vs. Bed Volumes

The effluent pH readings from both resins were taken using an online analyzers and grab samples. The grab samples and online analyzer readings were compared to ensure similar readings between devices and to capture the characteristics of breakthrough. As shown in Figure 6, the pH online analyzer and grab samples had similar results, and S-curve breakthrough was observed.

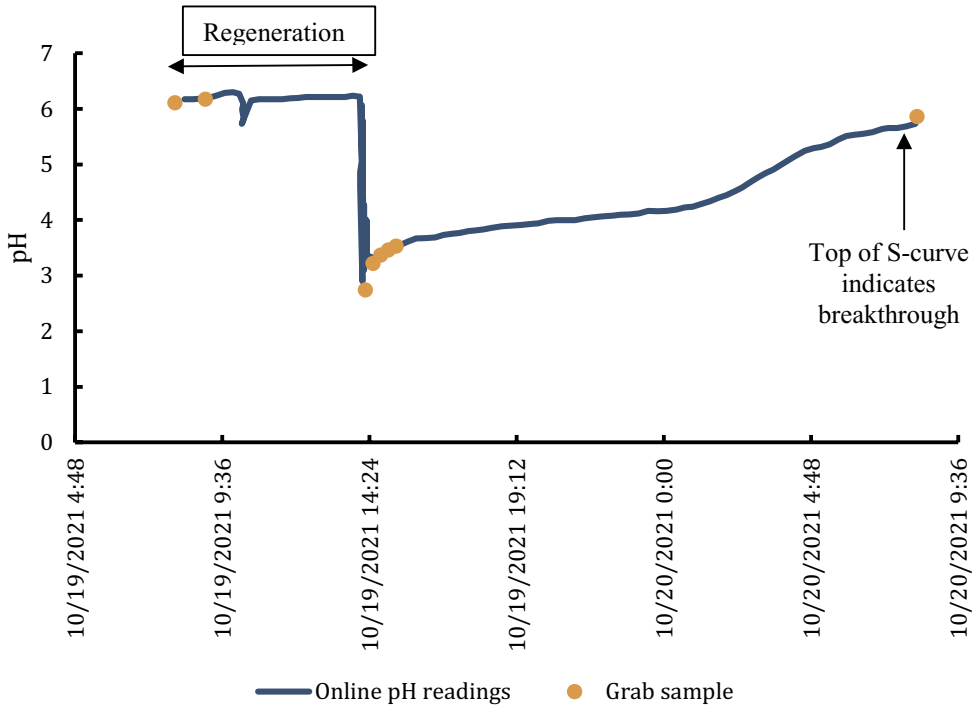


Figure 6-34. Online pH Analyzer and pH Grab Sample Comparison

The effluent pH readings for all WAC runs were compared to the bed volumes of treated water produced. The effluent pH vs. bed volumes for the ResinTech resin is shown in Figure 6-34 and for the Purolite resin is shown in Figure 6-35. The data shows that **the effluent pH is strongly correlated with effluent hardness, and the effluent pH could be measured online at full-scale to determine regeneration frequency.**

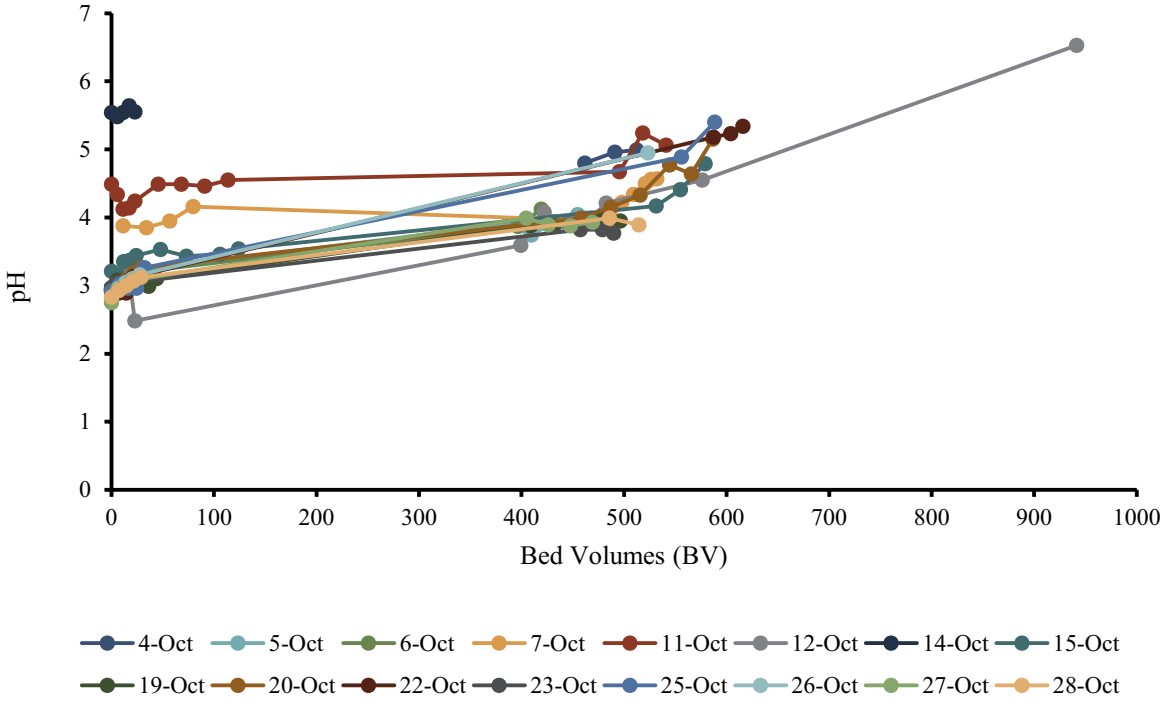


Figure 6-35. Effluent pH vs. Bed Volumes for ResinTech Resin

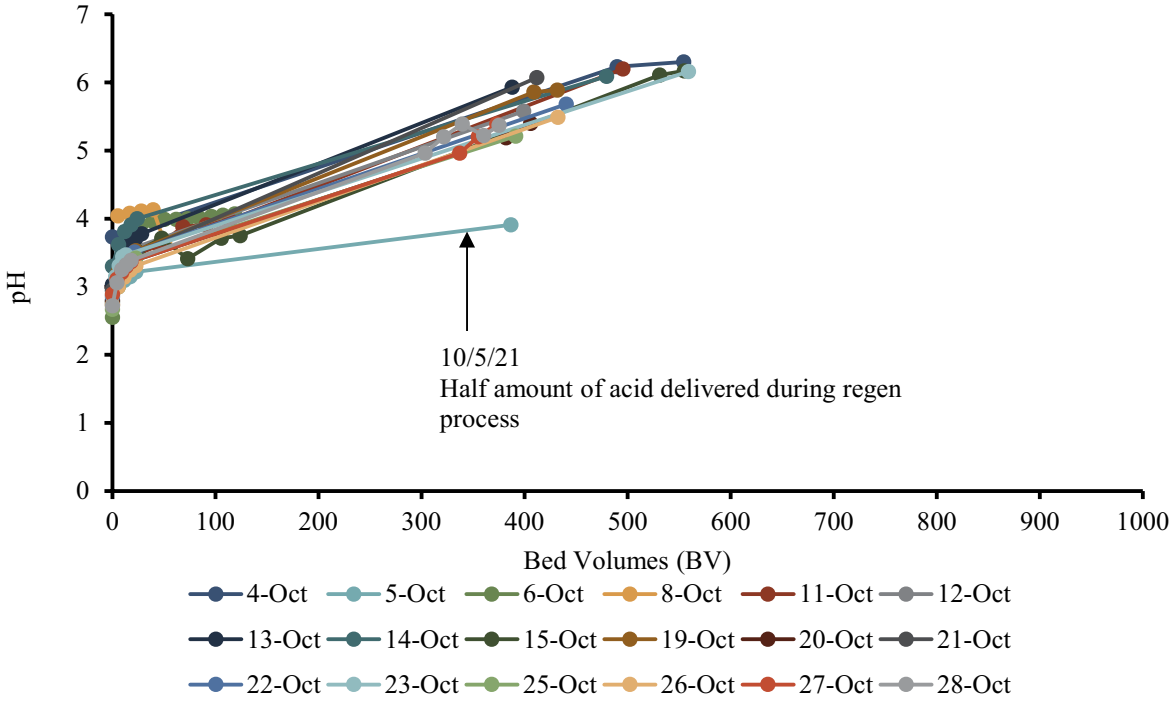


Figure 6-36. Effluent pH vs. Bed Volumes for Purolite Resin

Like pH, effluent conductivity readings from both resins were taken using an online analyzer and grab samples. The online analyzer and grab sample readings were taken to corroborate data and to capture the characteristics of breakthrough for conductivity readings. As shown in Figure 6-33, the conductivity online analyzer and grab samples had similar data, and there was a steady decline and increase in conductivity throughout a run as alkalinity and hardness started to break through. The vendors confirmed that this inflection point indicates breakthrough of resin.

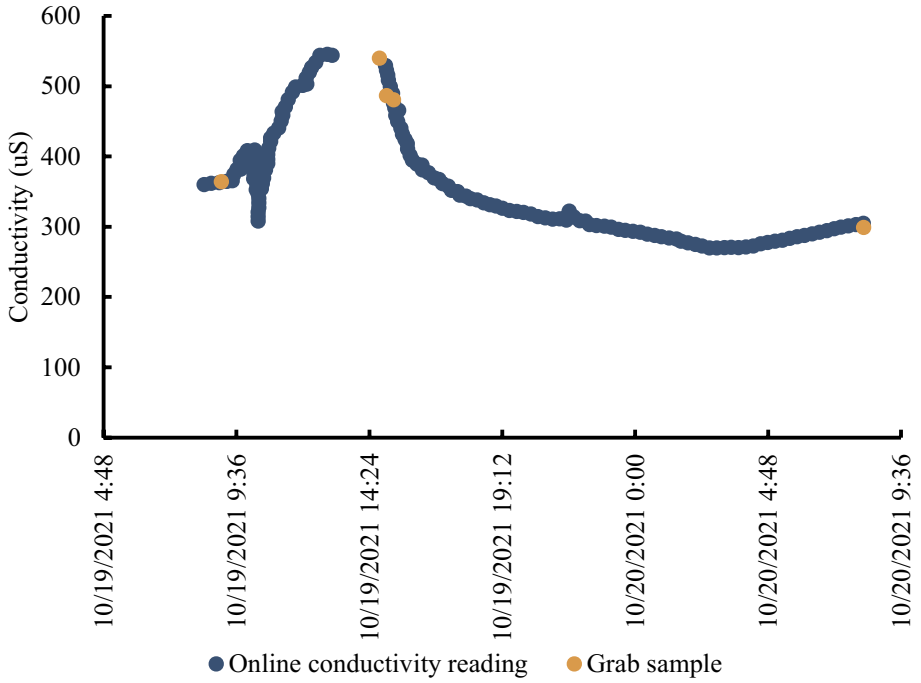


Figure 6-37. Online Conductivity Analyzer and Conductivity Grab Sample Comparison

The effluent conductivity readings for all WAC runs were compared to the bed volumes of treated water produced. The effluent conductivity vs. bed volumes for the ResinTech resin is shown in Figure 6-37 and for the Purolite resin is shown in Figure 6-38. Breakthrough was associated with an inflection point in conductivity, where an increase was observed after a steady decline. As shown in Figure 6-37 and Figure 6-38, the inflection point varied from run to run but remained close to the breakthrough bed volumes seen in the effluent hardness and pH data. Overall, this data shows that the effluent conductivity is correlated with effluent hardness; however, the correlation relationship is not as strong as that of effluent pH and hardness.

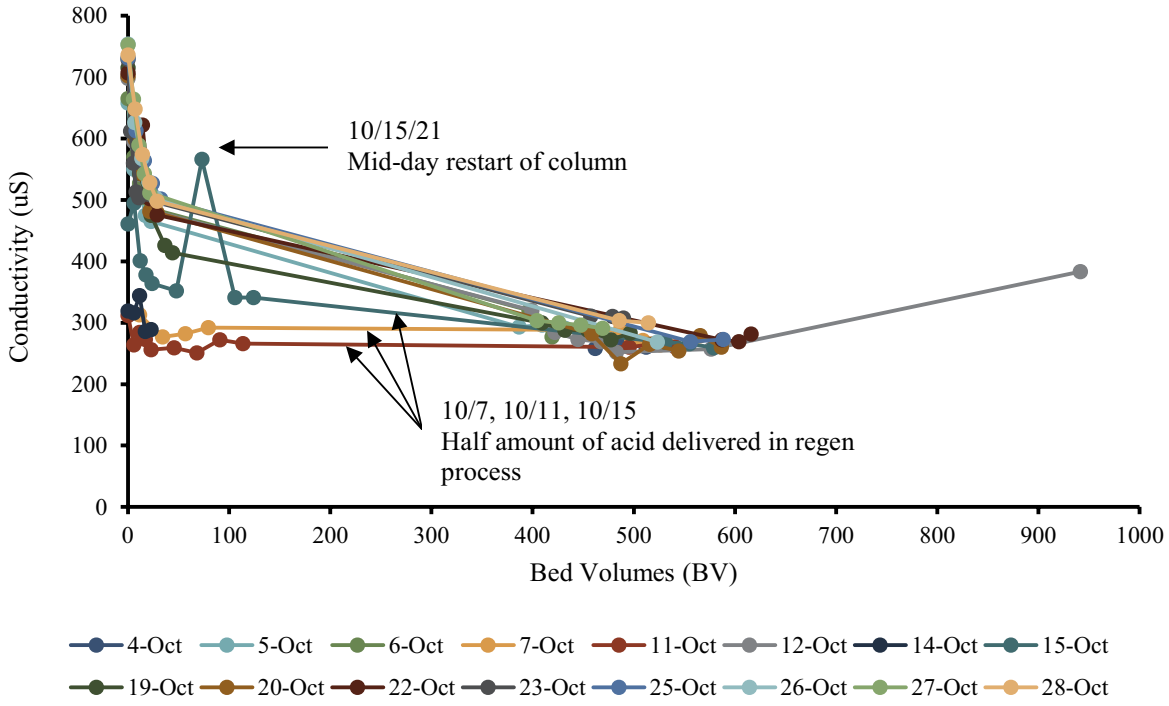


Figure 6-38. Effluent Conductivity vs. Bed Volumes for ResinTech WAC

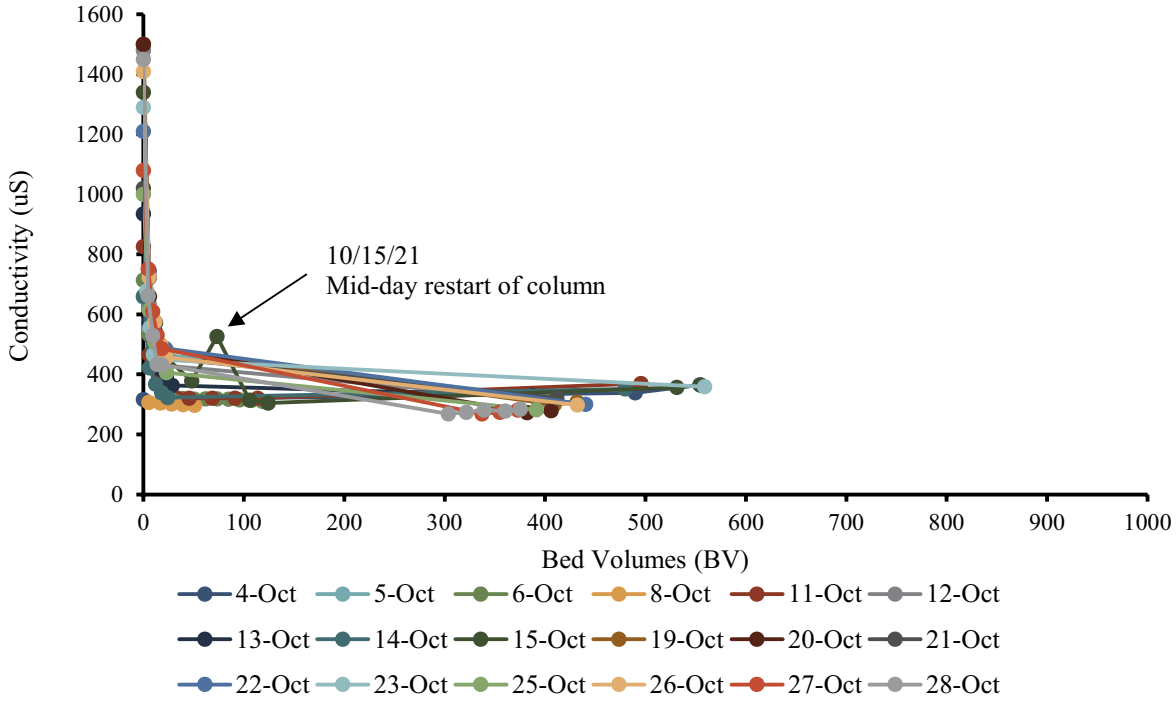


Figure 6-39. Effluent Conductivity vs. Bed Volumes for Purolite WAC

6.7 pH Adjustment and Corrosion Indices

6.7.1 pH Adjustment

To estimate sodium hydroxide doses required after WAC, effluent samples were blended with raw water and titrated with sodium hydroxide to achieve a pH of 7.2, which was the average historical Williams Station effluent pH. Blend ratios of softened water to unsoftened water tested included 50/50, 75/25, and 90/10. Results of this testing are shown in Figure 6-39 and summarized in Table 6-7. As expected, sodium hydroxide doses were higher at the beginning of a run (i.e., post-regen) than at the end of a run (pre-breakthrough). This is explained by having higher acid concentrations at the beginning of the run, while some alkalinity may leak through at the end of a run. Higher doses of sodium hydroxide were also needed at higher bypass fractions (i.e., 90/10) than at lower bypass fractions (i.e., 50/50).

Based on the effluent hardness observed, it was estimated that 75% of the flow would need to be softened to meet SJW's hardness objective of 100 mg/L as $CaCO_3$. At a 75/25 blend ratio, the sodium hydroxide dose to raise pH to 7.2 was 21 to 71 mg/L with an average of 40 mg/L after regeneration, and 10 to 37 mg/L with an average of 24 mg/L prior to breakthrough. These are high sodium hydroxide doses that will impact the cost and feasibility of the project. Decarbonation could reduce the sodium hydroxide dose required and was tested during the pilot.

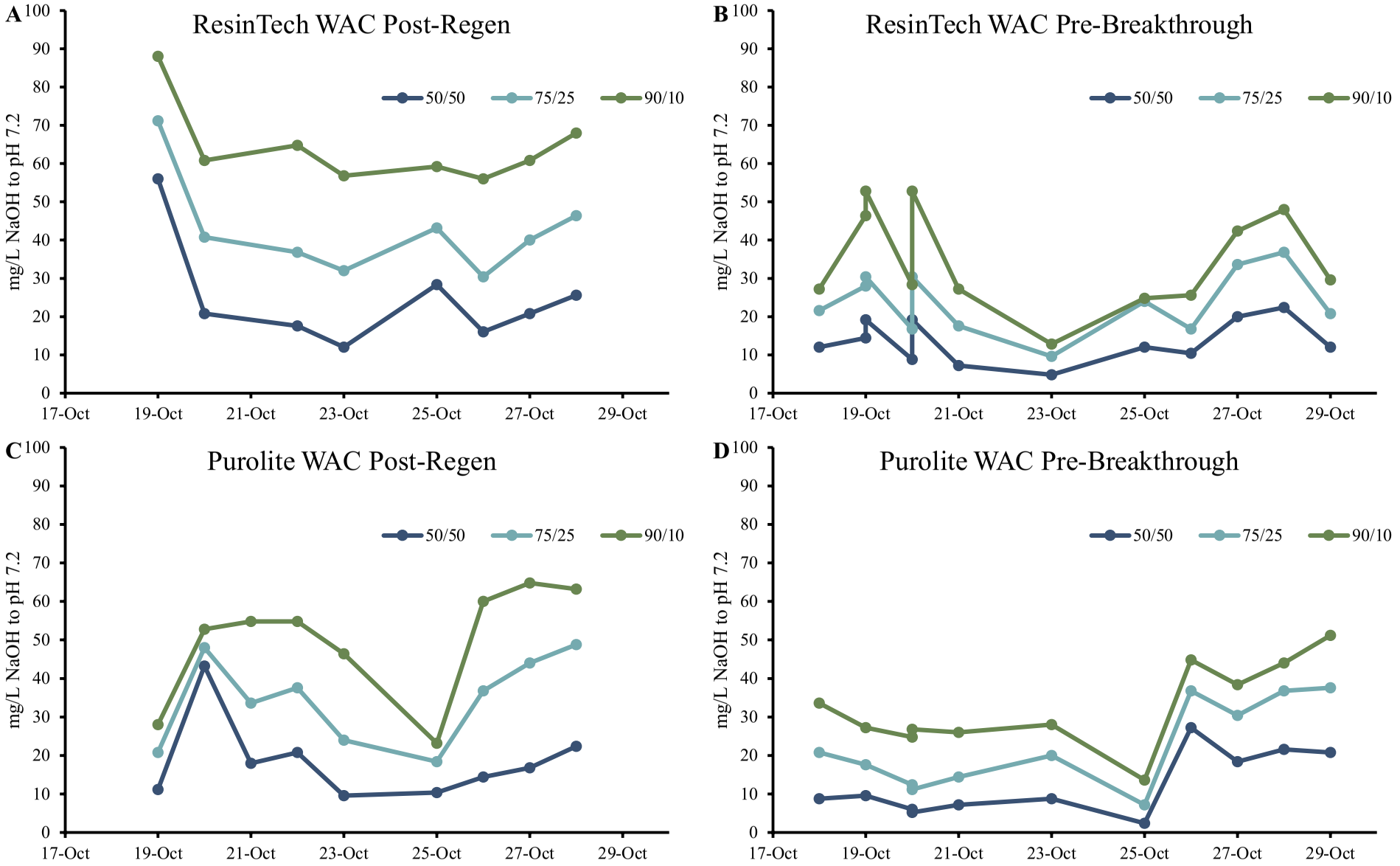


Figure 6-40. Sodium Hydroxide Dose Required to Reach pH 7.2 in ResinTech effluent (A) Post-Regen and (B) Pre-Breakthrough, and Purolite effluent (C) Post-Regen and (D) Pre-Breakthrough.

Table 6-7. Sodium Hydroxide Dose at Different Blend Ratios Required to Raise pH of Softened Water

	mg/L NaOH to raise pH to 7.2, Average (Range)			
	ResinTech WAC		Purolite WAC	
Softened: Bypass Ratio	After Regen	Prior to Breakthrough	After Regen	Prior to Breakthrough
50/50	23 (9-56)	14 (5-22)	19 (10-43)	12 (2-27)
75/25	40 (21-71)	24 (10-37)	35 (18-43)	22 (7-38)
90/10	61 (34-88)	35 (13-53)	50 (23-65)	33 (14-51)

The effect of the decarbonator working in tandem with dosing sodium hydroxide was analyzed. Approximately two hours after regen, samples were taken from the ResinTech effluent, Purolite effluent, and downstream of the decarbonator, and these samples were dosed with sodium hydroxide until the pH reached 7.2 as shown in Figure 6-40. It was found that high doses of sodium hydroxide were needed to raise the pH to 7.2. Decarbonation reduced the sodium hydroxide dose required to reach pH 7.2 by approximately 45-54%.

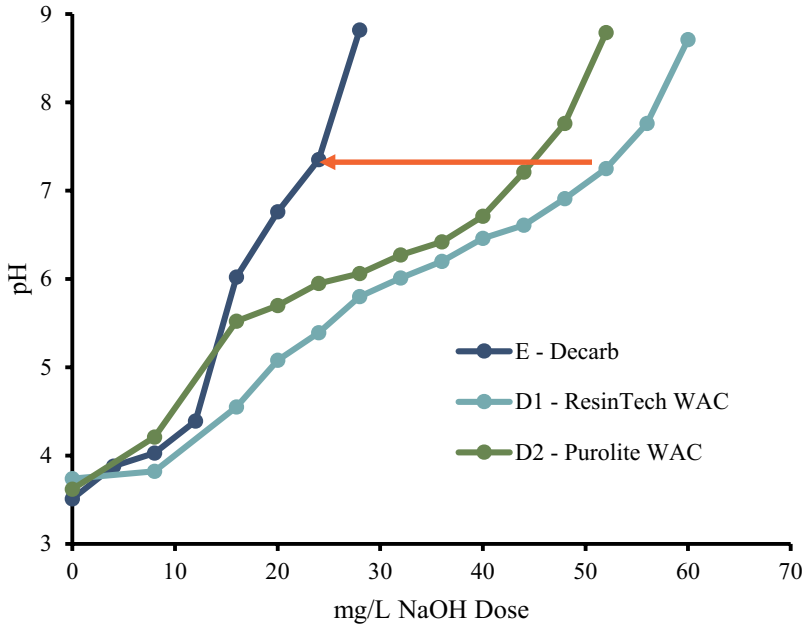


Figure 6-41. Sodium hydroxide Dose Required to Raise pH to 7.2 in Softened Water vs. After Decarbonation

SJW's initial project goal was to produce no increase in sodium concentrations. Based on the results of the pilot study, it would be necessary to add 15-40 mg/L of sodium hydroxide to reach the pH of 7.2, and this addition of sodium hydroxide would increase sodium concentrations by 8.6-23 mg/L. This increase in sodium concentrations would exceed the lower range of EPA's 30-60 mg/L Drinking Water Advisory for taste impacts. Further sodium hydroxide doses may be needed for corrosion control. Considering these

results, **pH adjustment after WAC does not meet SJW's original water quality goals for sodium**. For reference, Na+ regeneration (see Section 2.3.4) was expected to increase Na concentrations by 61 mg/L.

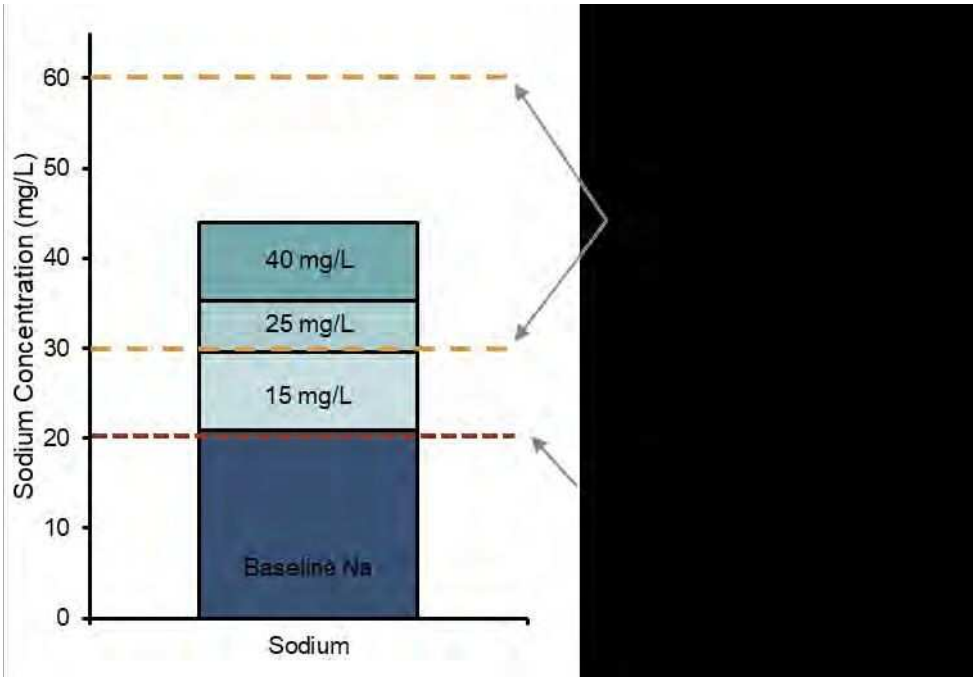


Figure 6-42. Estimated Sodium Concentration Under Baseline Conditions and at Different Sodium hydroxide Doses

6.7.2 Corrosion Indices

WAC softening can affect the corrosivity of treated water. Desktop analyses were conducted to evaluate corrosivity after startup of resins (following regeneration and during operation) using the corrosion indices shown in Table 6-8.

Table 6-8. Corrosivity Indices Evaluated During Pilot Study

Corrosivity Index	Acronym	Equation
Calcium Carbonate Precipitation Potential	CCPP	Iterative calculations including calcium, alkalinity, pH, and temperature
Langelier Saturation Index	LSI	$LSI = pH - pH_s$
Larson Ratio	LR	$\frac{[Cl^-] + 2[SO_4^{2-}]}{[HCO_3^-]}$

CCPP and LSI are parameters used to estimate the potential for $CaCO_3$ precipitation or dissolution. The target range for CCPP is 0 to 10 mg/L as shown in Figure 6-42. Based on the calculations for CCPP, the raw water was slightly negative at -1.6 mg/L and close to the target range. After softening and blending, water be highly corrosive. Decarbonation and sodium hydroxide addition would be needed to adjust CCPP and LSI closer to the target range of 0 to 10 mg/L.

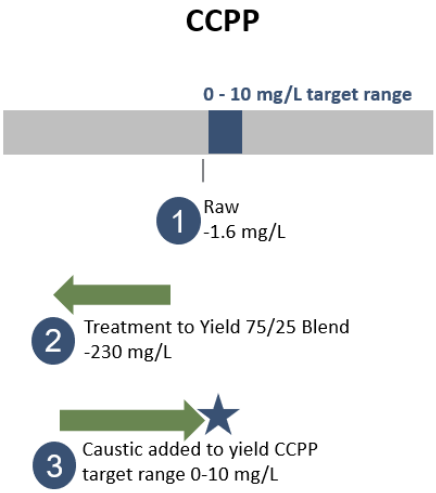


Figure 6-43. Raw Water, Blended Water, and Blended Water with Decarbonation CCPP

The Larson Ratio was also assessed due to concerns by SJW about increases of iron corrosion. The guidelines for what the LR indicates are as follows:

1. LR < 0.8 – Unlikely to interfere with natural film foundation
2. 0.8 < LR < 1.2 – Corrosion may occur
3. LR > 1.2 – Tendency toward high corrosion rates

The unsoftened water LR was between 1.15 and 1.47, while the softened water LR was between 3 and 300. After blending the softened water with the unsoftened water and adding high dose of sodium hydroxide, the LR was approximately 1.44. **Pipe loop testing is recommended to confirm that WAC treated water does not increase iron corrosivity.**

6.8 Swelling, Headloss, and Hydraulic Loading Rate

WAC resins are known to swell when H^+ is replaced by other cations (e.g., sodium, calcium, magnesium). Resin swelling has important implications for pressure vessel design because sufficient freeboard is necessary to allow for the bed expansion of swelled resin during backwash without media washout. ResinTech and Purolite reported H^+ and Na^+ swelling at 50-60% and 50%, respectively. H^+ and Ca^+ swelling was reported by Purolite only, and was listed at 7% under normal operating conditions and 20% under worst case (e.g., complete exhaustion) conditions. No Na^+ removal was observed, and WAC swelling during piloting was observed to be ~5% (see Figure 6-43). This observation was consistent with swelling reported by Purolite during normal operation, and can be used to design the required freeboard during vessel design.



Figure 6-44. Observed WAC Resin Swelling

Headloss across different hydraulic loading rates (HLRs) was tested after piloting was completed in order to supplement data provided by vendors (Figure 6-44). Observed headloss was similar to vendor projections for IX resins; headloss projections were not provided by the FS vendor. Headloss for the Purolite resin was less than 8 psi at the IX design HLR; for a lead-lag system, this would be approximately 16 psi across the media (with additional headloss from the vessels). FS 200 had similar headloss to the IX resins at a given flow rate. FS 400 had negligible headloss across the loading rates tested, due to the media's larger grain size compared to FS 200. Because the surface-area-to-volume ratio is lower for FS 400 than FS 200, the FS vendor has not considered it for use in drinking water applications. However, it may be worth testing this media to investigate bed life (i.e., using RSSCTs) for wellhead applications where pump replacement is infeasible or undesireable.

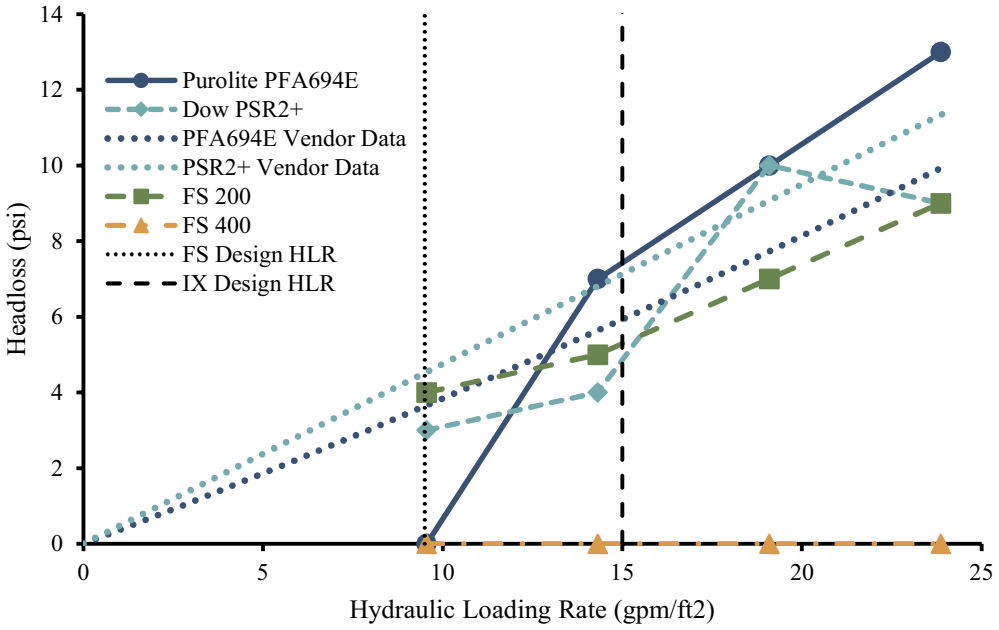


Figure 6-45. Headloss vs. Hydraulic Loading Rate for PFAS Media

WAC vendors initially recommended an HLR of 9.4 gpm/ft^2. HLR was varied for the ResinTech column toward the end of piloting to accommodate operational logistics, namely severe weather that prevented one day of regeneration (i.e., HLR reduced to 4.5 gpm/ft^2 to produce breakthrough in two days instead of one) and increased HLR to 11.9 and 13.4 gpm/ft^2 to try to get the Purolite and ResinTech columns to breakthrough at similar times. Whether HLR was decreased by 50%, increased by 25%, or increased by 40%, the bed volumes to breakthrough were similar under all tested HLR conditions (Figure 6-45). These results demonstrate that more flow can be produced from the same number of WAC vessels and achieve comparable performance, albeit with more frequent regeneration, which could allow higher water production rates or a higher fraction of softened flow without requiring more vessels.

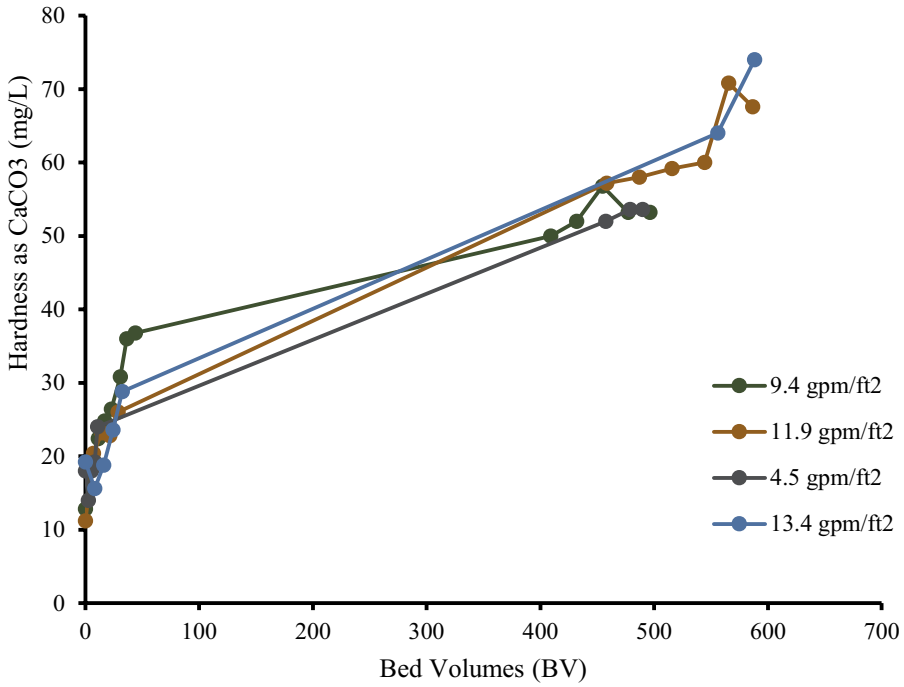


Figure 6-46. Softening Performance of ResinTech Resin at Various HLR

7. Refined Technology Overview

7.1 Comparison of IX and FS

During bench testing and the alternatives evaluation stage, FS was considered to be an alternative to IX with similar EBCT requirements (2-3 min) and HLR limits (16 gpm/ft^2). However, just prior to piloting, the FS vendor noted that they had observed media compaction and rapid headloss buildup at higher HLRs, prompting them to recommend limiting HLR to 9.5 gpm/ft^2. This lower loading rate was tested during piloting. However, the lower HLR increases the number of lead-lag vessel pairs from 9 to 14, which impacts the overall lifecycle cost comparison.

In Section 3.1, estimated lifecycle costs were compared for a 10,000-gpm system operating at an annual average flow rate of 6.24 MGD. Based on more recent operations data, SJW increased the system size to 14,000 gpm and the average flow rate to 7.0 MGD. Figure 7-1 shows the lifecycle cost comparison of the IX and FS. Despite the lower O&M cost of FS, reducing the design HLR to 9.5 gpm/ft^2 increased the initial capital cost such that IX was expected to be lower cost over the system life. Given that the lower capital cost of IX, as well as that it is a proven technology which is easier to permit and doesn't require backwash, **IX was selected as the PFAS treatment technology over FS**.

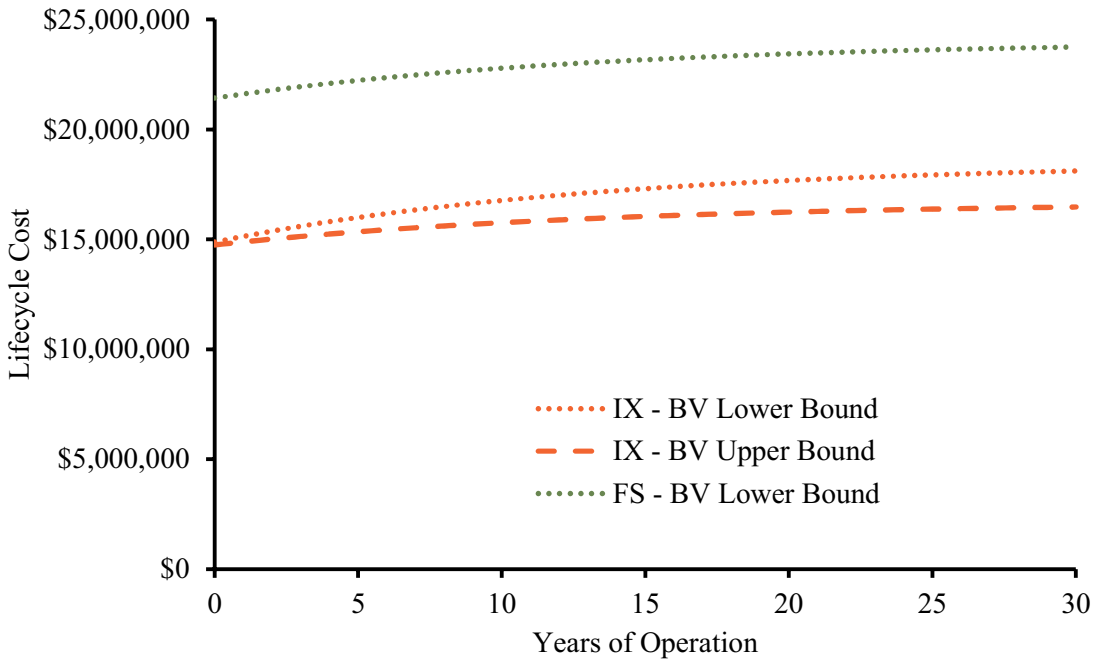


Figure 7-1. Lifecycle Cost Estimate Comparison of IX and FS

7.2 Conceptual Design

7.2.1 Design Parameters

Piloting resulted in changes to the process flow design. When the acid regen IX softening alternative was initially chosen, softening was located upstream of the IX/FS to reduce fouling potential from dissolved iron. With the results of the pilot study and pretreatment sampling and testing, it was found that dissolved iron could be well controlled by break tanks and cartridge filters. In addition, increased headloss was observed when pilot IX and FS were operated downstream of softening. The increased headloss likely resulted air binding due to carbon dioxide offgassing. To reduce the potential for air binding, softening should be located downstream of the PFAS IX/FS treatment. The post-pilot PFD compared to the pre-pilot PFD can be found in Figure 7-2. A detailed PFD of the post-pilot design can be found in Figure 7-3.

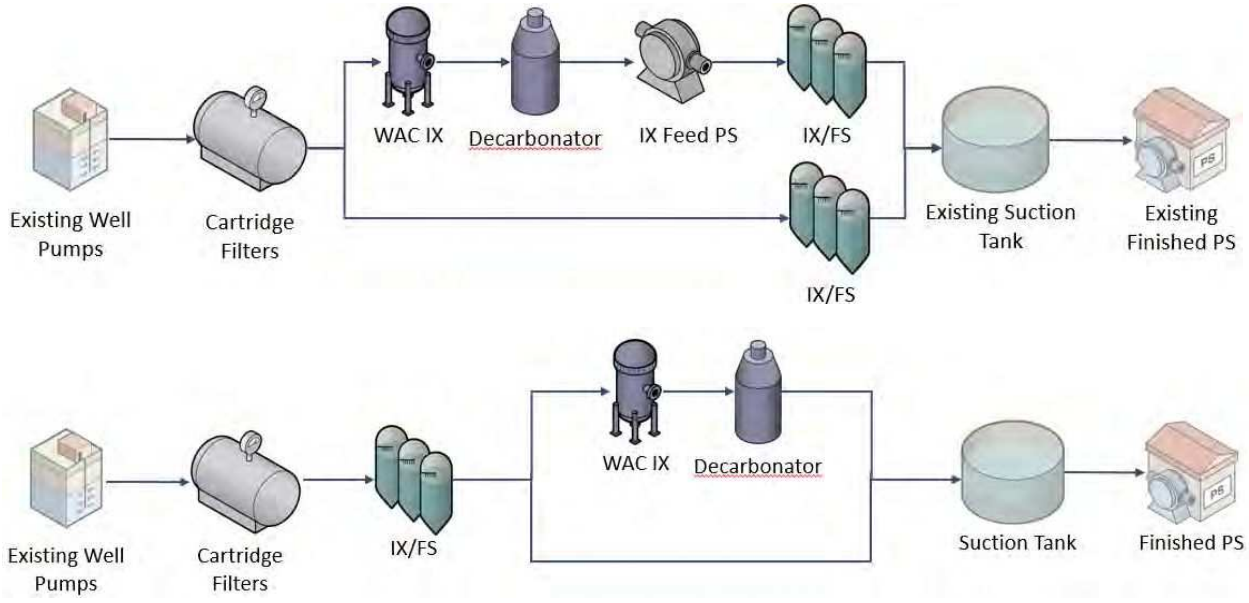


Figure 7-2. Simplified Process Flow Diagram Pre-Pilot (top) vs. Post-Pilot (bottom)

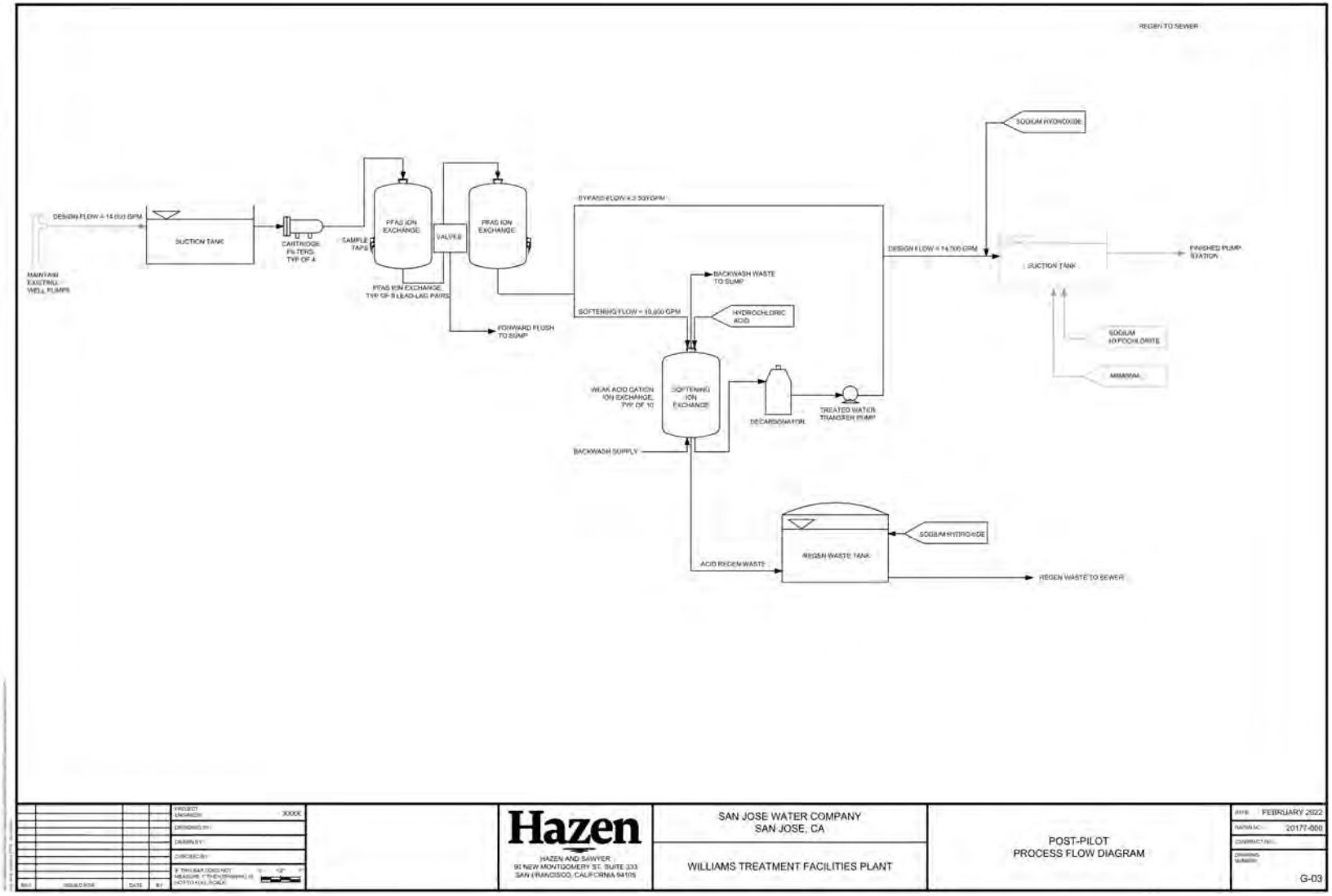


Figure 7-3. Post-Pilot PFD

The design parameters for treatment processes were unchanged by the results of piloting. Table 7-1 provides a summary of the design parameters for IX, FS, and WAC softening processes.

Table 7-1. Design Parameter Summary for IX, FS, and WAC

Design Requirements				
Parameter	**Units**	**PFAS IX**	**Fluoro-Sorb**	**WAC Softening**
Flow Rate	gpm	14,000	14,000	10,500
	MGD	20.2	20.2	15.1
min EBCT	min	2.5	2.5	2.7
max HLR	gpm/ft2	15.0	9.5	9.5
Temp	°C	20.0	N/A	15.6
Design Details				
		PFAS Treatment		**Softening**
Design Parameter	**Units**	**Ion Exchange**	**Fluoro-Sorb**	**WAC**
Vessel Diameter	ft	12	12	12
Vessel Surface Area	ft2	113	113	113
Max Flow Per Vesel	gpm	1,800	1,800	1,800
Volume of Media	ft3	520	420	380
Configuration	-	Lead/Lag	Lead/Lag	Lead Only
Min Number of Trains	-	9	14	10
Total Number of Vessels	-	18	28	10
EBCT (Lead Vessel)	min	2.5	3.1	2.7
HLR	gpm/ft2	13.8	8.8	9.3
Flow Per Vessel (Lead)	gpm	1,556	1,000	1,050
Depth of Media	ft	4.6	3.7	3.4
Backwash	**Units**	**Ion Exchange**	**Fluoro-Sorb**	**WAC**
BW Percent Expansion	%	N/A	Bed Expansion vs.	80%
BW Bed Expansion	ft		Flowrate Not Yet	2.7
Freeboard	ft		Defined	2.0
Backwash Rate	gpm/sf		5, 8, 10	5.8
Backwash Flow Rate	gpm		565, 905, 1,131	661
Backwash Duration	min		3, 3, 25	15
Vertical Height	ft		N/A	8.0
Backwash Waste Water	Gal		32,685	9,919
Headloss	**Units**	**Ion Exchange**	**Fluoro-Sorb**	**WAC**
Media Headloss				
Headloss / Media Depth	psi/ft	1.3	Empirical Data Only	1.0
Headloss / Vessel	psi	6.2	4.0	3.3
Headloss / Train	ft	28.6	18.5	7.6
Headloss / Train	psi	12.4	8.0	3.3
Vessel Headloss				
Headloss / Vessel	psi/ves.	3.0	3.0	2.5
Headloss / Train	psi	6.0	6.0	2.5
Dirty Headloss	psi	15.0	15.0	5.0
Total Headloss (Clean Conditions)	psi	18.4	14.0	5.8
Total Headloss (Dirty Conditions)	psi	33.4	29.0	10.8
Averaged Headloss for O&M Cost Estimate	psi	25.9	21.5	8.3

Although the design parameters were unchanged, one key operational parameter was updated: acid dosing during regeneration. Model projections of bed volumes at regen, acid doses for softened and overall flows, and process efficiency were obtained from Hungerford & Terry, Dow Chemical, and Purolite. A summary of these parameters can be found in Table 7-2. Compared to the Hungerford & Terry projections used in the technology screening, the bed volumes to regen and acid dose parameters were found to be significantly higher during the pilot study. Due to these findings, **it is recommended that acid dose optimization be investigated further during demonstration testing prior to full-scale construction.**

Table 7-2. Comparison of Operational WAC IX Softening Parameters

Parameter	Units	Hungerford & Terry *	Dow Chemical	Purolite	Pilot Results	% Change
Bed Volumes at Regen	BV	310	450	470	570	85%
Acid Dose (Softened Flow)	mg/L	170	210	280	230	39%
Acid Dose (Overall Flow)	mg/L	130	160	210	180	39%
Process Efficiency (Less Backwash & Rinse)	%	98.9	97.7	98.5	98.8	0%

* Basis of technology screening

7.2.2 Survey

A site survey of the Williams station was performed, based on NAD83 and NAVD88 as the horizontal and vertical datum with SJW-provided local benchmarks. The survey included 1-ft contour intervals and captured all visible ground features. Trees with a circumference of 6-in or larger, fences, paved roads, structures, trenches/trench scars, and manholes were captured within the survey. A potholing specialist marked all identified underground utilities. The potholing effort included vacuum excavation to confirm underground utilities and backfill with class II in pavement and cold permanent patch in asphalt/concrete. Manhole invert elevation, pipe diameter, and flow direction were captured and noted in the site survey. Storm drain facilities including catch basins, size of pipes, invert elevations, and diameter and direction if visible were captured and added to the site survey. A survey of the depth to the top of the nut for all water valves and indication of the type of valve, valve extension, and length if visible was performed.

The site survey drawing with a map scale of 1” = 40’ was prepared by CalVada Surveying. CalVada provided an electronic CAD file of the site survey. The site survey drawing was the basis for all conceptual layouts developed.

7.2.3 Geotechnical

Geotechnical investigation of the site was performed by Cal Engineering and Geology in August of 2021. Summary of findings and values below are in reference to the Geotechnical Report and for complete findings and recommendations see the complete report included in **Appendix B**. Proposed facilities include equipment on mat slab foundation at grade and concrete ring footing for steel break tanks. Site geologic and seismic hazards were identified, and design criteria defined. Three bore holes were made on site to depths between 20 and 25 ft below ground surface, see Figure 7-4 for locations.

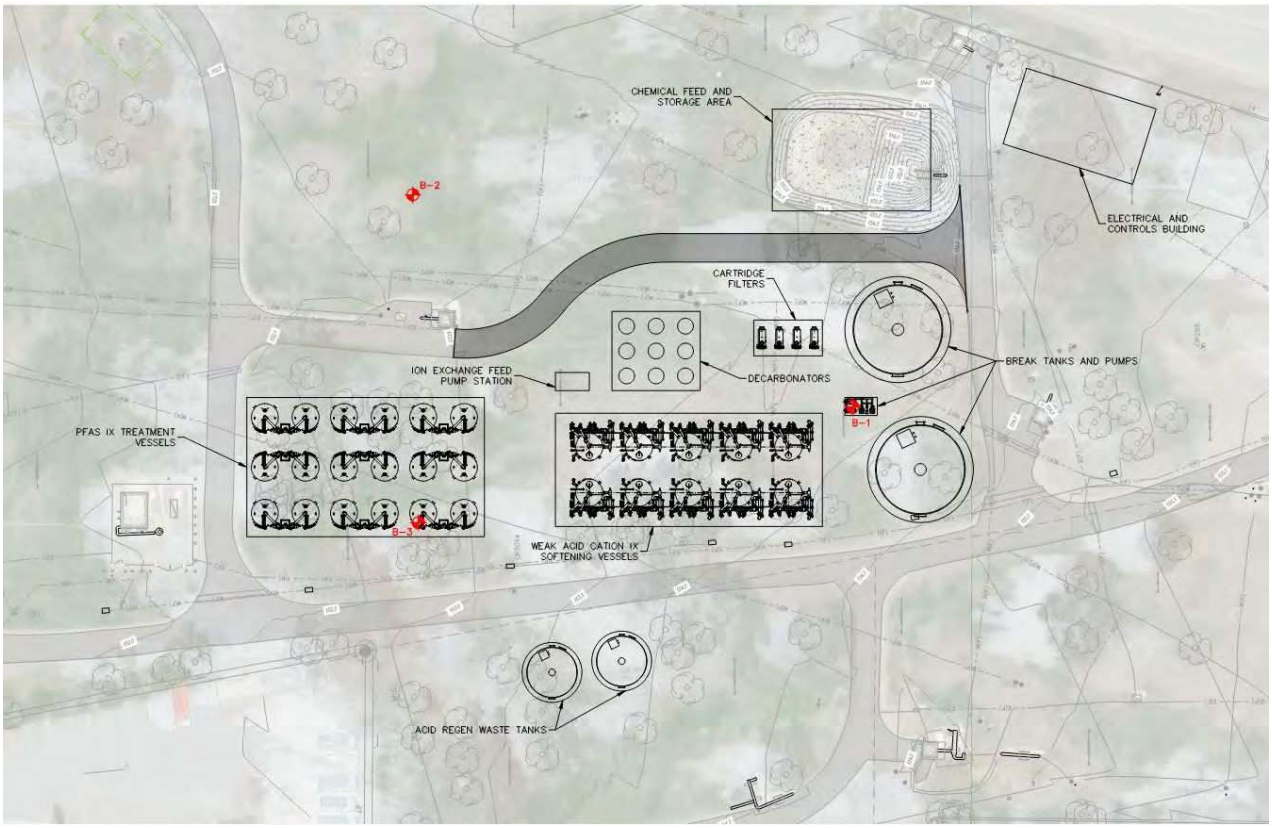


Figure 7-4. Boring Locations

Site hazards from liquefaction and seismic densification were identified as low potential for the site. Corrosion potential of the onsite soils is classified as negligible for concrete per ACI criteria. The top 18 inches of soil show heavy burrowing animal activity and should be scarified and recompacted to 90 percent relative compaction. The seismic design criteria for the site are included in Table 7-3.

Table 7-3. Seismic Design Criteria

Parameter	Value
Site Class	D
Mapped Short Period (0.2 second) Spectral Response Acceleration (S_s)	1.615g
Mapped 1-Second Spectral Response Acceleration (S_1)	0.600g
Site Coefficient F_a	1.0
Site Coefficient F_v	1.7
Design Spectral Response Acceleration for Short Period (SDS)	1.076g
Design Spectral Response Acceleration for 1-Second Period (SD1)	0.724g
Mapped Peak Ground Acceleration, PGAM	0.724g

Allowable soil bearing for mat foundations is 2,000 lb/ft^2 with one third increase allowed for transitory loads. Mat foundation minimum depth below adjacent is 12 inches with 12-inch subgrade scarification and re-compaction to 95 percent relative compaction. A subgrade bearing modulus of 200 kci may be used for foundation design. Lateral loading may be resisted by soil friction using a coefficient of 0.35 combined with an equivalent fluid passive pressure of 350 lb/ft^3.

Allowable soil bearing for conventional isolated, spread, or continuous footings is 4,500 lb/ft^2 with one third increase allowed for transitory loads. Footing minimum depth below adjacent is 24 inches with 12-inch subgrade scarification and re-compaction to 95 percent relative compaction. Lateral resistance from soil friction using a coefficient of 0.35 that may be combined with equivalent fluid passive pressure of 350 lb/ft^3.

7.2.4 Layout

The post-pilot site layout is shown in Figure 7-5. In addition to the PFAS and softening treatment equipment, a new road is recommended on the eastern edge of the treatment area to allow for access to service equipment. Further investigation into site entrance improvements is recommended to facilitate truck access to the site for chemical and media delivery, which was a challenge during the pilot study.

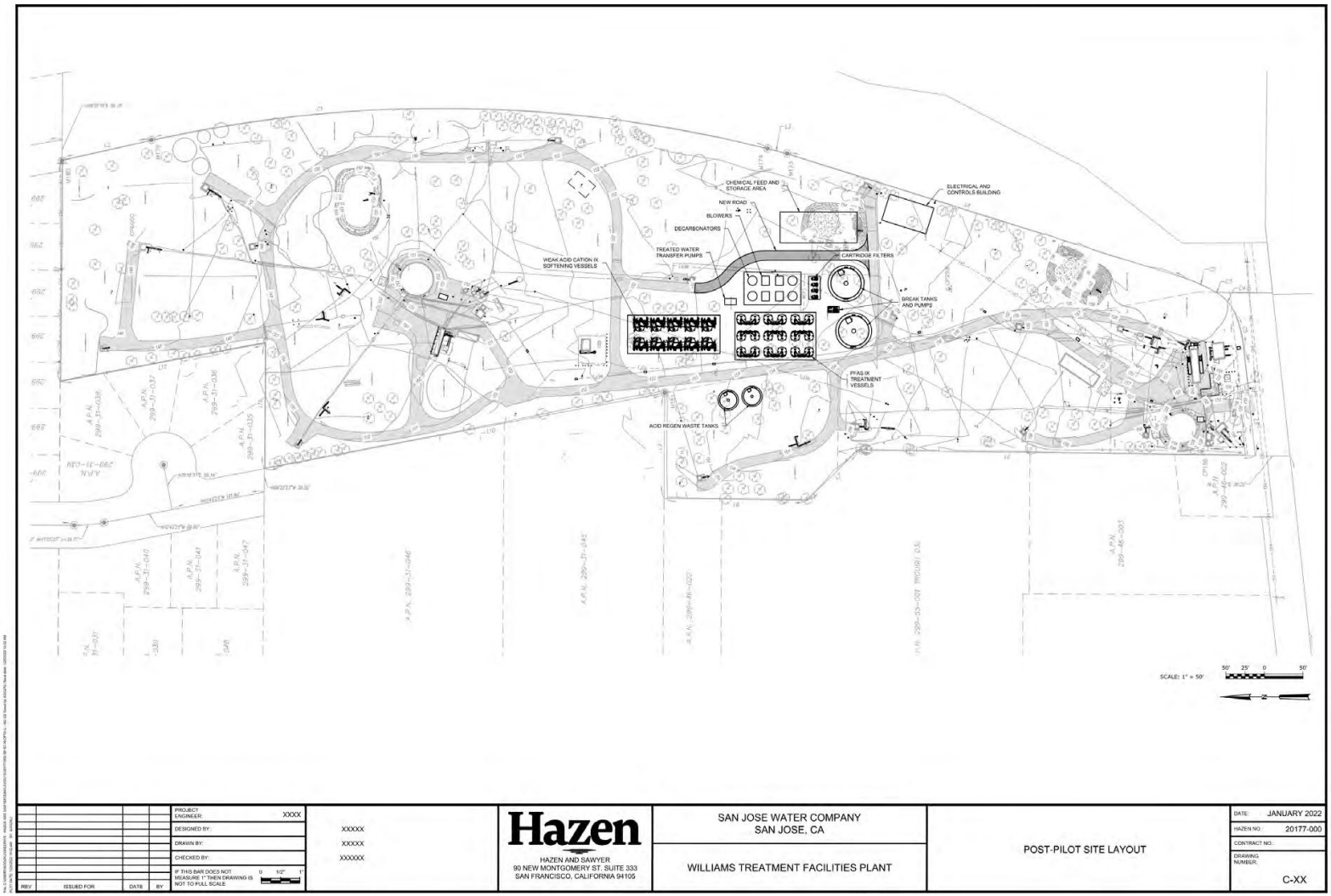


Figure 7-5. Post-Pilot Site Layout

7.3 Capital, O&M, and Lifecycle Costs

This section provides revised estimates of capital, O&M, and lifecycle costs. The capital, O&M, and lifecycle costs presented in Section 4.3 were revised to reflect the findings from the pilot study and further development of the treatment system. The annual average flow was increased from 6.24 MGD to 7 MGD to reflect recent increases in demand.

7.3.1 Capital Cost

Capital costs for the acid regen softening and PFAS IX treatment system are summarized in Table 7-4. The associated capital cost assumptions are shown in Table 7-5. The estimate serves for planning and preliminary budget approval and is considered to be an AACE Class 3 level. Class 3 has a typical accuracy range of -20% on the low side and +30% on the high side. A 30% design contingency has been added to the estimate based on current status of the design documents, the nature of the project, and the estimate classification.

The probable project cost increased from the alternatives evaluation estimate of $48,800,000 to $60,100,000. The project cost increased by $10,000,000 due to increasing design flow from 10,000 to 14,000 gpm, adding break tanks and feed pumps, but removing greensand filtration. The project cost also increased due to higher revised cost estimates for decarbonators and blowers from vendors. The project cost of the electrical building also increased. However, some equipment costs decreased, including the WAC IX, electrical and instrumentation, and yard piping.

Table 7-4. Detailed Summary for Post-Pilot Capital Cost

Description	Cost
Demolition	$200,000
Break Tank	$1,000,000
Feed Pump	$1,200,000
Cartridge Filters	$900,000
Ion Exchange	$14,600,000
Treated Water Transfer Pump Station	$800,000
Weak Acid Cation IX	$13,000,000
Acid Waste Tank	$1,200,000
Decarbonator	$3,400,000
Chemical Storage	$3,400,000
Electrical Building	$800,000
Site Work	$400,000
Yard Piping	$2,000,000
Electrical and Instrumentation	$3,300,000
PROBABLE CONSTRUCTION COST	$46,200,000
Project Costs (Design & ESDC, PM, CM, Legal)	$13,900,000
PROBABLE PROJECT COST	$60,100,000

Table 7-5. Post-Pilot Capital Cost Assumptions

Assumption	Percentage
Portion of work performed by Subcontractor	20%
Subcontractor Overhead and Profit	25%
Contractor Mark-up on Subcontractor work	5%
Contractor Overhead	10%
Contractor Profit	10%
Escalation at 3% annually	5%
Bond and Insurance	3%
Contingency	30%
Contingency (IX Vessels)	15%

7.3.2 O&M Cost

The preliminary O&M cost estimate was revised to incorporate the findings from the pilot study. The O&M cost estimate consisted of the following costs: chemical cost, media/consumable replacement, additional Valley Water (VW) in 2029 rates, electricity, labor, analytical, sewer disposal fees, and solids disposal. Table 7-6 summarizes the O&M cost estimates for the alternatives evaluation, pre-pilot (PM3), and post-pilot.

Table 7-6. Alternatives Evaluation, Pre-Pilot, and Post-Pilot O&M Cost Summary

	Alternatives Evaluation (Section 4.3.2)	Pre-Pilot (PM3)	Post-Pilot
Chemical Cost	$538	$581	$604
Media / Consumable Replacement	$109	$118	$127
Additional VW Fees (2029 rates)	$236	$209	$232
Electricity	$121	$102	$79
Labor	Not Included	$157	$235
Analytical	Not Included	$59	$59
Sewer Disposal Fees	$154	$128	$143
Solids Disposal	$0	$0	$0
Total O&M ($/MG)	**$1,158**	**$1,353**	**$1,478**
Annual O&M ($/yr)	**$3,000,000**	**$3,500,000**	**$3,800,000**

The chemical cost increased between the preliminary stages of design and the revised design. During the alternatives evaluation, the chemicals used in the acid-regen IX softening, PFAS IX with Greensand pretreatment included sodium hypochlorite (OSG), sodium bisulfite, sodium hydroxide, hydrochloric acid, and liquid ammonium sulfate. When Greensand filtration was eliminated from pretreatment in the selected alternative, OSG and sodium bisulfite were no longer necessary for the treatment system. However, with the low pH in the softened effluent, it was necessary to significantly increase the chemical dose of sodium hydroxide, from 5 mg/L to 30 mg/L. Due to the significant increase in sodium hydroxide dose, the chemical cost increased in both the pre- and post-pilot design stages. For the post-pilot O&M chemical cost estimate, the chemical doses of OSG and LAS for the planned onsite chloramine generation were incorporated. The increase in OSG and LAS doses from the pre-pilot cost estimate is reflected in the post-pilot O&M chemical cost. A summary of preliminary and revised chemical dosages is shown in Table 7-7.

Table 7-7. Preliminary and Revised Chemical Dosages Summary

Chemical	Preliminary Chemical Dose (mg/L)	Revised Chemical Dose (mg/L)
Sodium hypochlorite (OSG)	4	4
Sodium bisulfite	3	0
Sodium hydroxide	5	30
Hydrochloric acid	113	113
Liquid ammonium sulfate (LAS)	0.5	0.8

The media and consumables replacement increased between the alternatives evaluation, pre-pilot, and post-pilot designs. In the development of the selected alternative, cost of PFAS IX resin was increased from an assumed \$290/ft^3 to \$325/ft^3 to reflect increasing disposal costs, and the volume of PFAS IX resin was increased from 449 ft^3 to 520 ft^3 to achieve 2.5 min EBCT at the increased flow rate.

The additional Valley Water (VW) fees (2029 rates) changed throughout the development of the selected alternative. In the alternatives evaluation, the Greensand filtration along with the regen brine resulted in approximately 2.6% loss, which was then multiplied by the estimated cost of groundwater per MG in 2029 (\$236/MG). After field testing and discussions with SJW, Greensand filtration was no longer considered for pretreatment as part of the selected treatment alternative in PM3. Removal of greensand filtration reduced loss from 2.6% to 2.3% (\$209/MG). However, the estimated loss increased to 2.5% after analyzing the pilot results. The pilot results indicated that the fraction of flow to be softened should be increased to 75% instead of 67%. In both the alternatives evaluation and PM3, the fraction of softened flow was 67% based on vendor recommendations. Due to the increase in fraction of flow to be softened, the estimated loss of 2.5% O&M cost from additional Valley Water fees increased to \$232/MG.

The sewer disposal fees were related to water loss, similar to the additional VW fees. The respective estimated losses of 2.6%, 2.3%, and 2.5% for the alternatives evaluation, pre-pilot, and post-pilot design resulted in the variation in sewer disposal fees. For all three stages of design, it was estimated that the capital recovery was \$6 per MG treated water and O&M recovery was \$136 per MG treated water.

Electricity O&M cost estimates decreased between the alternatives evaluation, pre-pilot, and post-pilot design. The electricity O&M cost estimate for the alternatives evaluation was higher than that of the pre-

and post-pilot design due to Greensand filtration. To overcome the added headloss from Greensand filtration, larger pumps with higher electrical demands were required. When Greensand filtration was eliminated from the treatment system, the electrical demands and costs decreased for the pre- and post-pilot design. The electrical demands decreased between the pre- and post-pilot design with the refinement of anticipated treatment headlosses.

In the Alternatives Evaluation, labor and analytical O&M costs were not estimated. In discussion with SJW during PM3, SJW provided an estimate for the annual loaded labor per FTE: $200,000/FTE. It was also estimated that one to three FTEs would be required to operate the proposed treatment plant, and the initial cost estimate from PM3 assumed two FTEs. After experience with piloting and better defining the frequency of chemical deliveries, the number of additional FTEs was increased from two to three to account for additional labor in handling chemicals.

Analytical O&M costs were estimated based on assumptions for PFAS and other water quality parameter sampling frequency and analysis. The analytical O&M cost assumptions can be found in Table 7-8 below.

Table 7-8. Analytical O&M Cost Assumptions

O&M Category	Cost or Frequency
PFAS Sample Cost ($/sample)	$250
Number of Sample Points	15
Sampling Events per Year	24
PFAS Analytical	$90,000
Additional Analytical	$60,000
Annual Cost ($/MG)	**$59**

Figure 7-6 shows the differences in O&M cost estimates between the alternatives evaluation, pre-pilot (PM3), and post-pilot.

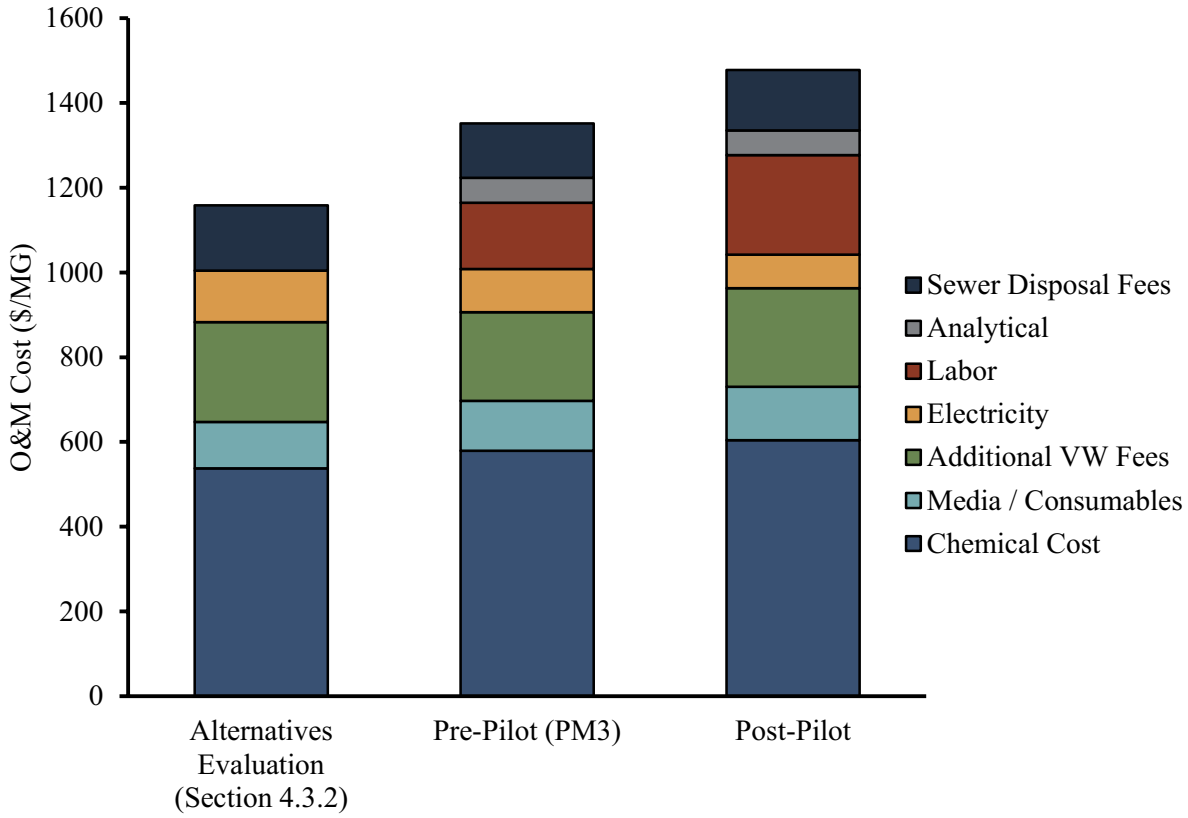


Figure 7-6. Anticipated O&M Cost Breakdown Comparison ($/MG)

7.3.3 Lifecycle Costs

A lifecycle cost analysis was performed based on the previous assumptions listed in Section 4.3.3 and the updated O&M and annual average flow rate. The results of this analysis and its comparison with that of Section 4.3.3 are summarized in Table 7-9. The annual O&M and O&M NPV increased from the previous lifecycle cost analysis due to revised O&M cost estimates. The capital cost estimate was revised from AACE Class 4 to Class 3, and capital costs increased from the additional equipment and revised vendor quotes. With the increase in O&M and capital cost estimates, the revised lifecycle cost increased from the preliminary lifecycle cost by approximately 31%.

Table 7-9. Preliminary and Revised Lifecycle Cost Comparison

	Preliminary Lifecycle Costs	Revised Lifecycle Costs
AACE Cost Estimate Class		
Estimate Class	Class 4	Class 3
Expected Accuracy Range	-30% to +50%	-20% to +30%
O&M		
Annual O&M	$2,700,000	$3,800,000
O&M NPV	$38,400,000	$54,000,000
Capital		
Project Cost	$48,800,000	$60,100,000
Upfront Capital	$26,100,000	$32,100,000
Financed Amount	$22,800,000	$28,100,000
Debt Service NPV	$19,800,000	$24,300,000
Total Capital NPV	$45,800,000	$56,300,000
30-Year Lifecycle Cost		
Total Lifecycle NPV	**$84,200,000**	**$110,300,000**

7.4 Estimated Construction Schedule

The estimated construction schedule is shown in Figure 7-7. The overall time for design, permitting, and construction was estimated to be 28 months, with 10.5 months for design and 15 months for construction. Assuming a detailed design award of September 1, 2022, startup and commissioning could be completed by the end of 2024. Alternative project delivery mechanisms, such as design-build, could be considered to accelerate the overall schedule.

SJW Williams PFAS IX and Softening - Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Demonstration-Scale Testing**	**320 days**	**Thu 9/1/22**	**Wed 11/22/23**	
2	Engineering Design Award	0 days	Thu 9/1/22	Thu 9/1/22	
3	Procurement & Construction	9 mons	Thu 9/1/22	Wed 5/10/23	2
4	Demonstration-Scale Testing	6 mons	Thu 5/11/23	Wed 10/25/23	3
5	SJW Design Decision	4 wks	Thu 10/26/23	Wed 11/22/23	4
6	**Detailed Design PS&E**	**260 days**	**Wed 4/10/24**	**Wed 4/9/25**	
7	Detailed Design Award	0 days	Wed 4/10/24	Wed 4/10/24	5FS+5 mons
8	Prepare 30% Design	12 wks	Thu 4/11/24	Wed 7/3/24	7
9	SJW Review	3 wks	Thu 7/4/24	Wed 7/24/24	8
10	Prepare 75% Design	20 wks	Thu 7/25/24	Wed 12/11/24	9
11	SJW Review	3 wks	Thu 12/12/24	Wed 1/1/25	10
12	Prepare 90% Design	8 wks	Thu 1/2/25	Wed 2/26/25	9,11
13	SJW Review	3 wks	Thu 2/27/25	Wed 3/19/25	12
14	Final PS&E	3 wks	Thu 3/20/25	Wed 4/9/25	13
15	**DDW Permitting**	**460 days**	**Thu 7/4/24**	**Wed 4/8/26**	
16	Review 30% Design	6 wks	Thu 7/4/24	Wed 8/14/24	8,5
17	75% Design Review Meeting	6 wks	Thu 12/12/24	Wed 1/22/25	10
18	Submit Final Plans	0 days	Wed 4/9/25	Wed 4/9/25	14
19	Draft OMMP and Engineering Report	6 wks	Thu 4/17/25	Wed 5/28/25	13FS+4 wks
20	DDW Review	8 wks	Thu 5/29/25	Wed 7/23/25	19
21	Final OMMP and Engineering Report	3 wks	Thu 7/24/25	Wed 8/13/25	20
22	Permit Application	4 wks	Thu 8/14/25	Wed 9/10/25	21
23	DDW Permit Issued	30 wks	Thu 9/11/25	Wed 4/8/26	22
24	**Construction Bidding**	**70 days**	**Thu 4/10/25**	**Wed 7/16/25**	
25	Project Advertised for Bid	6 wks	Thu 4/10/25	Wed 5/21/25	18
26	Bid Review, Award, NTP	8 wks	Thu 5/22/25	Wed 7/16/25	25
27	**Construction**	**320 days**	**Thu 7/17/25**	**Wed 10/7/26**	
28	Submittals, Equipment Procurement	26 wks	Thu 7/17/25	Wed 1/14/26	26
29	Active Construction	40 wks	Thu 10/9/25	Wed 7/15/26	28SS+12 wks
30	Startup and Commissioning	12 wks	Thu 7/16/26	Wed 10/7/26	29,23

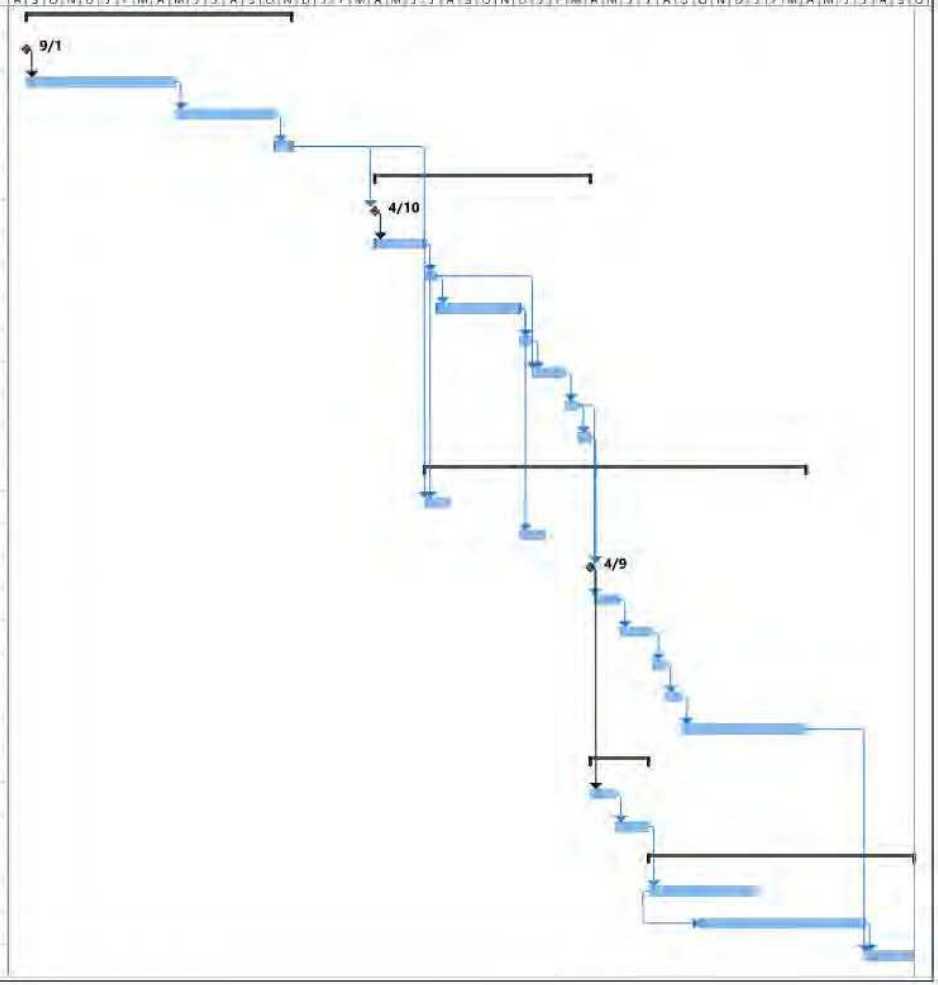


Figure 7-7. Estimated Construction Schedule

Appendix A: RSSCT and Recirculating Isotherm Bench Testing Report

BENCH-SCALE TESTING OF PFAS REMOVAL FROM SAN JOSE WATER COMPANY'S W2 WELL WATER

Technical Report

PREPARED FOR:

Hazen and Sawyer
&
San Jose Water Company

PREPARED BY:

WATER QUALITY & TREATMENT SOLUTIONS, INC.

Los Angeles, California



www.WQTS.com

MARCH 26, 2021

The San Jose Water Company (SJWC) owns and operates 14 wells as part of the Williams Station located at 3601 Williams Road in San Jose, California. Some of the wells were found to contain low levels of per- and poly-fluoroalkyl substances (PFAS). SJWC retained the services of Hazen and Sawyer (Hazen) to evaluate treatment alternatives for the Williams Station wells, and Water Quality & Treatment Solutions, Inc. (WQTS) is supporting Hazen's effort by conducting bench-scale testing aimed at evaluating the removal of PFAS from the groundwater with different adsorbents. The objectives of the testing were as follows:

1. *Compare the performance of different adsorbents for the removal of PFAS from Williams Well #2 water.*
2. *Estimate the replacement frequency for each adsorbent when treating Williams Well #2 water.*

Testing was conducted at WQTS' facility in Los Angeles. This report presents the details of the bench testing work and its results.

1.1 HISTORICAL WATER QUALITY

Historical water quality data collected by SJWC from Williams Station Wells 2 through 18 in 2019 and 2020 were received and analyzed. The average and range of values of various water quality parameters in all the wells are presented in Table 1.1. The range was limited to 5th percentile to 95th percentile to eliminate outliers. The water from the wells has a relatively low pH of 7.2 with an alkalinity of 168 mg/L as $CaCO_3$. The water is also relatively hard with an average calcium concentration of 55 mg/L and a total hardness concentration of 242 mg/L as $CaCO_3$.

Other water quality parameters of interest to the treatment system include sulfate, which is typically present in the water at an average concentration of 39 mg/L, and iron, which is present in the water at an average concentration of 75 µg/L. Sulfate competes with PFAS for absorption on IX resins, but the concentration of sulfate in this groundwater is relatively low, which should allow for higher IX resin utilization rates. However, the iron concentration of 75 µg/L is high enough to cause significant precipitation of iron deposits on any adsorbent media, which can foul the adsorbent and reduce its adsorption capacity.

Table 1.1 – General Water Quality of the Williams Station Wells (2019 – 2020)

Parameter	Unit	Average	Range (5th to 95th Percentile)
pH	--	7.2	6.2 – 7.7
Alkalinity	mg/L as $CaCO_3$	168	131 – 206
Calcium	mg/L	55	42 – 69
Magnesium	mg/L	13	6.7 – 23
Total Hardness	mg/L as $CaCO_3$	242	199 – 295
Chloride	mg/L	45	37 – 52
Sulfate	mg/L	39	31 – 43
Iron	µg/L	75	0 – 293
LSI @ Source Temp.	--	–0.46	–0.03 to –0.76
Manganese	µg/L	0.4	0 – 1.7
Nitrate	mg/L as N	3.2	1.8 – 4.8
Conductivity	µS/cm	440	479 – 650
Silica	mg/L as Si	23	13 – 28
Sodium	mg/L	21	19 – 24
TDS	mg/L	343	294 – 391
Turbidity	NTU	0.5	0.2 – 1.5
Temperature	°C	17	13 – 19

The PFAS levels measured by SJWC in the Williams Station wells in 2019 and 2020 were consolidated and analyzed. A total of six (6) PFAS chemicals were detected in the groundwater. The average of each of the six PFAS chemicals measured in each well is plotted in Figure 1.1. The three PFAS chemicals with California Notification Levels (NLs), PFOA, PFOS, and PFBS, are plotted first, followed by PFHpA, PFHxS, and PFNA, which do not yet have State NLs or other federal or California regulatory limits.

The data presented in Figure 1.1 show that the PFAS levels are quite low, with many below the Minimum Reporting Limit (MRL) of 2 ng/L. Of the two PFAS chemicals with NLs, PFOA is typically of greater concern because it has the lower NL of 5.1 ng/L and is less adsorbable on GAC and IX resins than PFOS. However, the average PFOA levels in all the wells were less than the MRL of 2 ng/L. For PFOS, the average levels were above the MRL in some wells, while three wells (2, 14, & 15) had PFOS around the NL of 6.5 ng/L. The highest PFBS concentration is 2.2 ng/L, which is far below the California NL of 500 ng/L. Other PFAS with levels above the MRL of 2 ng/L include PFHxS and PFNA.

Based on the values reported in Figure 1.1, water used for bench-scale testing was collected from Well #2 because this well appeared to have the highest concentrations of the measurable PFAS chemicals.

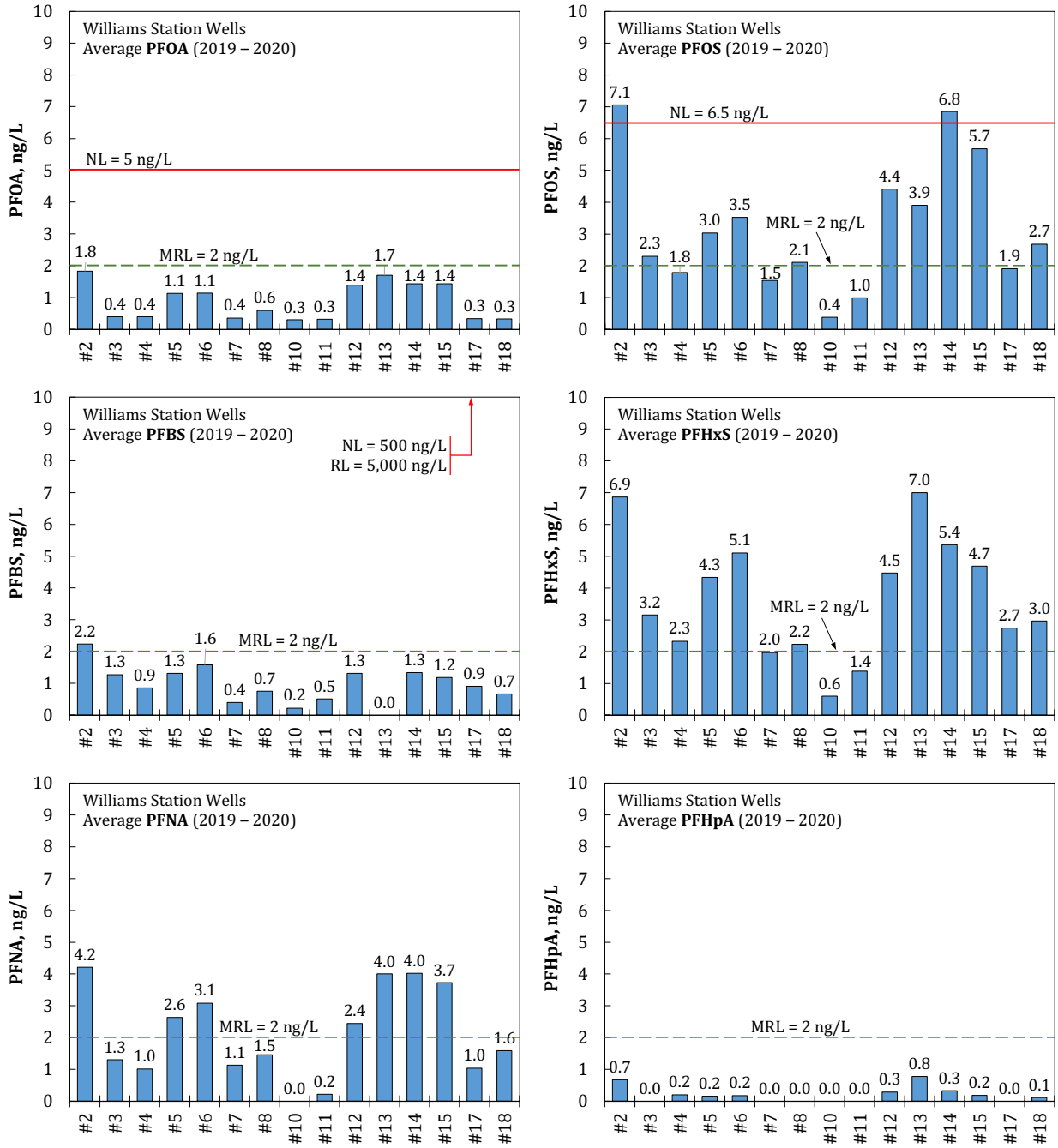


Figure 1.1 – Average PFAS Levels in the Williams Station Wells (2019 – 2020)
[ND = Non-Detectable; NA = Not Analyzed]

At this time, available PFAS treatment technologies are limited to removal – and not destruction – technologies. These include removal with reverse osmosis (RO) membranes in which the PFAS is concentrated in a liquid waste stream, or adsorption on solid adsorbents that concentrate the PFAS chemicals on their surface. When their surface capacity is exhausted, the adsorbent is removed and replaced with fresh adsorbent. The spent adsorbent is taken off site by the supplier for destruction or disposal. This study focused on the evaluation of PFAS removal with adsorbents. This section identifies the adsorbents evaluated and the experimental methodologies employed in their evaluation.

2.1 ADSORBENTS

Three (3) Granular Activated Carbon (GAC) materials, two (2) ion-exchange (IX) resins, and one (1) specialty adsorbent were evaluated in this study. The supplier and name of each product are listed in Table 2.1. The three GAC materials evaluated were Filtrasorb-400 (F400) GAC provided by Calgon Carbon Corporation, UC1240LD GAC provided by Evoqua™, and AV1240 GAC provided by AqueoUSVets™. The two IX resins evaluated were PFA694E™ resin, provided by Purolite™, and PSR2 Plus™ resin, provided by Evoqua™. The one specialty adsorbent was Fluoro-Sorb™ 200 (FS200) provided by Mineral Technologies, Inc. The technical specifications of the six adsorbents, as provided by their suppliers, are attached as Appendix A.

Table 2.1 – Products Planned for Testing

Product	Supplier	Product Name
GAC	Calgon Carbon	F400
GAC	Evoqua	UC1240LD
GAC	AqueoUSVets	AV1240
Specialty Adsorbent	Minerals Technologies, Inc.	Fluoro-Sorb® 200
IX Resin	Evoqua	PSR2+
IX Resin	Purolite	PFA694E

The capacities of the three GAC materials and FS200 for PFAS were evaluated using the Rapid Small Scale Column Test (RSSCT) procedure. The two IX resins were evaluated using Recirculating Column Isotherm (RCI) test. A discussion of the specifics of each test is presented later in this section.

2.2 TEST WATER

Untreated groundwater was collected from the Well #2 on January 19, 2021. The well was flushed by SJWC operations several times during the three days prior to sampling. On the morning of sample collection, the well and sample hoses were flushed for approximately one hour before a total of 16 55-gallon drums were filled water. The drums were lined with Low Density Polyethylene (LDPE)

liners to prevent sample contamination. Once filled, the drums were sealed and transported to the WQTS facility in Los Angeles where they were held at room temperature (~22 °C). A raw water sample was collected from one of the barrels and submitted to Eurofins Eaton Analytical Laboratories (EEA Labs, Monrovia, CA) for analyses of various water quality parameters including PFAS and perchlorate. WQTS also performed some in-house water quality analyses. Table 1 presents a summary of the raw water sample results including the four detectable PFAS chemicals. All other PFAS chemicals were below the Minimum Reporting Limit (MRL) of 2 ng/L and are listed in the footnote to Table 1.

Table 1 – Measured water quality parameters in Well #2 Water Sampled on January 19, 2021

Parameter	Unit	Value	Parameter	Unit	Value
General Chemical and Mineral Parameters					
pH	--	7.8*	Conductivity	µS/cm	540
UV_{254} (0.45-µm filtered)	cm^{-1}	0.004	Alkalinity	mg/L $CaCO_3$	152
TOC	mg/L	0.53	Total Hardness	mg/L $CaCO_3$	235
Bromide	µg/L	150	Calcium	mg/L	53
Nitrate	mg/L as N	2.4	Magnesium	mg/L	27
Sulfate	mg/L	42	Potassium	mg/L	<1.0
Iron	mg/L	<0.02	Sodium	mg/L	20
Metals					
Aluminum	µg/L	<20	Lead	µg/L	<0.5
Antimony	µg/L	<1.0	Manganese	µg/L	2.8
Arsenic	µg/L	<1.0	Nickel	µg/L	<5.0
Barium	µg/L	71	Selenium	µg/L	<5.0
Beryllium	µg/L	<1.0	Silver	µg/L	<0.5
Cadmium	µg/L	<0.5	Thallium	µg/L	<1.0
Chromium	µg/L	1.1	Zinc	µg/L	<20
Copper	µg/L	<2.0	Mercury	µg/L	<0.2
Detected PFAS Chemicals (EPA Method 537.1)*					
Perfluorooctanesulfonic acid (PFOS)				ng/L	7.8
Perfluorohexanesulfonic acid (PFHxS)				ng/L	8.5
Perfluorononanoic acid (PFNA)				ng/L	5.0
Perfluorobutanesulfonic acid (PFBS)				ng/L	2.5

* The pH varied from 7.5 to 8.3 during the testing

** Non-detectable (<2 ng/L) PFAS chemicals included: Perfluorooctanoic acid (PFOA), Perfluorohexanoic acid (PFHxA), Perfluoroheptanoic acid (PFHpA), Perfluorodecanoic acid (PFDA), Perfluorododecanoic acid (PFDoA), Perfluorotetradecanoic acid (PFTeDA), Perfluorotridecanoic acid (PFTriDA), Perfluoroundecanoic acid (PFUnA), 11-chloroeicosafluoro-3-oxaundecane-sulfonic acid, 4,8-dioxa-3H-perfluorononanoic acid (ADONA), 9-chlorohexadecafluoro-3-oxanone-sulfonic acid, Hexafluoropropylene oxide dimer acid (HFPO-DA), N-ethyl Perfluorooctanesulfonamido acetic acid (NEtFOSAA), and N-methyl Perfluorooctanesulfonamido acetic acid (NMeFOSAA).

2.3 RAPID SMALL-SCALE COLUMN TEST

2.3.1 RSSCT Background

The RSSCT is a bench-scale testing procedure used to estimate the replacement frequency of an adsorbent at a full-scale treatment plant. The test procedure was developed at Michigan Technological University and has since become a standard test procedure in the water industry. Specifically, the RSSCT method is described in ASTM Standard Method D-6586-03 titled: "*Standard Practice for the Prediction of Contaminant Adsorption on GAC in Aqueous Systems Using Rapid Small-Scale Column Tests*". In this test, the adsorbent is crushed to a smaller size and put into a small column, which becomes a small-scale replica of the large-scale vessel. The operating time for the small-scale column is a fraction of that for the large-scale vessel, allowing for a faster prediction of the time to breakthrough and the full-scale GAC replacement frequency.

The scale-up model used to represent the relationship between the RSSCT column and the full-scale vessel depends on whether the diffusion of the chemical into the adsorbent is dependent on or independent of the adsorbent grain size. If the diffusivity is independent of the grain size, then the diffusivity is said to be constant, and the scale-up model is referred to as the Constant Diffusivity (CD) model. If the diffusivity is dependent on adsorbent size, then the scale-up model is referred as the Proportional Diffusivity (PD) model. For micropollutants, such as PFAS chemicals, their diffusivity is believed to be independent of the adsorbent size, and therefore, the CD scale-up model is applied in the design of the RSSCT test column.

2.3.2 RSSCT Design

The design of the RSSCT column involves selecting the adsorbent size to use and the operating conditions that are hydraulically equivalent to the anticipated full-scale system's design and operation. The primary equation used to select the size of the adsorbent under the CD scale-up model is represented in Equation 1. This equation states that the Scale Factor (SF) between the full-scale system and the small-scale system (i.e., RSSCT) is equal to the ratio of the Empty Bed Contact Time for the full-scale system, $EBCT_{FS}$, to that of the RSSCT, $EBCT_{SS}$, which is also equal to the square of the ratio of the adsorbent size in the full-scale contactor, d_{FS}, to that used in the RSSCT, d_{SS}. This ratio is also equal to the ratio of the operating times between the two scales as shown in Equation 1.

$$Scale\ Factor\ = \frac{EBCT_{FS}}{EBCT_{SS}} = \left(\frac{d_{FS}}{d_{SS}}\right)^2 = \frac{t_{FS}}{t_{SS}} \qquad \text{Eq. 1}$$

where: $EBCT_{FS}$ = Full-Scale EBCT value
$EBCT_{SS}$ = Small-Scale EBCT value
d_{FS} = Full-Scale media diameter
d_{SS} = Small-Scale media diameter
t_{FS} = Full-Scale operating time

t_{SS} = Small-Scale column operating time

The three GAC materials listed in Table 2.1 have a standard mesh size range of 12×40 mesh (i.e., 0.425 mm to 1.68 mm). For this GAC size, the d_{FS} value is calculated as the geometric mean of 0.425 mm and 1.68 mm, which is 0.845 mm. For the FS200 adsorbent, the supplier identifies its size as 20×40 mesh, which translates into a d_{FS} value of 0.60 mm.

Table 2.2 lists the RSSCT design parameters for the GAC RSSCT columns and the FS200 RSSCT columns. The design and operation of the RSSCT columns depends on the anticipated design and operation of the full-scale process. The top half of Table 2 presents the assumed full-scale system configuration using GAC or FS200, and the bottom half presents the corresponding RSSCT design for each. The EBCT of the full-scale GAC system is set at 7.5 minutes, while that of the full-scale FS200 system is set at 2 minutes. Both values were selected based on input from the suppliers and prior work conducted by WQTS and others.

Table 2.2 – RSSCT Design Parameters

Parameter	Units	GAC	FS200
Full-Scale System Configuration being Simulated			
US Mesh Size	--	12 × 40	20 × 40
Mean Grain Size	mm	0.845	0.60
Vessel Diameter	ft	12	12
Flowrate	gpm	900	1,650
Media Depth	ft	8	4
EBCT	minutes	7.5	2.0
Hydraulic Loading Rate	gpm/ft^2	8.0	14.6
Reynolds Number, *Re*	--	10.05	13.1
$Sc \times Re^{(1)}$	--	23,018	30,016
Bed Volumes Treated	BVs	158,000	300,000
Months of Operation	months	27	13.6
RSSCT Column Configuration & Operation			
US Mesh Size		140 × 200	140 × 200
Mean Grain Size	mm	0.089	0.089
Column Diameter	mm	6.6	6.6
Media Depth	cm	5.0	5.0
EBCT	minutes	0.084	0.044
Flowrate	mL/min	20.5	39
Reynolds Number, *Re*	--	1.96	3.72
$Sc \times Re^{(1)}$	--	4,490	8,522
Scaling Factor	--	90	45
Bed Volumes Treated	--	158,000	300,000
Water Volume Treated	gallons	71	136
Operating Time	days	9.0	9.0
Water Consumption Rate	gallons/day	7.8	15

(1) Product of the Schmidt Number (*Sc*) and the Reynolds Number (*Re*)

A standard 12-ft diameter vessel was assumed for both full-scale systems, and the flowrate was adjusted to result in a reasonable media depth in the contactor while meeting the selected EBCT value. This sets the hydraulic loading rate on each system.

With the full-scale values set, the RSSCT values were calculated based on Equation 1. The GAC and FS200 were crushed to a size of 140×200 mesh, which is equivalent to a grain size of 0.089 mm. Each RSSCT column had internal diameter of 0.66 cm and contained 5-cm of media depth. Each GAC RSSCT column was operated at a flowrate of 20.5 mL/min while the FS200 RSSCT column was operated at a flowrate of 39 mL/min. All columns were operated for nine (9) days, which translates into 158,000 bed volumes, BVs, treated through the GAC columns and 300,000 BVs treated through the FS200 column.

2.3.3 RSSCT Setup

To prepare each adsorbent for the RSSCT evaluation, the adsorbent was crushed and sieved through several standard sieves. The crushed adsorbent retained between US mesh #140 and US mesh #200 was separated and then repeatedly washed in deionized water for several hours until no additional fine particulates were observed in the water. The washed and wet adsorbent was then put in a desiccator under vacuum for 60 minutes to release air trapped in the adsorbent pores. After this step, each material was loaded into the RSSCT column.

WQTS set up four RSSCT columns in parallel as shown in Figure 2.1. All material in contact with the water is made from glass, polyethylene, or stainless steel. Water was pumped from a barrel through a prefilter, and then through each RSSCT column. The prefilter contained glass wool for the purpose of capturing any silts or fines in the water that would otherwise clog the RSSCT column. A rotameter with a pinch valve on the effluent of each column were used to fine-tune the flowrate and maintain it at the target value. While not shown in the schematic, pressure gauges were installed on the inlet and outlet of each RSSCT column to monitor for excess headloss buildup.

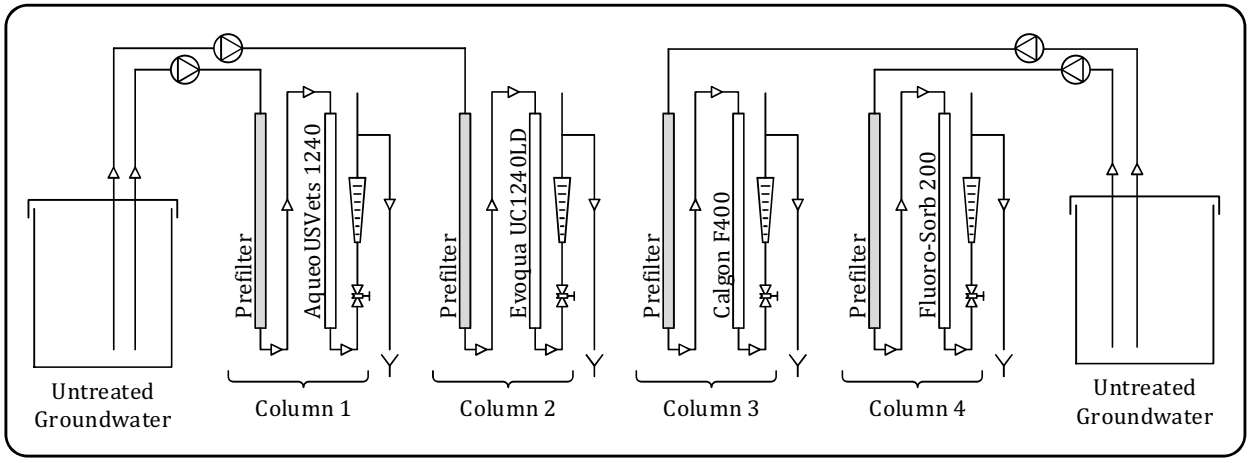


Figure 2.1 – RSSCT Testing Schematic

2.3.4 RSSCT Operation & Monitoring

As shown in Table 2.2, the RSSCT columns were operated for nine (9) days. Each GAC column consumed approximately eight (8) gallons per day, while the FS200 column consumed about 15 gallons per day. Water was pumped from one 55-gallon drum to two GAC RSSCT columns, and from another 55-gallon drum to the third GAC and F-200 RSSCT columns. As a result, each drum was in service for approximately 3 days before it was replaced with another drum.

The influent water to the four RSSCTs was sampled for PFAS once each day, while the effluent of each RSSCT column was sampled two times each day: Once in the early morning, and once in the late afternoon. This results in a total of nine (9) influent data points and 18 effluent datapoints from each

RSSCT column. The PFAS samples collected were stored at 4 °C until they were shipped EEA laboratories. PFAS compounds were quantified using EPA Method 537.1, which includes 18 chemicals. Table 2.3 lists the eighteen PFAS compounds included in this analytical method.

Table 2.3 – PFAS Compounds Analyzed by Method 537.1

Perfluorooctanesulfonic acid (PFOS)	Perfluorotetradecanoic acid (PFTA)
Perfluorooctanoic acid (PFOA)	Perfluorotridecanoic acid (PFTrDA)
Perfluorononanoic acid (PFNA)	Perfluoroundecanoic acid (PFUnA)
Perfluorohexanesulfonic acid (PFHxS)	Hexafluoropropylene oxide dimer acid (HFPO-DA)
Perfluoroheptanoic acid (PFHpA)	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
Perfluorobutanesulfonic acid (PFBS)	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
Perfluorodecanoic acid (PFDA)	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
Perfluorododecanoic acid (PFDoA)	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)
Perfluorohexanoic acid (PFHxA)	4,8-dioxa-3H-perfluorononanoic acid (ADONA)

Other parameters monitored in the influent water include calcium hardness, alkalinity, turbidity, conductivity, and pH. The pH of the water was monitored in the effluent of the RSSCT columns once each day. Lastly, the volumetric flow rate was measured each day to ensure normal operation of the columns.

2.4 RECIRCULATING COLUMN ISOTHERM TESTING

The RSSCT method was developed based on fundamental principles of chemical diffusion through porous material such as GAC. It is unclear if such principles hold for chemical removal with IX resins. Moreover, utilizing the RSSCT method requires crushing the material to smaller grains. GAC and FS200 are dry materials, but IX resins are hydrated beads. If they were to be crushed to smaller sizes, they would need to be dried, crushed, and then rehydrated. To our knowledge, there has been no demonstration of whether this action changes the capacity of the resin or its kinetics of chemical removal. For these reasons, WQTS does not use the RSSCT method for evaluating the removal of PFAS or other chemicals with IX resins. Instead, WQTS uses an equilibrium adsorption isotherm approach to estimate the capacity of the resin, and thus the anticipated IX resin runtime before breakthrough is reached.

2.4.1 Equilibrium Isotherm

When an adsorbent is immersed in a solution containing a chemical, the chemical will begin to adsorb onto the adsorbent over time until "equilibrium" is reached. At that point, some of the chemical is adsorbed to the adsorbent and some remains in the solution. The amount adsorbed onto the adsorbent is said to be in equilibrium with the concentration remaining in the water. This relationship between the amount adsorbed, expressed in mass adsorbed per volume of adsorbent, and the concentration remaining in the water is referred to as the "equilibrium relationship". The purpose of an isotherm test is to identify that relationship between a specific chemical and a specific adsorbent.

The standard isotherm procedure includes filling up multiple bottles with known volumes, V_w, of the test water containing a chemical at an initial concentration, C_o. Different masses of the test adsorbent, m, are added to the bottles. The bottles are then sealed and stirred for an extended period of time until equilibrium is reached. At that time, each bottle is opened, and its water is analyzed for the remaining concentration of the chemical, C_f. The load, Q, expressed in ng/mL, is calculated as:

$$Q = \frac{(C_o - C_f) \times V_w}{(m_A)} \times \rho_A \qquad (2)$$

where: Q = Load of PFAS on the resin, ng/mL
C_o = Initial concentration of the PFAS in the water, ng/L
C_f = Final concentration of the PFAS in the water, ng/L
m_A = Mass of adsorbent, mg
V_w = Volume of water contacted with the adsorbent, L
ρ_A = Packed density of the adsorbent, mg/mL of adsorbent

The relationship between Q and C_f is represented by a mathematical expression. For this study, the Freundlich isotherm expression was used to represent the relationship between Q and C_f:

$$Q = K \times (C_f)^n \qquad (3)$$

Where K and n are constants. While n is unitless, the unit for K is dependent on the units used for the various factors in Equation 2. Based on the units specified above, the units for K in this study are $(ng/mL)(L/ng)^n$.

Once this relationship is defined, it can be used to estimate the Bed Volumes (BVs) of water that can be treated through a bed of adsorbent until 50% breakthrough of the chemical is reached. This is referred to as "BV_{50}". Specifically, BV_{50} is calculated as shown in Equation 4:

$$BV_{50} = \frac{K\, C_o^n}{C_o} \times 1{,}000 \qquad (4)$$

The BV_{50} values can then be used to estimate the operating time to reach 50% breakthrough, T_{50}, in months, which is calculated as follows:

$$T_{50}\ (\text{Months}) = \frac{\text{BV}_{50} \times \text{EBCT}}{43{,}776} \qquad (5)$$

In Equation 4, C_o is the influent PFAS concentration to the full-scale system, expressed in ng/L, K and n are the coefficients of the isotherm equation, and EBCT is the empty bed contact time through the full-scale adsorption process. The number "43,776" is used to convert the time from minutes to months.

2.4.2 Isotherm Setup

The very low concentration of PFAS chemicals in the water, coupled with the high capacity of the resins for PFAS do not allow for the use of the bottle procedure discussed above. WQTS has modified the isotherm procedure to allow for the testing to be applied to high-capacity adsorbents. The method is referred to as the Recirculating Column Isotherm (RCI) procedure. Figure 2.2 shows a schematic of the RCI setup.

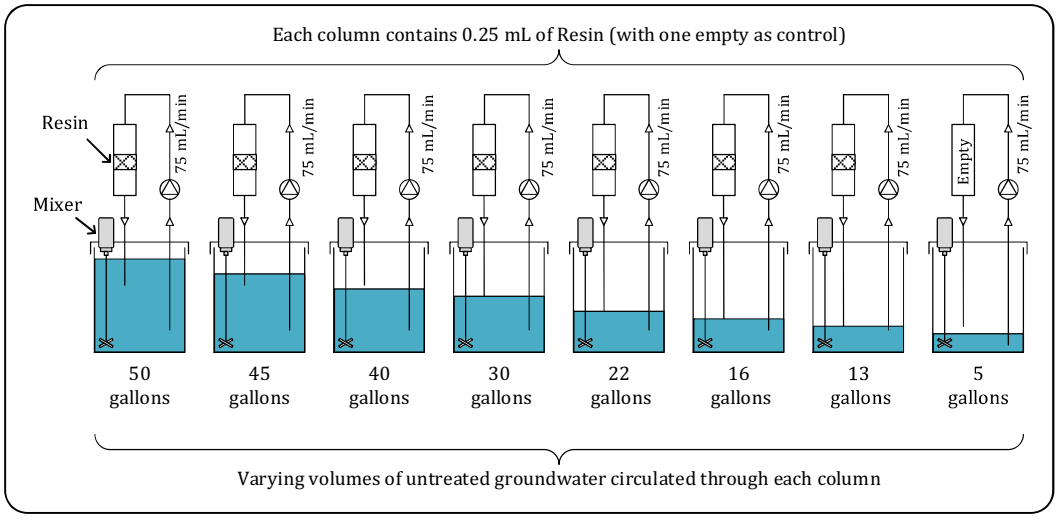


Figure 2.2 – Recirculating Column Isotherm Testing Schematic

The test water is split between eight containers with a different volume added to each. The water volumes ranged from 13 to 50 gallons. Each container was continuously mixed. A water pump drew water from each container at a rate of 75 mL/min, through a small column containing the resin, and

then back into the container. Each of the seven columns contained a 0.25-mL sample of the resin, while one column remained empty and served as an experimental control. A glass-wool prefilter was used (not shown) upstream of each resin column to protect it from clogging.

The water was recirculated through the columns for a period of four (4) weeks. The containers were tightly covered and were not opened during the entire 4-week testing period. PFAS samples were collected from each container at the start of the testing, and then weekly to monitor the progress of the adsorption process. The weekly samples were sent to EEA Laboratories for analysis by EPA Method 537.1.

3.1 RSSCT RESULTS

As noted in Table 2.2, each of the three GAC RSSCT columns was operated at a target flowrate of 20.5 mL/min, while the FS200 column was operated at a target flowrate of 39.0 mL/min. Figure 3.1 shows a plot of the daily volumetric flowrate measurements conducted on each RSSCT column during the 9-day test. The profiles show that the flowrate through the columns was held at the target levels through the testing duration. Figure 3.2 also shows a profile of the water pH measured daily in the influent and effluent of the RSSCT columns. In general, the pH of the water held steady in the range of 7.5 to 8.0.

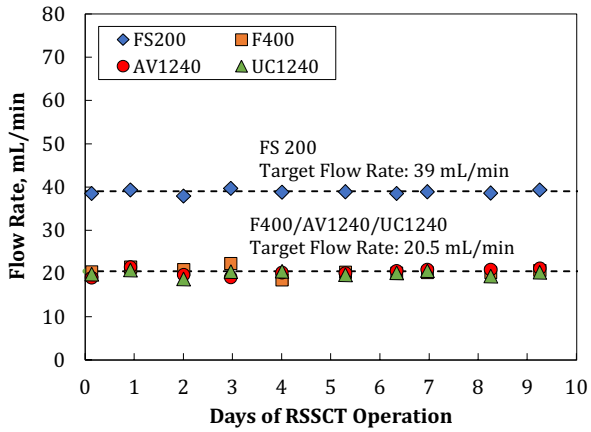


Figure 3.1 – Measured vs Target Flowrate through the four RSSCT Columns

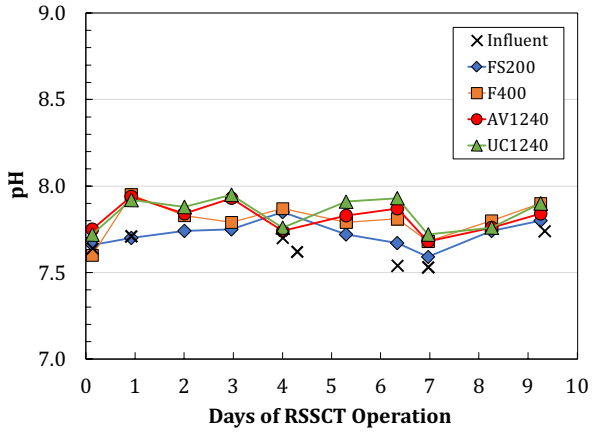


Figure 3.1 – Profiles of Water pH in the influent an Effluent of the RSSCT Columns

3.1.1 Individual RSSCT Results

Figures 3.3 through 3.10 present the breakthrough profiles of the four detectable PFAS chemicals through the GAC columns and the FS200 column. These include PFOS, PFHxS, PFBS, and PFNA. For all concentrations below the MRL of 2 ng/L, WQTS asked EEA Laboratories to provide an estimate of the PFAS concentration. Figures 3.11 through 3.16 include the profiles of three PFAS chemicals whose starting concentrations were already below the MRL of 2 ng/L. These include PFHxA, PFOA, and PFHpA. In these profiles, both the influent and effluent concentrations are estimates. It is noted that the minimum detection limit (MDL) identified by the laboratory was 0.39 ng/L for each PFAS chemical analyzed.

The chart in each figure has two horizontal axes. The lower axis is the Bed Volumes (BVs) treated. The upper axis is the equivalent operating time, in months, of the full-scale system using these media. For GAC media, the assumed design EBCT was 7.5 minutes (see Table 2.2). For FS200 media, the assumed EBCT was set at 2.0 minutes. The difference in the EBCT values explains why treating

350,000 BVs through the GAC contactors is equivalent to 60 months of operation, while treating the same 350,000 BVs through the FS200 contactors is equivalent to only 16 months of operation.

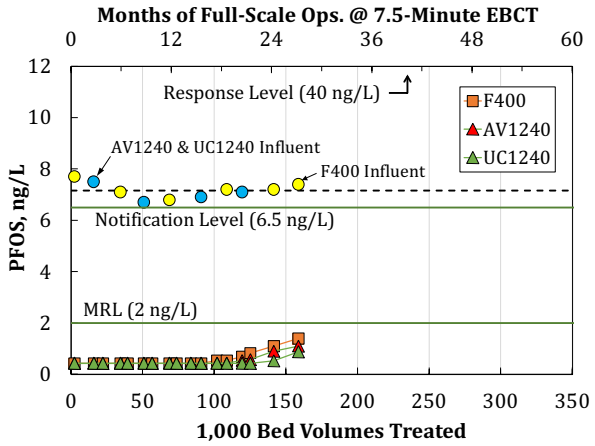


Figure 3.3 – Profile of PFOS in the Influent and Effluent of the three GAC RSSCT Columns

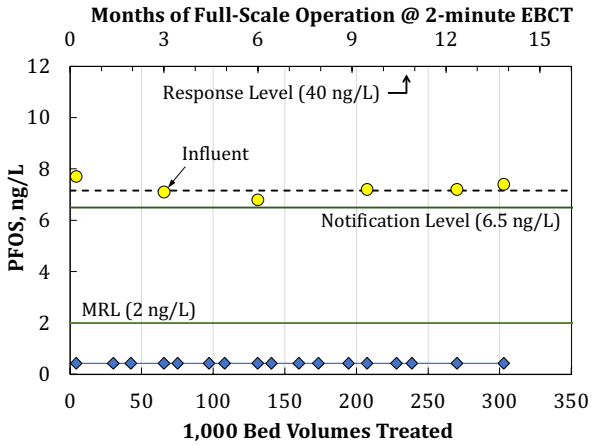


Figure 3.4 – Profile of PFOS in the Influent and Effluent of the FS200 RSSCT Column

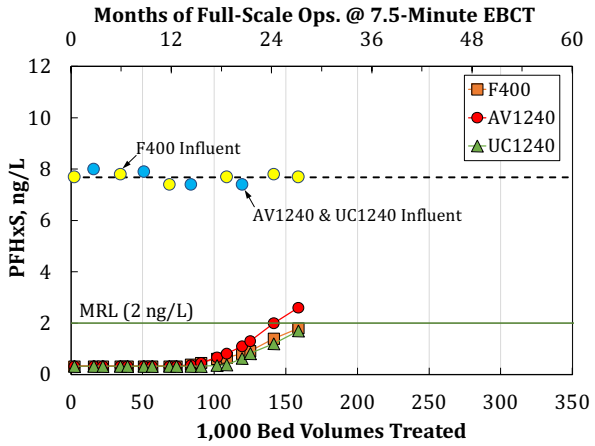


Figure 3.5 – Profile of PFHxS in the Influent and Effluent of the three GAC RSSCT Columns

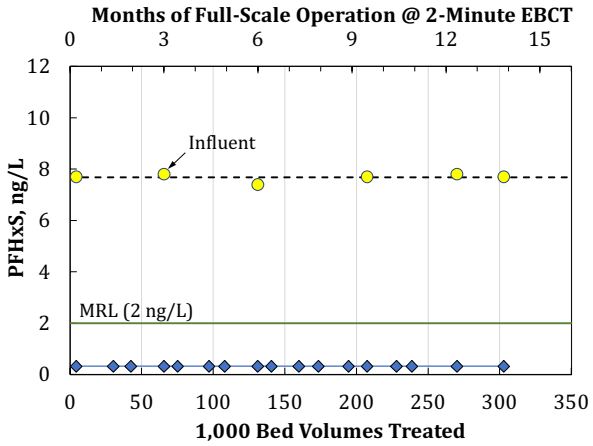


Figure 3.6 – Profile of PFHxS in the Influent and Effluent of the FS200 RSSCT Column

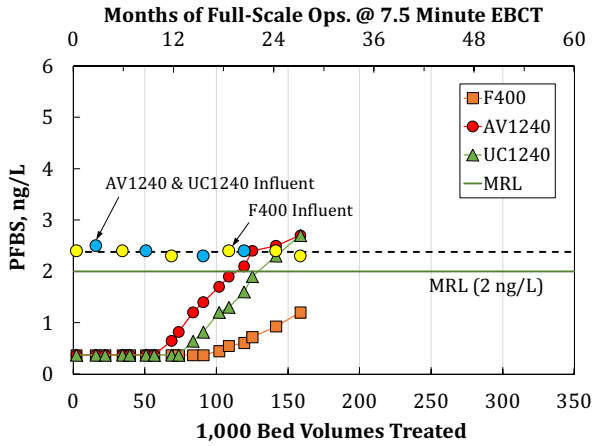


Figure 3.7 – Profile of PFBS in the Influent and Effluent of the three GAC RSSCT Columns

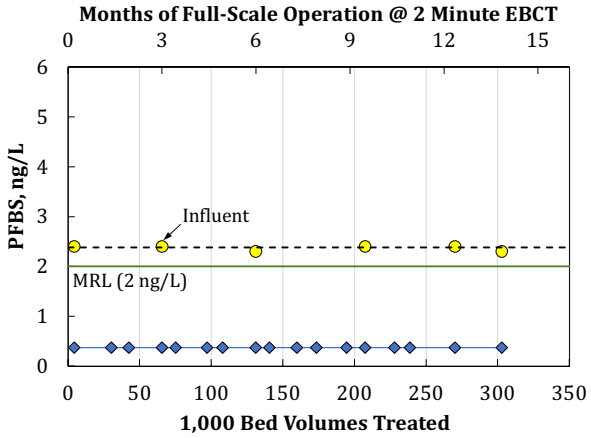


Figure 3.8 – Profile of PFBS in the Influent and Effluent of the FS200 RSSCT Column

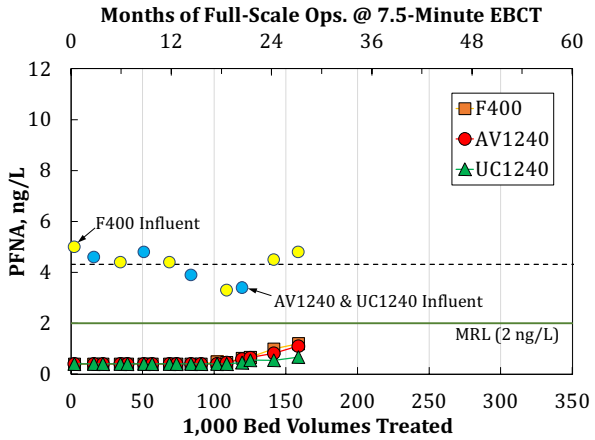


Figure 3.9 – Profile of PFNA in the Influent and Effluent of the three GAC RSSCT Columns

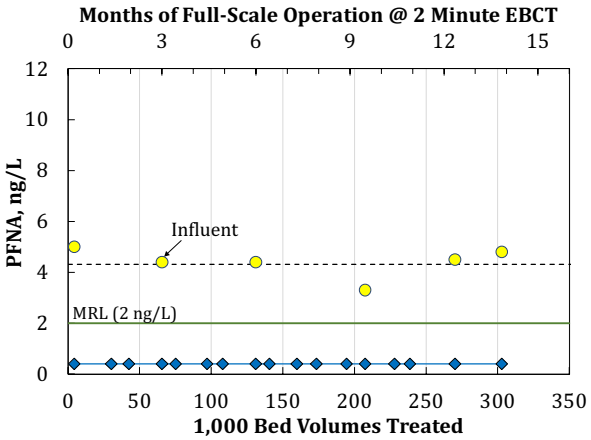


Figure 3.10 – Profile of PFNA in the Influent and Effluent of the FS200 RSSCT Column

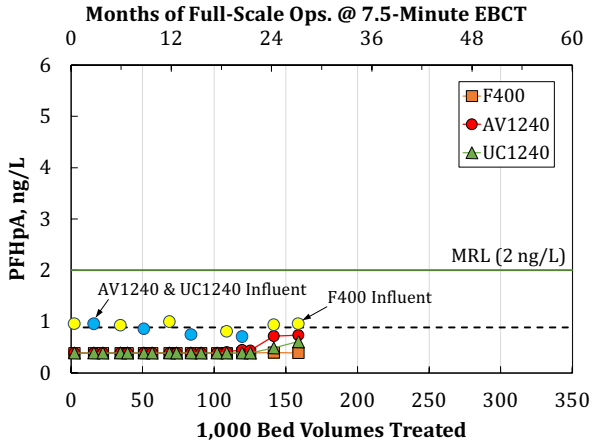


Figure 3.11 – Profile of PFHpA in the Influent and Effluent of the three GAC RSSCT Columns

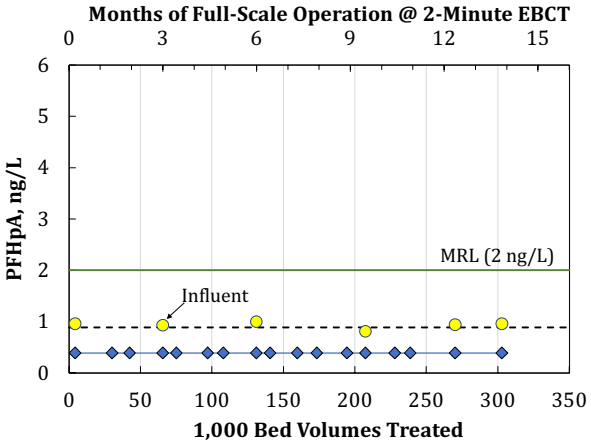


Figure 3.12 – Profile of PFHpA in the Influent and Effluent of the FS200 RSSCT Column

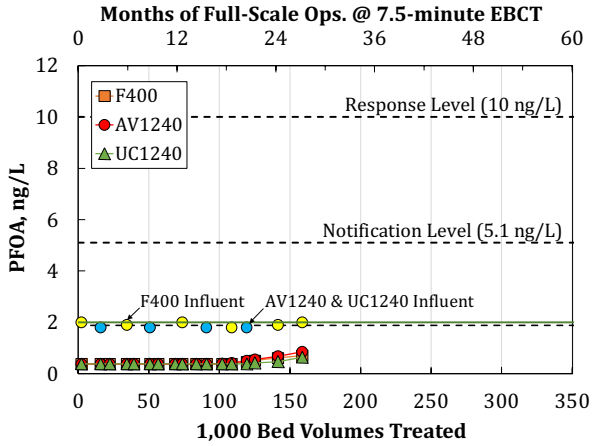


Figure 3.13 – Profile of PFOA in the Influent and Effluent of the three GAC RSSCT Columns

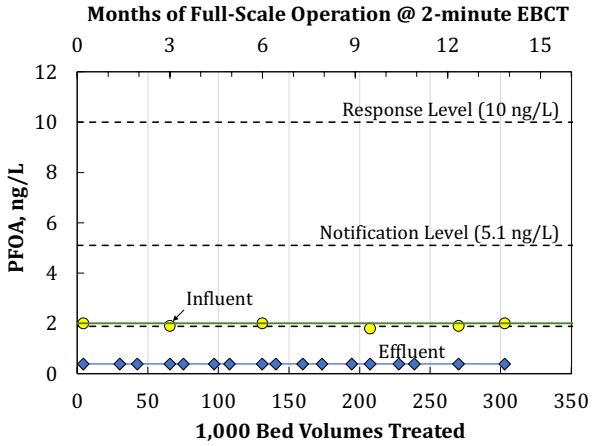


Figure 3.14 – Profile of PFOA in the Influent and Effluent of the FS200 RSSCT Column

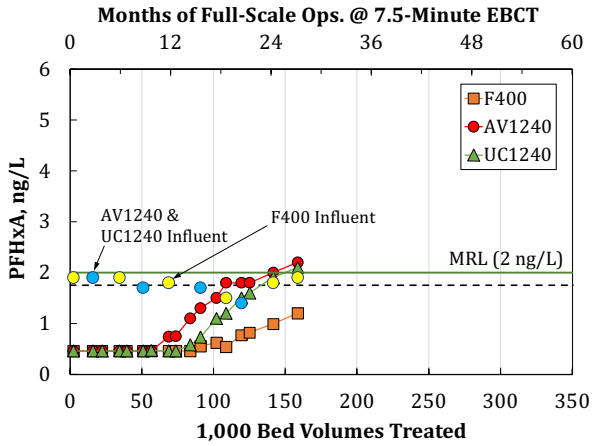


Figure 3.15 – Profile of PFHxA in the Influent and Effluent of the three GAC RSSCT Columns

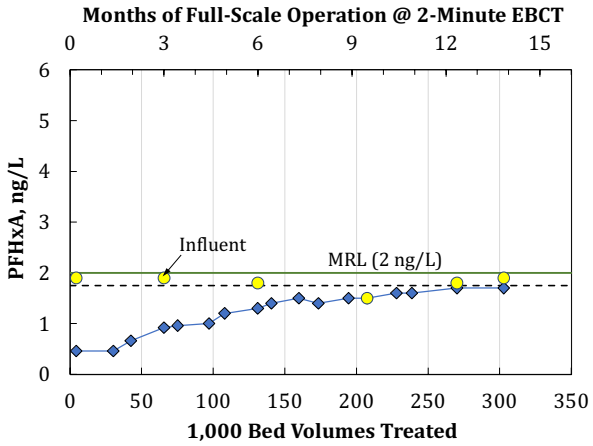


Figure 3.16 – Profile of PFHxA in the Influent and Effluent of the FS200 RSSCT Column

PFOS, which is present in Well #2 water at approximately 7.2 ng/L, was completely removed to below the MRL of 2 ng/L for the full duration of the RSSCT test (Figures 3.3 and 3.4). However, using the estimated values between the MDL and the MRL, Figure 3.3 shows that PFOS was beginning to break through into the effluent of all three GAC columns after about 120,000 BVs, and is likely to exceed the MRL after 200,000 BVs. At an EBCT of 7.5 minutes, 200,000 BVs for GAC is equivalent to approximately 34 months of operation. By comparison, Figure 3.4 shows that after 300,000 BVs of water treated through the FS200 media, PFOS remained below the MDL of 0.39 ng/L. At an EBCT of 2 minutes, 300,000 BVs for F-200 is equivalent to 14 months of operation. Due to the lack of any effluent values above the MDL, it is not possible to predict when PFOS would break through into the effluent at a level exceeding the MRL of 2 ng/L.

Figures 3.5 and 3.6 present the results for PFHxS, which was detected in the RSSCT influent water at an average concentration of approximately 7.8 ng/L. Based on estimated values between the MDL

and MRL, PFHxS began to break through the GAC columns around 100,000 BVs and reached the MRL of 2 ng/L at about 140,000 BVs for AV1240 GAC and 160,000 BVs for F400 and UC1240 GACs. At an EBCT of 7.5 minutes, 160,000 BVs for GAC is equivalent to approximately 27 months of operation. By comparison, Figure 3.6 shows that no PFHxS breakthrough above the MDL occurred in the FS200 column effluent for the entire testing duration of 300,000 BVs, which is equivalent to 14 months of operation at an EBCT of 2.0 minutes. Similar to PFOS, it is not possible to predict when PFHxS would break through into the effluent at a level exceeding the MRL of 2 ng/L.

Figures 3.7 and 3.8 present the results of PFBS removal with the four adsorbents. The influent PFBS concentration was 2.4 ng/L, which is only slightly above the MRL of 2 ng/L. Nonetheless, the estimated concentrations suggest that PFBS began to break through the GAC columns (Figure 3.7) between 70,000 and 100,000 BVs, with better performance achieved with Calgon's F400 GAC. While AV1240 and UC1240 reached the MRL after approximately 125,000 BVs, the profile of the F400 GAC suggests that the MRL may not be reached until after 200,000 BVs. By comparison, as for the other PFAS chemicals, no PFBS breakthrough occurred in the FS200 column up to 300,000 BVs of water treated.

Figures 3.9 and 3.10 present the PFNA breakthrough results. With an influent concentration of about 4.3 ng/L, the PFNA concentration remained below the MRL of 2 ng/L throughout the testing. However, using laboratory-estimated values below the MRL, PFNA appears to begin breaking through the GAC columns above the MDL around 150,000 BVs (see Figure 3.9), with a likely breakthrough above the MRL after 200,000 BVs. However, no breakthrough above the MDL was detected after 300,000 BVs in the FS200 column (Figure 3.10).

Figures 3.11 and 3.12 present the results for PFHpA removal with GAC and FS200. The concentration of PFHpA in the influent to the columns was below the MRL of 2 ng/L and could only be estimated at about 1.0 ng/L as shown in both figures. Again, breakthrough above the MDL of 0.39 ng/L appears to have begun around 150,000 BVs of water treated. No increase above the MDL was observed in the effluent of the FS200 column up to 300,000 BVs of water treated.

Figures 3.13 and 3.14 present the results for PFOA removal with GAC and FS200. The concentration of PFOA in the influent to the columns was slightly below the MRL of 2 ng/L, measured at an average of 1.9 ng/L in the RSSCT influent. Using estimated concentrations below the MRL, PFOA appears to begin breaking through the GAC effluent at levels above the MDL of 0.39 ng/L around 150,000 BVs (Figure 3.13), but no PFOA breakthrough was experienced after 300,000 BVs treated through the FS200 media (Figure 3.14).

Finally, Figure 3.15 and 3.16 present the breakthrough results of PFHxA, which was measured at an average concentration of 1.8 ng/L, below the MRL of 2 ng/L. Figure 3.15 shows that in spite of its low concentration, PFHxA breakthrough in the GAC columns began around 70,000 BVs for AV1240 GAC and about 100,000 BVs for F400 GAC. Surprisingly, unlike all other PFAS chemicals, PFHxA broke through the FS200 media as soon as 30,000 BVs after startup (Figure 3.16), which is equivalent

to only 1.5 months of operation at an EBCT of 2 minutes. It is unclear why FS200's capacity for PFHxA is that much lower than its capacity for all the other PFAS chemicals tested.

3.1.2 Comparison of Adsorbents

Using the results of the individual RSSCT columns, the BVs treated to reach a breakthrough of 2 ng/L for each individual PFAS was estimated. When needed, a linear extrapolation of the data was used to project the breakthrough time. Figures 3.17 through 3.24 present the estimated BVs to reach 2 ng/L breakthrough for each PFAS with a starting concentration greater than 2 ng/L, as well as the corresponding months of operating time at 7.5-minute EBCT for the three GACs, and 2-minute EBCT for FS200. The range presented for each condition was based on a ±20% of the value predicted by the RSSCT results. For the FS200 results, since none of the four PFAS chemicals broke through above the MDL of 0.39 ng/L over the entire run of 300,000 BVs, the figures only show the range as >300,000 BVs and >14 months of operation at 2-minute EBCT.

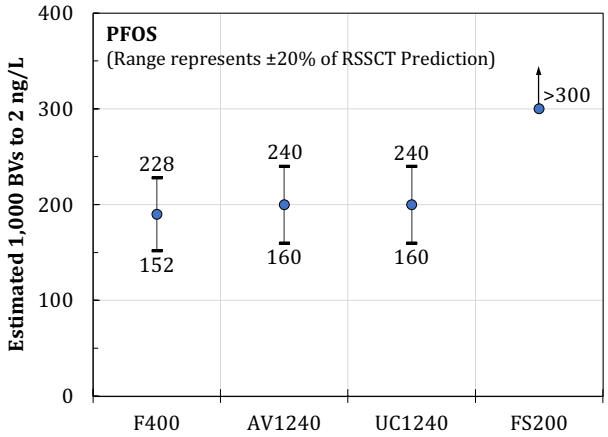


Figure 3.17 – Estimated 1,000 BVs Treated to Reach 2 ng/L PFOS Breakthrough

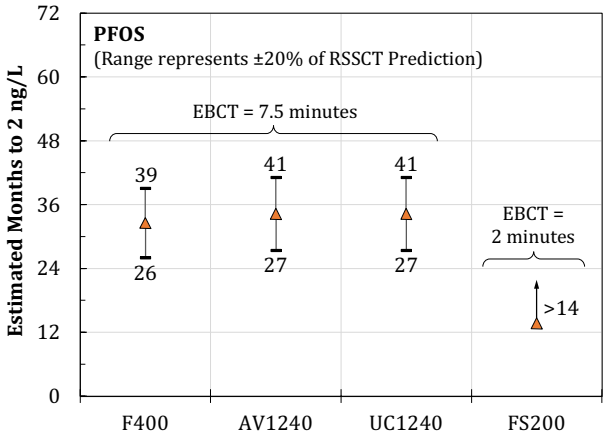


Figure 3.18 – Estimated Months of Operation to reach 2 ng/L PFOS Breakthrough at 7.5-minute EBCT for GAC and 2-minute EBCT for FS200

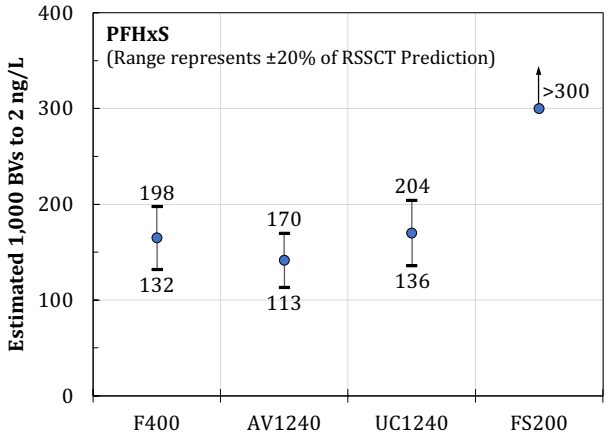


Figure 3.19 – Estimated 1,000 BVs Treated to Reach 2 ng/L PFHxS Breakthrough

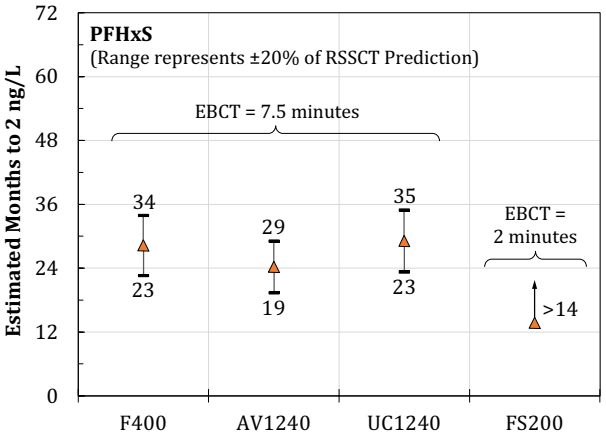


Figure 3.20 – Estimated Months of Operation to reach 2 ng/L PFHxS Breakthrough at 7.5-minute EBCT for GAC and 2-minute EBCT for FS200

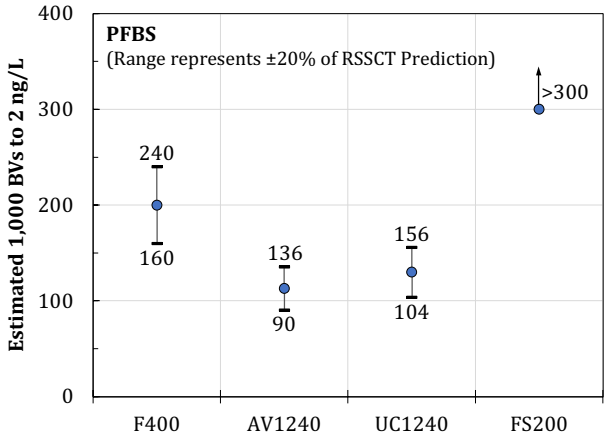


Figure 3.21 – Estimated 1,000 BVs Treated to Reach 2 ng/L PFBS Breakthrough

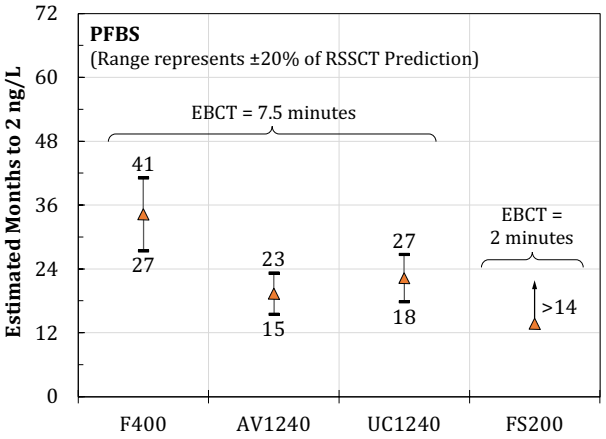


Figure 3.22 – Estimated Months of Operation to reach 2 ng/L PFBS Breakthrough at 7.5-minute EBCT for GAC and 2-minute EBCT for FS200

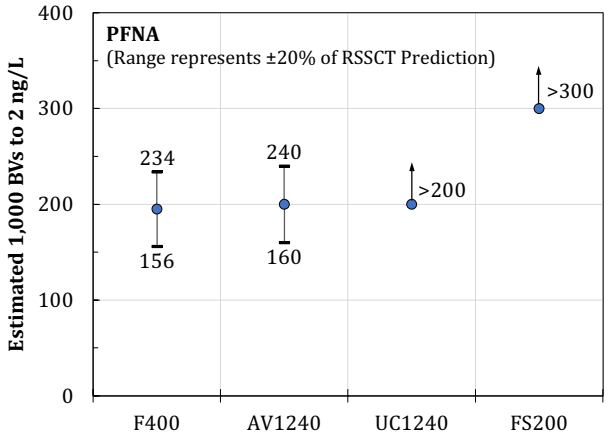


Figure 3.23 – Estimated 1,000 BVs Treated to Reach 2 ng/L PFNA Breakthrough

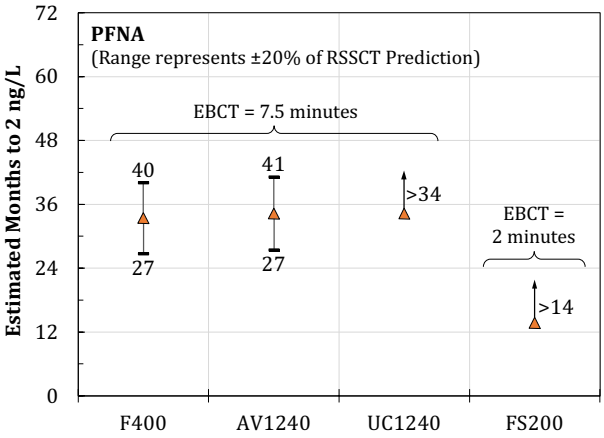


Figure 3.24 – Estimated Months of Operation to reach 2 ng/L PFNA Breakthrough at 7.5-minute EBCT for GAC and 2-minute EBCT for FS200

The ranges reported in Figures 3.17 through 3.24 suggest that the three GACs were relatively similar in their capacity for the four PFAS chemicals, with the exception of PFBS (Figure 3.21). The results suggest that F400 treated a larger volume of water than the two other GACs before reaching the 2 ng/L breakthrough point. For PFNA, the BVs to breakthrough for the UC1240 GAC could not be projected and are thus presented in Figure 3.23 as > 200,000 BVs.

WQTS reached out to suppliers of the four adsorbents evaluated with the RSSCT method, provided them with the water quality data, and asked them to make projections of the BVs to breakthrough using their inhouse models. As of the date of this report, AqueoUS Vets and Minerals Technologies, Inc. provided feedback.

AqueoUS Vets noted that their in-house model predicted no breakthrough up to 173,000 BVs. However, they noted that the confidence in the prediction decreases with longer operating time because of the effects of GAC fouling with organic matter and other constituents. Nonetheless, this value is within or close to the ranges presented in Figures 3.17 through 3.24 for AV1240 GAC.

Minerals Technologies noted that their data suggest that breakthrough may not take place for 100's of thousands of BVs. They also noted that that their research work suggests that the relationship between BVs to breakthrough and PFOS concentration (in ng/L) can be approximated by the following equation:

$$\text{BVs to Breakthrough} = 12{,}257{,}310 \times (\text{PFOS Concentration})^{-0.6694}$$

If the above equation is used for a PFOS concentration of 7.1 ng/L, then the estimated BVs to breakthrough is calculated at 3.3 million BVs. Considering that the RSSCT results showed no PFOS breakthrough up to 300,000 BVs, it is not possible to compare the RSSCT results to the supplier's estimate at this time.

3.2 RECIRCULATING COLUMN ISOTHERM RESULTS

Figure 3.25 through 3.28 show the profiles of all four detectable PFAS chemicals in the recirculating column isotherms over the four-week test period. As expected, the concentrations decrease over time as the PFAS chemicals adsorb onto the resin in the columns until they reach stable levels. Because the concentrations are only slight above the MRL, there is significant variability from week to week. For PFNA, some values were at the MRL, and for PFBS, all values were below the MRL and could only be estimated by the laboratory. For these reasons, the average of the 2nd, 3rd, and 4th week values was used as C_f in the isotherm Equations 2 and 3. There were also challenges with some of the control data, especially for PFOS, where one of the two controls showed a gradual reduction in PFOS concentration (3.25, left).

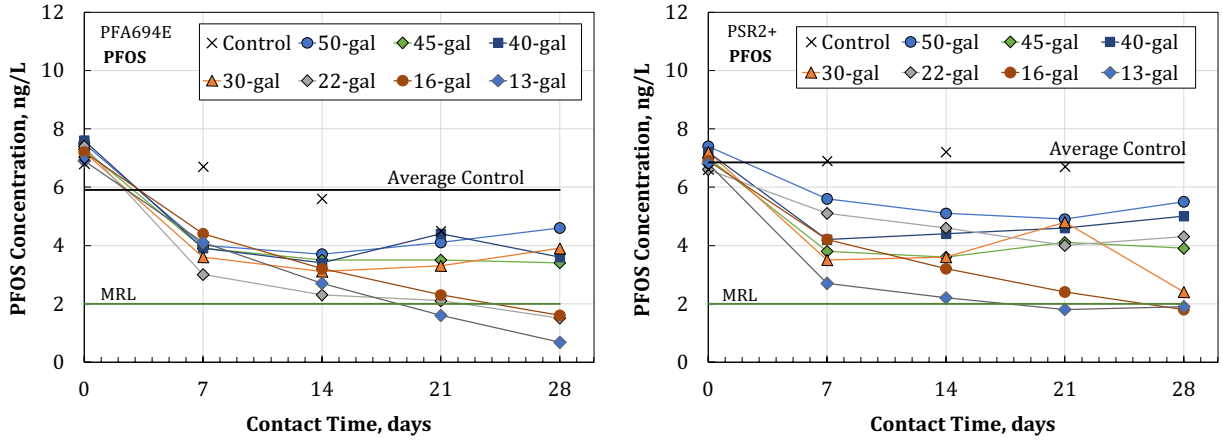


Figure 3.25 – Reduction in PFOS Concentration in the Recirculating Column Isotherm tests with Purolite's PFA694E resin (left) and PSR2+ resin (right)

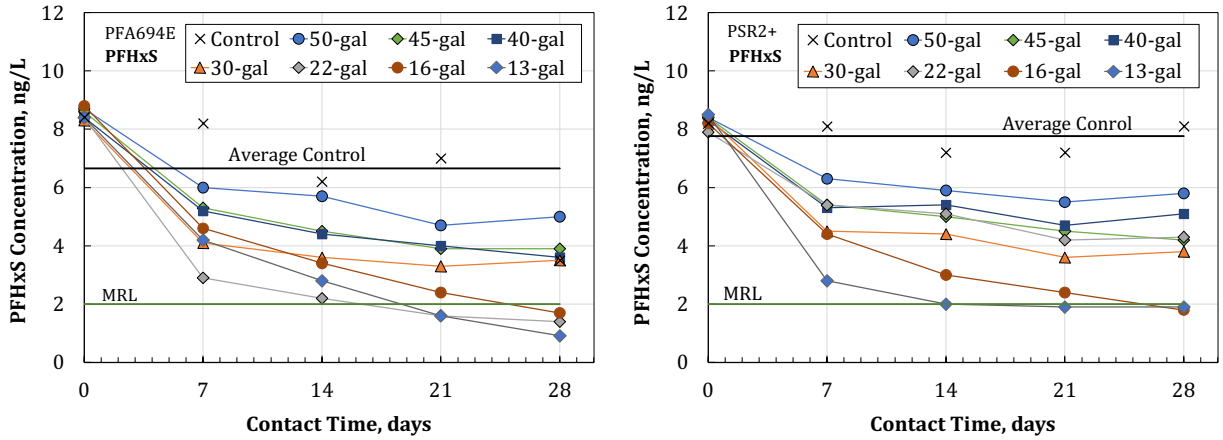


Figure 3.26 – Reduction in PFHxS Concentration in the Recirculating Column Isotherm tests with Purolite's PFA694E resin (left) and PSR2+ resin (right)

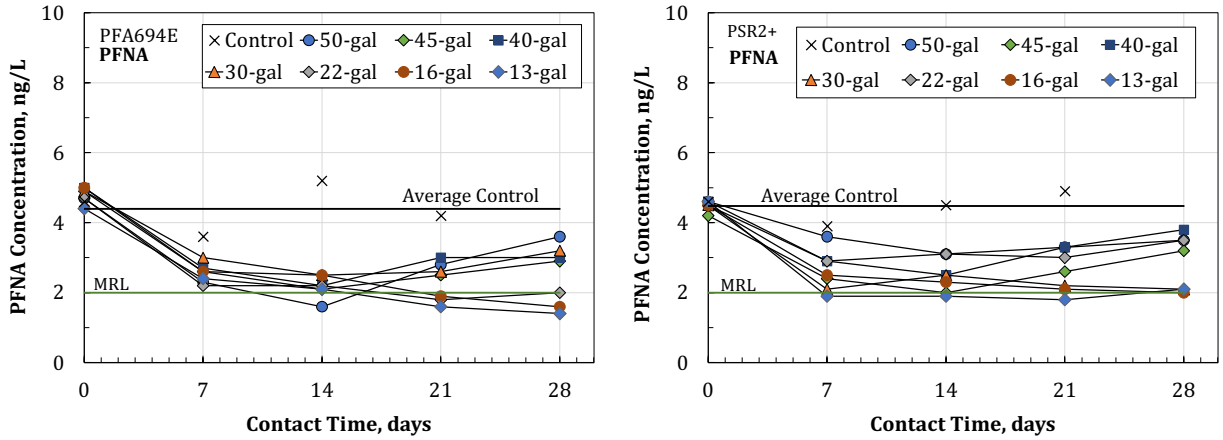


Figure 3.27 – Reduction in PFNA Concentration in the Recirculating Column Isotherm tests with Purolite's PFA694E resin (left) and PSR2+ resin (right)

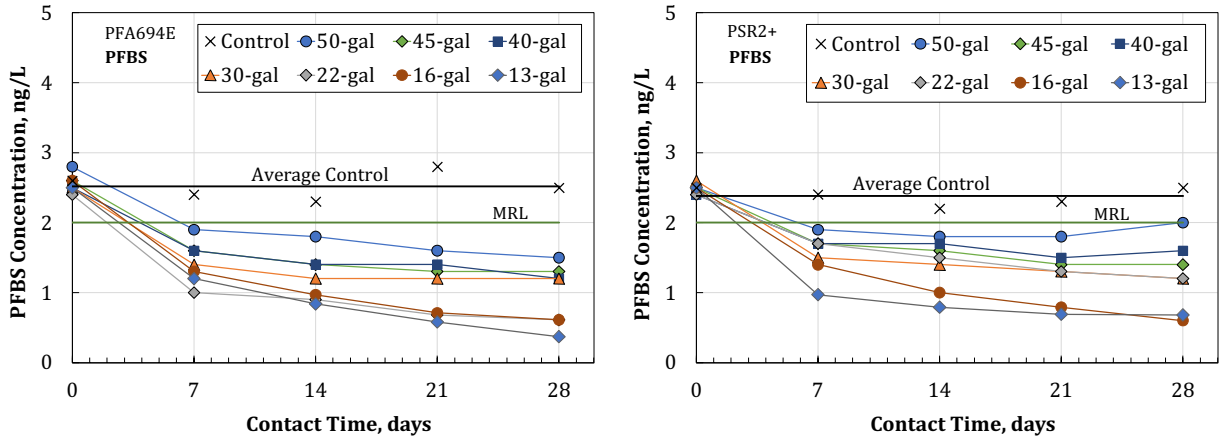


Figure 3.28 – Reduction in PFBS Concentration in the Recirculating Column Isotherm tests with Purolite's PFA694E resin (left) and PSR2+ resin (right)

Based on the data presented in Figures 3.25 through 3.28, the initial concentration, C_o, the final concentration, C_f, the water volume, Vw, and the resin mass, m_A, in each column were then used to calculate the resin load, Q, in each column using Equation 2. The values of the packed density, ρ_A, was measured at 43.1 lbs/ft^3 (691 mg/mL) for PSR2+ Resin and 41 lbs/ft^3 (657 mg/mL) for PFA694E resin. Figures 3.29 through 3.32 present plots of Q vs C_f for PFOS, PFHxS, PFNA, and PFBS, respectively. The left charts are for PSR2+ resin while the right charts are for PFA694E resin. Each chart also shows the data fit using Equation 3, along with the upper and lower bounds of the 90% confidence range. As noted earlier, some of the C_f values are lower than the MRL of 2 ng/L, which greatly reduces the confidence in their accuracy. That is certainly the case with the PFBS data where all the C_f values were below the MRL.

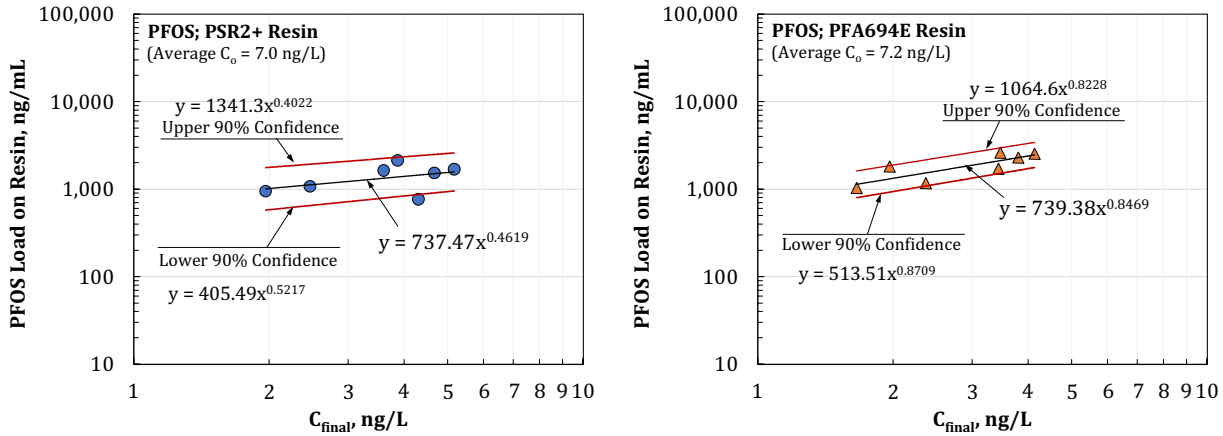


Figure 3.29 – Isotherm Data, Fit, and 90% Confidence Range of PFOS Adsorption on Evoqua's PSR2+ Resin (left) and Purolite's PFA694E Resin (right)

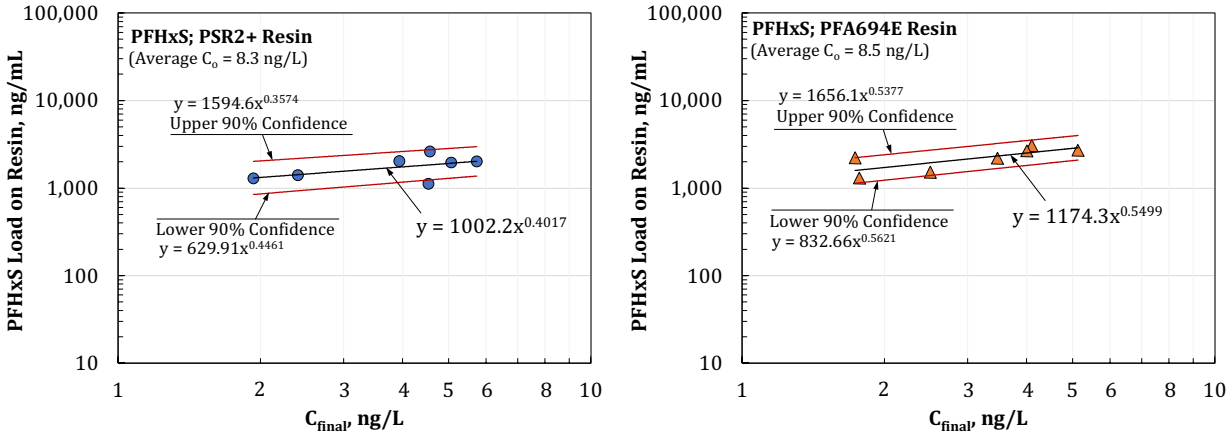


Figure 3.30 –Isotherm Data, Fit, and 90% Confidence Range of PFHxS Adsorption on Evoqua's PSR2+ Resin (left) and Purolite's PFA694E Resin (right)

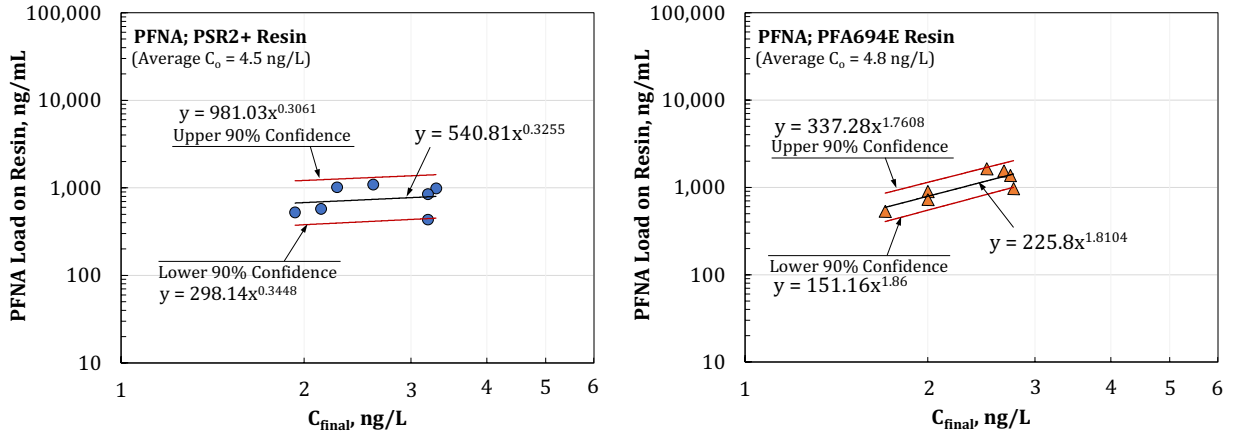


Figure 3.31 –Isotherm Data, Fit, and 90% Confidence Range of PFNA Adsorption on Evoqua's PSR2+ Resin (left) and Purolite's PFA694E Resin (right)

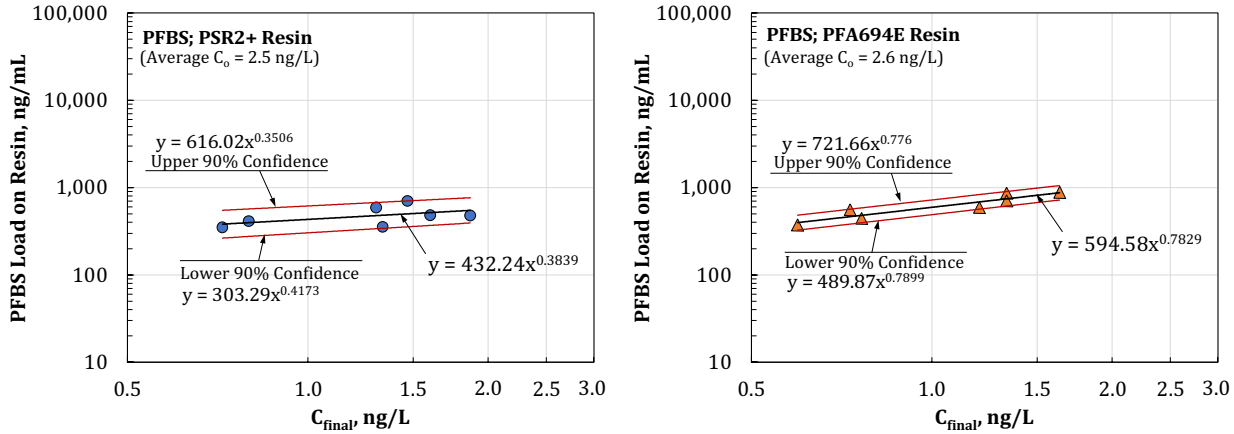


Figure 3.32 –Isotherm Data, Fit, and 90% Confidence Range of PFBS Adsorption on Evoqua's PSR2+ Resin (left) and Purolite's PFA694E Resin (right)

The isotherm data fits depicted in Figures 3.29 to 3.32 along with the 90% confidence bounds were used to project the anticipated BVs of water treated through a vessel of each resin until 50% breakthrough of each of the four PFAS chemicals is reached in its effluent. This calculation is made using Equation 4 presented and discussed in Section 2. The outcome of the analysis is presented in Figure 3.33 where the left chart is for Evoqua's PSR2+ resin while the right chart is for Purolite's PFA694E resin. The data point within each range represents the prediction based on the data fit line, while the upper and lower bound numbers represent the upper and lower 90% confidence bounds. Similarly, Figure 3.34 presents the estimated months of operation to reach 50% breakthrough, T_{50}, for a resin system operating at a constant EBCT of 2 minutes. Again, the left chart is for the PSR2+ resin and the right chart is for PFA694E resin.

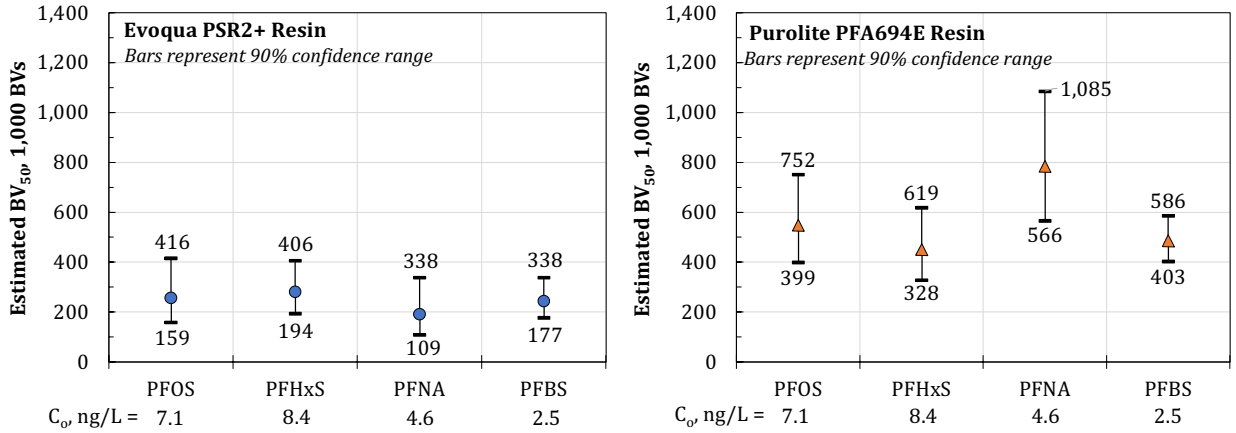


Figure 3.33 – Estimated Bed Volumes of Well #2 Water Treated with either Evoqua's PSR2+ Resin (Left) or Purolite's PFA694E Resin (Right) before the Effluent Concentration of a Constituent Reaches 50% its Influent Value

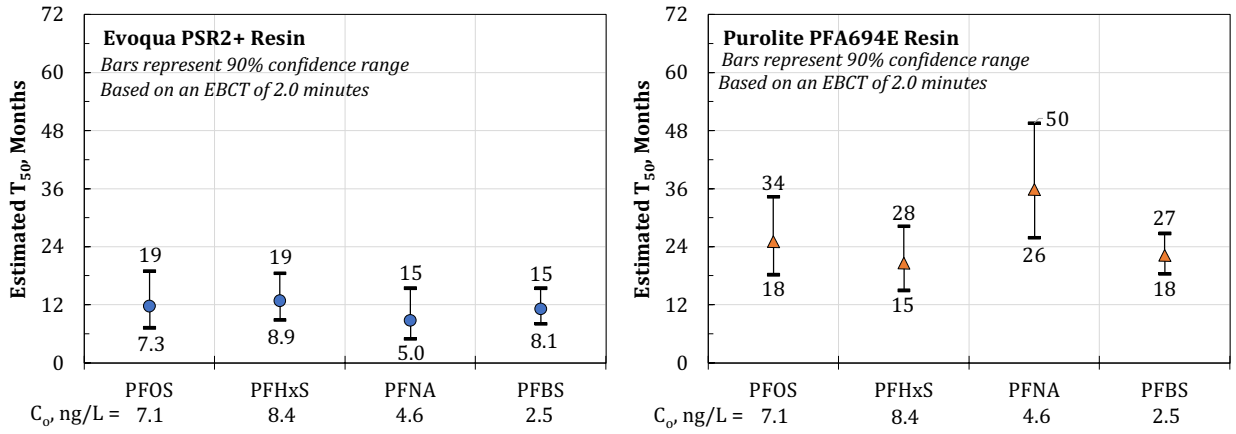


Figure 3.34 – Estimated Months of Operation Treating Well #2 Water with either Evoqua's PSR2+ Resin (Left) or Purolite's PFA694E Resin (Right) at an EBCT of 2 minutes before the Effluent Concentration of a Constituent Reaches 50% its Influent Value

A comparison between the left charts and right charts in Figures 3.33 and 3.34 suggests that the Purolite PFA694E resin is expected to have a longer service life between replacements than the Evoqua PSR2+ resin treating the PFAS levels present in Well #2 water. Based on PFOS breakthrough, PSR2+ resin may have a service life ranging from 7 to 19 months while PFA694E resin may have a life ranging between 18 and 34 months.

The suppliers of the two IX resins were contacted and asked to provide estimates of BV_{50} and T_{50} values for each PFAS present in the water. Results were received from Purolite™ and their projections were compared to the isotherm 90% confidence range values. The comparisons are presented in Figure 3.35. With the exception of PFNA, the projections provided by Purolite™ were within the 90% confidence range predicted by the RCI tests for PFOS, PFHxS, and PFBS. It is unclear

why the PFNA projection was outside the 90% confidence range of the isotherm test results. As of the date of this report, the projections from Evoqua have not yet been received.

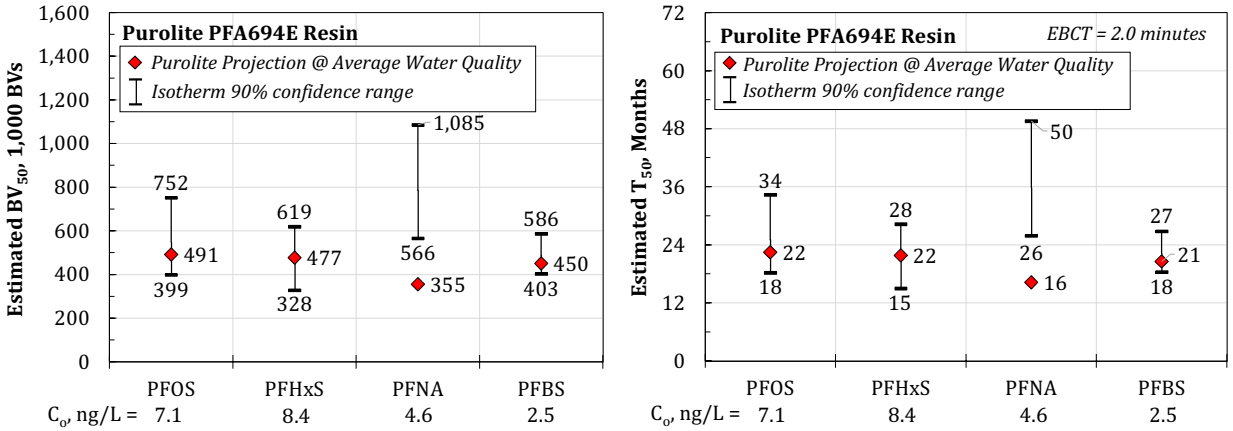


Figure 3.35 – Comparison between Isotherm 90% Confidence Range and Projections by Purolite for the Estimated BV_{50} (Left) and T_{50} (Right) Values Under Average Water Quality Conditions

It should be noted that the estimates generated from the isotherm testing as well as the projections made by Purolite™ are for fresh resin in the lead vessel. Unfortunately, in a lead-lag vessel operation, the resin life will be shorter than those estimated herein because of the preloading of the lag vessel resin with several competing constituents before it is moved to the lead position. At this time, it is not possible to predict how much the resin life will be shortened.

Bench-scale testing was conducted to evaluate the efficiency of PFAS removal from Williams Well #2 water using three GAC media, two IX resins, and one specialty adsorbent. The GAC media used were F400 (Calgon Carbon Corp.), UC1240 (Evoqua), and AV1240 (AqueoUS Vets). The IX resins evaluated were PSR2+™ (Evoqua), and PFA694E™ (Purolite). The specialty adsorbent evaluated was Fluoro-Sorb-200, FS200, provided by Minerals Technologies, Inc. The RSSCT method was used to evaluate PFAS removal with the three GAC media and with FS200. An adsorption isotherm method was used to estimate the capacity of the two IX resins for the PFAS chemicals measured in Well #2 water. The objectives of the testing were as follows:

3. *Compare the performance of different adsorbents for the removal of PFAS from Well #2 water.*
4. *Estimate the replacement frequency for each adsorbent when treating Well #2 water.*

Detailed descriptions of the testing methods and how the testing results were analyzed are presented in this report. The following are the main conclusions from the testing effort:

1. The water sample used in the bench-scale testing was collected from Well #2 on January 19, 2021. An initial sample analysis showed that the water contained similar PFAS levels as those measured by SJWC in past sampling events. Four PFAS chemicals were above the minimum reporting limit of 2 ng/L. They included PFHxS (8.5 ng/L), PFOS (7.8 ng/L), PFBS (2.5 ng/L), and PFNA (5 ng/L).

2. The RSSCT test simulated an EBCT of 7.5 minutes for the GAC treatment system and an EBCT of 2 minutes for the FS200 treatment system. Each RSSCT was operated for 9 days, which represented 158,000 Bed Volumes (BVs) for the GAC columns and 300,000 BVs for the FS200 column.

3. The isotherm tests cannot be used to predict the BVs treated to a specific effluent concentration. However, they can be used to predict an estimated BVs treated to reach approximately 50% breakthrough of each constituent chemical. These estimates were determined in this study, along with an estimate of the 90% confidence range in them.

4. Figure 4.1 presents a summary of the results of PFAS removal with GAC. The left chart in Figure 4.1 presents the projected BVs treated through the three GACs before each of the PFAS chemicals begins to breakthrough above the 2 ng/L MRL in the effluent of the lead vessel. The right chart in Figure 4.1 presents the number of months of operation of the three GACs at an EBCT of 7.5 minutes before each of the PFAS chemicals begins to breakthrough above the 2 ng/L MRL.

5. The results in Figure 4.1 show that the three GACs had similar capacities for the four PFAS chemicals, although F400 GAC performed better for PFBS removal from Well #2 water compared to the two other GACs.

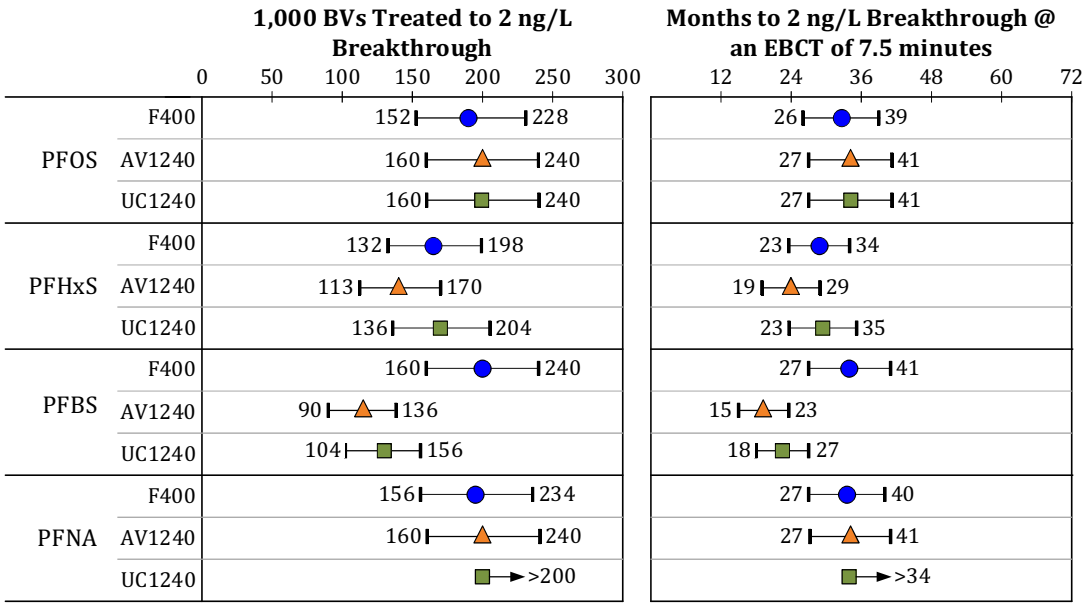


Figure 4.1 – Summary of Bed Volumes Treated with GAC to 2 ng/L Breakthrough and Corresponding Months of Operation at an EBCT of 7.5 minutes

6. Figure 4.2 presents a summary of the results of PFAS removal with FS200 and IX resins. The left chart in Figure 4.2 presents the projected BVs treated through the three media before 50% breakthrough of each of the PFAS chemicals. The right chart in Figure 4.2 presents the number of months of operation of the three media at an EBCT of 2.0 minutes before each of the PFAS chemicals reaches 50% breakthrough.

7. Since no PFAS breakthrough was experienced in the FS200 RSSCT test, it can only be stated that the FS200 media could treat more than 300,000 BVs of Well #2 water.

8. The isotherm tests suggest that the PFA694E resin had a higher capacity than the PSR2+ resin for PFAS present in Well #2 water.

9. Well #2 water quality was provided to the media suppliers who were asked to provide projections of their media life using their in-house models. Purolite provided projections for the anticipated BVs that could be treated through PFA694E resin before 50% breakthrough is reached. The results were then compared to those predicted by the isotherm testing conducted in this study. The comparison is presented in Figure 4.3, which shows that Purolite's projection was within the range predicted by the isotherm with the exception of PFNA. For PFNA, Purolite projected reaching 50% breakthrough after 355,000 BVs of water treated while the isotherm's 90% confidence range was 566,000 BVs to 1,085,000 BVs.

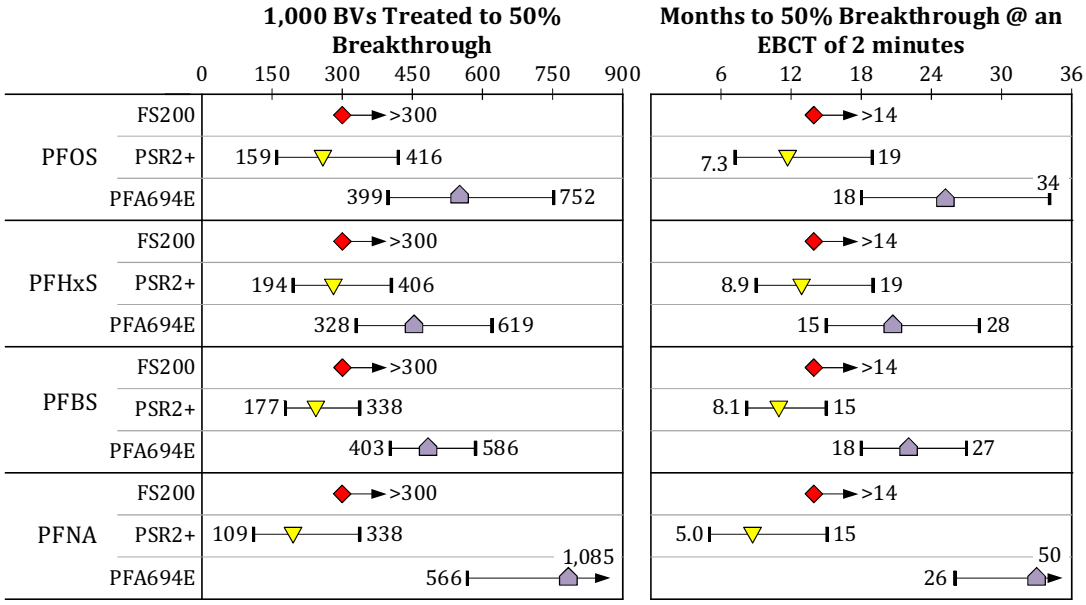


Figure 4.2 – Summary of Bed Volumes Treated with FS200 & IX Resins to 50% Breakthrough and Corresponding Months of Operation at an EBCT of 2.0 minutes

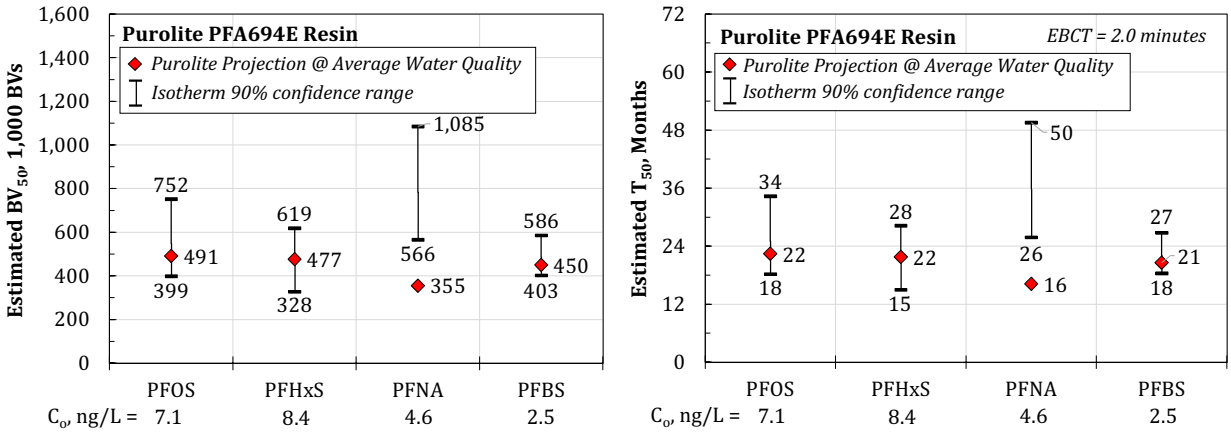


Figure 4.3 – Comparison between Isotherm 90% Confidence Range and Projections by Purolite for the Estimated BV_{50} (Left) and T_{50} (Right) Values Under Average Water Quality Conditions

Finally, it is important to emphasize that the testing results presented in this report estimate the anticipated performance of a new adsorbent. However, if the treatment system is designed and operated in a lead-lag configuration, then the time between media replacement will be shorter than that projected in this study. The reason is that, after the first changeout, the "lead" vessel will always contain media that had been preloaded with PFAS chemicals, and other constituents (e.g., sulfate)

Appendix F

Williams Station PFAS Treatment Plant Full Design

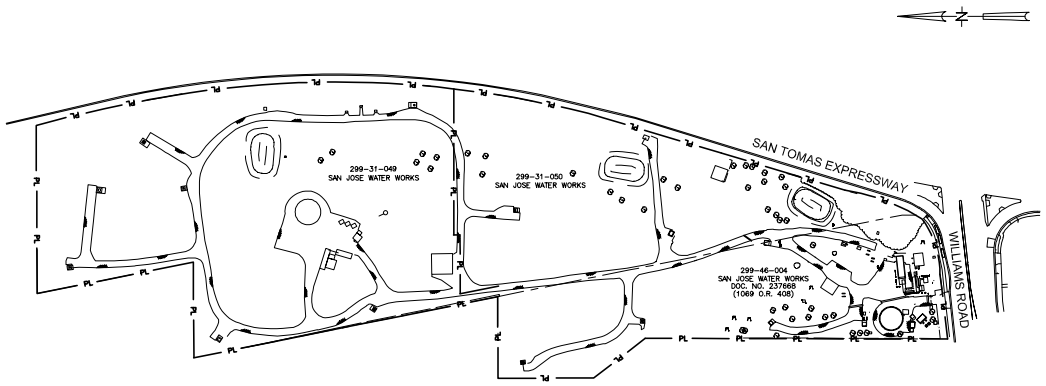
CDM Smith

LEGEND
REFER TO DRAWING NO. G-3

ABBREVIATIONS
REFER TO DRAWING NOS. C-1, S-2, A-1, M-1, H-1, E-2, AND I-1

WILLIAMS ROAD STATION
PFAS TREATMENT FACILITY PROJECT

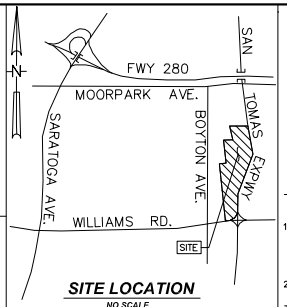
3601 & 3605 WILLIAMS RD
SAN JOSE, CA 95117



ADDRESS:
3601 & 3605 WILLIAMS ROAD
SAN JOSE, CA 95117

APN: 299-46-004, 299-31-050 & 299-31-049

SITE MAP
NO SCALE



SITE LOCATION
NO SCALE

SHEET INDEX
REFER DWG NO. G-2

INSTALL

1. NEW PFAS TREATMENT FACILITY CONSISTING OF TWO (2) RAW WATER TANKS, SEVEN (7) ION EXCHANGE FEED WATER PUMPS, AND FOURTEEN (14) ION EXCHANGE TRAINS, EACH TRAIN CONSISTING OF TWO ION EXCHANGE VESSELS IN LEAD-LAG CONFIGURATION.
2. ION EXCHANGE FEED WATER PUMPS WILL BE HOUSED IN A NEW BUILDING THAT HAS STORAGE ROOM, PUMP ROOM, AND ELECTRICAL ROOM.
3. YARD PIPING TO ROUTE GROUNDWATER FROM EXISTING WELLS TO THE NEW RAW WATER TANKS, AND ION EXCHANGE EFFLUENT WATER TO THE EXISTING SUCTION TANKS.
4. PROCESS DRAIN PUMP STATION TO PUMP PROCESS DRAIN TO EXISTING ENGINEERED SUMP.
5. SITE IMPROVEMENTS, INCLUDING DRIVEWAY AND SIDEWALK IMPROVEMENTS, NEW ON-SITE MAINTENANCE ROADWAYS, AND STORMWATER DETENTION POND.

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

THE (SJW) CONTRACTOR SHALL:

1. INSTALL ALL PIPE AND APPURTENANCES IN ACCORDANCE WITH CURRENT SJW STANDARDS AND SPECIFICATIONS. CALIFORNIA GREENBOOK STANDARDS SHALL GOVERN TO SUPPLEMENT WHERE SJW STANDARDS AND SPECIFICATIONS LACK SUBSTANTIATIVE DETAIL, UNLESS SHOWN OTHERWISE ON THESE PLANS.
2. FOLLOW METHODS AND PROCEDURES FOR SHUTDOWNS AS DIRECTED BY THE SJW CONSTRUCTION DEPT.
3. CONTACT LOCAL UTILITY COMPANIES FOR NEW SERVICE CONNECTIONS ASSOCIATED WITH THE PROPOSED IMPROVEMENTS:

   TELEPHONE:
   CABLE/INTERNET:
   ELECTRICAL:
   SEWER:
   STORM WATER:
   ROADWAYS:
4. NOTIFY SJW OPERATIONS DEPARTMENT 72 HOURS PRIOR TO STARTING WORK AT (408) 279-7807.
5. NOTIFY UNDERGROUND SERVICE ALERT (USA) AT 1-800-227-2600, 48 HOURS PRIOR TO EXCAVATION. CONTRACTOR SHALL FIELD VERIFY ALL EXISTING UTILITIES ON THE SITE. THESE PLANS SHALL NOT ABSOLVE RESPONSIBILITY FOR CONFIRMING ALL EXISTING UTILITIES.
6. REFER TO C-2 FOR SITE BEARINGS AND SURVEY NOTES.
7. ALL PIPES PROPOSED FOR DEMOLITION SHALL BE FILLED WITH FLOWABLE FILL AND ABANDONED IN-PLACE WHERE SHOWN ON THE PLANS. REFER TO SHEET C-XX FOR DETAILS.
8. VERTICAL CLEARANCE, WHEN CROSSING UTILITIES SHALL BE A MINIMUM OF 12", UNLESS OTHERWISE NOTED ON PLANS.
9. MAINTAIN MINIMUM 5 FEET CLEARANCE BETWEEN WATER MAINS AND SANITARY SEWERS, UNLESS OTHERWISE NOTED ON PLANS.
10. CENTER A FULL LENGTH OF PIPE WHEN UNDERCROSSING SANITARY SEWERS OR LATERALS. THE VERTICAL CLEARANCE SHALL BE A MINIMUM OF 12", UNLESS OTHERWISE NOTED ON PLANS. CROSSING BELOW ANY SEWERS SHALL REQUIRE CONCRETE ENCASEMENT PER DTL SD-2.
11. GEOTECHNICAL SITE CHARACTERIZATION AND SUBGRADE PREPARATION FOR FACILITIES WITH LOAD BEARING PRESSURES ARE COVERED ON THE STRUCTURAL SHEET S-1.
12. SITE UTILITY CONFLICTS WITH THE PROPOSED IMPROVEMENTS PROVIDED ON THE PLANS SHALL BE COORDINATED WITH THE ENGINEER OF RECORD AND SJW. ANY CONTRACTOR PROPOSED ALTERNATIVES SHALL BE APPROVED BY BOTH PARTIES.
13. ACCESS TO THE SITE FOR SJW STAFF SHALL BE FACILITATED DURING DELIVERIES AND ALL SITE WORK. CONTRACTOR SHALL COORDINATE WITH SJW IN THE EVENT OF SITE ACCESS ROUTE ALTERATIONS IN ADVANCE OF ALL WORK, AS REQUIRED.
14. DISRUPTIONS AND SHUTDOWNS OF EXISTING FACILITIES SHALL BE PERFORMED IN ACCORDANCE WITH SJW OPERATIONS PERMISSION. A MINIMUM OF 72-HRS OF ADVANCED NOTIFICATION IS REQUIRED FOR ALL SUCH OPERATIONS.
15. CONTACT THE LOCAL UTILITIES FOR COORDINATION OF TEMPORARY FACILITY CONNECTIONS.
16. SITE CONSTRUCTION SHALL ADHERE TO LOCAL NOISE CONTROL ORDINANCES.
17. CONTRACTOR SHALL ENSURE PROPER SITE SECURITY IS IN-PLACE WITH DETAILED LOCKOUT TAGOUT PROCEDURES BEING FOLLOWED.
18. CONTRACTOR WILL BE RESPONSIBLE FOR TRAFFIC CONTROL.
19. THE CONTRACTOR SHALL BE RESPONSIBLE FOR SECURING THE NECESSARY PERMITS PRIOR TO COMMENCING WORK AND COORDINATE ANY AND ALL ASSOCIATED INSPECTIONS PERFORMED BY CITY AND/OR COUNTY STAFF.

PROJECT TEAM

OWNER/ APPLICANT	CIVIL ENGINEER	CIVIL ENGINEER	PROCESS ENGINEER	STRUCTURAL ENGINEER	ARCHITECTURAL ENGINEER
FRANK DU SAN JOSE WATER COMPANY 1265 SOUTH BASCOM AVENUE SAN JOSE, CA 95128 PHONE: (408) 279 - 7880 EMAIL: frank.du@sjwater.com					

BUILDING MECH. ENGINEER	AUTOMATION ENGINEER	ELECTRICAL ENGINEER	CORROSION PROTECTION ENGINEER

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SJW SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

GENERAL
COVER SHEET

REGISTERED PROFESSIONAL ENGINEER
KEVIN CHU CHANG
No. C 70014
CIVIL
STATE OF CALIFORNIA

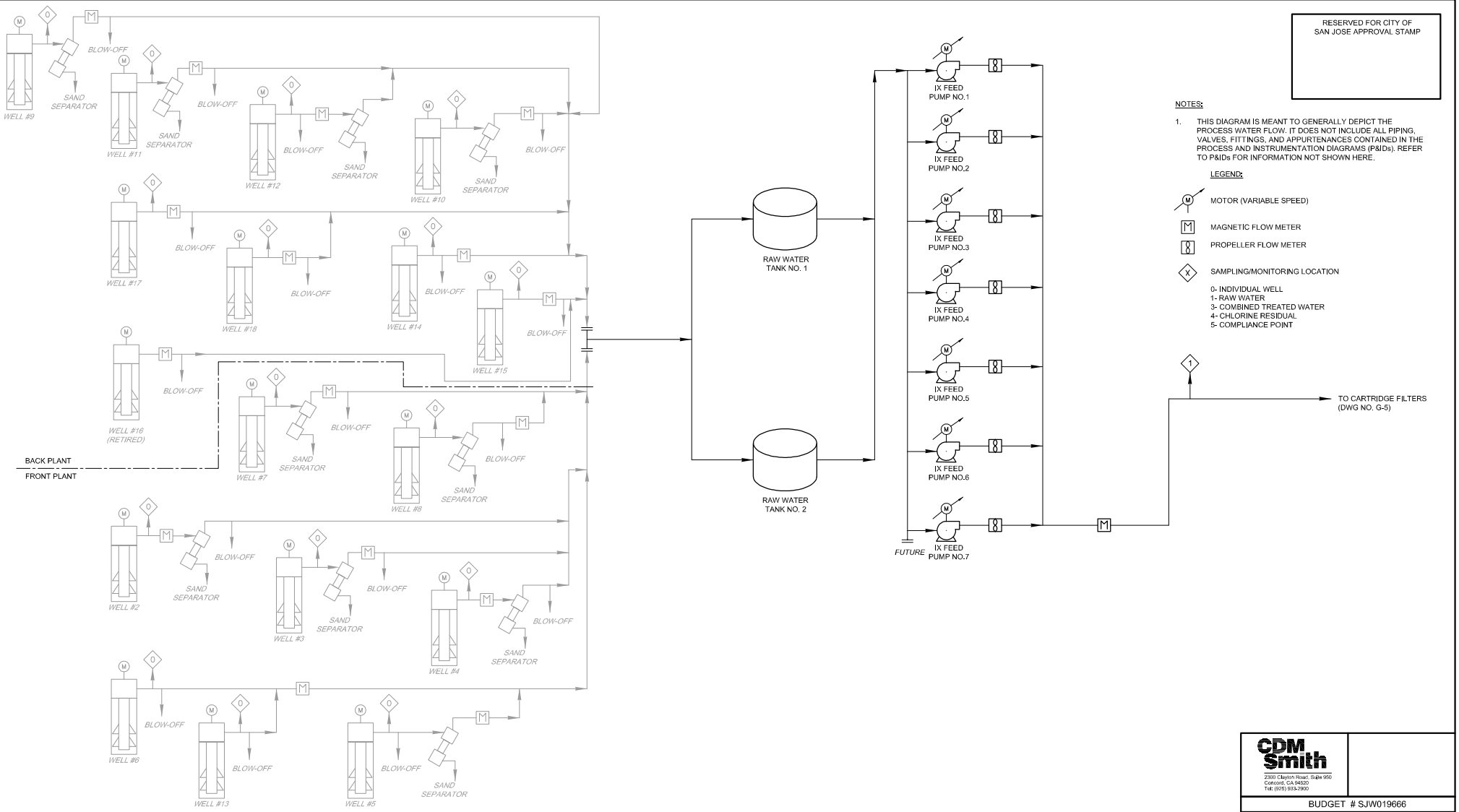
AS-BUILT STAMP

BY	REVISION	DATE	OK	DATE	OK

DATE: NOVEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: NTS	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: J.YOSHIMURA	ENGINEERING, PLANNING / DATE	
DRAWN: R.SAKA	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. G-1
CHECKED: E.CHANG	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date: 13 December 2024 - 5:16 PM Plotted By: Madhukar, Bavilskar (Jeevan) Filename: C:\Users\madhukarb\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\01 Gen\10 CADD\G000NFCV.dwg



RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

NOTES:

1. THIS DIAGRAM IS MEANT TO GENERALLY DEPICT THE PROCESS WATER FLOW. IT DOES NOT INCLUDE ALL PIPING, VALVES, FITTINGS, AND APPURTENANCES CONTAINED IN THE PROCESS AND INSTRUMENTATION DIAGRAMS (P&IDs). REFER TO P&IDs FOR INFORMATION NOT SHOWN HERE.

LEGEND:

- MOTOR (VARIABLE SPEED)
- MAGNETIC FLOW METER
- PROPELLER FLOW METER
- SAMPLING/MONITORING LOCATION

0- INDIVIDUAL WELL
1- RAW WATER
3- COMBINED TREATED WATER
4- CHLORINE RESIDUAL
5- COMPLIANCE POINT

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PROCESS FLOW DIAGRAM I - WELLS TO IX FEED PUMPS

REGISTERED PROFESSIONAL ENGINEER
JASON CHU CHANG
No. C 70014
CIVIL
STATE OF CALIFORNIA

AS-BUILT STAMP

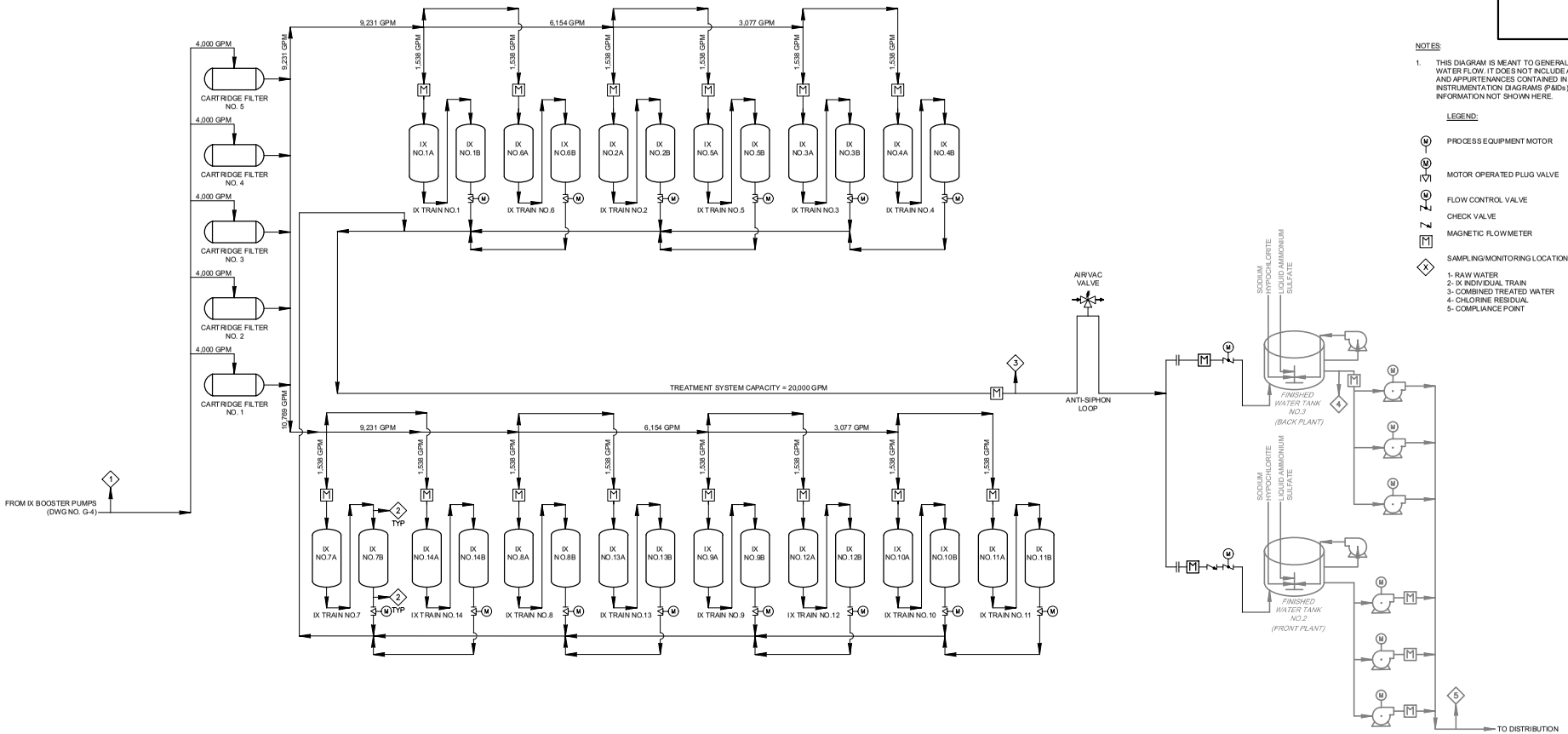
BY	REVISION	DATE	QK	DATE	QK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: NONE	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: J.YOSHIMURA	ENGINEERING, PLANNING / DATE	
DRAWN: B. PAWAN	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. G-4
CHECKED: E.CHANG	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date: 17 December 2024 - 9:20 PM Plotted By: Madhukar, Bavilskar (Jeevan) Filename: C:\Users\madhukarb\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\01 Gen\10 CADD\G004PFD1.dwg

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP



NOTES:

1. THIS DIAGRAM IS MEANT TO GENERALLY DEPICT THE PROCESS WATER FLOW. IT DOES NOT INCLUDE ALL PIPING, VALVES, FITTINGS, AND APPURTENANCES CONTAINED IN THE PROCESS AND INSTRUMENTATION DIAGRAMS (P&IDs). REFER TO P&IDs FOR INFORMATION NOT SHOWN HERE.

LEGEND:

- PROCESS EQUIPMENT MOTOR
- MOTOR OPERATED PLUG VALVE
- FLOW CONTROL VALVE
- CHECK VALVE
- MAGNETIC FLOWMETER
- SAMPLING/MONITORING LOCATION
  - 1- RAW WATER
  - 2- IX INDIVIDUAL TRAIN
  - 3- COMBINED TREATED WATER
  - 4- CHLORINE RESIDUAL
  - 5- COMPLIANCE POINT

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PROCESS FLOW DIAGRAM II - CARTRIDGE FILTERS TO TREATMENT/FINISHED WATER TANKS

REGISTERED PROFESSIONAL ENGINEER — JASON CHU CHANG — No. C 70014 — CIVIL — STATE OF CALIFORNIA

AS-BUILT STAMP

BY	REVISION	DATE	OK	DATE	OK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: NONE	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: J.YOSHIMURA	ENGINEERING, PLANNING / DATE	
DRAWN: B. PAWAN	ENGINEERING, SPECIAL FACILITIES / DATE	DWG NO. G-5
CHECKED: E.CHANG	CHIEF ENGINEER / DATE	

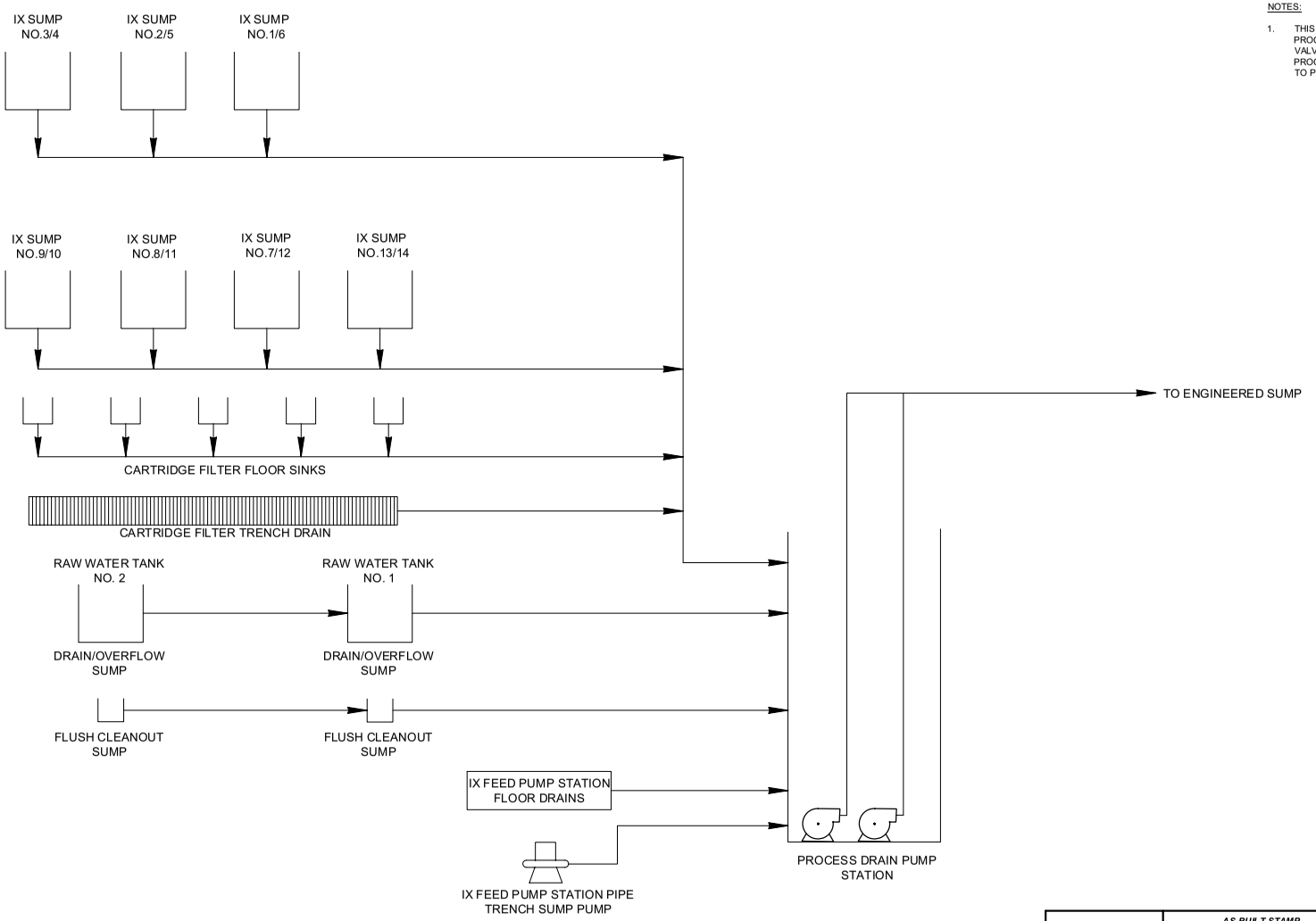
ISSUED FOR CONSTRUCTION

Plot Date: 17 December 2024 - 9:21 PM Plotted By: Madhukar, Baviskar (Jeevan) Filename: C:\Users\madhukarbj\DCVACCDocs\CDM Smith Incl\284565 SJW PFAS\Project Files\01 Gen\10 CADD\G005PFD2.dwg

RESERVED FOR CITY OF
SAN JOSE APPROVAL STAMP

NOTES:

1. THIS DIAGRAM IS MEANT TO GENERALLY DEPICT THE PROCESS WATER FLOW. IT DOES NOT INCLUDE ALL PIPING, VALVES, FITTINGS, AND APPURTENANCES CONTAINED IN THE PROCESS AND INSTRUMENTATION DIAGRAMS (P&IDs). REFER TO P&IDs FOR INFORMATION NOT SHOWN HERE.



CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PROCESS FLOW DIAGRAM III
SIDESTREAM MANAGEMENT

REGISTERED PROFESSIONAL ENGINEER
JASON CHU CHANG
No. C 70014
CIVIL
STATE OF CALIFORNIA

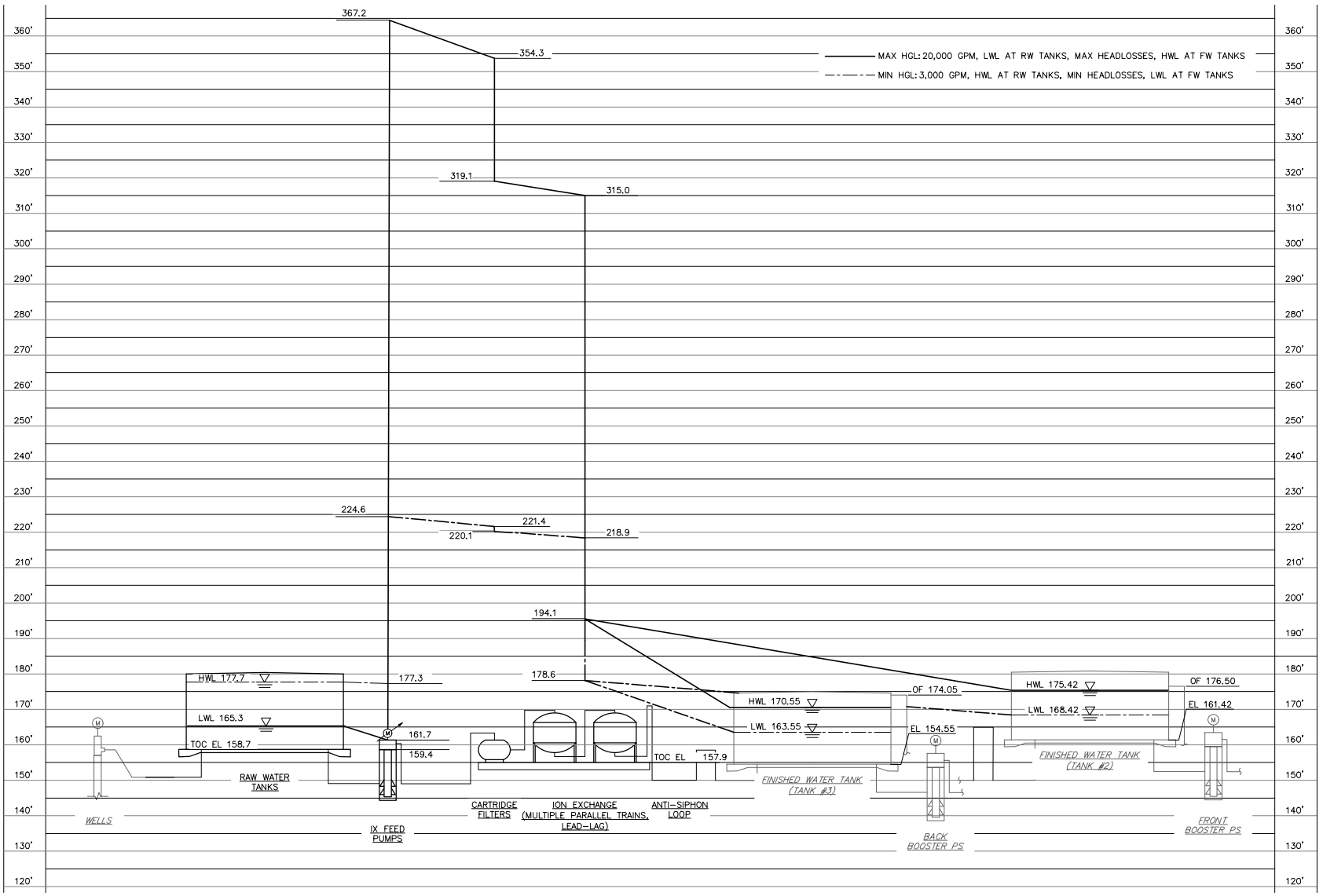
AS-BUILT STAMP

BY	REVISION	DATE	OK	DATE	OK

DATE: *NOVEMBER 2024*	HEALTH AND SAFETY / DATE	J30238
SCALE: *NONE*	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: *J.YOSHIMURA*	ENGINEERING, PLANNING / DATE	
DRAWN: *B. PAWAN*	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. *G-6*
CHECKED: *E.CHANG*	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date: 13 December 2024 - 5:27 PM Plotted By: Madhukar, Baviskar (Jeevan) Filename: C:\Users\madhukarbj\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\01 Gen\10 CADD\G006PFD3.dwg



HYDRAULIC PROFILE
NTS

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

HYDRAULIC PROFILE

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER — KEVIN CHU CHANG — No. C 70014 — CIVIL — STATE OF CALIFORNIA

BY	REVISION	DATE	CK	DATE	CK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: N.T.S	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: J.YOSHIMURA	ENGINEERING, PLANNING / DATE	
DRAWN: B. PAWAN	ENGINEERING, SPECIAL FACILITIES / DATE	DWG NO. G-7
CHECKED: E.CHANG	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date: 17 December 2024 - 9:21 PM Plotted By: Madhukar, Baviskar (Jeevan) Filename: C:\Users\madhukarbj\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\01 Gen\10 CADD\G007NFHP.dwg

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

DESIGN CRITERIA

PARAMETER	UNITS	CRITERIA
DESIGN FLOWS		
MINIMUM FLOW	GPM	3,000
MAXIMUM PLANT CAPACITY	GPM	20,000
RAW WATER TANKS		
NUMBER	EA	2
TYPE	-	WELDED STEEL
MAXIMUM VOLUME TO OVERFLOW, EACH	GAL	249,900
DIAMETER	FT	45
SIDE SHELL HEIGHT	FT	24
DESIGN/ MAX OVERFLOW RATE, EACH	GPM	20,000
ION EXCHANGE BOOSTER PUMPS		
NUMBER	-	7 (6 DUTY, 1 STANDBY)
TYPE	-	VERTICAL TURBINE CAN
CAPACITY, EACH	GPM	3,334
TOTAL HEAD	FT	210
MOTOR HORSEPOWER, MAXIMUM	HP	250
DRIVE	-	VFD
ION EXCHANGE PRE-TREATMENT		
TYPE	-	CARTRIDGE FILTRATION
NO. OF FILTER HOUSINGS	EA	5 (4 DUTY, 1 STANDBY)
CARTRIDGE FILTER ELEMENT DIAMETER	IN	6
CARTRIDGE FILTER ELEMENT LENGTH	IN	40
NO. CARTRIDGE FILTER ELEMENTS PER VESSEL	EA	36
LOADING RATE (n)	GPM/10"	27.8
LOADING RATE (n-1)	GPM/10"	34.7
INLET/OUTLET CONNECTION	IN	24
FILTRATION RATING	MICRONS	5
CLEAN FILTER DIFFERENTIAL PRESSURE	PSI	3
TERMINAL DIFFERENTIAL PRESSURE	PSI	15
VESSEL ORIENTATION	-	HORIZONTAL

PARAMETER	UNITS	CRITERIA
ION EXCHANGE TREATMENT SYSTEM		
TYPE	-	SERIES LEAD/LAG
NO. OF VESSEL PAIRS	EA	14 (13 DUTY, 1 STANDBY)
NO. OF VESSELS	EA	28
VESSEL DIAMETER	FT	12
STRAIGHT SIDE SHELL HEIGHT	FT	5
APPROX OVERALL SYSTEM HEIGHT	FT	16
VESSEL PRESSURE RATING	PSI	125
BED DEPTH	FT	4.7
RESIN VOLUME, EACH	CF	530
EMPTY BED CONTACT TIME, AVG PER VESSEL PAIR	MIN	5.0
HYDRAULIC LOADING RATE	GPM/FT^2	13.6
SERVICE FLOW RATE	GPM/FT^3	3.0
CLEAN BED DIFFERENTIAL PRESSURE	PSI	28
TERMINAL DIFFERENTIAL PRESSURE	PSI	35
PROCESS DRAIN PUMPS		
TYPE	-	SUBMERSIBLE
NUMBER	EA	2 (LEAD/LAG)
CAPACITY, EACH	GPM	1,500
TOTAL HEAD	FT	37
MOTOR HORSEPOWER, MAXIMUM	HP	30
DRIVE	-	VFD

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

DESIGN CRITERIA

REGISTERED PROFESSIONAL ENGINEER
ELVIN CHU CHANG
No. C 70014
CIVIL
STATE OF CALIFORNIA

AS-BUILT STAMP

BY	REVISION	DATE	OK	DATE	OK

DATE *DECEMBER 2024*	HEALTH AND SAFETY / DATE	J30238
SCALE *NTS*	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN *J.YOSHIMURA*	ENGINEERING, PLANNING / DATE	
DRAWN *R.SAKA*	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. *G-8*
CHECKED *E.CHANG*	CHIEF ENGINEER / DATE	

Plot Date: 17 December 2024 - 9:22 PM Plotted By: Madhukar, Baviskar (Jeevan) Filename: C:\Users\madhukarbj\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\01 Gen\10 CADD\G008NFDC.dwg

ISSUED FOR CONSTRUCTION

GENERAL NOTES

1. PRIOR TO BEGINNING CONSTRUCTION CONTRACTOR SHALL PERFORM INVESTIGATION TO VERIFY THE LOCATION, SIZE AND ELEVATIONS OF ALL EXISTING SUBSURFACE UTILITIES (WHETHER SHOWN ON THESE PLANS OR NOT) AND NOTIFY SAN JOSE WATER COMPANY IMMEDIATELY UPON DISCOVERY OF ANY DISCREPANCIES BETWEEN EXISTING CONDITIONS IN THE FIELD AND INFORMATION SHOWN ON THIS PLAN. CONTRACTOR SHALL PROTECT ALL EXISTING UNDERGROUND UTILITIES THAT ARE TO REMAIN IN PLACE.
2. CONTRACTOR IS RESPONSIBLE FOR MATCHING EXISTING PAVING, SURROUNDING LANDSCAPE AND OTHER IMPROVEMENTS WITH A SMOOTH TRANSITION IN PAVING, CURBS, GUTTERS, GRADING, ETC. AND TO AVOID ANY ABRUPT OR APPARENT CHANGES IN GRADES OR CROSS SLOPES, LOW SPOT OR HAZARDOUS CONDITIONS.
3. ALL MECHANICAL JOINT FITTINGS SHALL USE MEGALUGS: FOR PVC PIPE, USE EBAA SERIES 200PV MEGALUGS.
4. IF UTILITY CROSSING HAS LESS THAN 12" CLEARANCE (6" MINIMUM), PLACE HIGH DENSITY POLYURETHANE FOAM BLOCK SECURELY BETWEEN PIPES/FACILITIES. BACKFILL W/2 SACK CEMENT SAND SLURRY.
5. ALL NEW DUCTILE IRON UNDERGROUND PIPING AND FITTINGS SHALL BE ZINC COATED, CEMENT LINED AND USE V-BIO POLYWRAP.

SYMBOLS

- AIR CONDITIONING UNIT
- ANTENNA CELL
- ASPHALT PAVEMENT
- CONCRETE PAVEMENT
- CONTROL POINT
- DRAIN INLET
- ELECTRIC OUTLET
- FIRE HYDRANT
- FOUND MONUMENT AS NOTED
- GATE(S)
- GROUND ELECTRIC
- GUARD POLE (BOLLARD)
- GUY WIRE
- LADDER
- PALM TREE
- PINE TREE
- POWER POLE
- TELECOM MANHOLE
- TREE (TYPICAL)
- TREE STUMP
- UTILITY POLE
- WATER FAUCET
- WATER VALVE
- MONITORING WELL
- BENCH MARK
- SET SURVEY CONTROL POINT AS NOTED
- EX. BUSH/SHRUB/TREELINE
- SPOT ELEVATION (EX., PROPOSED)
- DELINEATOR POST
- ELECTROLIER
- JOINT POLE
- BLOCK WALL
- CENTERLINE
- EXISTING CHAIN LINK FENCE
- EASEMENT LINE
- EDGE OF PAVEMENT
- ELECTRIC LINE PAINTED
- OVERHEAD LINE
- PROPERTY LINE
- RIGHT-OF-WAY
- TELECOM LINE PAINTED
- ENGINEERED SUMP LINE
- WATER LINE
- WATER LINE RECORD
- IRRIGATION LINE WITH ASSOCIATED VALVE
- SANITARY SEWER LINE
- STORM DRAIN LINE
- GAS LINE
- UNKNOWN LINE PAINTED
- PROPOSED WATER LINE
- NEW CATCH BASIN
- NEW FENCE

ABBREVIATIONS

ABDN	ABANDON
AC	ASPHALT CONCRETE
APN	ASSESSOR'S PARCEL NUMBER
B.C.	BEGINNING OF CURVE
BFV	BACK-FLOW VALVE/ BUTTERFLY VALVE
BLDG	BUILDING
BM	BENCH MARK
BO	BLOW-OFF
BOT	BOTTOM
BTM	BOTTOM OF STRUCTURE
C/L ℄	CENTERLINE
CIP	CAST IRON PIPE
CL	CLASS
CLR	CLEAR
CML	CEMENT MORTAR LINING
CONC	CONCRETE
CPLG	COUPLING
Δ	DELTA
DET	DETAIL
DIA, ø	DIAMETER
DIP	DUCTILE IRON PIPE
DI	DUCTILE IRON
DICL	DUCTILE IRON CEMENT LINED
DR	DRAIN
EA	EACH
EBOX	ELECTRIC BOX
E.C.	END OF CURVE
EC	ELECTRIC CABINET
ECR	END CURB RETURN
EL	ELEVATION
ELL	ELBOW
EM	ELECTRIC METER
EOP	EDGE OF PAVEMENT
EP	ELECTRIC PANEL
EPB	ELECTRIC PULL BOX
EV	ELECTRIC VAULT
EW	EACH WAY
EXIST	EXISTING
FE	FIRE EXTINGUISHER
FF	FINISH FLOOR
FH	FIRE HYDRANT
FKCL	FIBER KRAFT (OR FLINT) COATED CEMENT LINED
FL	FLOW LINE
FLG	FLANGED
FLR	FLARED
FS	FINISH SURFACE
FT	FEET
FW	FINISHED WATER
GALV	GALVANIZED
GV	GATE VALVE
HCR	HANDICAP RAMP
ID	INSIDE DIAMETER
INV	INVERT
IJ	INSULATING JOINTS
IJTS	INSULATING JOINT TEST STATION
IX	ION EXCHANGE
IXE	ION EXCHANGE EFFLUENT
MJ	MECHANICAL JOINT
NG	NATURAL GROUND
NTS	NOT TO SCALE
NOAA	NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOM	NOMINAL
NPT	NATIONAL PIPE THREAD
OC	ON CENTER
OD	OUTSIDE DIAMETER
OT	OVERHANG TOP
PE	PLAIN END
℄	PROPERTY LINE
PCC	PORTLAND CEMENT CONCRETE
POJ	PUSH-ON JOINT
PVC	POLYVINYL CHLORIDE PIPE
PROP	PROPOSED
PUE	PUBLIC UTILITY EASEMENT
PVMT	PAVEMENT
R	RADIUS
REINF	REINFORCING
REQ	REQUIRED
RCP	REINFORCED CONCRETE PIPE
R/W	RIGHT OF WAY
RW	RAW WATER
SCH	SCHEDULE
SD	STORM DRAIN
SDR	STANDARD DIMENSION RATIO
SE	SOUTHEAST OR SAND EQUIVALENT
SG	SUB-GRADE
SPEC	SPECIFICATION
ST	STREET
STA	STATION
STD	STANDARD
STL	STEEL
T	TANGENT
TC	TOP OF CURB
TM	TOP OF METER
TN	TOP OF NUT
TP	TOP OF PIPE
TOP	TOP OF STRUCTURE
TS	TEST STATION
TV	TOP OF VALVE
TW	TOP OF WALL
TR	TRANSFORMER
TYP	TYPICAL
VERT	VERTICAL
W	WIDTH, WATER
WM	WATER METER
WSCL	WRAPPED STEEL CEMENT LINED

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

AS-BUILT STAMP

BY	REVISION	DATE	OK	DATE	OK

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

CIVIL SITE SYMBOLS, ABBREVIATIONS AND GENERAL NOTES

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: N.T.S	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: C. BALENDHRAN	ENGINEERING, PLANNING / DATE	
DRAWN: P.NANDURKAR	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-1
CHECKED: XXXX	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

LEGEND:

- EXISTING PAVEMENT
- NEW PAVEMENT

KEY NOTES:

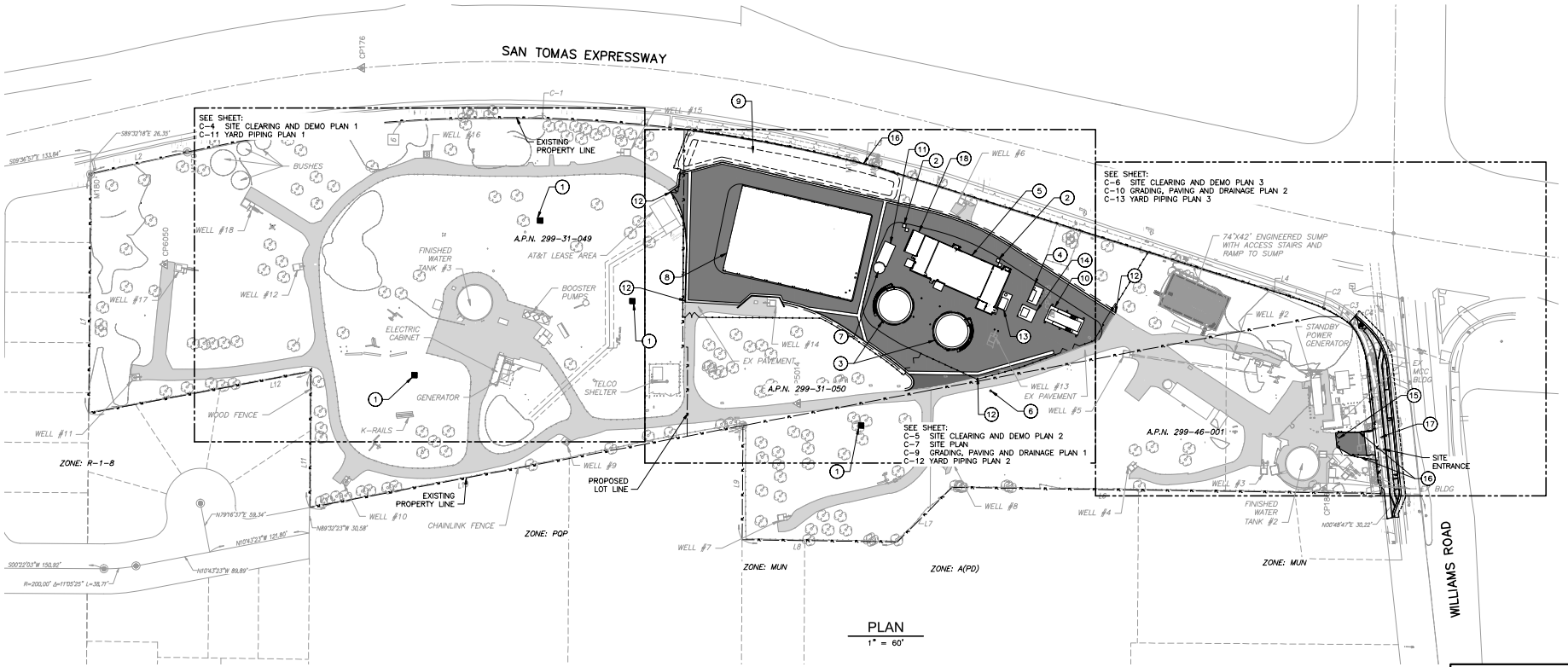
1. FUTURE POTENTIAL LOCATION OF NEW WELL (BY OTHERS)
2. ELECTRIC VAULT
3. RAW WATER TANKS
4. ELECTRIC SWITCH BOARD
5. PUMP STATION BUILDING
6. PG & E POWER POLE
7. PROCESS DRAIN PUMP STATION
8. IX TREATMENT AREA
9. STORM WATER BIORETENTION BASIN
10. EMERGENCY GENERATOR
11. CONCRETE PAD FOR PROCESS DRAIN PIPING AND FLOWMETER
12. MATCH EXISTING GRADE FOR PAVEMENT
13. AC UNIT
14. TRANSFORMER PAD
15. 17' SWING GATE
16. NEW FENCE
17. ENTRANCE MODIFICATION, SEE SHEET C-8
18. RESIN DRYING AREA

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

N

1" = 60'

30 0 60



PLAN

1" = 60'

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

OVERALL SITE PLAN

AS-BUILT STAMP

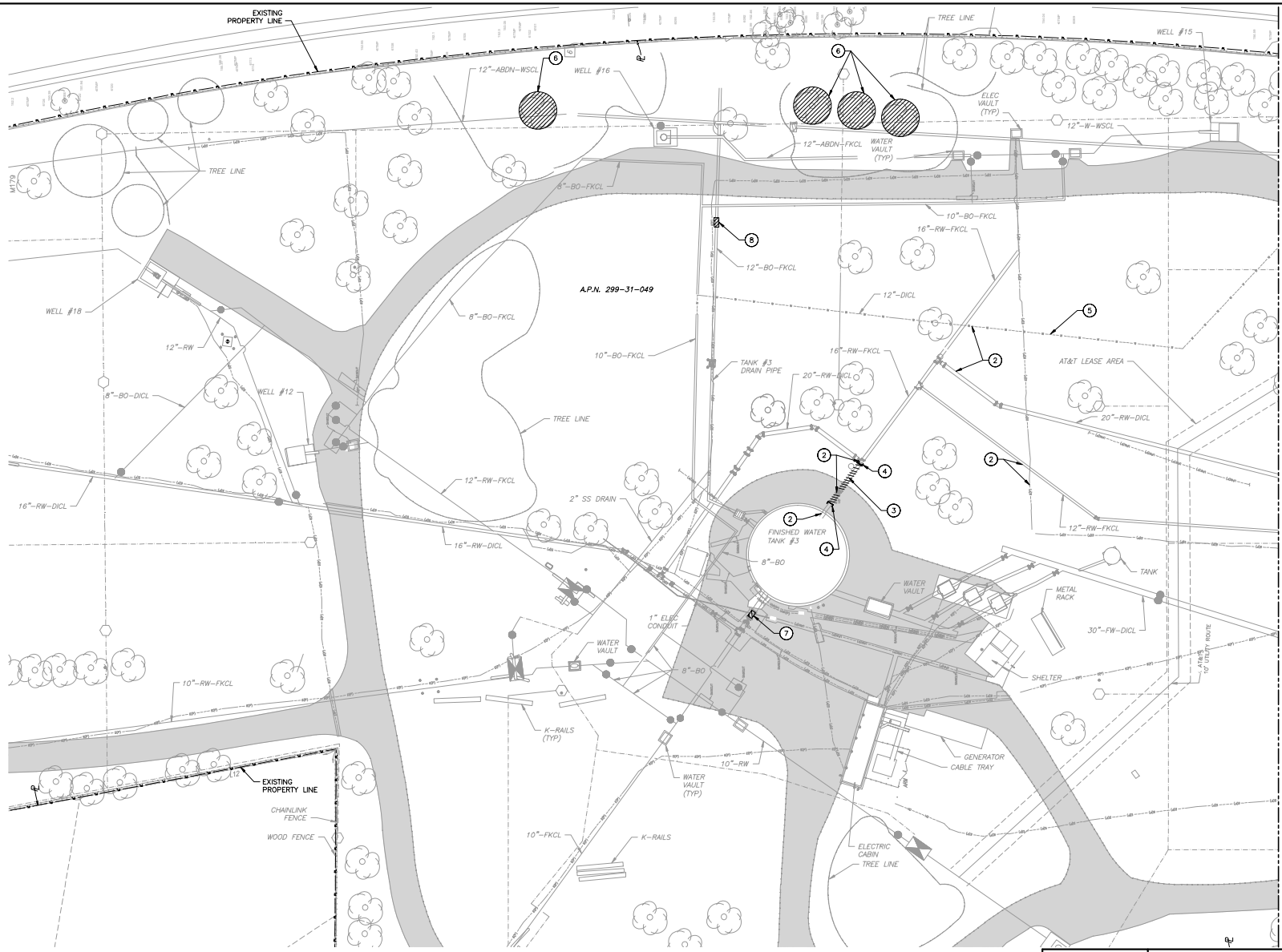
REGISTERED PROFESSIONAL ENGINEER — No. C-89CW Exp. 6/30/26 — CIVIL — STATE OF CALIFORNIA

BY	REVISION	DATE	OK	DATE	OK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=60'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: C. BALENDHRAN	ENGINEERING, PLANNING / DATE	
DRAWN: P.NANDURKAR	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-3
CHECKED: XXXX	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date: 23 December 2024 - 9:53 PM Plotted By: Nandurkar, Priya M. (Priya) Filename: C:\Users\nandurkarpm\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\02 Civil\10 CADD\C003STPL.dwg



PLAN
1" = 20'

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

N

1" = 20'
10 0 20

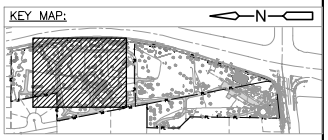
KEY NOTES:

1. NOT IN USE
2. PROTECT IN PLACE
3. CAP AND DEMOLISH EXISTING 16" DICL
4. CAP AND PROTECT IN PLACE FOR NEW TIE-IN
5. 12" DICL. TO ENGINEERED SUMP
6. REMOVE EXISTING TREE
7. REMOVE PIPE SPOOL AND PROVIDE BLIND FLANGE AND SOLID MJ PLUGS AT THE ENDS TO CAP THE PIPES
8. REMOVE PORTION OF 12" PIPE AS NEEDED TO INSTALL NEW CATCH BASIN

LEGEND:

- DEMOLITION
- EXISTING PAVEMENT
- PIPE DEMOLITION

KEY MAP:



AS-BUILT STAMP

BY	REVISION	DATE	OK	DATE	OK

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

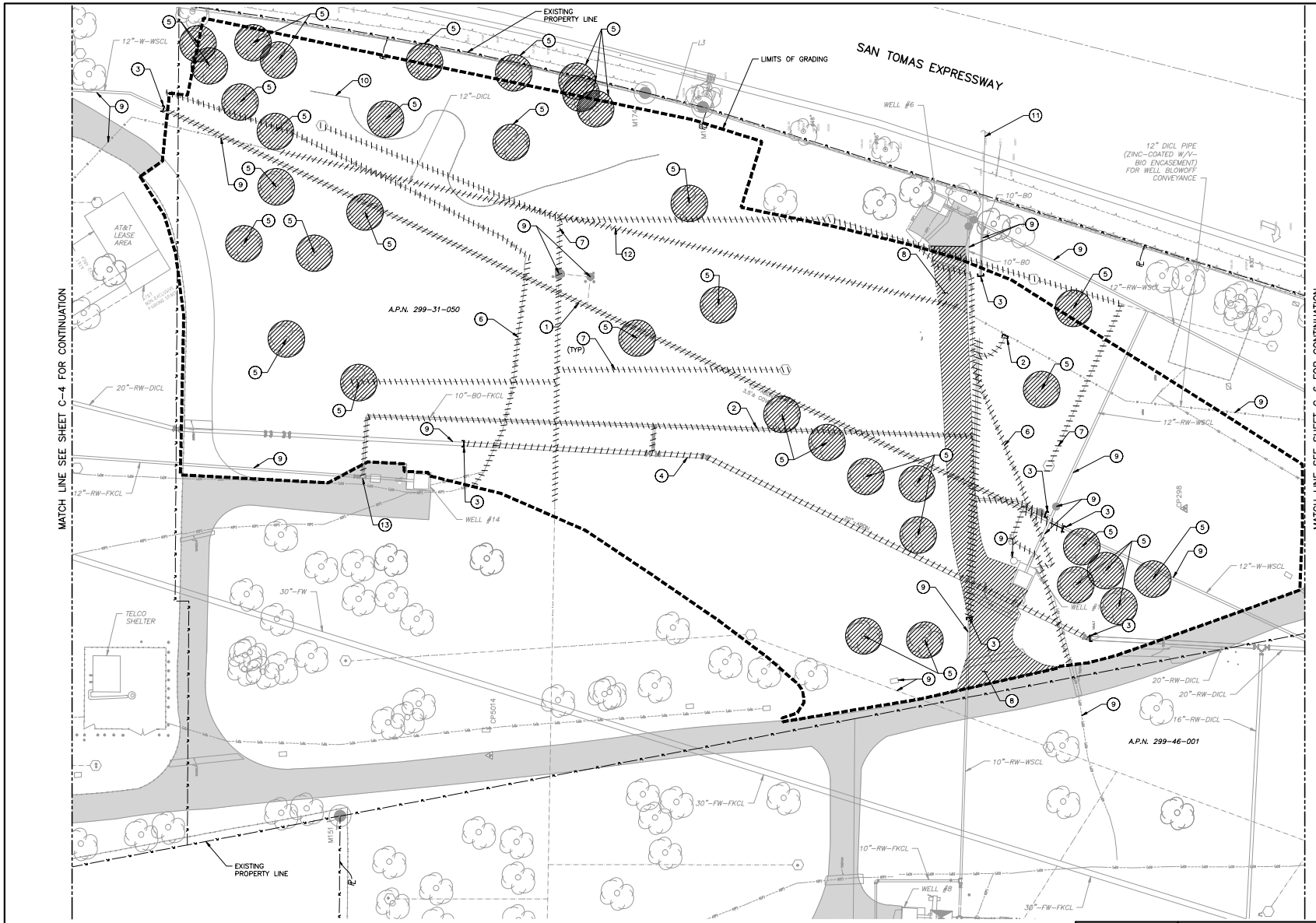
SITE CLEARING AND DEMO PLAN 1

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: C.BALENDHRAN	ENGINEERING, PLANNING / DATE	
DRAWN: P.NANDURKAR	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-4
CHECKED: XXXX	CHIEF ENGINEER / DATE	

REGISTERED PROFESSIONAL ENGINEER — No. C-69634 Exp. 6/30/26 — CIVIL — STATE OF CALIFORNIA

Plot Date: 23 December 2024 - 9:56 PM Plotted By: Nandurkar, Priya M. (Priya) Filename: C:\Users\nandurkarpm\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\02 Civil\10 CADD\C004STPL.dwg

ISSUED FOR CONSTRUCTION



PLAN
1" = 20'

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

N

1" = 20'
10 0 20

KEY NOTES:

1. CAP AND PROTECT IN PLACE THE TIE IN POINT OF 12"-W. SEE C-12 FOR RE-ROUTING
2. CAP AND DEMOLISH EXISTING 10"-BO PIPE
3. CAP AND PROTECT IN PLACE FOR NEW TIE-IN
4. CAP AND DEMOLISH EXISTING 20"-RW PIPE
5. REMOVE EXISTING TREE
6. RE-ROUTE ELECTRICAL CONDUITS AS NEEDED PER ELECTRICAL DRAWINGS
7. RE-ROUTE IRRIGATION LINES AND RELOCATE ASSOCIATED VALVES AS NEEDED PER LANDSCAPE DRAWINGS
8. DEMOLISH EXISTING PAVEMENT
9. PROTECT IN PLACE
10. REMOVE EXISTING TREE LINE/ BUSHES AS NEEDED FOR BMP INSTALLATION
11. CREEK OUTFALL
12. REMOVE AND RE-ROUTE ENGINEERED SUMP LINE AS NEEDED
13. REMOVE AND REUSE TEE

LEGEND:

- DEMOLITION
- LIMITS OF GRADING
- EXISTING PAVEMENT
- PIPE DEMOLITION

KEY MAP:

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

SITE CLEARING AND DEMO PLAN 2

AS-BUILT STAMP

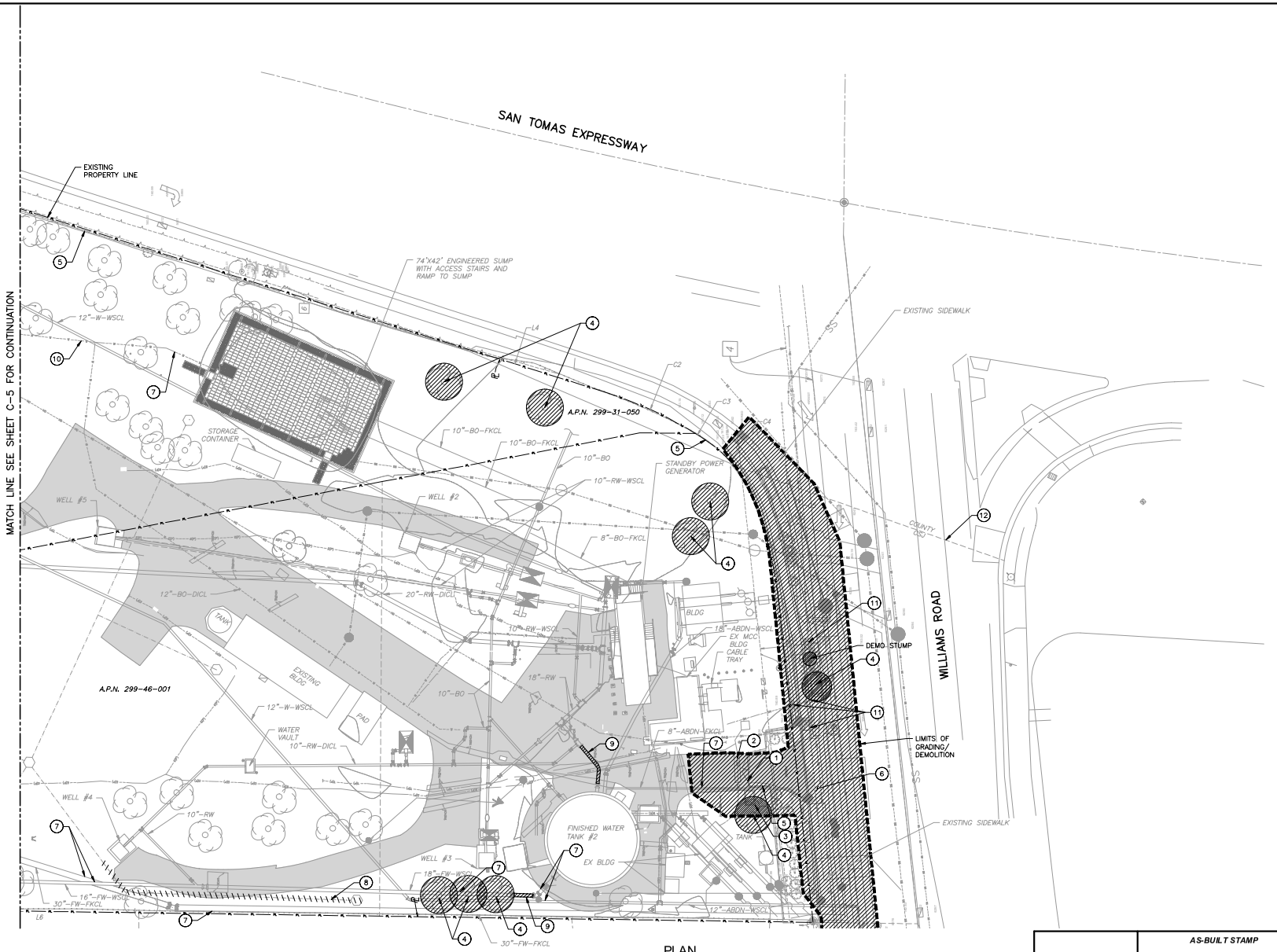
REGISTERED PROFESSIONAL ENGINEER — No. C-89634 Exp. 6/30/26 — CIVIL — STATE OF CALIFORNIA

BY	REVISION	DATE	CK	DATE	CK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: C.BALENDHRAN	ENGINEERING, PLANNING / DATE	
DRAWN: P.NANDURKAR	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-5
CHECKED: XXXX	CHIEF ENGINEER / DATE	

Plot Date: 23 December 2024 - 9:57 PM Plotted By: Nandurkar, Priya M. (Priya) Filename: C:\Users\nandurkarpm\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\02 Civil\10 CADD\C005STPL.dwg

ISSUED FOR CONSTRUCTION



PLAN
1" = 20'

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

N

1" = 20'
10 0 20

KEY NOTES:

1. REMOVE EXISTING GATE
2. PROTECT IN PLACE EXISTING DUCT BANK
3. PROTECT AND PROVIDE TRAFFIC RATED COVER FOR ELECTRICAL VAULT
4. REMOVE EXISTING TREE
5. REMOVE EXISTING FENCE,
6. DEMOLISH EXISTING PAVEMENT AS NEEDED FOR NEW DRIVEWAY
7. PROTECT IN PLACE
8. RE-ROUTE IRRIGATION LINES AND RELOCATE ASSOCIATED VALVES AS NEEDED
9. REMOVE PIPE SPOOL AND PROVIDE SOLID MJ PLUGS AT BOTH ENDS
10. 12" DICL. TO ENGINEERED SUMP
11. PROTECT EXISTING VAULT, POWER POLE & GUY WIRES, AND SIGN DURING DEMOLITION OF SIDEWALK
12. CITY/COUNTY RIGHT OF WAY LINE SHOWN BASED ON INTERPRETATION OF PLANS FOR CONSTRUCTION OF SAN TOMAS EXPRESSWAY 1963

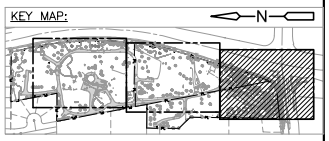
LEGEND:

- DEMOLITION
- LIMITS OF GRADING
- EXISTING PAVEMENT
- PIPE DEMOLITION

GENERAL NOTES:

1. SEPARATE ENCROACHMENT PERMIT IS REQUIRED FOR WORK WITHIN THE PUBLIC RIGHT OF WAY

KEY MAP:



CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

SITE CLEARING AND DEMO PLAN 3

AS-BUILT STAMP

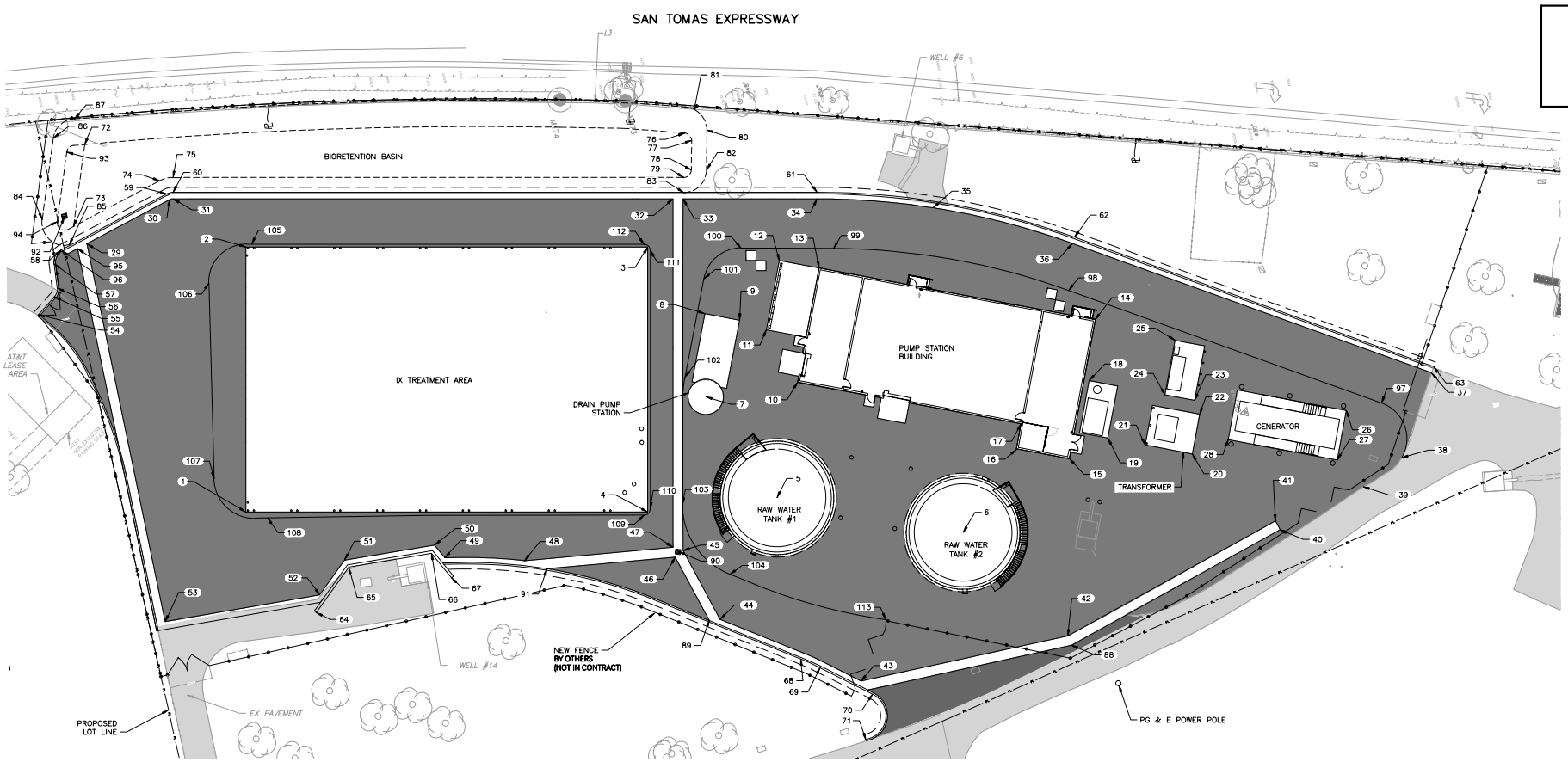
REGISTERED PROFESSIONAL ENGINEER No. C-89CW Exp. 6/30/26 CIVIL STATE OF CALIFORNIA

BY	REVISION	DATE	OK	DATE	OK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: C.BALENDHRAN	ENGINEERING, PLANNING / DATE	
DRAWN: P.NANDURKAR	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-6
CHECKED: XXXX	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date: 23 December 2024 - 9:57 PM Plotted By: Nandurkar, Priya M. (Priya) Filename: C:\Users\nandurkarpm\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\02 Civil\10 CADD\C006STPL.dwg



POINT TABLE		
POINT NO.	NORTHING	EASTING
1	1939041.33	6135968.73
2	1939017.56	6136071.01
3	1938862.53	6136034.97
4	1938886.30	6135932.70
5	1938835.14	6135926.56
6	1938766.44	6135896.47
7	1938853.59	6135971.93
8	1938846.44	6136004.17
9	1938833.63	6135998.51
10	1938816.76	6135969.40
11	1938824.22	6135992.33
12	1938812.96	6136017.97
13	1938798.27	6136011.52
14	1938696.40	6135966.80
15	1938718.79	6135915.48
16	1938738.43	6135923.75
17	1938734.35	6135933.23
18	1938704.22	6135943.80
19	1938702.13	6135919.95
20	1938670.98	6135906.28

POINT TABLE		
POINT NO.	NORTHING	EASTING
21	1938688.38	6135913.92
22	1938664.55	6135920.93
23	1938665.27	6135926.71
24	1938676.26	6135931.53
25	1938667.41	6135951.68
26	1938607.58	6135909.25
27	1938615.61	6135890.93
28	1938655.91	6135908.59
29	1939078.57	6136086.56
30	1939042.76	6136096.12
31	1939041.31	6136096.14
32	1938848.46	6136051.32
33	1938844.56	6136050.42
34	1938792.83	6136038.39
35	1938748.81	6136024.49
36	1938698.35	6135998.28
37	1938571.32	6135916.05
38	1938590.57	6135885.99
39	1938607.95	6135878.27
40	1938643.84	6135869.07

POINT TABLE		
POINT NO.	NORTHING	EASTING
41	1938644.93	6135872.92
42	1938735.32	6135847.17
43	1938819.12	6135848.26
44	1938867.97	6135884.72
45	1938876.13	6135914.62
46	1938879.77	6135912.78
47	1938879.72	6135916.81
48	1938938.17	6135924.92
49	1938968.62	6135933.19
50	1938971.51	6135938.98
51	1939007.62	6135941.26
52	1939020.30	6135930.09
53	1939082.34	6135933.59
54	1939103.72	6136063.48
55	1939095.89	6136068.91
56	1939094.02	6136072.07
57	1939093.02	6136081.66
58	1939088.90	6136086.49
59	1939043.43	6136098.63
60	1939040.72	6136098.68

POINT TABLE		
POINT NO.	NORTHING	EASTING
61	1938792.24	6136040.92
62	1938696.94	6136000.47
63	1938569.98	6135918.25
64	1939023.12	6135923.60
65	1939006.63	6135938.13
66	1938973.43	6135936.10
67	1938967.83	6135924.88
68	1938840.41	6135862.20
69	1938833.77	6135857.11
70	1938815.85	6135842.13
71	1938822.55	6135825.23
72	1939070.56	6136125.04
73	1939082.21	6136094.39
74	1939044.96	6136104.33
75	1939039.39	6136104.42
76	1938838.03	6136075.69
77	1938836.02	6136072.12
78	1938838.76	6136060.84
79	1938842.36	6136058.63
80	1938829.17	6136074.88

POINT TABLE		
POINT NO.	NORTHING	EASTING
81	1938832.18	6136083.95
82	1938832.93	6136059.42
83	1938843.71	6136052.79
84	1939093.67	6136099.87
85	1939085.47	6136087.68
86	1939082.12	6136130.27
87	1939072.16	6136135.94
88	1938734.70	6135843.19
89	1938872.27	6135885.30
90	1938878.12	6135914.77
91	1938930.26	6135919.79
92	1939084.83	6136098.94
93	1939078.19	6136123.73
94	1939088.07	6136097.74
95	1939082.60	6136085.48
96	1939088.74	6136085.91
97	1938593.34	6135908.86
98	1938704.00	6135980.50
99	1938790.92	6136017.75
100	1938826.60	6136026.22

POINT TABLE		
POINT NO.	NORTHING	EASTING
101	1938843.71	6136017.70
102	1938859.79	6135981.48
103	1938872.11	6135932.60
104	1938860.14	6135901.22
105	1939015.10	6136071.59
106	1939035.11	6136060.41
107	1939050.65	6135984.35
108	1939033.50	6135964.46
109	1938888.03	6135931.80
110	1938885.04	6135933.68
111	1938861.87	6136033.39
112	1938863.74	6136036.39
113	1938804.18	6135869.85

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

SITE PLAN

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER — No. C-89624 Exp. 6/30/26 — CIVIL — STATE OF CALIFORNIA

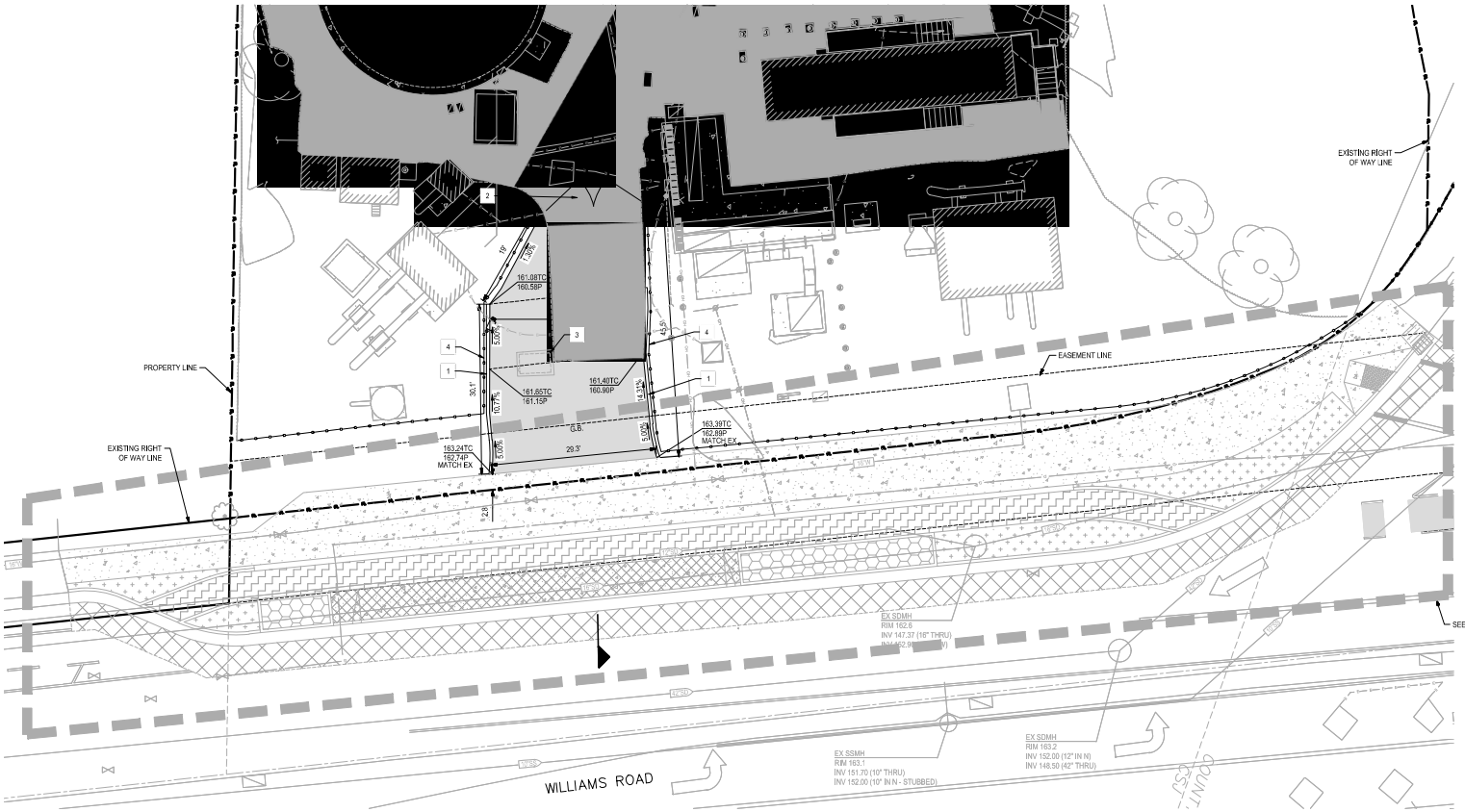
BY	REVISION	DATE	OK	DATE	OK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: C. BALENDHRAN	ENGINEERING, PLANNING / DATE	
DRAWN: P.NANDURKAR	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-7
CHECKED: XXXX	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date: 23 December 2024 - 9:58 PM Plotted By: Nandurkar, Priya M. (Priya) Filename: C:\Users\nandurkarpm\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\02 Civil\10 CADD\C007STPL.dwg

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP



LEGEND:

- SIDEWALK
- BIORETENTION AREA
- 4"ASPHALT PAVEMENT WITH 12"AB
- ASPHALT DEEPLIFT
- ASPHALT BIKE PATH
- CITY OF SAN JOSE DRIVEWAY CONCRETE
- LANDSCAPE

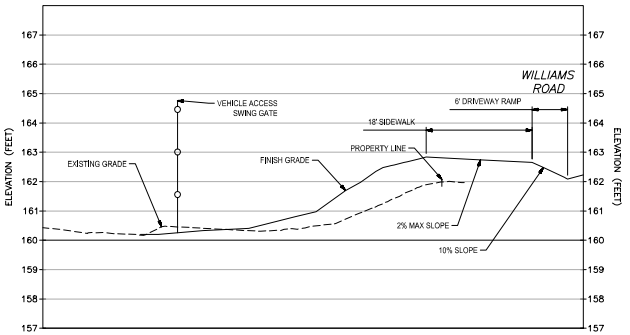
KEY NOTES

1. 6" VERTICAL CURB. REFER TO DETAIL 9 ON SHEET CD-5
2. PROPOSED GATE **BY OTHERS (NOT IN CONTRACT)**
3. ADJUST TO GRADE EXISTING ELECTRICAL VAULT. REPLACE EXISTING LID WITH NEW TRAFFIC RATED LID
4. PROPOSED FENCE **BY OTHERS (NOT IN CONTRACT)**

ENTRANCE MODIFICATION

PLAN

1" = 10'



SECTION 1

HOR 1" = 10'
VERT 1" = 2'

N

1" = 10'

5 0 10

CPM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

SIEGFRIED

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

ENTRANCE MODIFICATION

REGISTERED PROFESSIONAL ENGINEER
NATHAN J. BEREND
No. 85693
Exp. 09/30/26
CIVIL
STATE OF CALIFORNIA

DATE SIGNED: 12/17/24

AS-BUILT STAMP

BY	REVISION	DATE	CK	DATE	CK

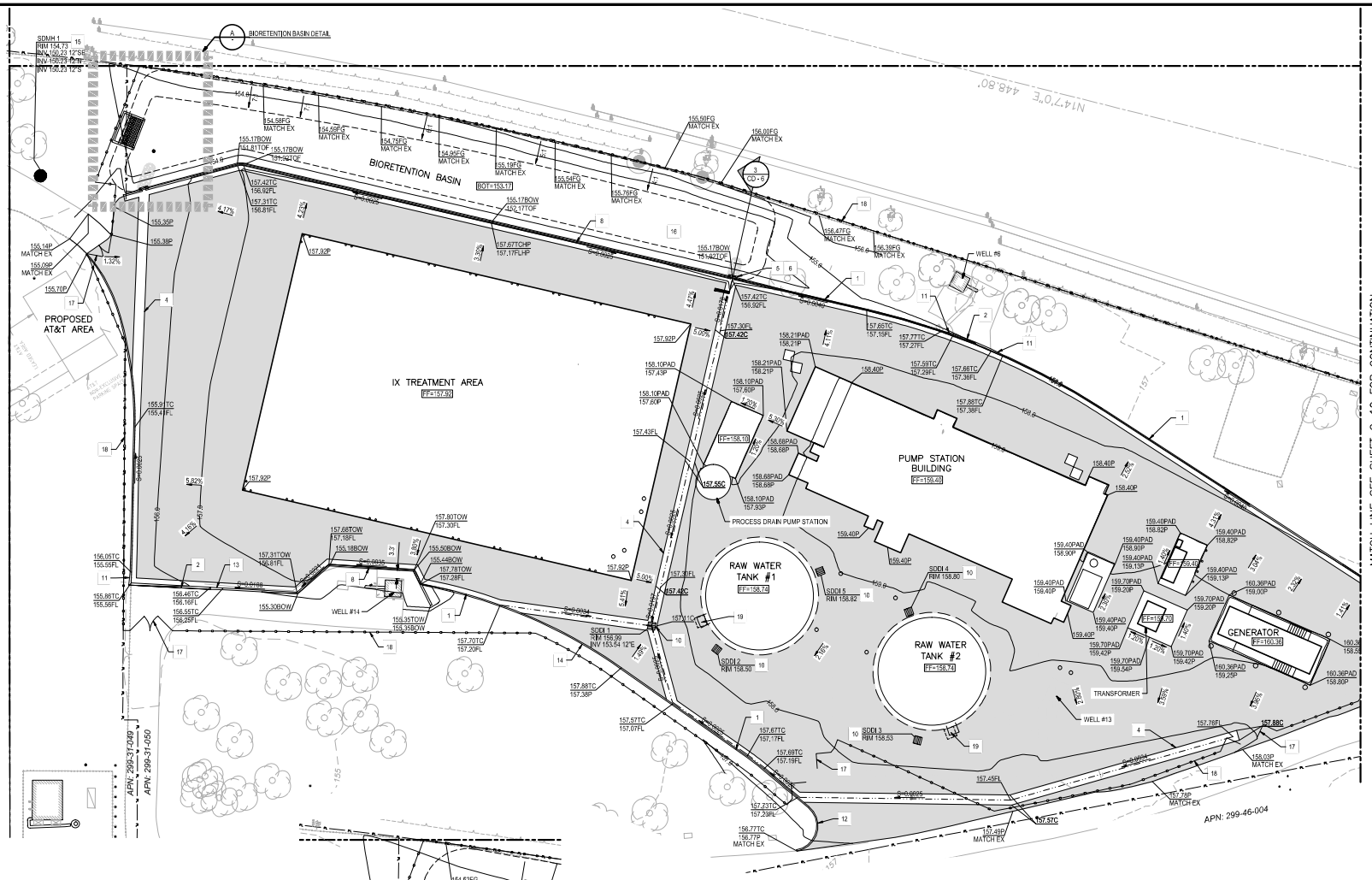
DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: NJB	ENGINEERING, PLANNING / DATE	
DRAWN: FSE	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-8
CHECKED: PJS	CHIEF ENGINEER / DATE	

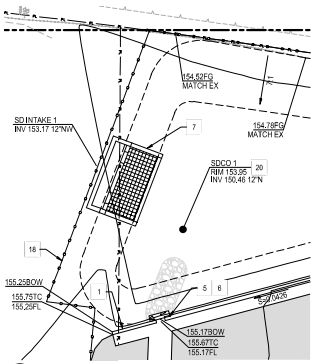
811 Know what's below. Call before you dig.

Plot Date: 17 December 2024 - 12:38 PM Plotted By: Nathan Berend

Filename: F:\24projects\24153 San Jose Water PFAS\Plans and Graphics\Improvement Plans\C008GRPL.dwg

ISSUED FOR CONSTRUCTION





A BIORETENTION BASIN DETAIL
1"= 10'

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

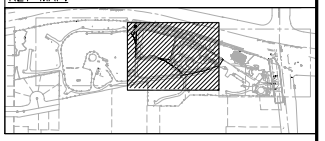
LEGEND

4" ASPHALT PAVEMENT WITH 12" AB

PAVING KEY NOTES

1. 6" VERTICAL CURB AND GUTTER. REFER TO SHEET CD - 5, DETAIL 3
2. ROLL CURB AND GUTTER. REFER TO SHEET CD - 5, DETAIL 6
3. 3' CONCRETE VALLEY GUTTER. REFER TO SHEET CD - 5, DETAIL 7
4. 4' CONCRETE VALLEY GUTTER. REFER TO SHEET CD - 5, DETAIL 8
5. CURB CUT. REFER TO SHEET CD - 5, DETAIL 4
6. COBBLE SWALE. REFER TO SHEET CD - 6, DETAIL 2
7. STORM DRAIN INTAKE STRUCTURE. REFER TO SHEET CD-07, DETAIL 3.
8. 30" MAX. RETAINING WALL. REFER TO SHEET CD - 5, DETAIL 5
9. SQUARE OVERFLOW STORM DRAIN INLET. REFER TO SHEET CD - 6, DETAIL 1
10. STORM DRAIN INLET. REFER TO SHEET CD - 6, DETAIL 1
11. TRANSITION FROM 6" VERTICAL TO ROLL CURB AND GUTTER
12. TRANSITION FROM 6" VERTICAL TO FLUSH CURB
13. TRANSITION FROM 30" RETAINING WALL TO ROLL CURB AND GUTTER
14. 6" VERTICAL CURB. REFER TO SHEET CD - 5, DETAIL 9
15. STORM DRAIN MANHOLE AND COVER. REFER TO SHEET CD-07, DETAILS 1 AND 2.
16. STORM DRAIN OUTFALL. REFER TO SHEET CD-06, DETAIL 4
17. PROPOSED GATE **BY OTHERS (NOT IN CONTRACT)**
18. PROPOSED FENCE **BY OTHERS (NOT IN CONTRACT)**
19. 4'X4' LANDING AT STAIRS, 2% MAX. SLOPE IN ALL DIRECTIONS
20. STORM DRAIN CLEANOUT. REFER TO SHEET CD-06, DETAIL 5

KEY MAP:



N

1" = 20'

Know what's below. Call before you dig.

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER NATHAN J. BERENDT No. 85693 Exp. 09/30/26 CIVIL STATE OF CALIFORNIA

DATE SIGNED: 12/17/24

BY	REVISION	DATE	CK	DATE	CK

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

SIEGFRIED

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

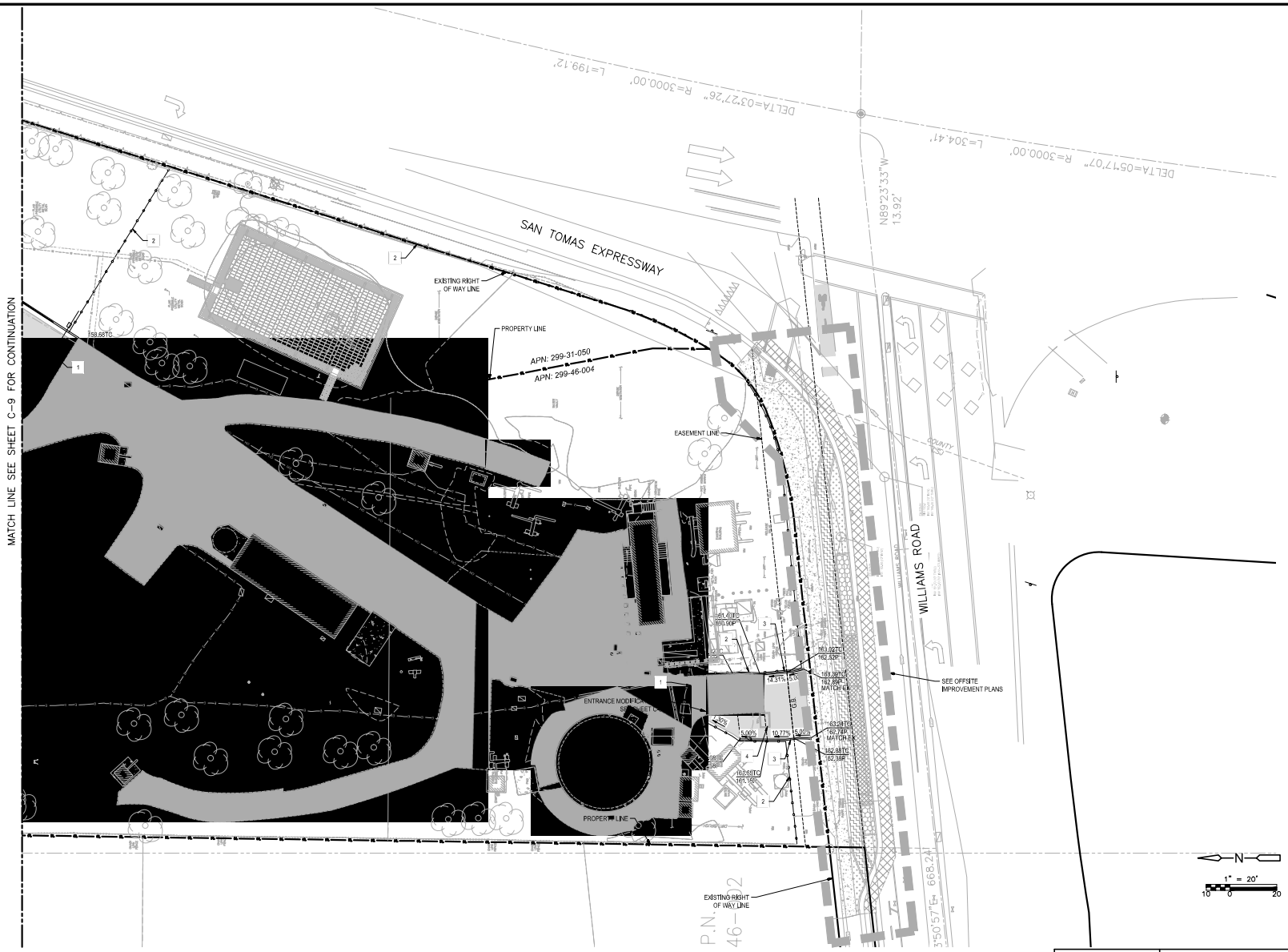
GRADING, PAVING AND DRAINAGE PLAN 1

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: NJB	ENGINEERING, PLANNING / DATE	
DRAWN: FSE	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-9
CHECKED: PJS	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date: 17 December 2024 - 12:38 PM Plotted By: Nathan Berend
Filename: F:\24projects\24153 San Jose Water PFAS\Plans and Graphics\Improvement Plans\C009GRPL.dwg

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP



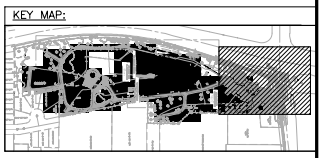
LEGEND:

- SIDEWALK
- BIORETENTION AREA
- 4"ASPHALT PAVEMENT WITH 12"AB
- ASPHALT DEEPLIFT
- ASPHALT BIKE PATH
- CITY OF SAN JOSE DRIVEWAY CONCRETE
- LANDSCAPE

PAVING KEY NOTES

1. PROPOSED GATE **BY OTHERS (NOT IN CONTRACT)**
2. PROPOSED FENCE **BY OTHERS (NOT IN CONTRACT)**
3. 6" VERTICAL CURB. REFER TO DETAIL 9 ON SHEET CD-5
4. ADJUST TO GRADE EXISTING ELECTRICAL VAULT. REPLACE EXISTING LID WITH NEW TRAFFIC RATED LID

KEY MAP:



N

1" = 20'

10 0 20

811 Know what's below. Call before you dig.

REGISTERED PROFESSIONAL ENGINEER NATHAN J. BEREND No. 85693 Exp. 09/30/26 CIVIL STATE OF CALIFORNIA

DATE SIGNED: 12/17/24

AS-BUILT STAMP

BY	REVISION	DATE	CK	DATE	CK

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

SIEGFRIED

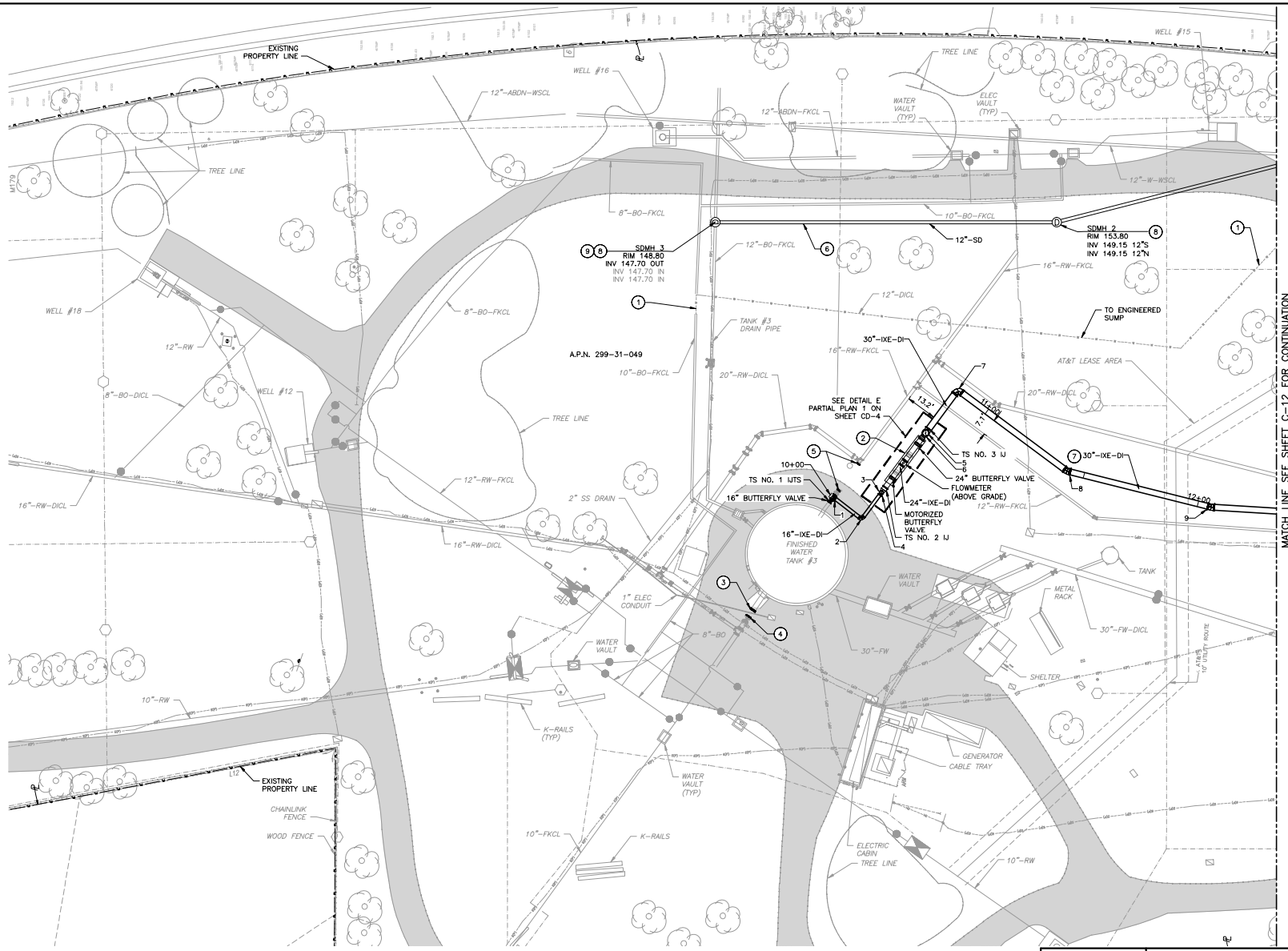
BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

GRADING, PAVING AND DRAINAGE PLAN 2

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: NJB	ENGINEERING, PLANNING / DATE	
DRAWN: FSE	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-10
CHECKED: PJS	CHIEF ENGINEER / DATE	



PLAN
1" = 20'

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

N

1" = 20'
10 0 20

MATCH LINE SEE SHEET C-12 FOR CONTINUATION

NOTES:

1. ALL EXISTING WATER PIPE LOCATIONS SHALL BE FIELD VERIFIED PRIOR TO START OF CONSTRUCTION.
2. FOR FITTINGS INFORMATION REFER TABLE ON SHEET C-13.
3. FOR YARD PIPING PROFILES REFER SHEETS C-14 TO C-17.
4. REFER TO SHEET CP-2 FOR TEST STATION SCHEDULE.
5. REFER TO SHEET CP-6 FOR INSULATING JOINT DETAILS.

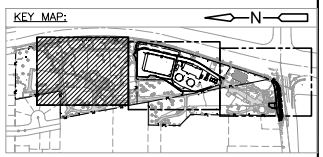
KEY NOTES:

1. 12" DICL. TO ENGINEERED SUMP
2. CONCRETE PAD FOR PIPE & FLOWMETER SUPPORT
3. PROVIDE 24" BLIND FLANGE
4. PROVIDE 24" SOLID MJ PLUG
5. PROVIDE 16" SOLID MJ PLUG
6. 12" SD FROM BIORETENTION BASIN TO STORM DRAIN MANHOLE
7. 30"-IXE-DI. SEE PROFILE ON C-14
8. STORM DRAIN MANHOLE AND COVER. REFER TO SHEET CD-07, DETAILS 1 AND 2.
9. CONNECT TO EXISTING STORM DRAIN SYSTEM. CONTRACTOR SHALL VERIFY EXISTING INVERT AND LOCATION PRIOR TO CONSTRUCTION. CONTRACTOR TO NOTIFY ENGINEER OF CONFLICTS IMMEDIATELY.

LEGEND:

EXISTING PAVEMENT

KEY MAP:



CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

YARD PIPING PLAN 1

AS-BUILT STAMP

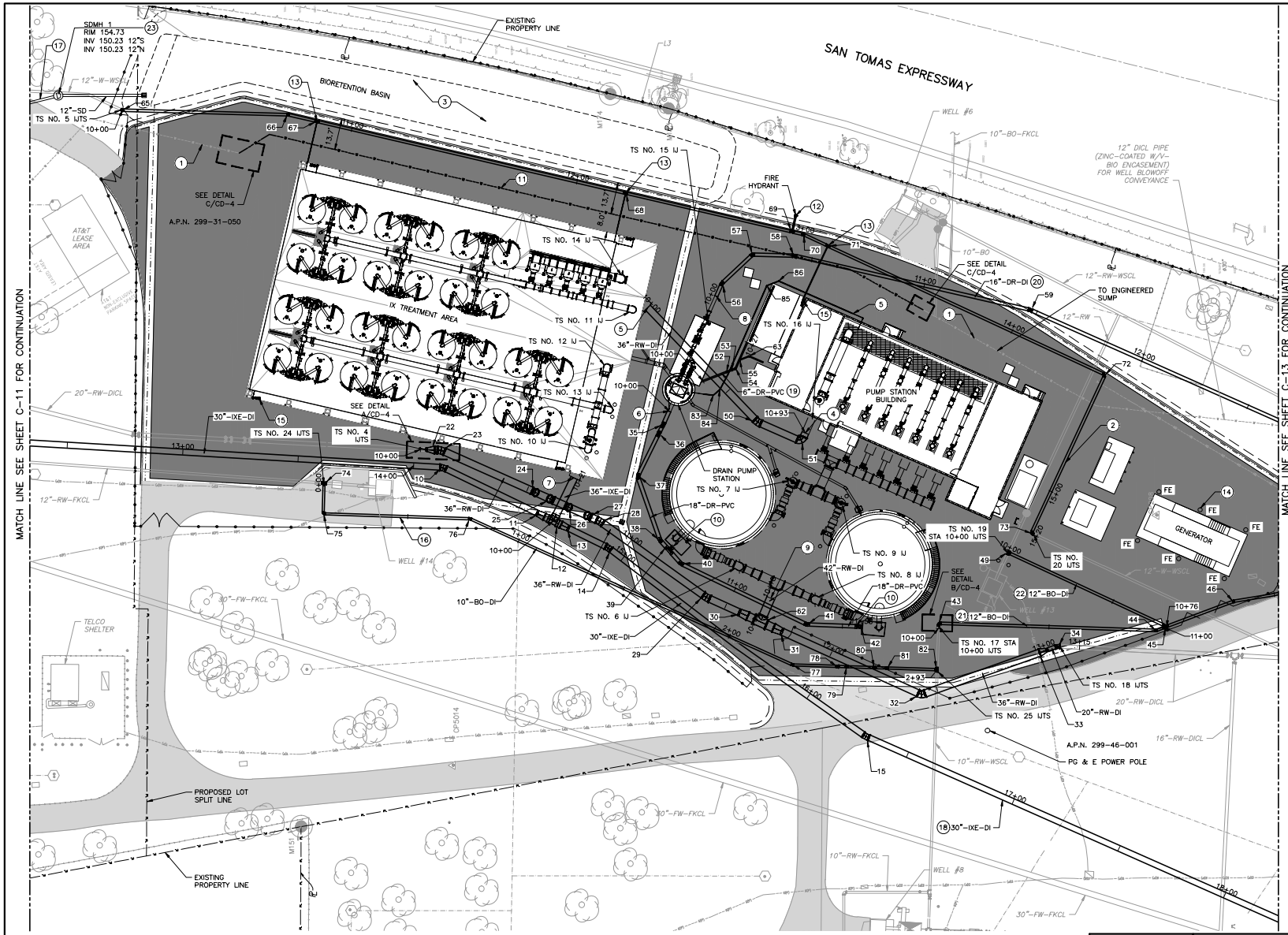
REGISTERED PROFESSIONAL ENGINEER — No. C-69634 Exp. 6/30/26 — CIVIL — STATE OF CALIFORNIA

BY	REVISION	DATE	OK	DATE	OK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: C. BALENDHRAN	ENGINEERING, PLANNING / DATE	
DRAWN: P.NANDURKAR	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-11
CHECKED: XXXX	CHIEF ENGINEER / DATE	

Plot Date: 23 December 2024 - 9:59 PM Plotted By: Nandurkar, Priya M. (Priya) Filename: C:\Users\nandurkarpm\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\02 Civil\10 CADD\C011YPPL.dwg

ISSUED FOR CONSTRUCTION



PLAN
1" = 20'

LEGEND:
- EXISTING PAVEMENT
- NEW PAVEMENT

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

N
1" = 20'
10 0 20

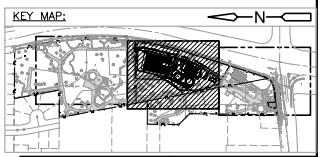
NOTES:

1. ALL EXISTING WATER PIPE LOCATIONS SHALL BE FIELD VERIFIED PRIOR TO START OF CONSTRUCTION.
2. FOR FITTINGS INFORMATION REFER TABLE ON SHEET C-13.
3. FOR YARD PIPING PROFILES REFER SHEETS C-14 TO C-16.
4. REFER TO SHEET CP-2 FOR TEST STATION SCHEDULE.
5. REFER TO SHEET CP-6 FOR INSULATING JOINT DETAILS.

KEY NOTES:

(1) 12" DICL. TO ENGINEERED SUMP
(2) RE-ROUTE 12" WATER. PROVIDE ARVS (SEE DETAIL C/CD-3) AT HIGH POINTS AND BLOWOFFS (SEE DETAIL D/CD-3) AT LOW POINTS
(3) SEE GRADING PLAN C-9 FOR DETAILS
(4) 36"-RW-DI. SEE PROFILE H/C-16 AND DWG M-3 FOR CONTINUATION
(5) 1 ½"-DR-PVC_80 ROUTE TO PROCESS DRAIN PUMP STATION. SEE SHEET M-3
(6) 18"-DR-PVC. SEE PROFILE E/C-15 AND DWG M-10 FOR CONTINUATION
(7) 36"-IXE-DI. SEE PROFILE B/C-15 AND DWG M-5 FOR CONTINUATION
(8) 14"-DR-DI. SEE PROFILE J/C-16 AND DWG M-10 FOR CONTINUATION
(9) 42"-RW-DI. SEE PROFILE C/C-15 AND DWG M-2 FOR CONTINUATION
(10) 18"-DR-PVC. SEE PROFILE E/C-15 AND DWG M-2 FOR CONTINUATION
(11) 12" DICL. ENGINEERED SUMP RE-ROUTED LOCATION. SEE PROFILE K/C-17
(12) FIRE HYDRANT SHALL BE CLOW MEDALLION (F-2454) OR MUELLER CENTURION (A423) DRY BARREL FIRE HYDRANT WITH 51/4" VALVE OPENING AND 4" PUMPER NOZZLE IN ACCORDANCE WITH AWWA C502. O-RINGS AND SEATS SHALL BE EPDM. SEE DETAIL B/CD-3
(13) 2" TAP MJ AND MEGALUG
(14) PROVIDE FIRE EXTINGUISHER MODEL 3A: 40B: C, TYP OF 6
(15) HOSE BIBB (TYP OF 5) PER DETAIL D/MD-3
(16) 10 INCH BLOW OFF FROM WELL 14. SEE PROFILE L/C-17
(17) 12" SD FROM BIORETENTION BASIN TO CATCH BASIN
(18) 30"-IXE-DI. SEE PROFILE ON C-14
(19) 6"-DR-PVC. SEE PROFILE I/C-16
(20) 16"-DR-DI. SEE PROFILE J/C-16
(21) 12"-BO-DI. SEE PROFILE F/C-15
(22) 12"-BO-DI. SEE PROFILE G/C-15
(23) STORM DRAIN MANHOLE AND COVER. REFER TO SHEET CD-07, DETAILS 1 AND 2.

KEY MAP:



CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

YARD PIPING PLAN 2

AS-BUILT STAMP

BY	REVISION	DATE	OK	DATE	OK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: C. BALENDHRAN	ENGINEERING, PLANNING / DATE	
DRAWN: P.NANDURKAR	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-12
CHECKED: XXXX	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

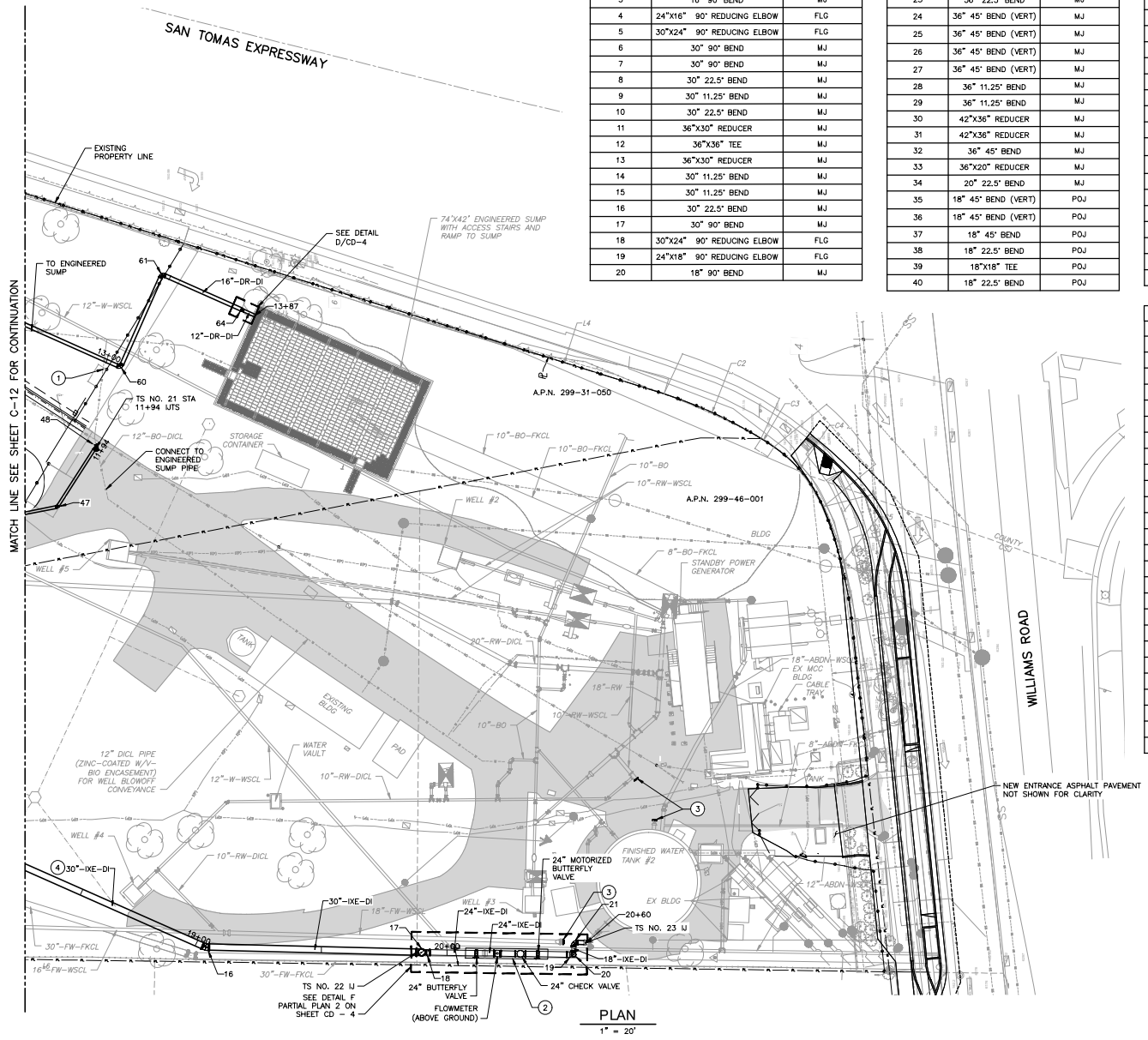
Plot Date: 23 December 2024 - 10:01 PM Plotted By: Nandurkar, Priya M. (Priya) Filename: C:\Users\nandurkarpm\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\02 Civil\10 CADD\C012YPPL.dwg

FITTING TABLE		
FITTING NAME	SIZE	CONNECTION TYPE
1	16"X16" TEE	MJ
2	16" 90° BEND	MJ
3	16" 90° BEND	MJ
4	24"X16" 90° REDUCING ELBOW	FLG
5	30"X24" 90° REDUCING ELBOW	FLG
6	30" 90° BEND	MJ
7	30" 90° BEND	MJ
8	30" 22.5° BEND	MJ
9	30" 11.25° BEND	MJ
10	30" 22.5° BEND	MJ
11	36"X30" REDUCER	MJ
12	36"X36" TEE	MJ
13	36"X30" REDUCER	MJ
14	30" 11.25° BEND	MJ
15	30" 11.25° BEND	MJ
16	30" 22.5° BEND	MJ
17	30" 90° BEND	MJ
18	30"X24" 90° REDUCING ELBOW	FLG
19	24"X18" 90° REDUCING ELBOW	FLG
20	18" 90° BEND	MJ

FITTING TABLE		
FITTING NAME	SIZE	CONNECTION TYPE
21	18" 90° BEND	MJ
22	20"X36" REDUCER	MJ
23	36" 22.5° BEND	MJ
24	36" 45° BEND (VERT)	MJ
25	36" 45° BEND (VERT)	MJ
26	36" 45° BEND (VERT)	MJ
27	36" 45° BEND (VERT)	MJ
28	36" 11.25° BEND	MJ
29	36" 11.25° BEND	MJ
30	42"X36" REDUCER	MJ
31	42"X36" REDUCER	MJ
32	36" 45° BEND	MJ
33	36"X20" REDUCER	MJ
34	20" 22.5° BEND	MJ
35	18" 45° BEND (VERT)	POJ
36	18" 45° BEND (VERT)	POJ
37	18" 45° BEND	POJ
38	18" 22.5° BEND	POJ
39	18"X18" TEE	POJ
40	18" 22.5° BEND	POJ

FITTING TABLE		
FITTING NAME	SIZE	CONNECTION TYPE
41	18" 22.5° BEND	POJ
42	18" 90° BEND (VERT)	POJ
43	12"X10" 90° REDUCING ELBOW	MJ
44	12" 22.5° BEND	MJ
45	12"X12" WYE	MJ
46	12" 11.25° BEND	MJ
47	12" 45° BEND	MJ
48	12"X12" WYE	MJ
49	12"X12" TEE	MJ (5)
50	36" 22.5° BEND	MJ
51	36" 90° BEND	MJ
52	6" 45° BEND (VERT)	POJ
53	6" 45° BEND (VERT)	POJ
54	6" 45° BEND	POJ
55	6"X4" WYE	POJ
56	16" 22.5° BEND	MJ
57	16" 45° BEND	MJ
58	16" 11.25° BEND	MJ
59	16" 11.25° BEND	MJ
60	16" 90° BEND	MJ

FITTING TABLE		
FITTING NAME	SIZE	CONNECTION TYPE
61	16" 90° BEND	MJ
62	42"X42" TEE	MJ
63	4" 45° BEND	MJ
64	16"X12" REDUCER	MJ
65	12" 22.5° BEND	MJ (5)
66	12" 11.25° BEND	MJ
67	12"X2" TEE	MJ
68	12"X2" TEE	MJ
69	12"X6" TEE	MJ
70	12" 11.25° BEND	MJ
71	12"X2" TEE	MJ
72	12" 90° BEND	MJ
73	12" 90° BEND	MJ (5)
74	12"X10" TEE	MJ (5)
75	10" 90° BEND	MJ
76	10" 22.5° BEND	MJ
77	10" 22.5° BEND	MJ
78	10" 45° BEND (VERT)	MJ
79	10" 45° BEND (VERT)	MJ
80	10" 45° BEND (VERT)	MJ
81	10" 45° BEND (VERT)	MJ
82	10"X10" TEE	MJ (5)
83	1 1/2" 45° BEND	MJ
84	1 1/2" 22.5° BEND	MJ
85	1 1/2" 45° BEND	MJ
86	1 1/2" 45° BEND	MJ



RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

N

1" = 20'

10 0 20

NOTES:

1. ALL EXISTING WATER PIPE LOCATIONS SHALL BE FIELD VERIFIED PRIOR TO START OF CONSTRUCTION.
2. FOR FITTINGS INFORMATION REFER TABLE. FITTING MATERIAL SHALL MATCH PIPE MATERIAL.
3. FOR YARD PIPING PROFILES REFER SHEETS C-14 TO C-16.
4. REFER TO SHEET CP-2 FOR TEST STATION SCHEDULE.
5. REFER TO SHEET CP-6 FOR INSULATING JOINT DETAILS.

KEY NOTES:

(1) 12" DICL TO ENGINEERED SUMP

(2) CONCRETE PAD FOR PIPE & FLOWMETER SUPPORT

(3) PROVIDE 18" SOLID MJ PLUG

(4) 30"-IXE-DI. SEE PROFILE ON C-14

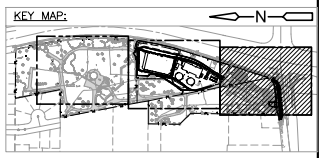
(5) PROVIDE INSULATION FLANGE KIT ON BOTH SIDES OF THE FITTING

LEGEND:

EXISTING PAVEMENT

NEW PAVEMENT

KEY MAP:



AS-BUILT STAMP

BY	REVISION	DATE	OK	DATE	OK

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

YARD PIPING PLAN 3

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=20'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: C. BALENDHRAN	ENGINEERING, PLANNING / DATE	
DRAWN: P.NANDURKAR	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-13
CHECKED: XXXX	CHIEF ENGINEER / DATE	

Plot Date: 24 December 2024 - 3:02 PM Plotted By: Nandurkar, Priya M. (Priya) Filename: C:\Users\nandurkarpm\DC\ACCDocs\CDM Smith Inc\284565 SJW PFAS\Project Files\02 Civil\10 CADD\C013YPPL.dwg

ISSUED FOR CONSTRUCTION

OPERATION AND MAINTENANCE INFORMATION:

1. PROPERTY INFORMATION:
   - I.A. PROPERTY ADDRESS: 3601 & 3605 WILLIAMS ROAD., SAN JOSE, CA 95117
   - I.B. PROPERTY OWNER: SAN JOSE WATER
2. RESPONSIBLE PARTY FOR MAINTENANCE:
   - II.A. CONTACT: CARLOS RAMOS
   - II.B. PHONE NUMBER OF CONTACT: 408-918-7384
   - II.C. EMAIL: OPS_SUPS@SJWATER.COM
   - II.D. ADDRESS: 1265 S. BASCOM AVE, SAN JOSE, CA 95128

STANDARD STORMWATER CONTROL NOTES

- STANDING WATER SHALL NOT REMAIN IN THE TREATMENT MEASURES FOR MORE THAN FIVE DAYS, TO PREVENT MOSQUITO GENERATION SHOULD ANY MOSQUITO ISSUES ARISE, CONTACT THE SANTA CLARA VALLEY VECTOR CONTROL DISTRICT (DISTRICT). MOSQUITO LARVICIDES SHALL BE APPLIED ONLY WHEN ABSOLUTELY NECESSARY, AS INDICATED BY THE DISTRICT, AND THEN ONLY BY A LICENSED PROFESSIONAL OR CONTRACTOR. CONTACT INFORMATION FOR THE DISTRICT IS PROVIDED BELOW.

  WEBSITE: HTTPS://VECTOR.SCCGOV.ORG/HOME

  PHONE: (408) 918-4770
- DO NOT USE PESTICIDES OR OTHER CHEMICAL APPLICATIONS TO TREAT DISEASED PLANTS, CONTROL WEEDS OR REMOVED UNWANTED GROWTH. EMPLOY NON-CHEMICAL CONTROLS (BIOLOGICAL, PHYSICAL AND CULTURAL CONTROLS) TO TREAT A PEST PROBLEM. PRUNE PLANTS PROPERLY AND AT THE APPROPRIATE TIME OF YEAR. PROVIDE ADEQUATE IRRIGATION FOR LANDSCAPE PLANTS. DO NOT OVER WATER.

SOURCE CONTROL MEASURES:

1. GOOD HOUSEKEEPING, EG. SWEEP PAVEMENT AND CLEAN CATCH BASIN
2. LABEL STORM DRAINS
3.1 INDUSTRIAL, OUTDOOR MATERIAL STORAGE, AND RECYCLING FACILITIES MUST (ALL REQUIRED):
3.2 STOCKPILE MATERIAL ON AN IMPERVIOUS SURFACE OR UNDER A PERMANENT ROOF OR COVERING.

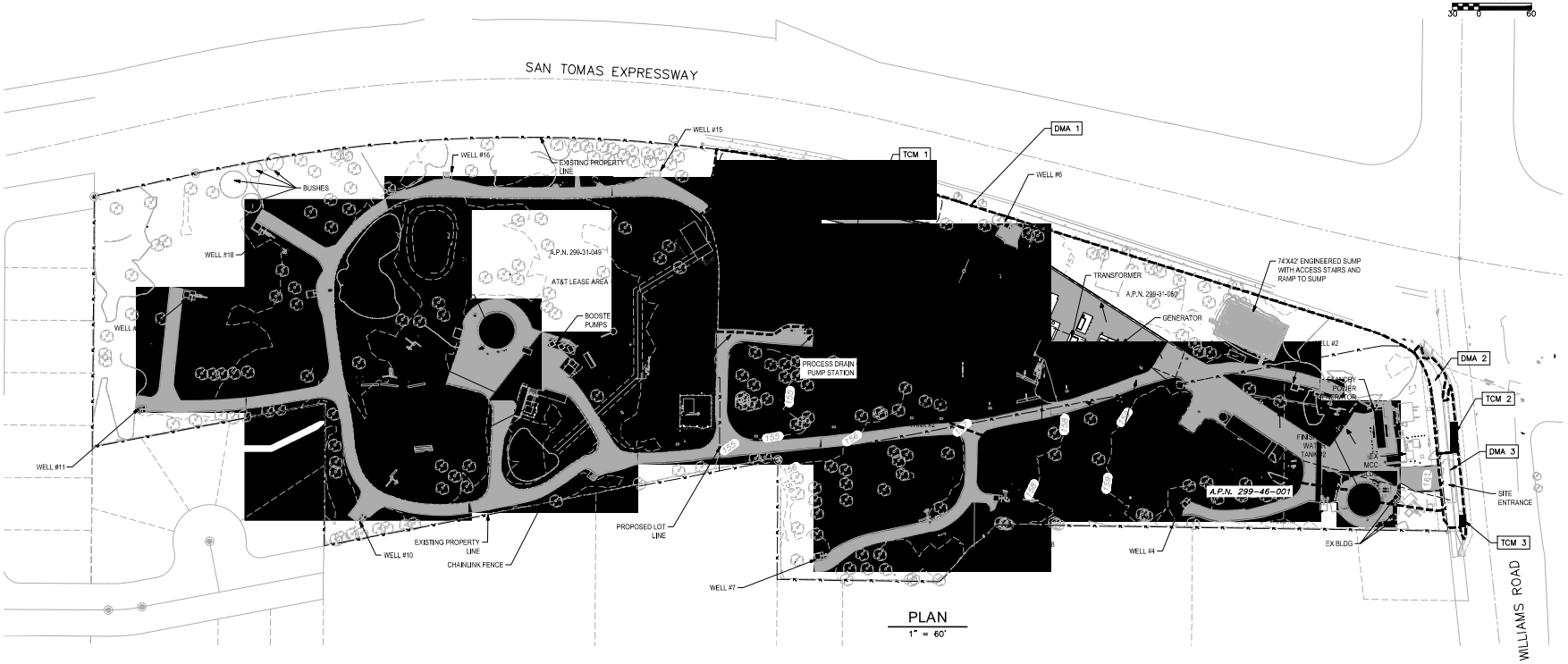
NOTES:

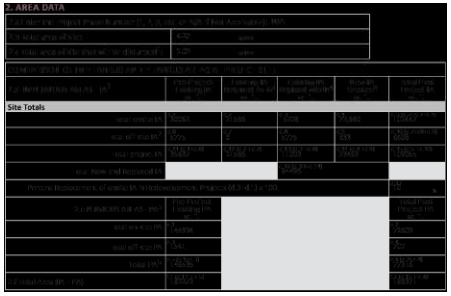
1. PLANT MATERIAL FOR BIORETENTION AREA SHOULD MATCH THE REQUIREMENTS DESCRIBED IN TABLE D-1 OF SANTA CLARA VALLEY URBAN RUNOFF POLLUTION PREVENTION PROGRAM MANUAL.

LEGEND

- DMA 1 — DRAINAGE MANAGEMENT AREA (SEE SIZING CALCULATIONS ON THIS SHEET AND THE NEXT)
- TCM
- DMA BOUNDARY
- FLOW DIRECTION

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP





811 Know what's below. Call before you dig.

TABLE 1
ROUTINE MAINTENANCE ACTIVITIES FOR BIORETENTION AREAS

NO.	MAINTENANCE TASK	FREQUENCY OF TASK
1	REMOVE OBSTRUCTIONS, WEEDS, DEBRIS AND TRASH FROM BIORETENTION AREA AND ITS INLETS AND OUTLETS; AND DISPOSE OF PROPERLY.	QUARTERLY, OR AS NEEDED AFTER STORM EVENTS
2	INSPECT BIORETENTION AREA FOR STANDING WATER. IF STANDING WATER DOES NOT DRAIN WITHIN 2-3 DAYS, TILL AND REPLACE THE SURFACE BIOTREATMENT SOIL WITH THE APPROVED SOIL MIX AND REPLANT.	QUARTERLY, OR AS NEEDED AFTER STORM EVENTS
3	CHECK UNDERDRAINS FOR CLOGGING. USE THE CLEANOUT RISER TO CLEAN ANY CLOGGED UNDERDRAINS.	QUARTERLY, OR AS NEEDED AFTER STORM EVENTS
4	MAINTAIN THE IRRIGATION SYSTEM AND ENSURE THAT PLANTS ARE RECEIVING THE CORRECT AMOUNT OF WATER (IF APPLICABLE)	QUARTERLY
5	ENSURE THAT THE VEGETATION IS HEALTHY AND DENSE ENOUGH TO PROVIDE FILTERING AND PROTECT SOILS FROM EROSION. PRUNE AND WEED THE BIORETENTION AREA. REMOVE AND/OR REPLACE ANY DEAD PLANTS.	ANNUALLY, BEFORE THE WET SEASON BEGINS
6	USE COMPOST AND OTHER NATURAL SOIL AMENDMENTS AND FERTILIZERS INSTEAD OF SYNTHETIC FERTILIZERS, ESPECIALLY IF THE SYSTEM USES AN UNDERDRAIN.	ANNUALLY, BEFORE THE WET SEASON BEGINS
7	CHECK THAT MULCH IS AT APPROPRIATE DEPTH (2-3 INCHES PER SOIL SPECIFICATIONS) AND REPLENISH AS NECESSARY BEFORE WET SEASON BEGINS. IT IS RECOMMENDED THAT 2"-3" OF ARBOR MULCH BE REAPPLIED EVERY YEAR.	ANNUALLY, BEFORE THE WET SEASON BEGINS
8	INSPECT THE ENERGY DISSIPATION AT THE INLET TO ENSURE IT IS FUNCTIONING ADEQUATELY, AND THAT THERE IS NO SCOUR OF THE SURFACE MULCH. REMOVE ACCUMULATED SEDIMENT.	ANNUALLY, BEFORE THE WET SEASON BEGINS
9	INSPECT OVERFLOW PIPE TO ENSURE THAT IT CAN SAFELY CONVEY EXCESS FLOWS TO A STORM DRAIN. REPAIR OR REPLACE DAMAGED PIPING.	ANNUALLY, BEFORE THE WET SEASON BEGINS
10	REPLACE BIOTREATMENT SOIL AND MULCH, IF NEEDED. CHECK FOR STANDING WATER, STRUCTURAL FAILURE AND CLOGGED OVERFLOWS. REMOVE TRASH AND DEBRIS, REPLACE DEAD PLANTS.	ANNUALLY THE END OF THE RAINY SEASON, AND/OR AFTER LARGE STORM EVENTS
11	INSPECT BIORETENTION AREA USING THE ATTACHED INSPECTION CHECKLIST.	ANNUALLY, BEFORE THE WET SEASON

PROJECT SITE INFORMATION:

1. SOILS TYPE: LEAN CLAY (C)
2. GROUND WATER DEPTH: 50 TO 60 FT
3. NAME OF RECEIVING BODY: SAN TOMAS WATERSHED
4. FLOOD ZONE: AO
5. FLOOD ELEVATION (IF APPLICABLE): 1 FOOT DEPTH

SITE DESIGN MEASURES:

1. PROJECT EXISTING TREES, VEGETATION, AND SOIL.
2. DIRECT RUNOFF FROM ROOFS, SIDEWALKS, PATIOS TO LANDSCAPED AREA.

REGISTERED PROFESSIONAL ENGINEER NATHAN J. BERREND No. 85693 Exp. 09/30/26 CIVIL STATE OF CALIFORNIA

DATE SIGNED: 12/17/24

AS-BUILT STAMP

BY	REVISION	DATE	CK	DATE	CK

CDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

SIEGFRIED

BUDGET # SJW019666

SAN JOSE WATER

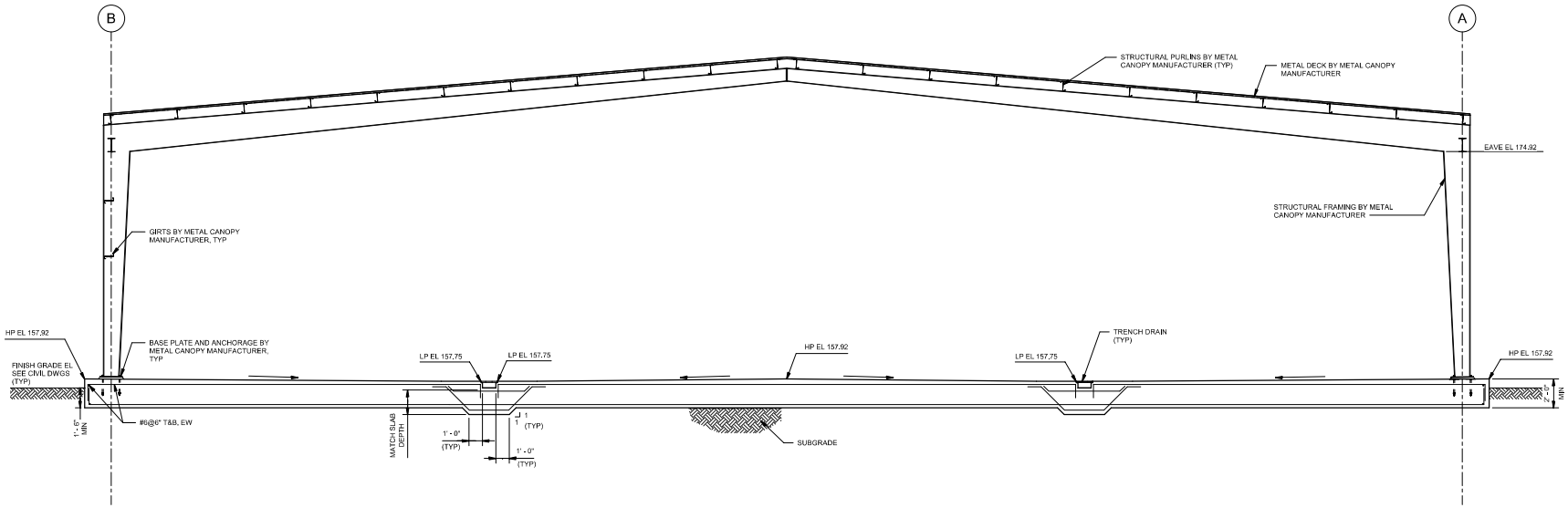
WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

STORMWATER CONTROL PLAN

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	J30238
SCALE: 1"=60'	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: NJB	ENGINEERING, PLANNING / DATE	
DRAWN: FSE	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. C-30
CHECKED: PJS	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

RESERVED FOR CITY OF
SAN JOSE APPROVAL STAMP



1 SECTION
S-8 1/4" = 1'-0"

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

TREATMENT AREA EQUIPMENT PAD
STRUCTURAL
SECTIONS I

DATE: ***DECEMBER 2024***	HEALTH AND SAFETY / DATE	
SCALE: ***1/4" = 1'-0"***	OPERATIONS / DATE	REF. NOS. ***SM: 026***
DESIGN: ***R. CHU***	ENGINEERING, PLANNING / DATE	
DRAWN: ***S. SRIDHARAN***	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. ***S-8***
CHECKED: ***E. CHANG***	CHIEF ENGINEER / DATE	

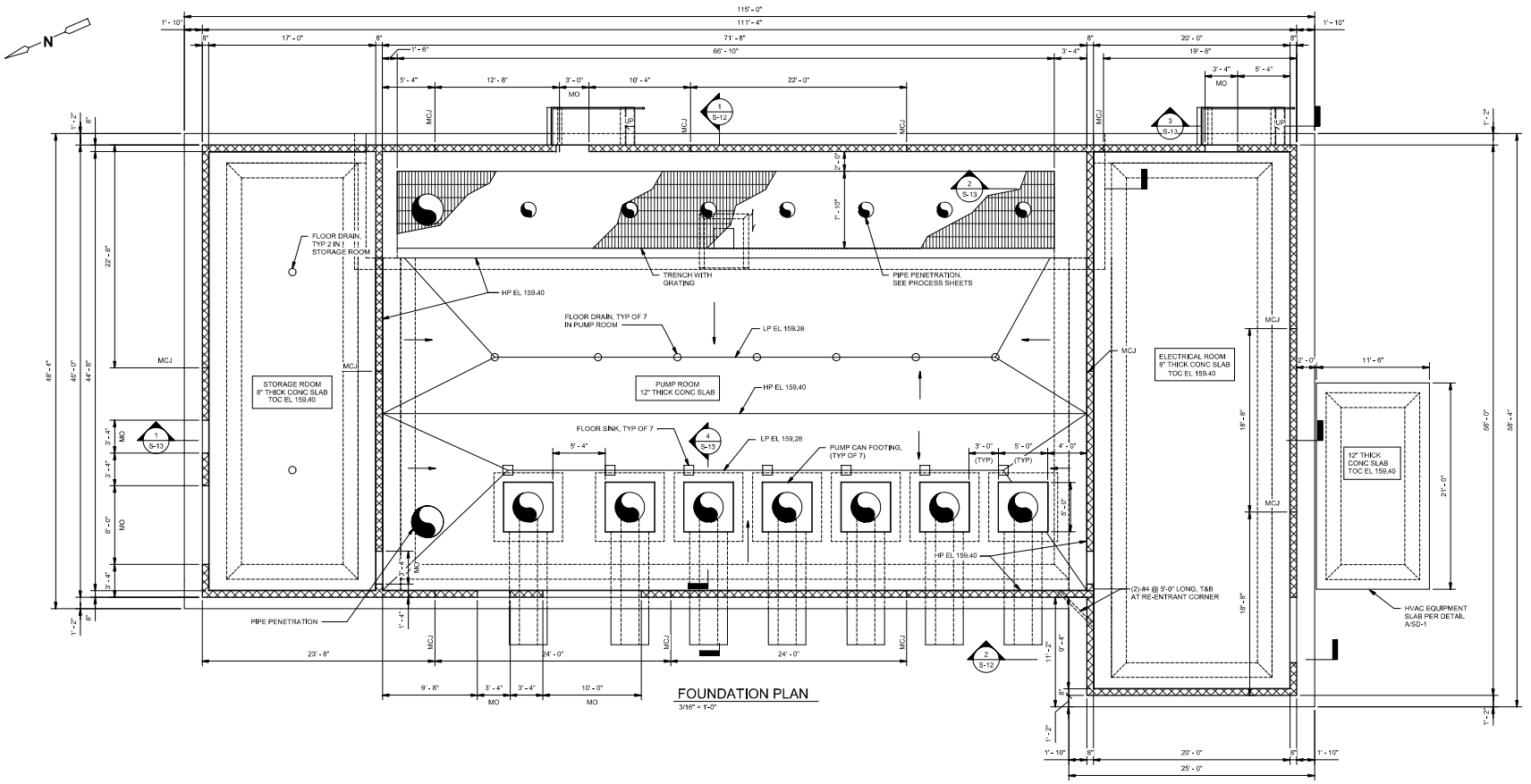
REGISTERED PROFESSIONAL ENGINEER
RONNIE CHU
STATE OF CALIFORNIA
EXP: 3/31/2026

AS-BUILT STAMP

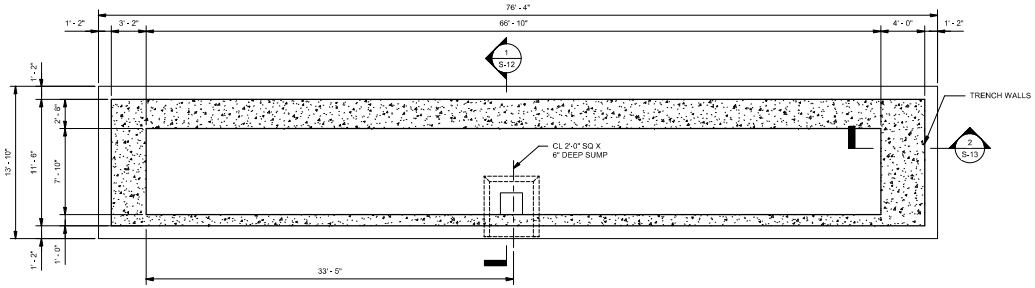
BY	REVISION	DATE	OK	DATE	OK

ISSUED FOR CONSTRUCTION

Plot Date : 12/11/2024 12:20:18 PM Plotted By : A. ASHMI File Name: Autodesk Docs://284565 SJW PFAS/SWZ000TA.rvt



FOUNDATION PLAN
3/16" = 1'-0"



TRENCH FOUNDATION PLAN
3/16" = 1'-0"

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

NOTES:

1. SEE CIVIL DRAWINGS FOR FINISHED GRADE ELEVATIONS AND SITE LAYOUT INFORMATION.
2. SEE ARCHITECTURAL DRAWINGS FOR OPENING LOCATIONS IN MASONRY WALLS.

3/16" = 1'-0"

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PUMP STATION BUILDING
STRUCTURAL
FOUNDATION PLAN

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER RONNIE CHU STATE OF CALIFORNIA
EXP: 3/31/2026

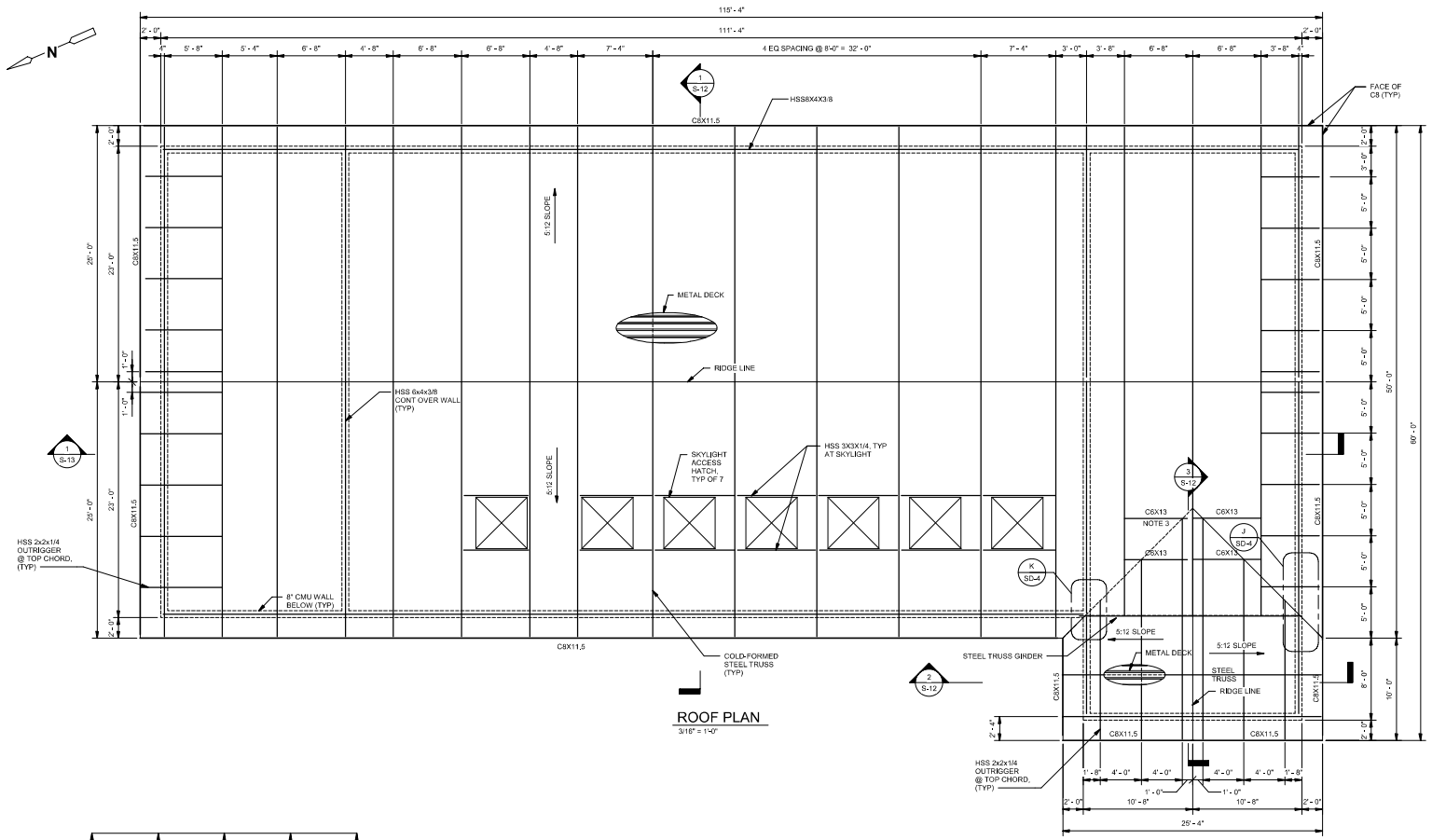
BY	REVISION	DATE	OK	DATE	OK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	
SCALE: 3/16" = 1'-0"	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: R. CHU	ENGINEERING, PLANNING / DATE	
DRAWN: M. ARIEF	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. S-10
CHECKED: E. CHANG	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date : 12/12/2024 7:30:35 PM Plotted By : A. ASHMI File Name: Autodesk Docs://284565 SJW PFAS/SWZ000EB.rvt

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

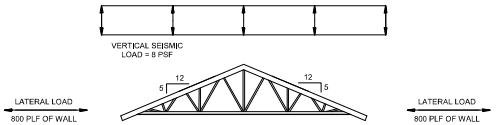


ROOF PLAN
3/16" = 1'-0"

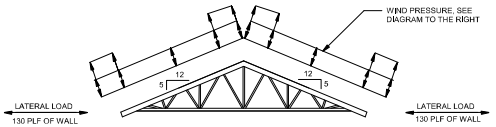
3/16" = 1'-0"

NOTES:

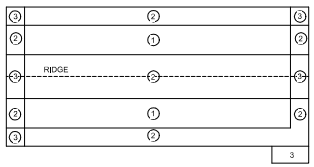
1. SEE CIVIL DRAWINGS FOR FINISHED GRADE ELEVATIONS AND SITE LAYOUT INFORMATION.
2. ALL GALVANIZED STEEL CONSTRUCTION, UON.
3. TRUSS MANUFACTURER TO PROVIDE SECONDARY FRAMING CHANNELS AS REQUIRED TO SUPPORT ROOF FRAMING.



STEEL TRUSS SEISMIC LOADS



STEEL TRUSS WIND LOADS



STEEL TRUSS LOAD NOTES:

1. APPLY WIND DIRECTION IN ACCORDANCE WITH ASCE 7-16.
2. MINIMUM WIDTH OF STRIP "a" IS 5'-0".
3. LOADS SHOWN ARE STRENGTH LEVEL AND DO NOT INCLUDE LOAD FACTORS.
4. DESIGN TRUSS GIRDER FOR 33 KIP SEISMIC COLLECTOR FORCE IN ADDITION TO VERTICAL ROOF LOADS. THE COLLECTOR FORCE INCLUDES OVERSTRENGTH, $\Omega_0 = 2.5$.

MINIMUM WINDLOAD PRESSURE FOR LOAD DIAGRAMS		
LOCATION	PRESSURE (PSF)	
ZONE 1 (INTERIOR)	+20.2	-38.0
ZONE 2 (EDGE STRIP)	+20.2	-66.8
ZONE 3 (CORNER)	+20.2	-84.9

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER RONNIE CHU STATE OF CALIFORNIA
IEXP: 3/31/2026

BY	REVISION	DATE	OK	DATE	OK

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PUMP STATION BUILDING
STRUCTURAL
ROOF PLAN

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	
SCALE: As indicated	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: R. CHU	ENGINEERING, PLANNING / DATE	
DRAWN: M. ARIEF	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. S-11
CHECKED: E. CHANG	CHIEF ENGINEER / DATE	

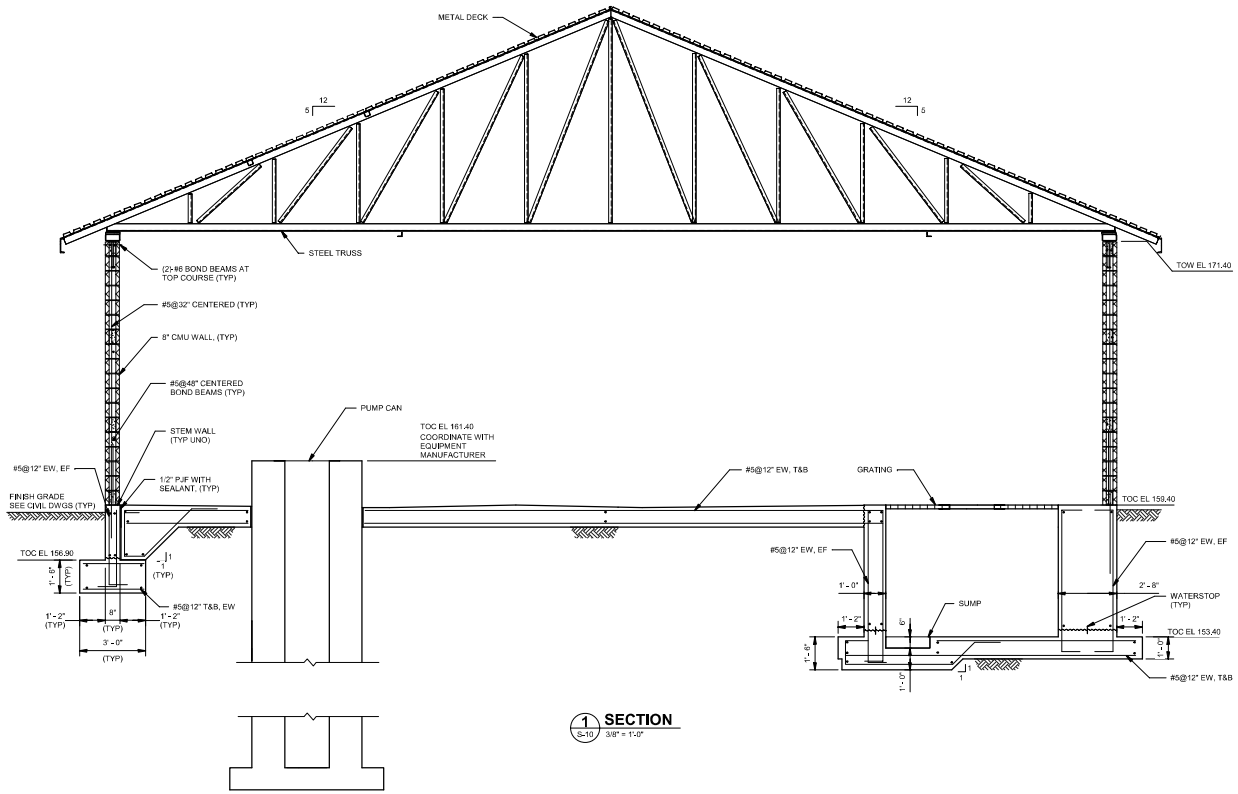
ISSUED FOR CONSTRUCTION

Plot Date : 12/11/2024 5:14:10 PM Plotted By : A. ASHMI File Name: Autodesk Docs://284565 SJW PFAS/SWZ000EB.rvt

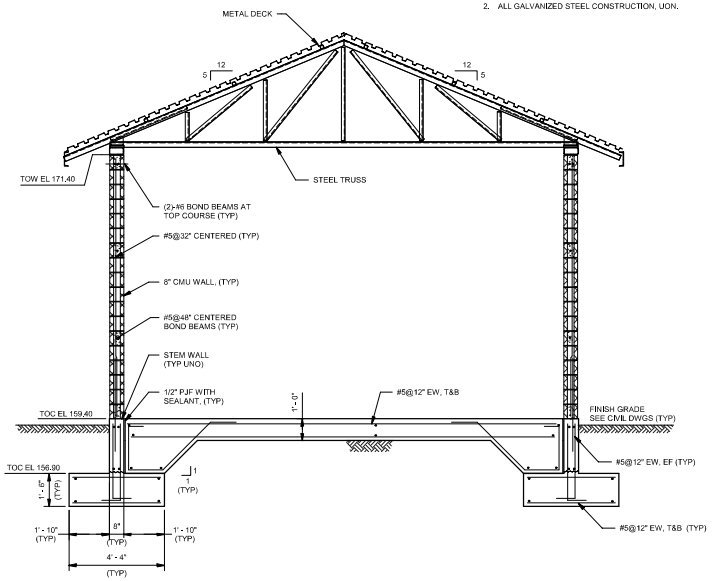
RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

NOTES:

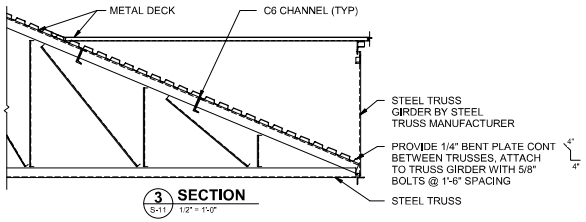
1. SEE CIVIL DRAWINGS FOR FINISHED GRADE ELEVATIONS AND SITE LAYOUT INFORMATION.
2. ALL GALVANIZED STEEL CONSTRUCTION, UON.



1 SECTION
S-10 3/8" = 1'-0"



2 SECTION
S-10 3/8" = 1'-0"



3 SECTION
S-11 1/2" = 1'-0"

3/4"=1'-0"

3/8" = 1'-0"

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PUMP STATION BUILDING
STRUCTURAL
SECTIONS I

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER RONNIE CHU STATE OF CALIFORNIA
EXP: 3/31/2026

BY	REVISION	DATE	OK	DATE	OK

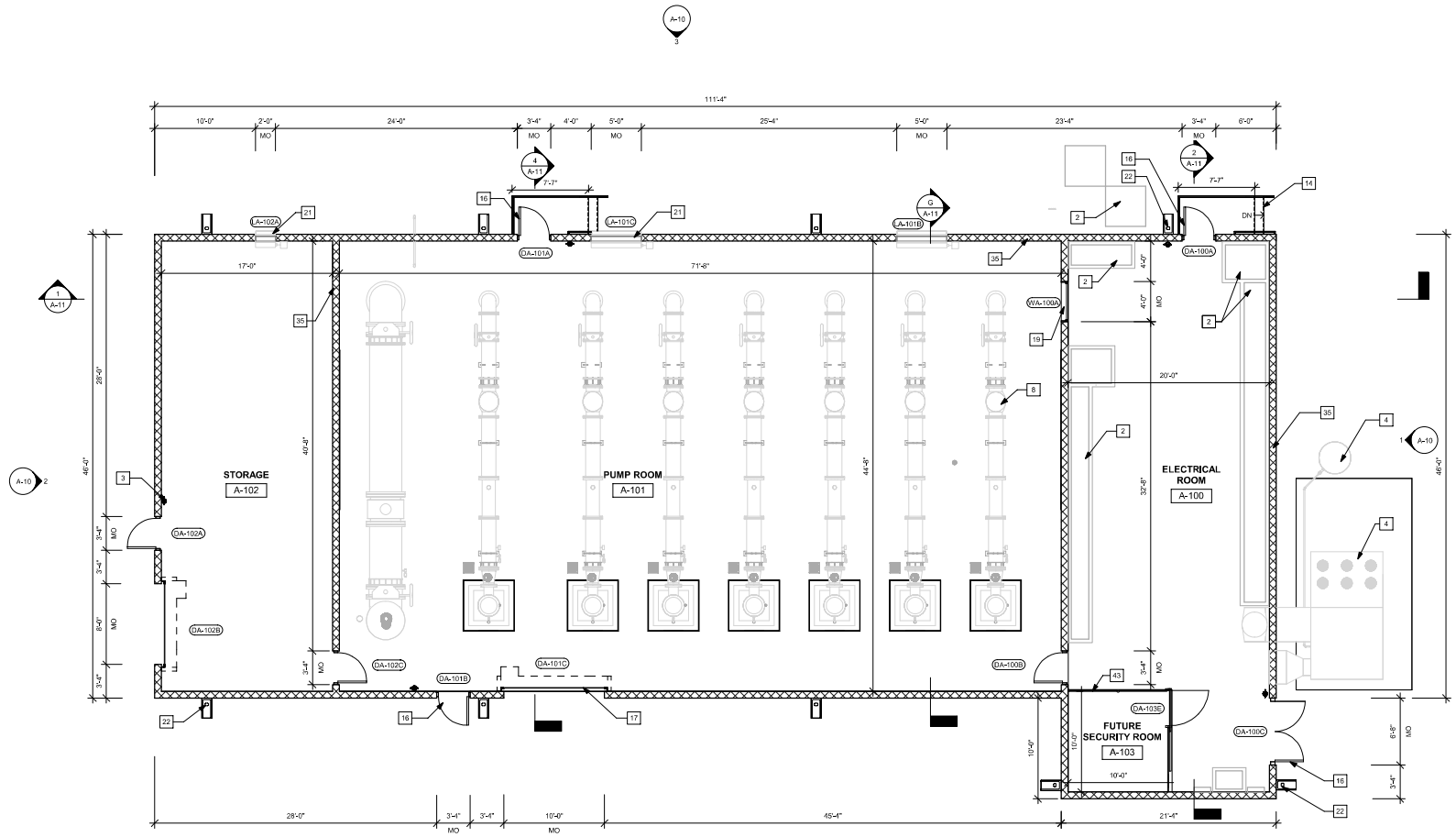
DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	
SCALE: As indicated	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: R. CHU	ENGINEERING, PLANNING / DATE	
DRAWN: M. ARIEF	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. S-12
CHECKED: E. CHANG	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date : 12/11/2024 5:20:46 PM Plotted By : A. ASHMI File Name: Autodesk Docs://284565 SJW PFAS/SWZ000EB.rvt

RESERVED FOR CITY OF
SAN JOSE APPROVAL STAMP

KEYNOTE LEGEND	
KEY VALUE	KEYNOTE TEXT
2	ELEC EQUIP, SEE "E" DWGS
3	FIRE EXTINGUISHER, TYP
4	HVAC DUCTWORK, SEE "H" DWGS
8	PROCESS PIPING, SEE "M" DWGS
14	STAIR, SEE "S" DWGS
16	HOLLOW METAL DOOR AND FRAME, SEE SCHD
17	INSULATED OVERHEAD COILING DOOR, SEE SCHD
19	ALUMINUM WINDOW, SEE SCHD
21	ALUMINUM LOUVER, SEE "H" SCHD
22	DOWNSPOUT, TYP
35	9" CMU
43	WIRE MESH PARTITION, SEE SPEC 102213



FLOOR PLAN
3/16" = 1'-0"

0 2' 4' 6' 10'
SCALE: 3/16" = 1'-0"

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SJW SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PUMP STATION BUILDING
FLOOR PLAN

AS-BUILT STAMP

BY	REVISION	DATE	OK	DATE	OK

DATE: *DECEMBER 2024*
SCALE: *3/16" = 1'-0"*
DESIGN: *ARTEAGA D.*
DRAWN: *NORATO V.*
CHECKED: *CHONG R.*

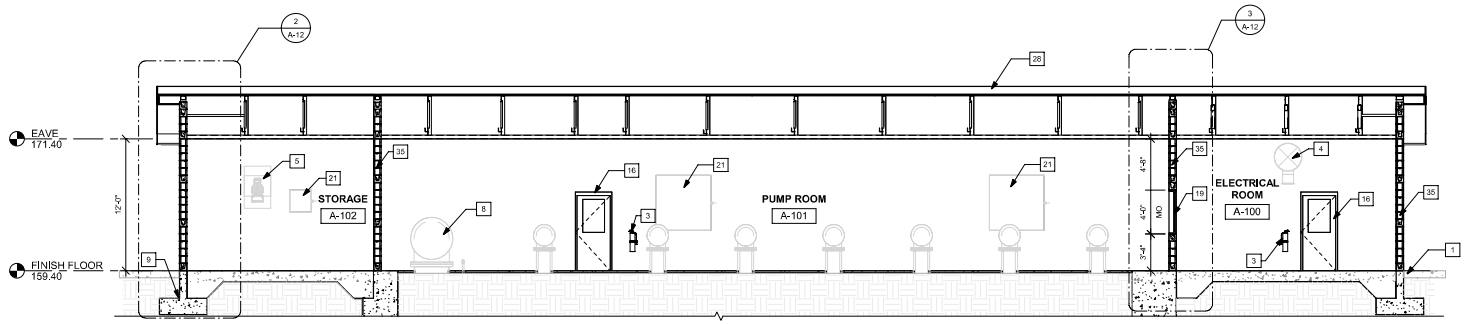
HEALTH AND SAFETY / DATE
OPERATIONS / DATE
ENGINEERING, PLANNING / DATE
ENGINEERING, SPECIAL FACILITIES / DATE
CHIEF ENGINEER / DATE

REF. NOS. *SM: 026*
DWG. NO. *A-8*

ISSUED FOR CONSTRUCTION

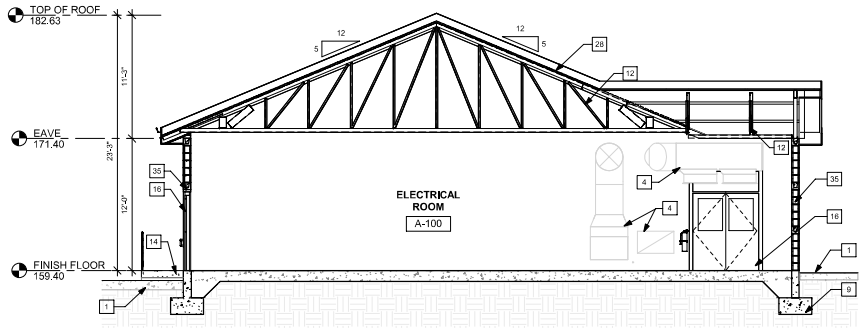
Plot Date : 12/13/2024 5:10:47 PM Plotted By : File Name: Autodesk Docs://284565 SJW PFAS/AWZ000EB.rvt

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

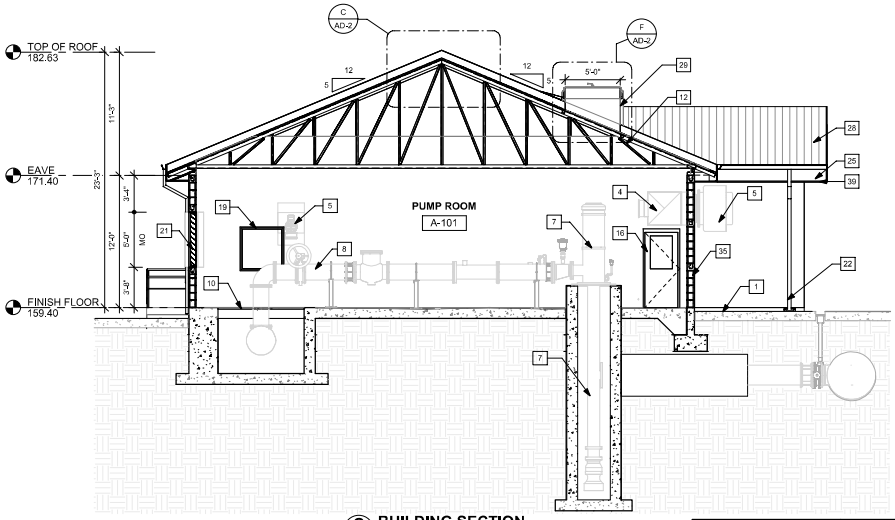


1 BUILDING SECTION
A-8 3/16" = 1'-0"

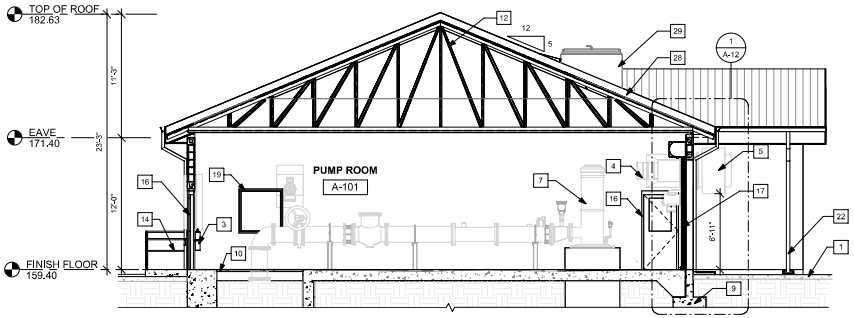
KEYNOTE LEGEND	
KEY VALUE	KEYNOTE TEXT
1	PAVEMENT, SEE "C" DWGS
3	FIRE EXTINGUISHER, TYP
4	HVAC DUCTWORK, SEE "H" DWGS
5	HVAC EQUIP, SEE "H" DWGS
7	PROCESS MECH EQUIP, SEE "M" DWGS
8	PROCESS PIPING, SEE "M" DWGS
9	FOUNDATION, TYP SEE "S" DWGS
10	GRATING, SEE "S" DWGS
12	STEEL TRUSS, SEE "S" DWGS
14	STAIR, SEE "S" DWGS
16	HOLLOW METAL DOOR AND FRAME, SEE SCHD
17	INSULATED OVERHEAD COILING DOOR, SEE SCHD
18	STAINLESS STEEL ROLLING FIRE SHUTTER HOOD
19	ALUMINUM WINDOW, SEE SCHD
21	ALUMINUM LOUVER, SEE "H" SCHD
22	DOWNSPOUT, TYP
25	ALUMINUM FASCIA WITH DRIP EDGE
28	STANDING SEAM METAL ROOFING OVER RIGID INSULATION R30 CI (MIN) ABOVE METAL DECK, TYP
29	ROOF HATCH WITH 5'-0" x 5'-0" CLEAR OPENING INSTALLED ON PRE-FAB CURB, TO BE CENTERED WITH PUMP BELOW, TYP
35	8" CMU
39	METAL SOFFIT



2 BUILDING SECTION
A-8 3/16" = 1'-0"



6 BUILDING SECTION
A-8 3/16" = 1'-0"



4 BUILDING SECTION
A-8 3/16" = 1'-0"

0 2' 4' 8' 10'
SCALE: 3/16" = 1'-0"

GPM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SJW SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PUMP STATION BUILDING SECTIONS

AS-BUILT STAMP

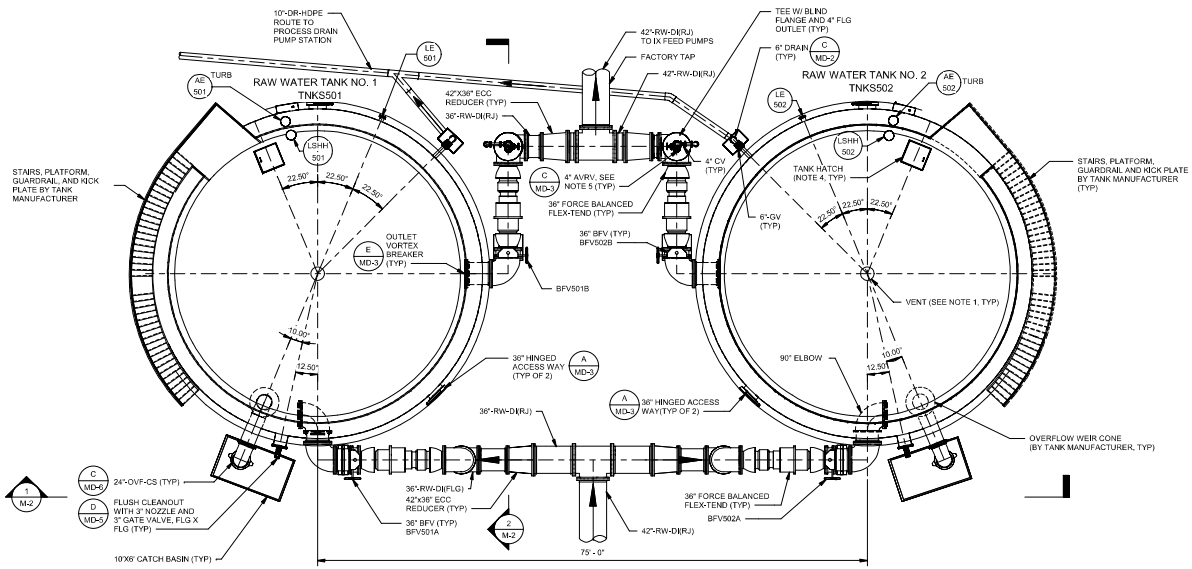
BY	REVISION	DATE	OK	DATE	OK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	
SCALE: 3/16" = 1'-0"	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: ARTEAGA D.	ENGINEERING, PLANNING / DATE	
DRAWN: NORATO V.	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. A-11
CHECKED: CHONG R.	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date : 12/13/2024 5:10:50 PM Plotted By : File Name: Autodesk Docs://284565 SJW PFAS/AWZ000EB.rvt

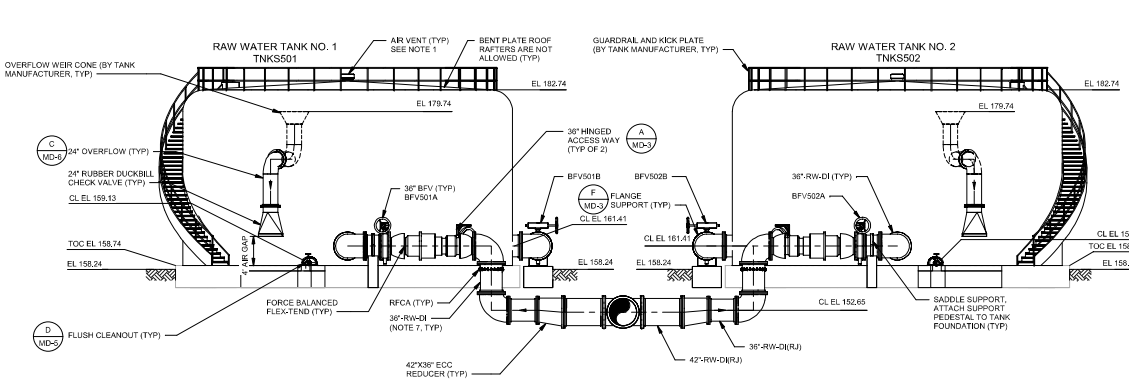
RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP



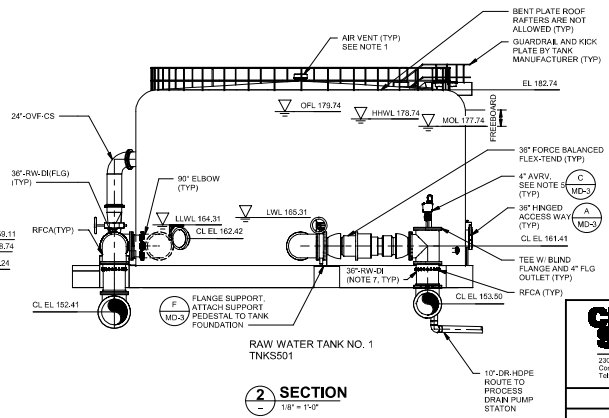
PLAN
1/8" = 1'-0"

NOTES:

1. SIZING BY TANK MANUFACTURER. CONSTRUCT VENT FROM 316 STAINLESS STEEL WITH DIELECTRIC ISOLATION FROM TANK ROOF. FURNISH WITH #24 MESH (INTERIOR) AND #4 MESH (EXTERIOR) NON-CORRODIBLE SCREEN. SEE DETAIL E/MD-7.
2. PROVIDE INTERIOR OF DRAIN OUTLET AND OVERFLOW WITH #24 MESH SS SCREEN AND COVER OUTLET FLANGE WITH #4 MESH SS SCREEN. SEE DETAIL C/MD-2.
3. SUPPORT OVERFLOW PIPING FROM THE TANK. TANK MANUFACTURER TO DESIGN AND PROVIDE INTERNAL AND EXTERNAL PIPING SUPPORTS UNLESS NOTED OTHERWISE.
4. PROVIDE ROOF HATCH WITH FALL PROTECTION PER SAN JOSE WATER COMPANY STANDARDS. SEE DETAIL A/MD-6.
5. ROUTE AIR VALVE VENT DOWN TO 12" ABOVE FINISHED GRADE AND COVER END OF PIPE WITH #24 MESH STAINLESS STEEL SCREEN.
6. FOR OTHER TANK CONSTRUCTION DETAILS, SEE SHEETS MD-5 THROUGH MD-8 AND SECTION 434113.
7. PE x PE DI PIPE.



1 SECTION
1/8" = 1'-0"



2 SECTION
1/8" = 1'-0"

0 4' 8' 16'
SCALE: 1/8" = 1'-0"

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

RAW WATER TANKS PLAN AND SECTIONS

AS-BUILT STAMP

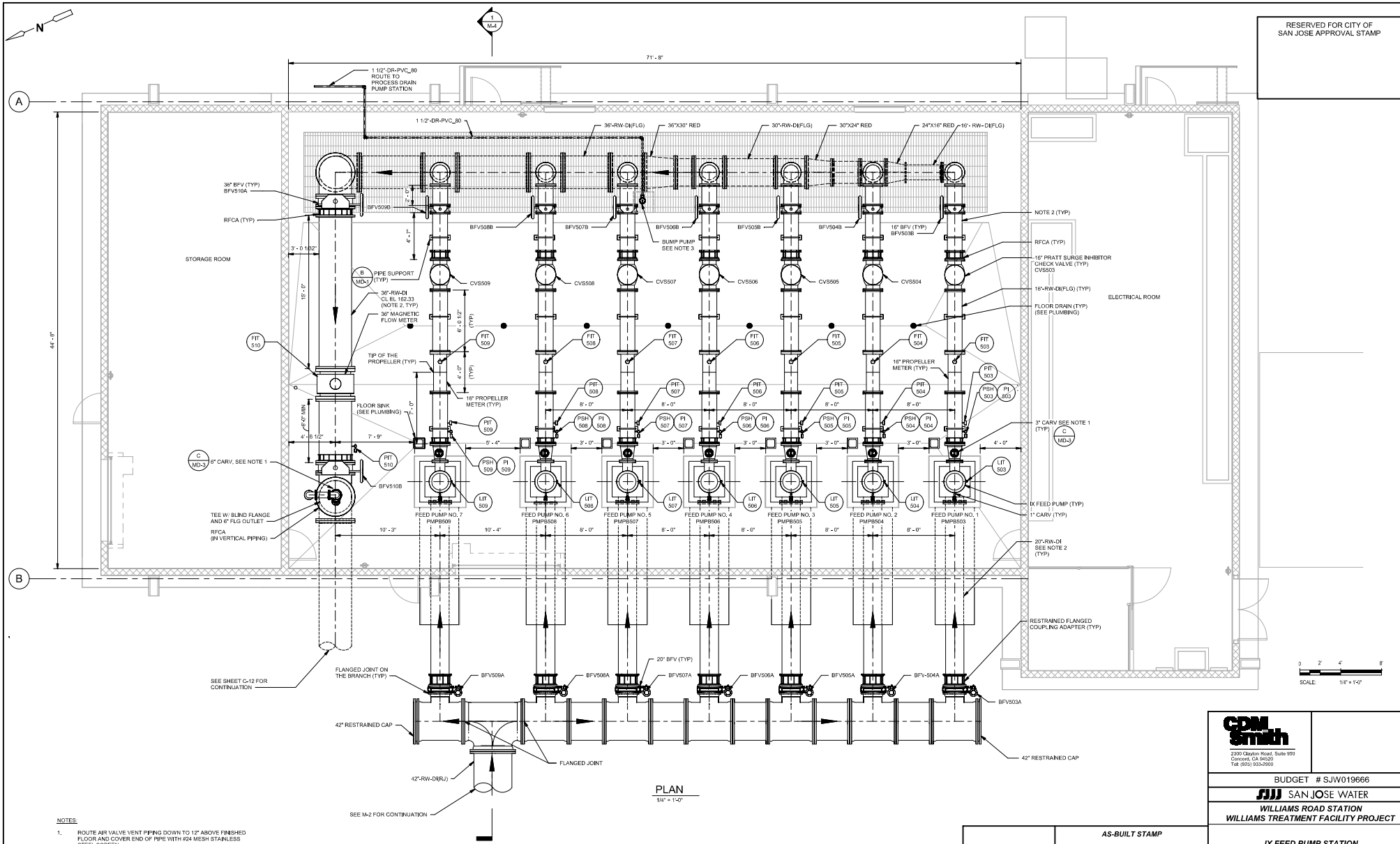
REGISTERED PROFESSIONAL ENGINEER — JOSHUA TAKEO YOSHIMURA — No. 83112 — CIVIL — STATE OF CALIFORNIA

BY	REVISION	DATE	CK	DATE	CK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	
SCALE: 1/8" = 1'-0"	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: J. YOSHIMURA	ENGINEERING, PLANNING / DATE	
DRAWN: B. PAWAN	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. M-2
CHECKED: E. CHANG	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date : 12/17/2024 8:36:53 PM Plotted By : B. PAWAN File Name: Autodesk Docs://284565 SJW PFAS/MW2001TK.rvt



PLAN
1/4" = 1'-0"

NOTES:

1. ROUTE AIR VALVE VENT PIPING DOWN TO 12" ABOVE FINISHED FLOOR AND COVER END OF PIPE WITH #24 MESH STAINLESS STEEL SCREEN.
2. FLG x PE DI PIPE.
3. GOULDS GSP0511, 1/2 HP.

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER — JOSHUA TREED YOSHIMURA — No. 83112 — CIVIL — STATE OF CALIFORNIA

BY	REVISION	DATE	OK	DATE	OK

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SJW SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

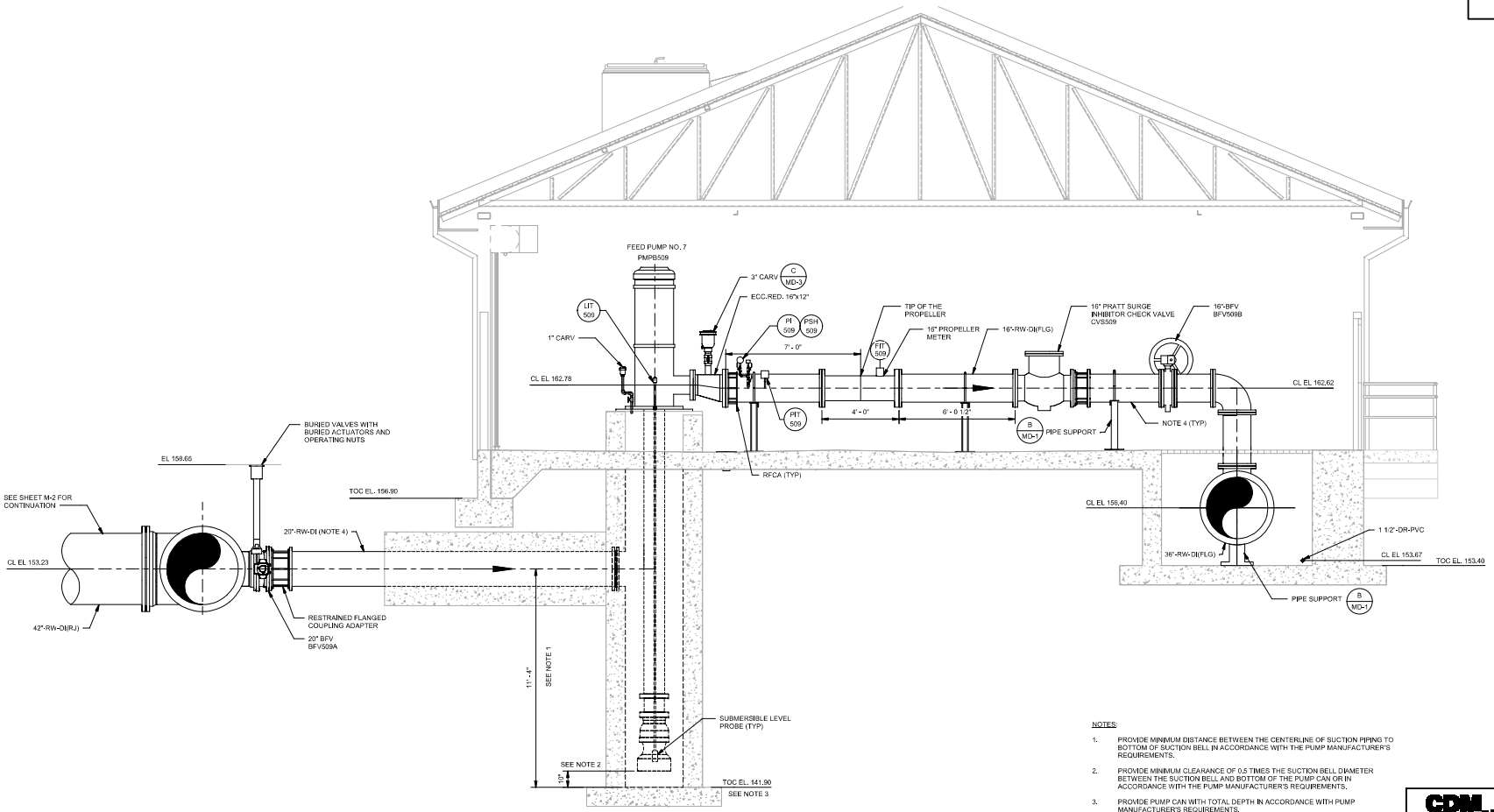
IX FEED PUMP STATION
PLAN

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	
SCALE: 1/4" = 1'-0"	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: J. YOSHIMURA	ENGINEERING, PLANNING / DATE	
DRAWN: B. PAWAN	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. M-3
CHECKED: E. CHANG	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date : 12/17/2024 8:45:06 PM Plotted By : B. PAWAN File Name: Autodesk Docs://284565 SJW PFAS/MV2001PS.rvt

RESERVED FOR CITY OF
SAN JOSE APPROVAL STAMP



1 SECTION
M-3 3/8" = 1'-0"

NOTES:

1. PROVIDE MINIMUM DISTANCE BETWEEN THE CENTERLINE OF SUCTION PIPING TO BOTTOM OF SUCTION BELL IN ACCORDANCE WITH THE PUMP MANUFACTURER'S REQUIREMENTS.
2. PROVIDE MINIMUM CLEARANCE OF 0.5 TIMES THE SUCTION BELL DIAMETER BETWEEN THE SUCTION BELL AND BOTTOM OF THE PUMP CAN OR IN ACCORDANCE WITH THE PUMP MANUFACTURER'S REQUIREMENTS.
3. PROVIDE PUMP CAN WITH TOTAL DEPTH IN ACCORDANCE WITH PUMP MANUFACTURER'S REQUIREMENTS.
4. FLG x PE DI PIPE.

0 1' 2' 3' 5'
SCALE: 3/8" = 1'-0"

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

IX FEED PUMP STATION
SECTION

AS-BUILT STAMP

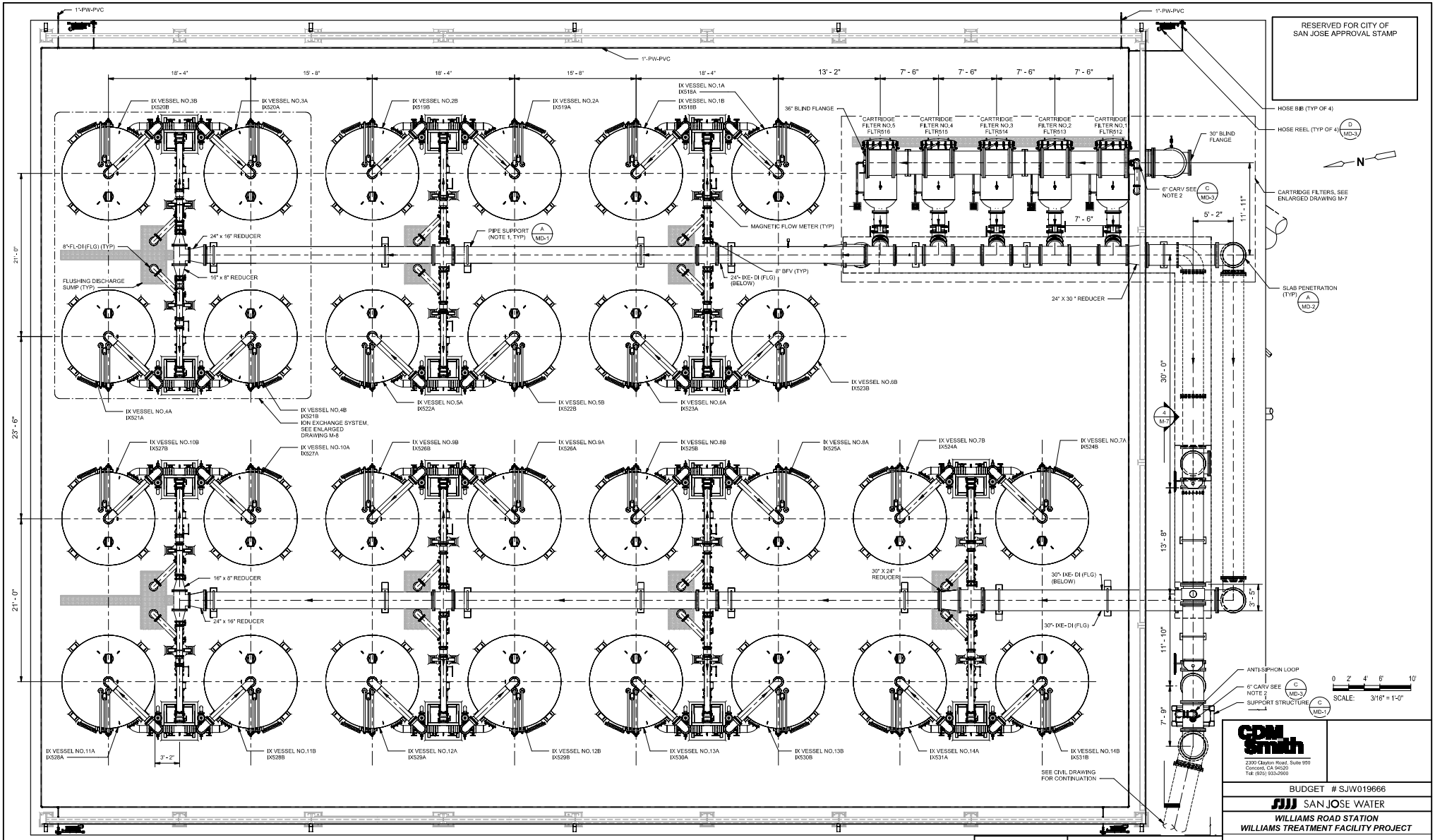
REGISTERED PROFESSIONAL ENGINEER
JESSE TREO YOSHIMURA
No. 83112
CIVIL
STATE OF CALIFORNIA

BY	REVISION	DATE	OK	DATE	OK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	
SCALE: 3/8" = 1'-0"	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: J. YOSHIMURA	ENGINEERING, PLANNING / DATE	
DRAWN: B. PAWAN	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. M-4
CHECKED: E. CHANG	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date : 12/17/2024 8:45:07 PM Plotted By : B. PAWAN File Name: Autodesk Docs://264565 SJW PFAS/MVZ001PS.rvt



PLAN
3/16" = 1'-0"

RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

NOTES:

1. MAXIMUM SUPPORT SPACING OF 25 FEET FOR IX HEADER PIPING.
2. ROUTE AIR VALVE VENT PIPING DOWN TO 12" ABOVE TOP OF CONCRETE AND COVER END OF PIPING WITH #24 MESH STAINLESS STEEL SCREEN.

REGISTERED PROFESSIONAL ENGINEER — JEREMY THEO YOSHIMURA — No. 83112 — CIVIL — STATE OF CALIFORNIA

AS-BUILT STAMP

BY	REVISION	DATE	CK	DATE	CK

GDM smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SJW SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

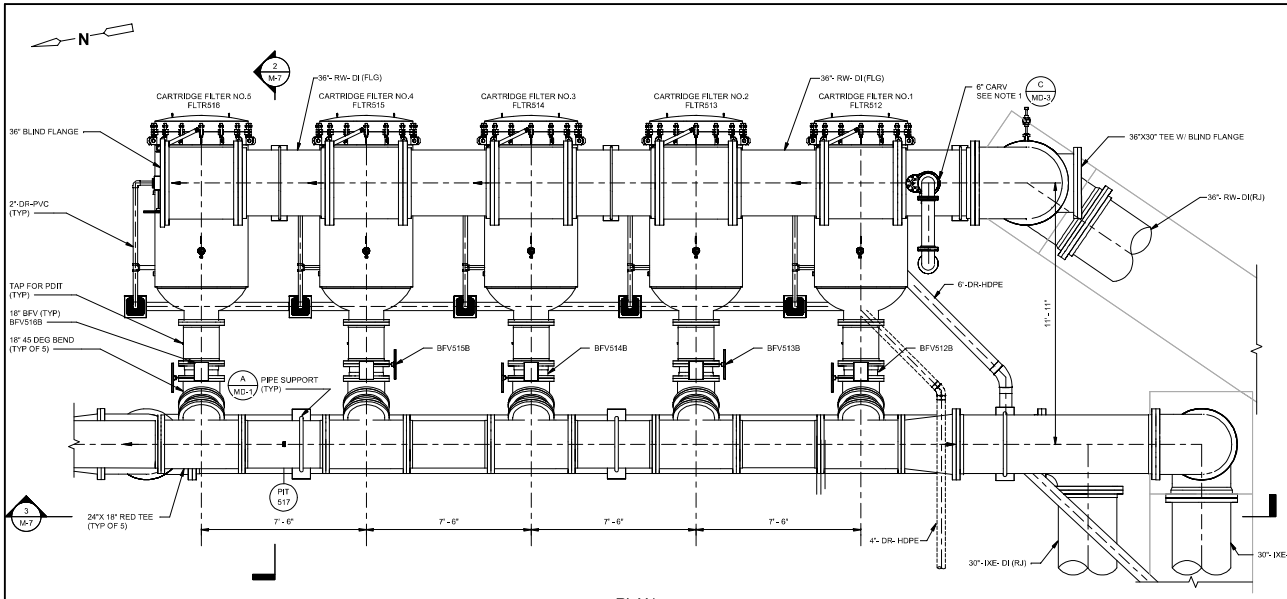
PFAS TREATMENT PLAN

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	
SCALE: 3/16" = 1'-0"	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: J. YOSHIMURA	ENGINEERING, PLANNING / DATE	
DRAWN: B.PAWAN	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. M-6
CHECKED: E. CHANG	CHIEF ENGINEER / DATE	

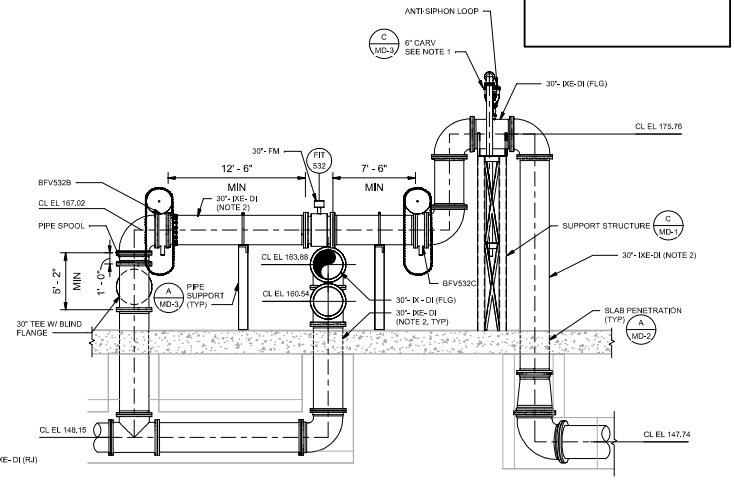
ISSUED FOR CONSTRUCTION

Plot Date : 12/17/2024 8:07:15 PM Plotted By : B. PAWAN File Name: Autodesk Docs://284565 SJW PFAS/MW2001IX.rvt

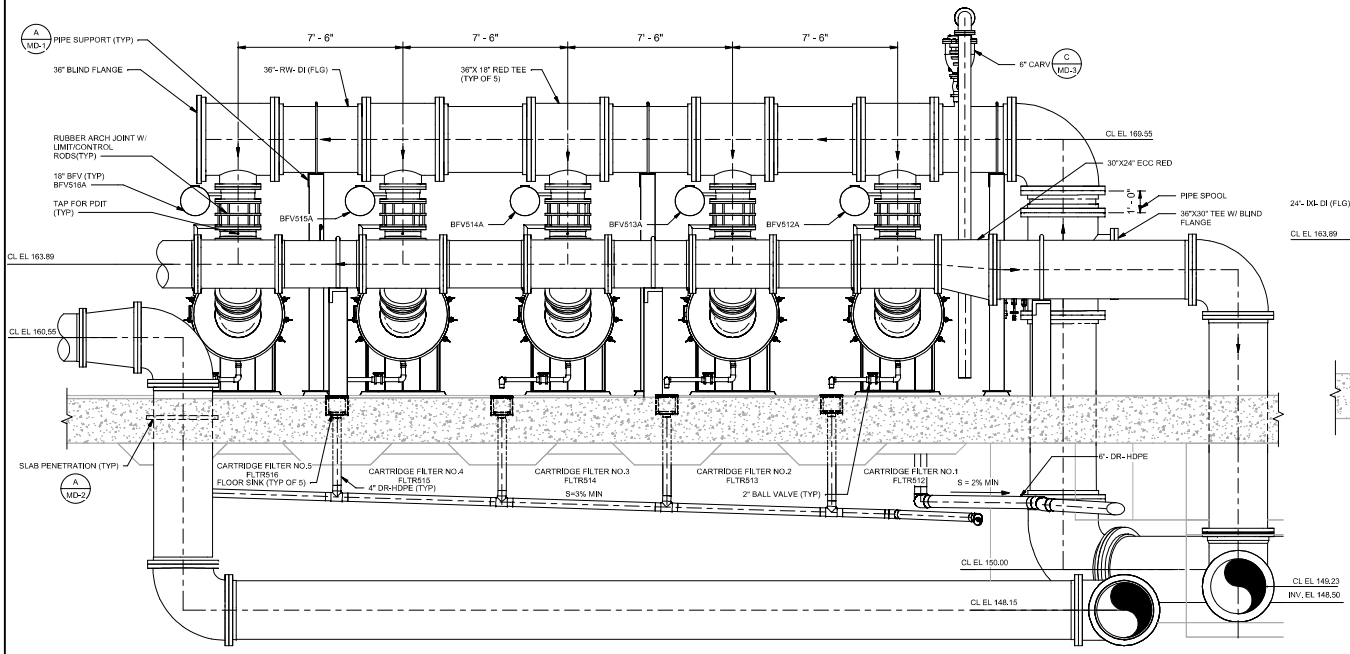
RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP



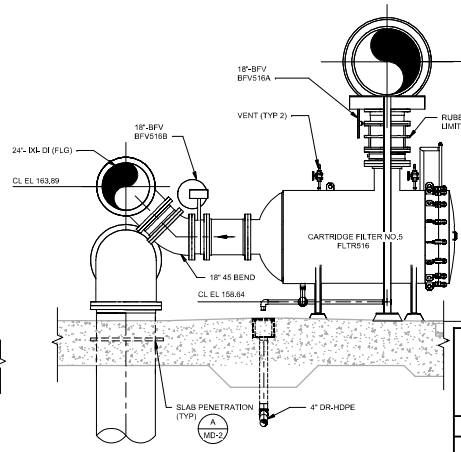
PLAN
3/8" = 1'-0"



4 SECTION
M-6 3/16" = 1'-0"



3 SECTION
3/8" = 1'-0"



2 SECTION
3/8" = 1'-0"

NOTES:

1. ROUTE AIR VENT PIPING DOWN TO 12" ABOVE TOP OF CONCRETE AND COVER END OF PIPE WITH #24 MESH STAINLESS STEEL SCREEN.
2. FLGxPE DI PIPE.

0 2' 4' 6' 10'
SCALE: 3/16" = 1'-0"

0 1' 2' 3' 5'
SCALE: 3/8" = 1'-0"

GDM smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SJW SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PRETREATMENT PLAN AND SECTIONS

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER JESSE THEO YOSHIMURA No. 63112 CIVIL STATE OF CALIFORNIA

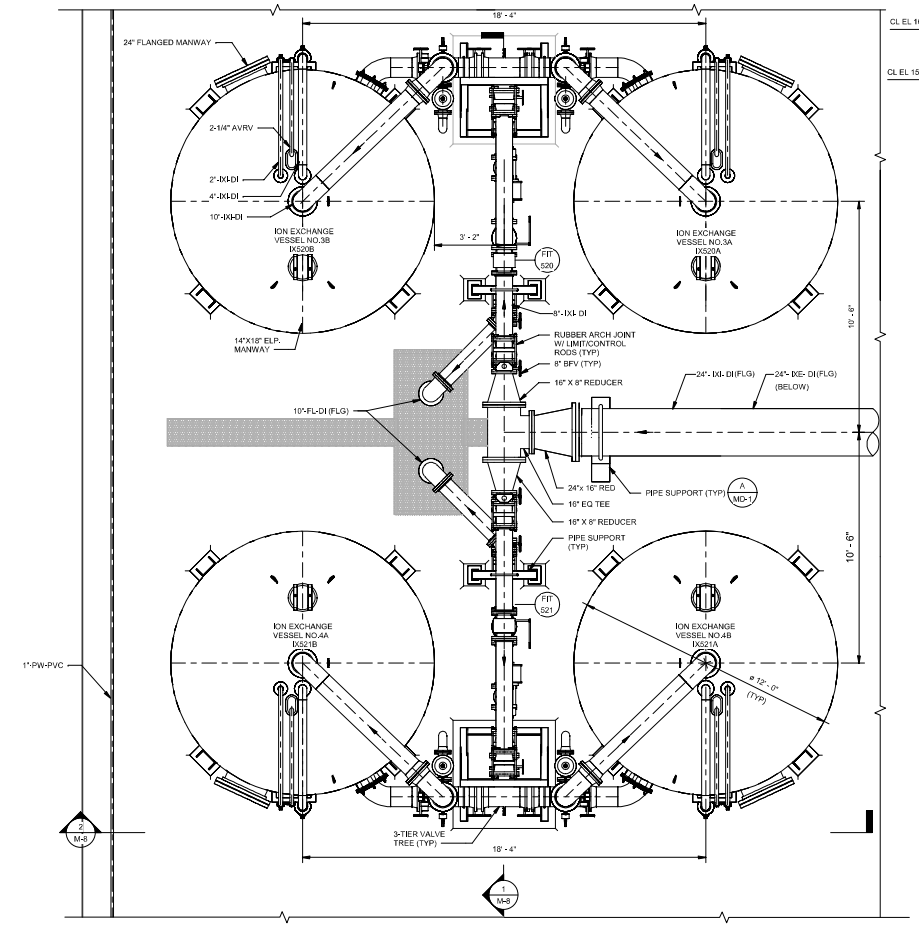
BY	REVISION	DATE	CK	DATE	CK

DATE: DECEMBER 2024	HEALTH AND SAFETY / DATE	
SCALE: As indicated	OPERATIONS / DATE	REF. NOS. SM: 026
DESIGN: J. YOSHIMURA	ENGINEERING, PLANNING / DATE	
DRAWN: B.PAWAN	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. M-7
CHECKED: E. CHANG	CHIEF ENGINEER / DATE	

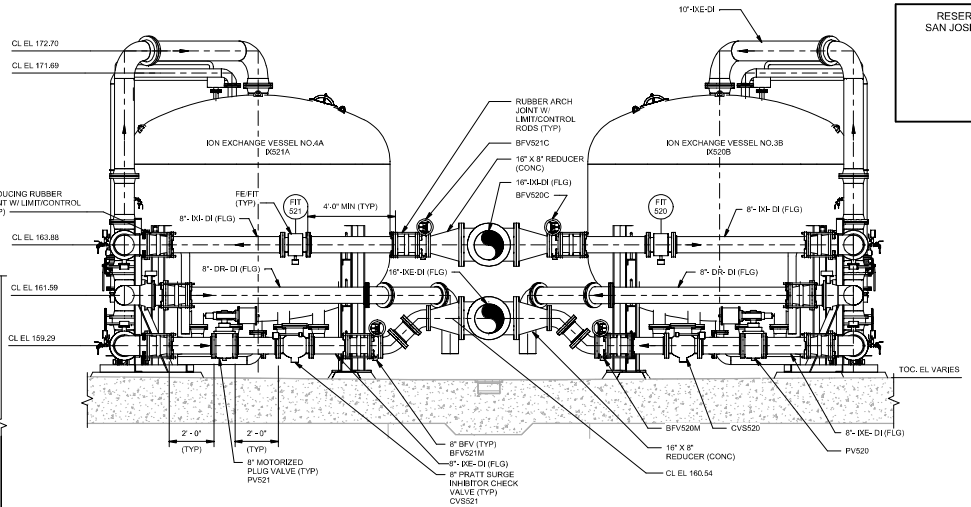
ISSUED FOR CONSTRUCTION

Plot Date : 12/17/2024 8:07:17 PM Plotted By : B. PAWAN File Name: Autodesk Docs://264565 SJW PFAS/MW2001X.rvt

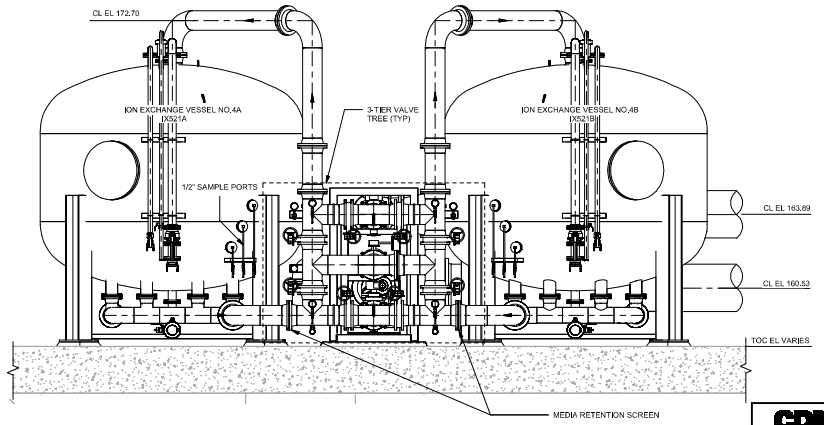
RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP



PLAN
3/8" = 1'-0"



1 SECTION
3/8" = 1'-0"



2 SECTION
3/8" = 1'-0"

0 1' 2' 3' 5'
SCALE: 3/8" = 1'-0"

GDM smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

I/X TYPICAL VESSEL PLAN AND SECTIONS

REGISTERED PROFESSIONAL ENGINEER — JASON TAKEO YOSHIMURA — No. 63112 — CIVIL — STATE OF CALIFORNIA

AS-BUILT STAMP

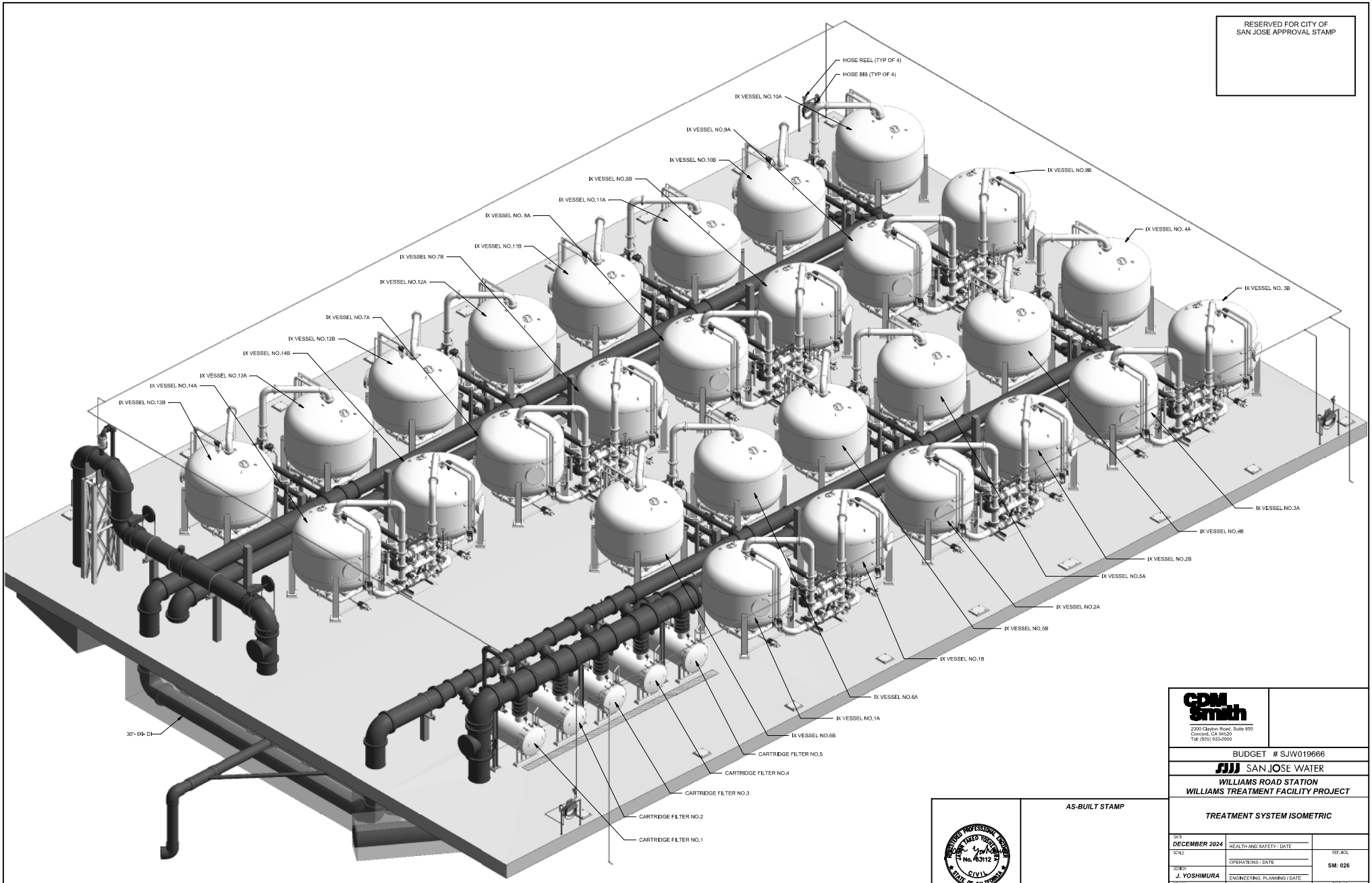
BY	REVISION	DATE	OK	DATE	OK

DATE: *DECEMBER 2024*	HEALTH AND SAFETY / DATE	
SCALE: *3/8" = 1'-0"*	OPERATIONS / DATE	REF. NOS. *SM: 026*
DESIGN: *J. YOSHIMURA*	ENGINEERING, PLANNING / DATE	
DRAWN: *B. PAWAN*	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. *M-8*
CHECKED: *E. CHANG*	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date : 12/17/2024 8:07:19 PM Plotted By : B. PAWAN File Name: Autodesk Docs://284565 SJW PFAS/MW2001IX.rvt

RESERVED FOR CITY OF
SAN JOSE APPROVAL STAMP



TREATMENT SYSTEM ISOMETRIC

GDM smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

TREATMENT SYSTEM ISOMETRIC

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER
JASON THEO YOSHIMURA
No. 83112
CIVIL
STATE OF CALIFORNIA

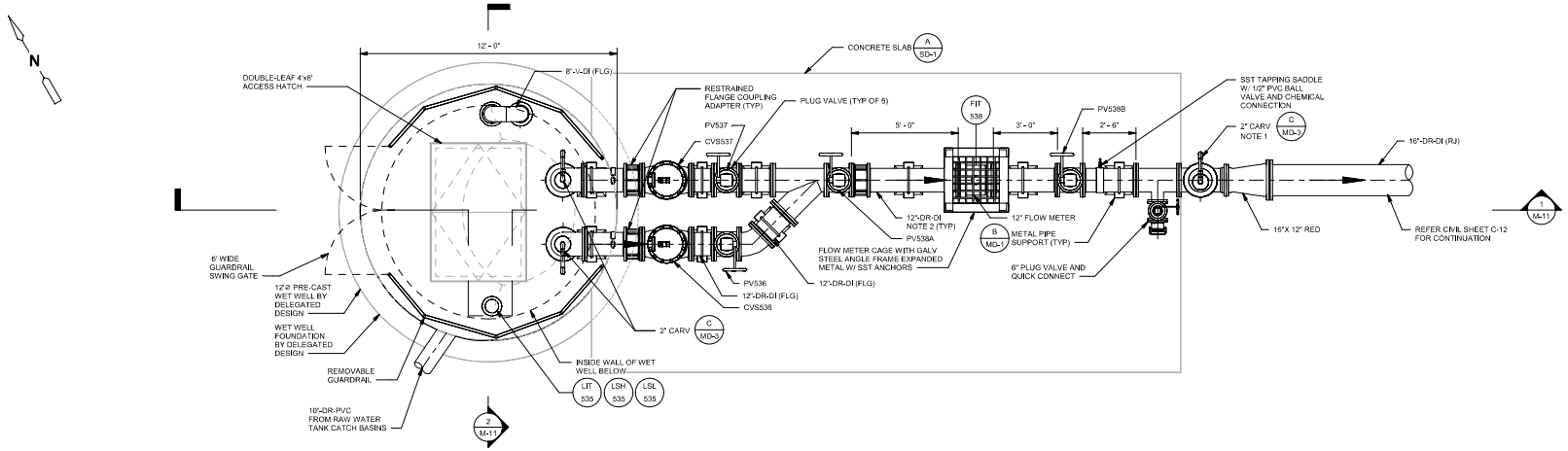
BY	REVISION	DATE	OK	DATE	OK

DATE: ***DECEMBER 2024***	HEALTH AND SAFETY / DATE	
SCALE	OPERATIONS / DATE	REF. NOS. ***SM: 026***
DESIGN: ***J. YOSHIMURA***	ENGINEERING, PLANNING / DATE	
DRAWN: ***B. PAWAN***	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. ***M-9***
CHECKED: ***E. CHANG***	CHIEF ENGINEER / DATE	

ISSUED FOR CONSTRUCTION

Plot Date : 12/17/2024 8:11:03 PM Plotted By : B. PAWAN File Name: Autodesk Docs://264565 SJW PFAS/MW2001IX.rvt

RESERVED FOR CITY OF
SAN JOSE APPROVAL STAMP



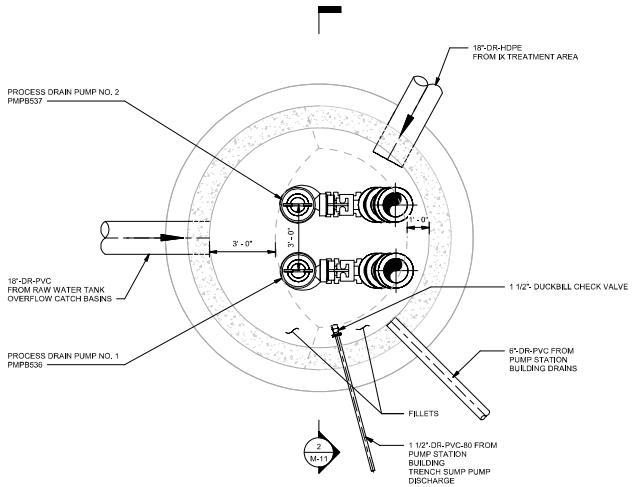
UPPER LEVEL WET WELL PLAN

PLAN

3/8" = 1'-0"

NOTES:

1. ROUTE AIR VALVE VENT PIPING DOWN TO 12" ABOVE FINISHED GRADE AND COVER END OF PIPE WITH #24 MESH STAINLESS STEEL SCREEN.
2. FLG X PE DI PIPE.



LOWER LEVEL WET WELL PLAN

PLAN

3/8" = 1'-0"

0 1" 2" 3" 5"

SCALE: 3/8" = 1'-0"

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PROCESS DRAIN PUMP STATION PLAN

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER — JESSE TAKEO YOSHIMURA — No. 83112 — CIVIL — STATE OF CALIFORNIA

BY	REVISION	DATE	OK	DATE	OK

DATE: ***DECEMBER 2024***	HEALTH AND SAFETY / DATE	
SCALE: ***3/8" = 1'-0"***	OPERATIONS / DATE	REF. NOS. ***SM: 026***
DESIGN: ***J. YOSHIMURA***	ENGINEERING, PLANNING / DATE	
DRAWN: ***B. PAWAN***	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. ***M-10***
CHECKED: ***E. CHANG***	CHIEF ENGINEER / DATE	

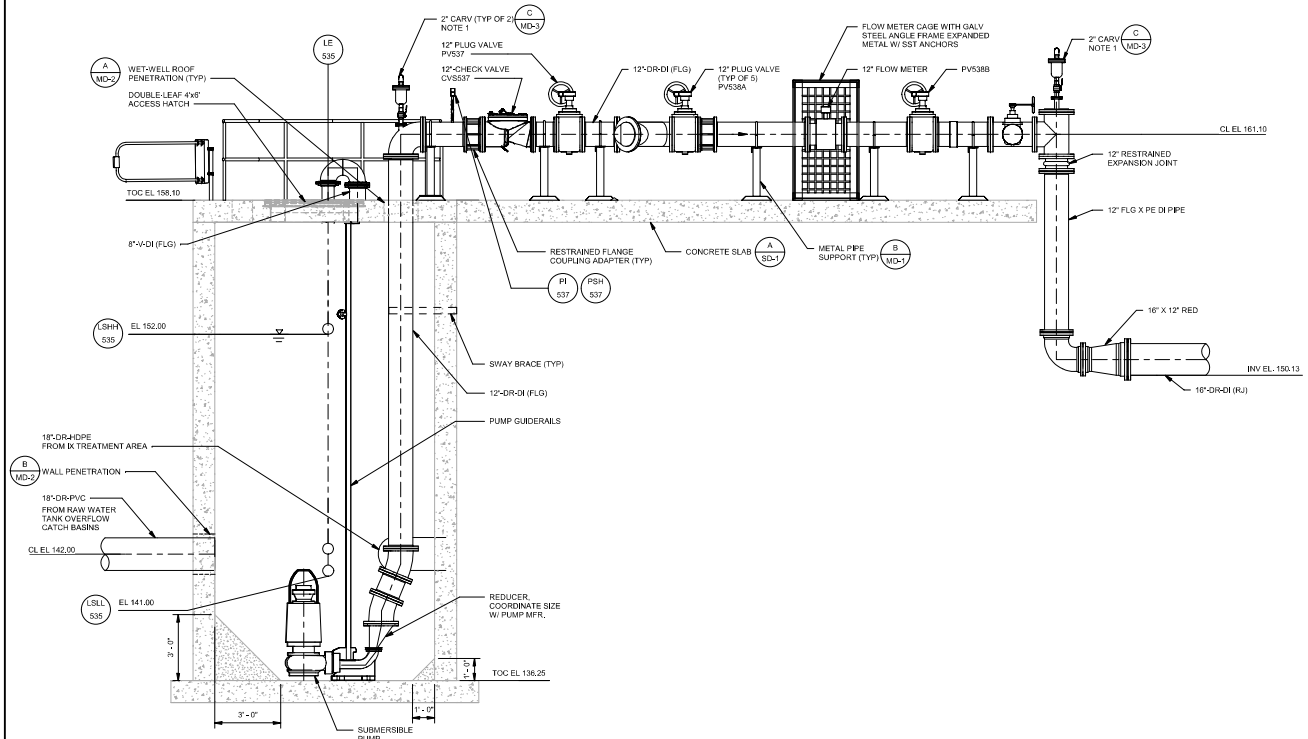
ISSUED FOR CONSTRUCTION

Plot Date : 12/17/2024 8:12:06 PM Plotted By : B. PAWAN File Name: Autodesk Docs://284565 SJW PFAS/MWZ001WW.rvt

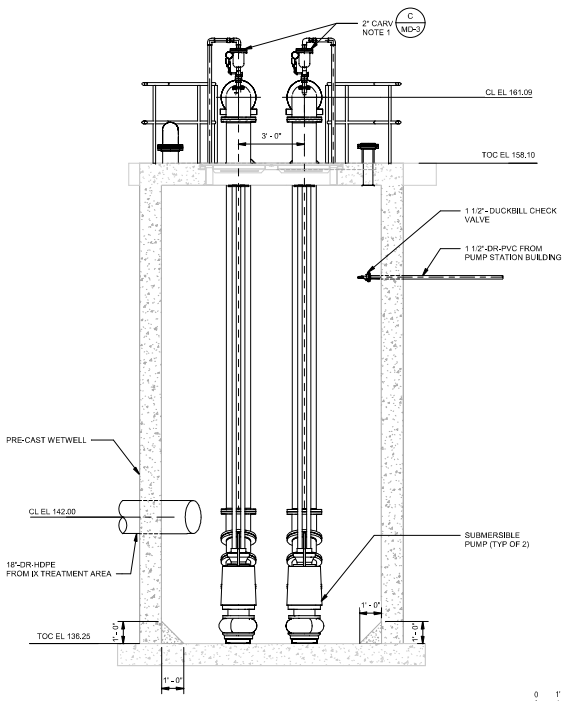
RESERVED FOR CITY OF SAN JOSE APPROVAL STAMP

NOTES:

1. ROUTE AIR VALVE VENT PIPING DOWN TO 12" ABOVE FINISHED GRADE AND COVER END OF PIPE WITH #24 MESH STAINLESS STEEL SCREEN.
2. FLG X PE DI PIPE.



1 M-10 **SECTION** 3/8" = 1'-0"



2 M-10 **SECTION** 3/8" = 1'-0"

0 1' 2' 3' 5'
SCALE: 3/8" = 1'-0"

GDM Smith
2300 Clayton Road, Suite 950
Concord, CA 94520
Tel: (925) 933-2900

BUDGET # SJW019666

SAN JOSE WATER

WILLIAMS ROAD STATION
WILLIAMS TREATMENT FACILITY PROJECT

PROCESS DRAIN PUMP STATION SECTIONS

AS-BUILT STAMP

REGISTERED PROFESSIONAL ENGINEER JEREMY THEO YOSHIMURA No. 83112 CIVIL STATE OF CALIFORNIA

BY	REVISION	DATE	OK	DATE	OK

DATE: ***DECEMBER 2024***	HEALTH AND SAFETY / DATE	
SCALE: ***3/8" = 1'-0"***	OPERATIONS / DATE	REF. NOS. ***SM: 026***
DESIGN: ***J. YOSHIMURA***	ENGINEERING, PLANNING / DATE	
DRAWN: ***B. PAWAN***	ENGINEERING, SPECIAL FACILITIES / DATE	DWG. NO. ***M-11***
CHECKED: ***E. CHANG***	CHIEF ENGINEER / DATE	

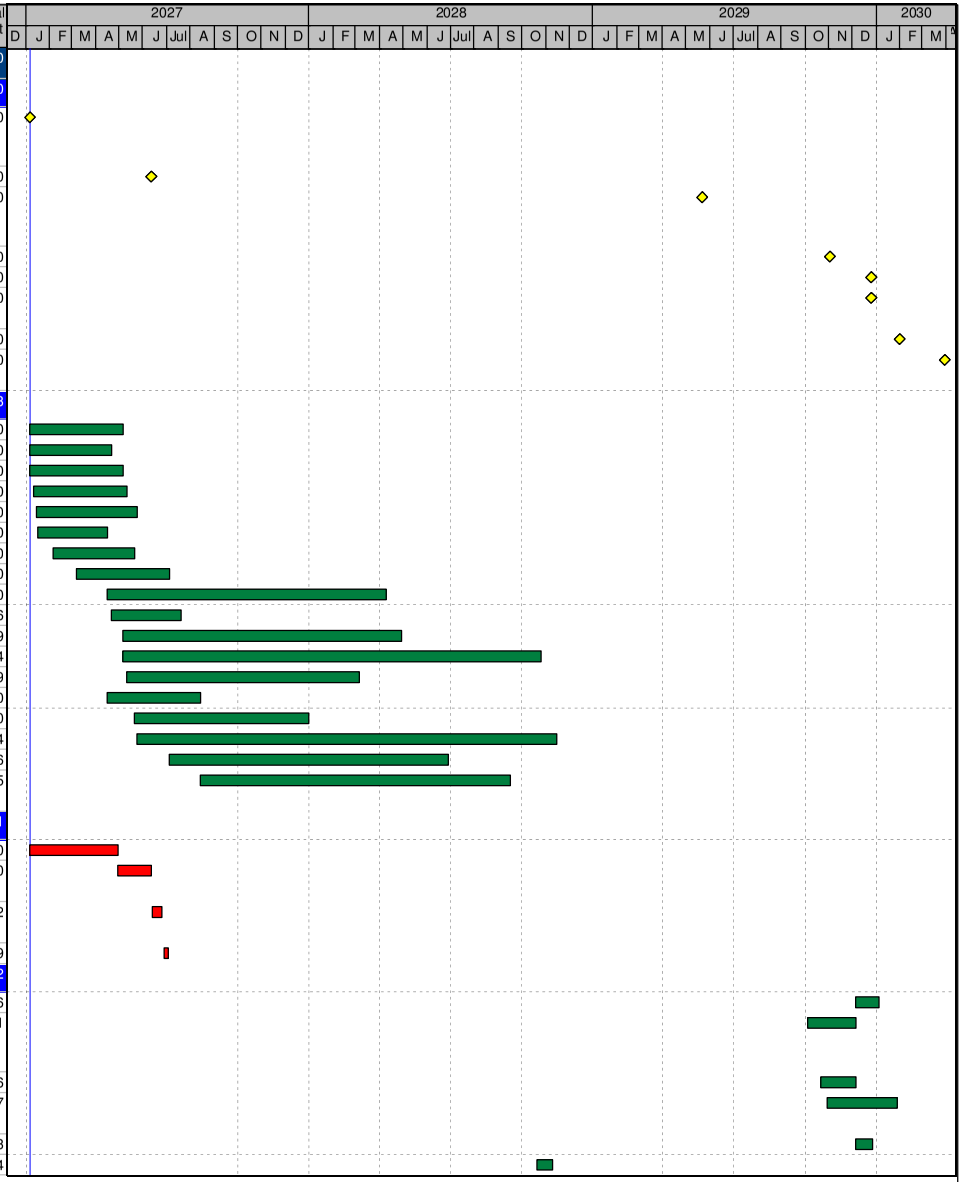
ISSUED FOR CONSTRUCTION

Plot Date : 12/17/2024 8:12:07 PM Plotted By : B. PAWAN File Name: Autodesk Docs://264565 SJW PFAS/MW2001WW.rvt

Appendix G

Williams Station PFAS Treatment Plant
Project Schedule (February 8, 2026)
CDM Smith

Activity ID	Activity Name	Duration	Start	Finish	Total Float	Predecessors	Successors	Budgeted Total Cost
SJW Williams Treatment System		808	06-Jan-27	29-Mar-30	0			$115,000,000
Project Milestones		1179	06-Jan-27	29-Mar-30	0			$0
M.10	NTP	0	06-Jan-27		0		00.100, 00.140, 00.170, 00.180, 00.110, 00.160, 00.120, 00.150	$0
M.15	Start of Construction	0	12-Jun-27		2	5.110	5.120	$0
M.20	Power Available	0	21-May-29		79	20.210, 45.200, 65.130	45.270, 40.180, 50.250, 55.210, 65.180, 100.130	$0
M.25	Loop Testing Complete	0		02-Nov-29	2	200.100	200.110	$0
M.30	Startup Complete (ready for discharge)	0		26-Dec-29	94	200.130	M.45	$0
M.35	Substantial Completion	0		26-Dec-29	94	300.110, 200.130	M.45	$0
M.40	Commissioning Complete	0		30-Jan-30	58	200.140	M.45	$0
M.45	Final Completion	0		29-Mar-30	0	300.130, M.35, M.30, M.40		$0
Procurement		679	06-Jan-27	14-Nov-28	500			$52,417,443
00.100	Ion Exchange Vessels Submittals	120	06-Jan-27	05-May-27	204	M.10	00.220	$500,000
00.110	Yard Piping & Valves Submittals	105	06-Jan-27	20-Apr-27	66	M.10	00.200	$700,000
00.120	MCC Submittals	120	06-Jan-27	05-May-27	200	M.10	00.230	$400,000
00.140	Cartridge Filters Submittals	120	11-Jan-27	10-May-27	268	M.10	00.240	$100,000
00.150	Emergency Generator Submittals	130	15-Jan-27	24-May-27	217	M.10	00.270	$250,000
00.160	Welded Steel Tanks Submittals	90	16-Jan-27	15-Apr-27	358	M.10	00.190	$125,000
00.170	Pumps Submittals	105	05-Feb-27	20-May-27	370	M.10	00.260	$400,000
00.180	MSB Submittals	120	07-Mar-27	04-Jul-27	639	M.10	00.280	$500,000
00.190	Welded Steel Tanks Fab/Deliver (cost is in Install)	360	16-Apr-27	09-Apr-28	358	00.160	40.110	$0
00.200	Yard Piping & Valves Fab/Deliver	90	21-Apr-27	19-Jul-27	66	00.110	25.130	$6,683,046
00.220	Ion Exchange Vessels Fab/Deliver	360	06-May-27	29-Apr-28	204	00.100	50.160	$26,900,859
00.230	MCC Fab/Deliver	540	06-May-27	26-Oct-28	200	00.120	60.100	$2,839,644
00.240	Cartridge Filters Fab/Deliver	300	11-May-27	05-Mar-28	268	00.140	50.170	$1,392,729
00.250	Controls/SCADA Submittals	120	16-Apr-27	13-Aug-27	198	M.10	00.310	$100,000
00.260	Pumps Fab/Deliver	225	21-May-27	31-Dec-27	370	00.170	45.180	$2,059,750
00.270	Emergency Generator Fab/Deliver	540	25-May-27	14-Nov-28	217	00.150	65.120	$6,034,004
00.280	MSB Fab/Deliver	360	05-Jul-27	28-Jun-28	639	00.180		$2,500,366
00.310	Controls/SCADA Fab/Deliver	400	14-Aug-27	16-Sep-28	198	00.250	100.100, 100.100	$932,045
Mobilization		125	06-Jan-27	02-Jul-27	0			$1,434,561
5.100	Obtain Construction Documents and Access	80	06-Jan-27	29-Apr-27	0	M.10	5.110	$0
5.110	Site Mobilization and Temp Facilities/Environ Controls	30	30-Apr-27	11-Jun-27	0	5.100	5.120, M.15	$502,650
5.120	Conduct Site Survey and Demo Underground Piping	10	14-Jun-27	25-Jun-27	0	5.110, M.15	5.130	$573,602
5.130	Conduct Site Clearing and Grading	5	28-Jun-27	02-Jul-27	0	5.120	25.100, 25.130	$358,309
Site Work		315	20-Oct-28	28-Jan-30	2			$3,032,962
10.100	Install Entrance Modifications Paving/Curbs	20	06-Dec-29	04-Jan-30	2	20.090	20.110	$114,206
15.100	Install Site Paving and Curb/Sidewalks	40	05-Oct-29	05-Dec-29	2	65.170, 55.200, 50.260, 45.260	20.090	$1,316,191
20.090	Install Site Lighting/Security	30	22-Oct-29	05-Dec-29	2	15.100	10.100	$336,346
20.100	Install Site Finishes	60	29-Oct-29	28-Jan-30	2	20.110	300.120, 25.120	$575,497
20.110	Install Site Fencing	15	06-Dec-29	27-Dec-29	2	10.100	20.100	$57,643
75.100	Install Metering Vault Structure	15	20-Oct-28	09-Nov-28	200	65.110	75.120	$228,304



Critical Work
Forecast Work
Milestone

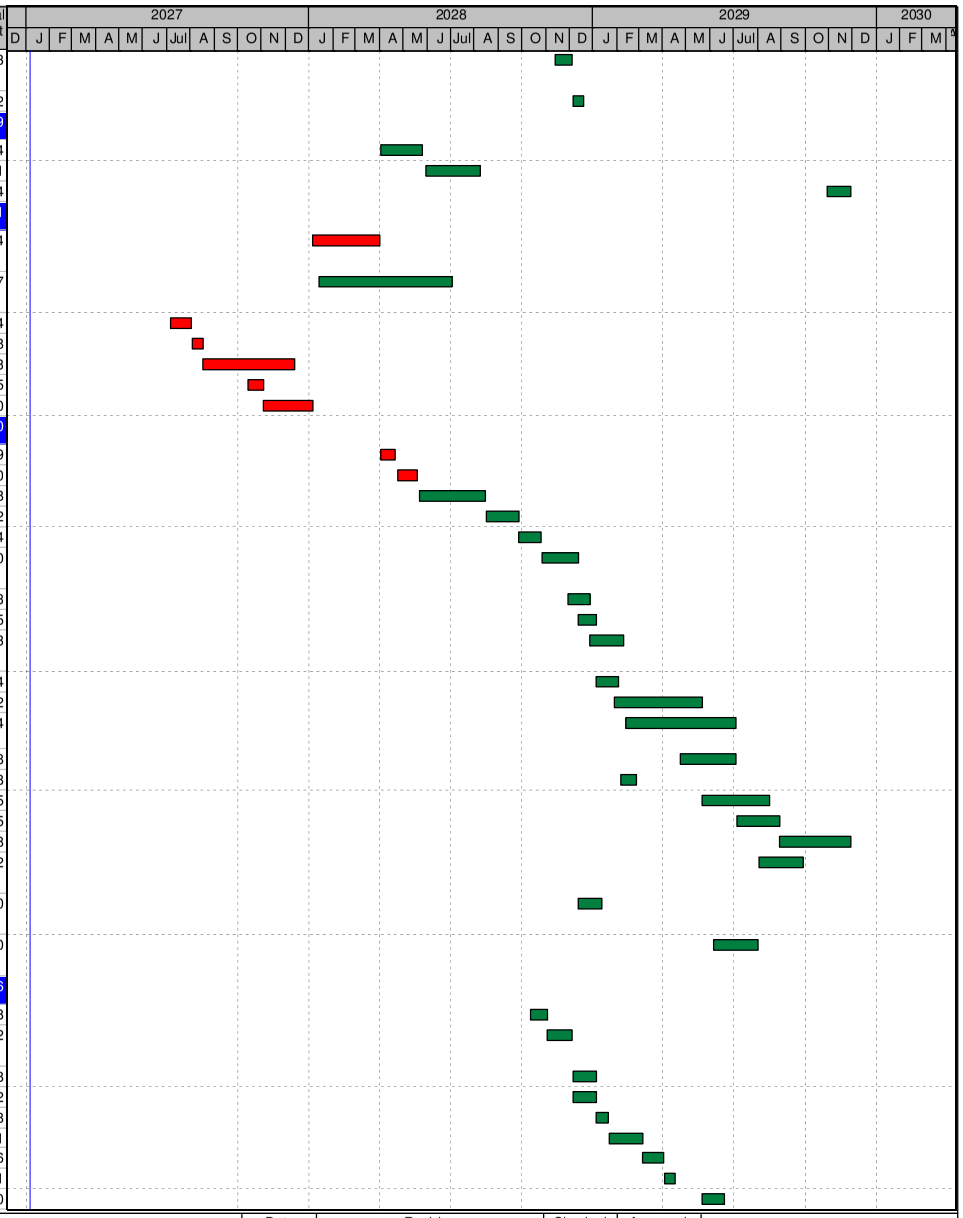
SJW Williams Treatment System

Detail Construction Cost Loaded Schedule

Date	Revision	Checked	Approved
18-Jun-25	Draft Schedule	CAB	
06-Feb-26	Draft Final Schedule	CAB	

Data Date = 06-Jan-27

Activity ID	Activity Name	Duration	Start	Finish	Total Float	Predecessors	Successors	Budgeted Total Cost
75.120	Install Main Service Switchboard (MSB) including pad and conduit	15	13-Nov-28	05-Dec-28	200	75.100	75.130	$206,553
75.130	Install Metering Vault Electrical I&C	10	06-Dec-28	19-Dec-28	200	75.120	200.100	$198,222
Dentention Basin		415	03-Apr-28	28-Nov-29	22			$2,346,019
25.100	Construct Detention Basin Excavation and Lining	40	03-Apr-28	26-May-28	327	5.130, 20.200	25.110	$928,414
25.110	Construct Detention Basin Outfall/Retaining Wall	50	30-May-28	08-Aug-28	327	25.100	25.120	$1,075,101
25.120	Install Detention Basin Finishes	20	29-Oct-29	28-Nov-29	22	25.110, 20.100	300.120	$342,504
Yard Piping		250	06-Jul-27	03-Jul-28	215			$6,821,011
20.200	Install Facility Ductbanks Vaults	60	06-Jan-28	31-Mar-28	0	35.130	20.210, 45.100, 25.100	$801,814
20.210	Install Site Ductbanks and Vaults	120	13-Jan-28	03-Jul-28	215	20.200	65.180, 60.100, M.20	$1,498,567
25.130	Install Stormwater Conveyance/Manholes	20	06-Jul-27	02-Aug-27	0	5.130, 00.200	35.100	$323,014
35.100	Install RW Piping	10	03-Aug-27	16-Aug-27	0	25.130	35.110	$539,918
35.110	Install Process Piping D1	80	17-Aug-27	13-Dec-27	0	35.100	35.120	$3,198,923
35.120	Install Finished Water Piping	15	14-Oct-27	03-Nov-27	0	35.110	35.130	$170,255
35.130	Install Process Piping D2	40	04-Nov-27	05-Jan-28	0	35.120	20.200	$288,520
IX Feed Pump Station		415	03-Apr-28	28-Nov-29	27			$13,623,170
45.100	Excavate/Install Cans/Underground Piping	15	03-Apr-28	21-Apr-28	0	20.200	45.110	$1,175,639
45.110	FRP Footings and Slab/sumps	20	24-Apr-28	19-May-28	0	45.100	45.120, 50.100	$1,565,930
45.120	FRP Equipment Pads and Pipe Supports	60	22-May-28	15-Aug-28	5	45.110	45.130, 40.100	$84,008
45.130	Construct Masonry	30	16-Aug-28	27-Sep-28	5	45.120	45.140	$709,162
45.140	Install Structure Steel / Joist	20	28-Sep-28	26-Oct-28	5	45.130	45.150	$831,394
45.150	Install Roof	30	27-Oct-28	12-Dec-28	5	45.140	45.180, 60.100, 45.160, 45.155	$839,370
45.155	Install Doors/Windows (including frames)	20	29-Nov-28	27-Dec-28	5	45.150	45.180	$275,763
45.160	Install HVAC	15	13-Dec-28	04-Jan-29	115	45.150	45.190	$626,915
45.180	Install Pumps and Equipment	30	28-Dec-28	09-Feb-29	5	45.150, 00.260, 45.155	45.200, 45.210	$646,693
45.190	Install Plumbing	20	05-Jan-29	02-Feb-29	115	45.160	45.220	$154,414
45.200	Install Electrical Raceways/Wire Pull	80	29-Jan-29	21-May-29	5	45.180	45.230, M.20	$1,144,972
45.210	Install Above Mechanical Piping/Supports	100	12-Feb-29	03-Jul-29	27	45.180	45.240, 45.215	$4,359,014
45.215	Install Process (sm) Piping/Supports	50	24-Apr-29	03-Jul-29	27	45.210	45.240	$115,188
45.220	Install Fire Protection	15	05-Feb-29	26-Feb-29	115	45.190	45.270	$293,648
45.230	Install Lighting and Misc Electrical	60	22-May-29	15-Aug-29	5	45.200	60.120	$368,435
45.240	Place Misc Metals	40	05-Jul-29	29-Aug-29	27	45.210, 45.215	45.260	$23,725
45.260	Complete Building Finishes and Painting	60	30-Aug-29	28-Nov-29	27	45.240	15.100	$271,078
45.270	Conduct Feed Pump Station Testing and Startup	40	02-Aug-29	27-Sep-29	5	45.220, 60.120, M.20	200.100	$23,162
60.100	Install Electrical Equipment / Panels	20	13-Dec-28	11-Jan-29	105	45.150, 00.230, 20.210	60.120, 100.110	$0
60.120	Install I&C	40	06-Jun-29	01-Aug-29	5	45.230, 60.100	45.270, 100.120	$114,660
Raw Water Tanks		170	13-Oct-28	19-Jun-29	75			$10,123,176
40.100	Grade/FRP Foundation and Pad	15	13-Oct-28	02-Nov-28	100	45.120	40.110	$1,299,698
40.110	Install Tank 1	20	03-Nov-28	05-Dec-28	100	40.100, 00.190	40.120, 40.130	$2,831,172
40.120	Install Tank 2	20	06-Dec-28	04-Jan-29	100	40.110	40.140	$2,607,338
40.130	Tank Testing	20	06-Dec-28	04-Jan-29	100	40.110	40.140	$23,162
40.140	Install Mechanical Piping (above ground)	10	05-Jan-29	19-Jan-29	100	40.120, 40.130	40.150	$2,936,208
40.150	Install Misc Metals/Railing/Stairs	30	22-Jan-29	05-Mar-29	100	40.140	40.160	$179,481
40.160	Install Electrical and Lighting	20	06-Mar-29	02-Apr-29	100	40.150	40.170	$230,646
40.170	Install I&C	10	03-Apr-29	16-Apr-29	100	40.160	40.180	$15,471
40.180	Conduct RW Tanks System Testing	20	22-May-29	19-Jun-29	75	40.170, M.20	200.100	$0



Critical Work
Forecast Work
Milestone

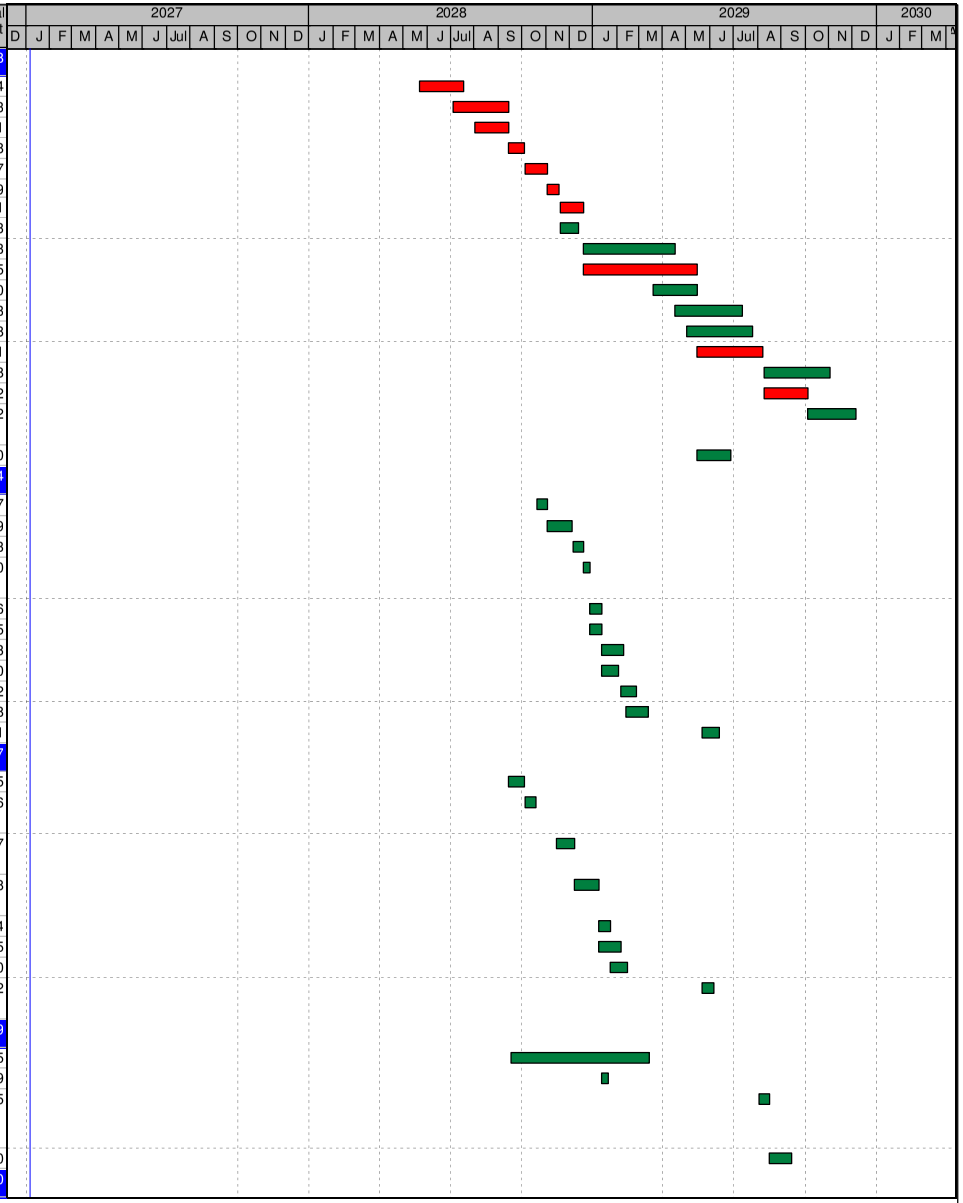
SJW Williams Treatment System

Detail Construction Cost Loaded Schedule

Date	Revision	Checked	Approved
18-Jun-25	Draft Schedule	CAB	
06-Feb-26	Draft Final Schedule	CAB	

Data Date = 06-Jan-27

Activity ID	Activity Name	Duration	Start	Finish	Total Float	Predecessors	Successors	Budgeted Total Cost
IX Treatment		385	22-May-28	05-Dec-29	2			$18,572,938
50.100	Excavate/Install Underground Piping	40	22-May-28	18-Jul-28	0	45.110	50.110	$1,959,944
50.110	FRP Footings and Slab	50	05-Jul-28	13-Sep-28	0	50.100	50.120, 65.100	$3,142,693
50.120	FRP Sumps	30	02-Aug-28	13-Sep-28	0	50.110	50.130	$120,851
50.130	Construct Building Framing	15	14-Sep-28	04-Oct-28	0	50.120	50.140	$388,328
50.140	Install Roof	20	05-Oct-28	02-Nov-28	0	50.130	50.150	$382,947
50.150	Install Siding	10	03-Nov-28	17-Nov-28	0	50.140	50.160, 50.170	$191,639
50.160	Set IX Units and Equipment	20	20-Nov-28	19-Dec-28	0	50.150, 00.220	50.190, 50.180	$824,291
50.170	Set Filters and Equipment	15	20-Nov-28	12-Dec-28	5	50.150, 00.240	50.190	$342,703
50.180	Install Electrical Raceways/Wire Pull (300)	80	20-Dec-28	16-Apr-29	10	50.160	50.200, 50.210	$4,304,173
50.190	Install Above Large Mechanical Piping/Supports	100	20-Dec-28	14-May-29	0	50.160, 50.170	50.230, 50.270	$5,043,685
50.200	Install Electrical Equipment / Panels	40	20-Mar-29	14-May-29	10	50.180	50.220	$271,860
50.210	Install Lighting and Misc Electrical	60	17-Apr-29	11-Jul-29	62	50.180	50.260	$459,953
50.220	Install I&C	60	01-May-29	25-Jul-29	10	50.200	50.250	$281,398
50.230	Install Above Small Mechanical Piping/Supports	60	15-May-29	08-Aug-29	0	50.190	50.250, 50.240	$385,301
50.240	Place Misc Metals	60	09-Aug-29	02-Nov-29	2	50.230	50.260	$211,988
50.250	Conduct IX Treatment Testing and Startup	40	09-Aug-29	04-Oct-29	0	50.230, 50.22	200.100	$23,162
50.260	Complete Building Finishes and Painting	40	05-Oct-29	05-Dec-29	2	50.210, 50.240, 50.270	15.100	$35,972
50.270	Install Fire Protection and Plumbing	30	15-May-29	26-Jun-29	112	50.190	50.260	$202,050
Drain Pump Station		160	20-Oct-28	12-Jun-29	82			$1,231,014
55.100	Excavate/Install Underground Piping	10	20-Oct-28	02-Nov-28	140	65.110	55.110	$16,667
55.110	FRP Footings/Slab/Walls	20	03-Nov-28	05-Dec-28	140	55.100	55.120	$107,289
55.120	Install Manholes	10	06-Dec-28	19-Dec-28	140	55.110	55.130	$436,463
55.130	Install Pumps and Equipment	5	20-Dec-28	27-Dec-28	140	55.120	55.140, 55.150	$49,940
55.140	Install Electrical Raceways/Wire Pull	10	28-Dec-28	11-Jan-29	140	55.130	55.170	$211,236
55.150	Install Above Mechanical Piping/Supports	10	28-Dec-28	11-Jan-29	147	55.130	55.160	$277,825
55.160	Place Misc Metals	20	12-Jan-29	09-Feb-29	147	55.150	55.200	$36,023
55.170	Install Electrical Equipment / Panels / Lighting	15	12-Jan-29	02-Feb-29	140	55.140	55.190, 55.200	$41,000
55.190	Install I&C	15	05-Feb-29	26-Feb-29	140	55.170	55.210	$30,122
55.200	Install Finishes	20	12-Feb-29	12-Mar-29	147	55.160, 55.170	15.100	$12,868
55.210	Conduct Drain Pump Station Testing and Startup	15	22-May-29	12-Jun-29	80	55.190, M.20	200.100	$11,581
Generator / Transformer		180	14-Sep-28	05-Jun-29	87			$1,238,857
65.100	Excavate/Install Underground Conduit	15	14-Sep-28	04-Oct-28	140	50.110	65.110	$57,685
65.110	FRP Footings/Slab/Equipment Pads	10	05-Oct-28	19-Oct-28	140	65.100	65.120, 55.100, 75.100	$162,946
65.120	Install Electrical Equipment / Panels / Conduit-Wire	15	15-Nov-28	07-Dec-28	148	65.110, 00.270	65.130	$259,937
65.130	Install Transformer and Conduit/Wire	20	08-Dec-28	08-Jan-29	148	65.120	65.160, 65.140, M.20	$470,448
65.140	Place Misc Metals	10	09-Jan-29	23-Jan-29	165	65.130	65.170	$217,694
65.160	Install I&C/FireSystem	20	09-Jan-29	06-Feb-29	158	65.130	65.180	$46,985
65.170	Install Finishes	15	24-Jan-29	13-Feb-29	165	65.140	15.100	$0
65.180	Conduct Generator Testing and Startup	10	22-May-29	05-Jun-29	85	65.160, 20.210, M.20	200.100	$23,162
Controls		248	18-Sep-28	13-Sep-29	35			$3,133,849
100.100	Conduct Controls Software Programing	120	18-Sep-28	14-Mar-29	133	00.310, 00.310	100.120	$1,032,045
100.110	Install I&C Panels	5	12-Jan-29	19-Jan-29	170	60.100	100.120	$833,339
100.120	Install Controls Equipment and Software	10	02-Aug-29	15-Aug-29	35	100.110, 100.100, 60.120	100.130	$968,465
100.130	Test Controls	20	16-Aug-29	13-Sep-29	35	100.120, M.20	200.110	$300,000
Startup and Commissioning		77	05-Oct-29	30-Jan-30	0			$900,000



Critical Work
Forecast Work
Milestone

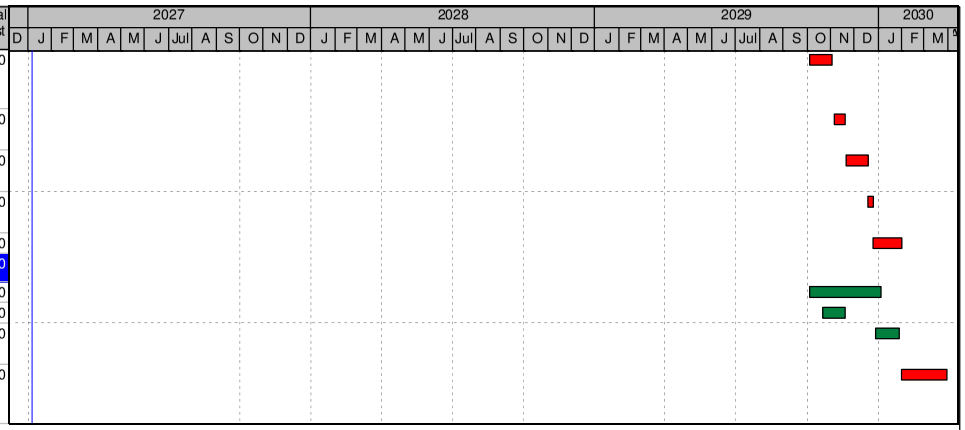
SJW Williams Treatment System

Detail Construction Cost Loaded Schedule

Date	Revision	Checked	Approved
18-Jun-25	Draft Schedule	CAB	
06-Feb-26	Draft Final Schedule	CAB	

Data Date = 06-Jan-27

Activity ID	Activity Name	Duration	Start	Finish	Total Float	Predecessors	Successors	Budgeted Total Cost
200.100	System Mechanical Testing	20	05-Oct-29	02-Nov-29	0	75.130, 45.270, 40.180, 50.250	200.120, 300.100, M.25	$250,000
200.110	System Electrical / Controls Testing	10	05-Nov-29	19-Nov-29	0	100.130, M.25	200.120, 300.110	$200,000
200.120	Plant Startup	20	20-Nov-29	19-Dec-29	0	200.110, 200.100	200.130	$200,000
200.130	7-day Acceptance Testing	7	19-Dec-29	26-Dec-29	0	200.120	200.140, M.30, M.35	$100,000
200.140	Conduct Commissioning	40	26-Dec-29	30-Jan-30	0	200.130	300.130, M.40	$150,000
Project Closeout		118	05-Oct-29	29-Mar-30	0			$125,000
300.100	Project As-builts and Reporting	60	05-Oct-29	04-Jan-30	58	200.100	300.130	$50,000
300.110	Pre-Punchlist	20	22-Oct-29	19-Nov-29	27	200.110	300.120, M.35	$25,000
300.120	Conduct Site Demob and Clean	20	28-Dec-29	28-Jan-30	2	300.110, 20.100, 25.120	300.130	$50,000
300.130	Final Punchlist	41	30-Jan-30	29-Mar-30	0	300.100, 300.120, 200.140	M.45	$0



Critical Work
Forecast Work
Milestone

SJW Williams Treatment System

Detail Construction Cost Loaded Schedule

Date	Revision	Checked	Approved
18-Jun-25	Draft Schedule	CAB	
06-Feb-26	Draft Final Schedule	CAB	

Data Date = 06-Jan-27

Appendix H

Technical Memorandum
Feasibility of GAC and Higher Treatment Flow Rates at Williams Station (August 2022)
Hazen and Sawyer

Hazen *Technical Memorandum*

August 12, 2022

To: Suzanne DeLorenzo, PhD
Sarah Richardson

From: Nicole Blute, PhD, PE
Alex Gorzalski, PhD, PE, PO
Audrey Gozali, PE

Re: Feasibility of GAC and Higher Treatment Flow Rates at Williams Station

Feasibility of GAC and Higher Treatment Flow Rates at Williams Station



Table of Contents

1. Background 3
   1.1 Regulatory Considerations 3
   1.2 Objectives 3
   1.3 Siting Feasibility and Treatment Capacities Considered 4
2. Design Parameters & Equipment Sizing 5
   2.1 Hydraulic Considerations 5
   2.2 Conceptual Process Flow Diagrams 5
   2.3 Break Tank Sizing 6
   2.4 PFAS IX and GAC Equipment Sizing 6
   2.5 Backwash and Forward Flush Disposal 7
3. Layouts 7
4. Cost Estimate 18

1. Background

1.1 Regulatory Considerations

Regulatory guidance for per- and polyfluoroalkyl substance (PFAS) compounds has recently been published by the State Water Resources Control Board (SWRCB) and United States Environmental Protection Agency (EPA). The new regulatory guidance consisted of Health Advisory Levels (HALs), Notification Levels (NLs), and Reporting Limits (RLs) for PFAS compounds.

Under the Safe Drinking Water Act, HALs are established by EPA for contaminants not subjected to a National Primary Drinking Water Regulation and serve as information to drinking water systems and officials responsible for protecting public health. HALs are health-based concentrations below which adverse health or aesthetic effects are not anticipated to occur over the specific exposure duration. Interim HALs provide information in response to an urgent or rapidly developing situation, and provide concentrations above which action should be taken to reduce contaminant exposure in drinking water.

NLs are health-base advisory levels established by the SWRCB's Division of Drinking Water (DDW) for chemicals in drinking water that lack maximum contaminant levels (MCLs). RLs are similarly established by DDW and are advisory levels at which DDW recommends the source be taken out of service.

The regulatory guidance from SWRCB and EPA for PFAS compounds are described in Table 1-1. The EPA HALs are all lifetime health advisories.

Table 1-1: Regulatory Guidance from EPA and SWRCB

PFAS Compound	EPA 2016 HAL	EPA 2022 HAL	California NL	California RL
PFOA	70 ppt combined	0.004 ppt[2]	5.1 ppt	10 ppt
PFOS		0.02 ppt[2]	6.5 ppt	40 ppt
GenX	N/A	10 ppt[3]	N/A	N/A
PFBS	N/A	2000 ppt[3]	0.5 ppb	5 ppb
PFHxS	N/A	N/A	2 ppt[1]	20 ppt[1]

[1] Draft
[2] Interim
[3] Final

For SJW to meet the revised regulatory guidance for PFAS compounds, treatment would be needed for the wells at Williams Station.

1.2 Objectives

In response to the recent regulatory guidance, San Jose Water Company (SJW) requested this study to assess the feasibility of locating PFAS treatment at Williams Station. The study builds upon the existing 2022 Williams Treatment Facilities Plan by Hazen, and investigates the siting feasibility of ion exchange (IX) treatment and granular activated carbon (GAC) treatment at Williams Station.

The objectives of the study are to size and cost PFAS treatment systems to meet SJW's goal of reducing PFAS concentrations below the limit of detection. The EPA HALs for PFOA and PFOS are below the

detection limit (2 ng/L) for current methods. SJW had originally planned to treat the 90th percentile flow and bypass flows exceeding the design flow, with the blended effluent falling concentrations below the detection limit. The lower EPA HALs recently published have caused SJW to consider treating the full design flow (20,000 gpm) as an alternative to the 90th percentile flow (14,000 gpm). Further detail on SJW's other treatment goals is outlined in the Williams Station Facilities Plan Report.

In this study, conceptual layouts were developed to assess siting feasibility as well as to estimate the capital and operations and maintenance (O&M) costs.

1.3 Siting Feasibility and Treatment Capacities Considered

Siting for PFAS treatment at Williams Station was discussed during Pumping Alternatives Meeting (May 2021). This meeting considered whether a single centralized location should be used versus separate systems for the front and back station, as well as how water should be pumped through the system to introduce the additional head required. SJW selected a single centralized system to be located in the area shown in Figure 1-1. SJW also selected the pumping alternative that included maintaining the existing well pumps and constructing new suction tanks and booster pumps to deliver water through the treatment system and into the existing suction tanks.



Figure 1-1: Potential PFAS Treatment Location

Siting for PFAS treatment also considered future plans for Williams Station, including the proposed engineered sump located toward the front of the station (near Williams Rd and San Thomas Expy) and potential locations for new wells shown in the *Groundwater Well Asset Management Plan* (2020). It was assumed that the backwash waste stream from GAC treatment, after bag filtration, would be routed to the proposed engineered sump. Siting for treatment aimed to avoid conflicts with potential locations for new wells. However, some alternatives included treatment improvements near the potential new well locations; distances to proposed wells are provided in site layouts.

Site layouts were prepared for the following treatment alternatives and design flow rates:

1. PFAS IX Treatment (14,000 gpm)
2. PFAS IX Treatment (20,000 gpm)
3. PFAS GAC Treatment (14,000 gpm)
4. PFAS GAC Treatment (20,000 gpm)

As space permitted, each treatment alternative assessed a variety of configurations of equipment to optimize space onsite and maintain existing infrastructure.

2. Design Parameters & Equipment Sizing

2.1 Hydraulic Considerations

The Williams Station Facilities Plan Report contains details on headlosses and pressure assumptions for IX, but not for GAC. Please refer to the Williams Station Facilities Plan Report for the IX treatment hydraulic considerations.

For the GAC system, treatment headlosses were based on the average of clean and dirty (i.e., fouled) conditions. The average headloss estimates of GAC treatment were 7 psi for cartridge filters and 27 psi for GAC, and 10 psi for general piping. The backwash waste stream was assumed to be pumped through bag filters prior to discharging to the sump. An average headloss for the bag filters was estimated to be 15 psi.

2.2 Conceptual Process Flow Diagrams

For PFAS treatment using IX, raw water would be pumped from the existing well pumps to two break tanks. From the break tanks, raw water would be pumped through treatment into cartridge filters and IX. The treated water would be routed to the front and/or back station suction tanks. A conceptual process flow diagram for IX treatment is shown below in Figure 2-1.

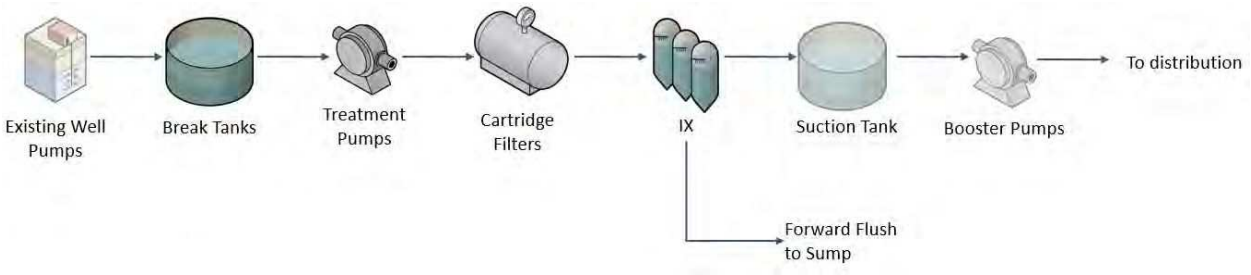


Figure 2-1: Conceptual Process Flow Diagram for IX Treatment

For PFAS treatment using GAC, raw water would be pumped from the existing well pumps to the new break tanks. From the break tanks, raw water would be pumped through treatment into cartridge filters and GAC. The treated water would be routed to the front and/or back station suction tanks. Waste from backwash of the GAC media would be piped to a backwash waste tank to discharge later to the proposed engineered sump located near the front of the station. The conceptual process flow diagram for GAC treatment is shown in Figure 2-2.

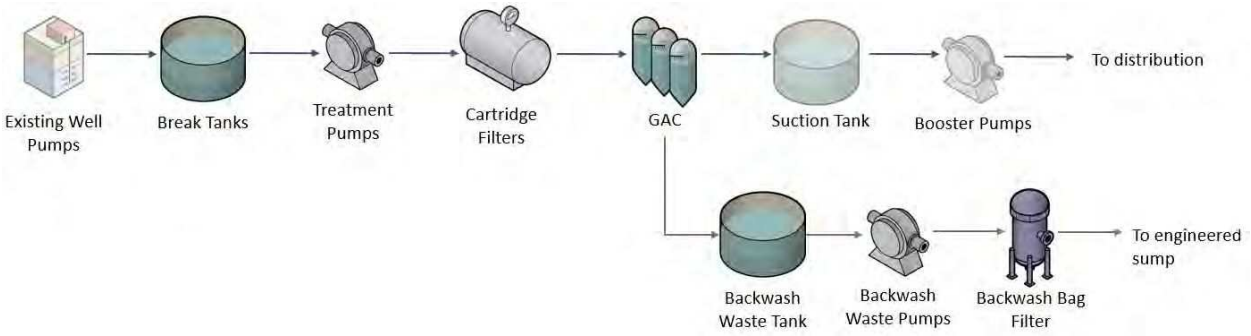


Figure 2-2: Conceptual Process Flow Diagram for GAC Treatment

2.3 Break Tank Sizing

In discussions with SJW, SJW indicated a preference for two break tanks to provide residence time for flow attenuation, solids removal, and iron oxidation (for the small fraction of wells that require it). With two tanks, one tank can be serviced and cleaned while the other is operational. Initial break tank sizing at Williams Station estimated two 32-ft diameter break tanks with a combined volume of 180,000 gallons would provide approximately 18 minutes of residence time at a design flow rate of 10,000 gpm (Pumping Alternatives Meeting). At the increased design flow rates of 14,000 and 20,000 gpm, the initial break tank sizing was revised to provide similar residence time at the lower flow rates. For the 14,000 gpm design flow, the conceptual break tank sizing included two 39-ft diameter break tanks with a combined volume of 280,000 gallons for a residence time of approximately 20 minutes. For the 20,000 gpm design flow, the conceptual break tank sizing included two 45-ft diameter break tanks with a combined volume of 376,000 gallons for a residence time of approximately 19 minutes.

2.4 PFAS IX and GAC Equipment Sizing

Design criteria were developed for IX and GAC treatment systems. It was assumed that the backwash supply for the GAC treatment system would be the raw water from the break tank, and the GAC treatment system would utilize a four-tier GAC valve tree. Detailed study of supply piping and valving would be investigated in future detailed design. A summary of the IX and GAC sizing is provided in Table 2-1.

Table 2-1: IX and GAC Treatment Design Criteria

Design Parameter	14,000 gpm System		20,000 gpm System		Units
	IX	GAC	IX	GAC	
Flow Rate	14,000	14,000	20,000	20,000	gpm
Number of Parallel Trains	9	16	13	23	-
Flow per Train	1,556	875	1,538	870	gpm
Vessels per Train	2	2	2	2	-
Configuration	Lead/lag	Lead/lag	Lead/lag	Lead/lag	-
Vessel Diameter	12	12	12	12	ft
Volume of Media (per vessel)	520	1,187	520	1,187	ft^3
Depth of Media	4.6	10.5	4.6	10.5	ft
Vessel Headloss	3.0	3.0	3.0	3.0	psi/vessel
Clean Media Headloss	1.3	0.3	1.3	0.3	psi/ft
Total Headloss (Per Train)	33	19	33	19	psi
EBCT (Lead Vessel)	2.5	10	2.5	10	minutes
HLR	14	7.7	14	7.7	gpm/ft^2

2.5 Backwash and Forward Flush Disposal

It was assumed that both the forward flush from the IX vessels and backwash waste from the GAC vessels would be disposed to the engineered sump. The backwash waste from the GAC vessels would be contained in a backwash waste tank onsite, and the waste stream would be filtered using bag filters prior to pumping the waste to the sump. Future detailed design will investigate changeout frequency required for bag filters.

3. Layouts

Conceptual site layouts were prepared to demonstrate the feasibility of locating PFAS treatment at Williams Station, and four scenarios with several options were evaluated to prepare nine overall layouts. The nine layout names and descriptions are shown in Table 3-1.

Table 3-1: Conceptual Site Layout Names and Descriptions

Figure	Layout Name	Layout Description
Figure 3-1	PFAS IX Treatment (14,000 gpm), Site Layout, Option 1	Site layout shown in Williams Station Facilities Plan Report – PFAS treatment equipment is contained in western side of selected treatment area and sited closely together to allow for additional future treatment (e.g., softening).
Figure 3-2	PFAS IX Treatment (14,000 gpm), Site Layout, Option 2	PFAS treatment equipment is contained in western side of selected treatment area. More space is added between PFAS treatment equipment and potential future well location. IX vessels are aligned with existing road on western edge of treatment area.
Figure 3-3	PFAS IX Treatment (14,000 gpm), Site Layout, Option 3	PFAS treatment equipment moved to eastern side of selected treatment area to avoid existing pipelines. More space is added between PFAS treatment equipment and potential future well location. Access roads on the eastern edge and middle of the selected treatment area are added.
Figure 3-4	PFAS IX Treatment (20,000 gpm), Site Layout, Option 1	PFAS treatment equipment is contained in western side of selected treatment area. IX vessels and cartridge filters are

		located on same equipment pad, and equipment pad is aligned with existing western road.
Figure 3-5	PFAS IX Treatment (20,000 gpm), Site Layout, Option 2	PFAS treatment equipment is contained in northeastern and northwestern sides of selected treatment area. IX vessels are aligned with existing western road, and break tank, pumps, and cartridge filters are sited in northeastern side of selected treatment area. Access roads on the eastern edge and middle of the selected treatment area are added.
Figure 3-6	PFAS IX Treatment (20,000 gpm), Site Layout, Option 3	PFAS treatment equipment is contained in eastern side of selected treatment area. An access road on the eastern edge of the selected treatment area is added.
Figure 3-7	PFAS GAC Treatment (14,000 gpm), Site Layout, Option 1	PFAS treatment equipment is mostly contained in western side of selected treatment area except for the backwash waste tank, waste pumps, and bag filters, which are located on the eastern side of the proposed new access road. The access road runs in the middle of the selected treatment alternative area.
Figure 3-8	PFAS GAC Treatment (14,000 gpm), Site Layout, Option 2	PFAS treatment equipment is mostly contained in eastern side of selected treatment area except for the backwash waste tank, waste pumps, and bag filters, which are located on western side of existing road. An access road on eastern edge of selected treatment area is added.
	PFAS GAC Treatment (20,000 gpm), Site Layout, Option 1	PFAS treatment equipment is contained mostly contained in western side of selected treatment area except for backwash waste tank, waste pumps, and bag filters, which are located on eastern side of existing road.

The potential future wells from the *Groundwater Asset Management Plan* (2020) and the potential future sump from the *Williams Road Station Contract Drawings Engineered Sump* (2019) were incorporated into the layouts for reference. Please refer to the Williams Station Facilities Plan Report to see the locations of the treated water tanks and pumps.

In Figure 3-9, it was found that to successfully implement GAC treatment for a design flow rate of 20,000 gpm, it would be necessary to consider relocating the potential well further east to avoid potential conflicts. In addition, Williams Station will likely require site entrance improvements to allow for IX resin and GAC media delivery trucks to access the site.

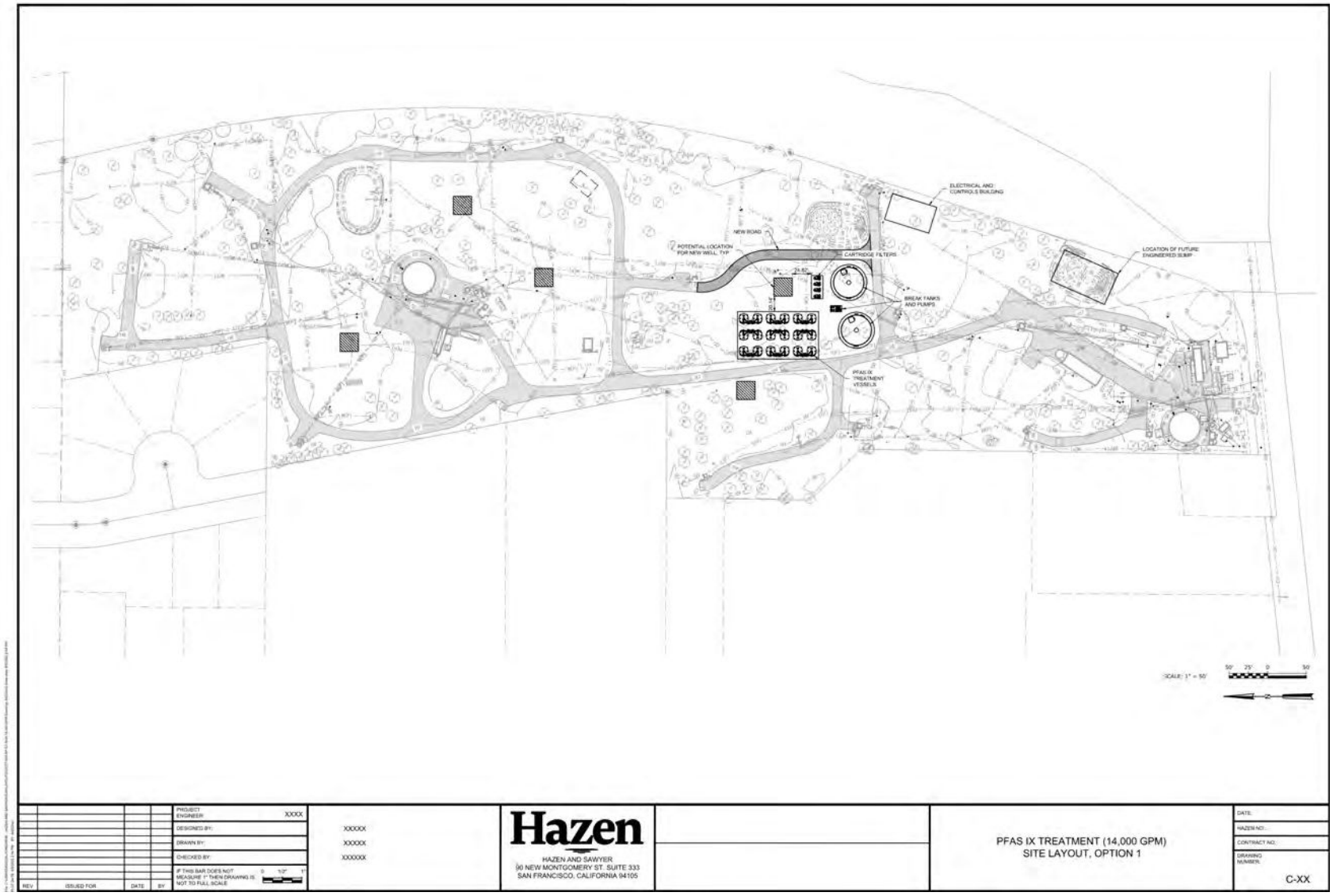


Figure 3-1: PFAS IX Treatment (14,000 gpm), Site Layout, Option 1

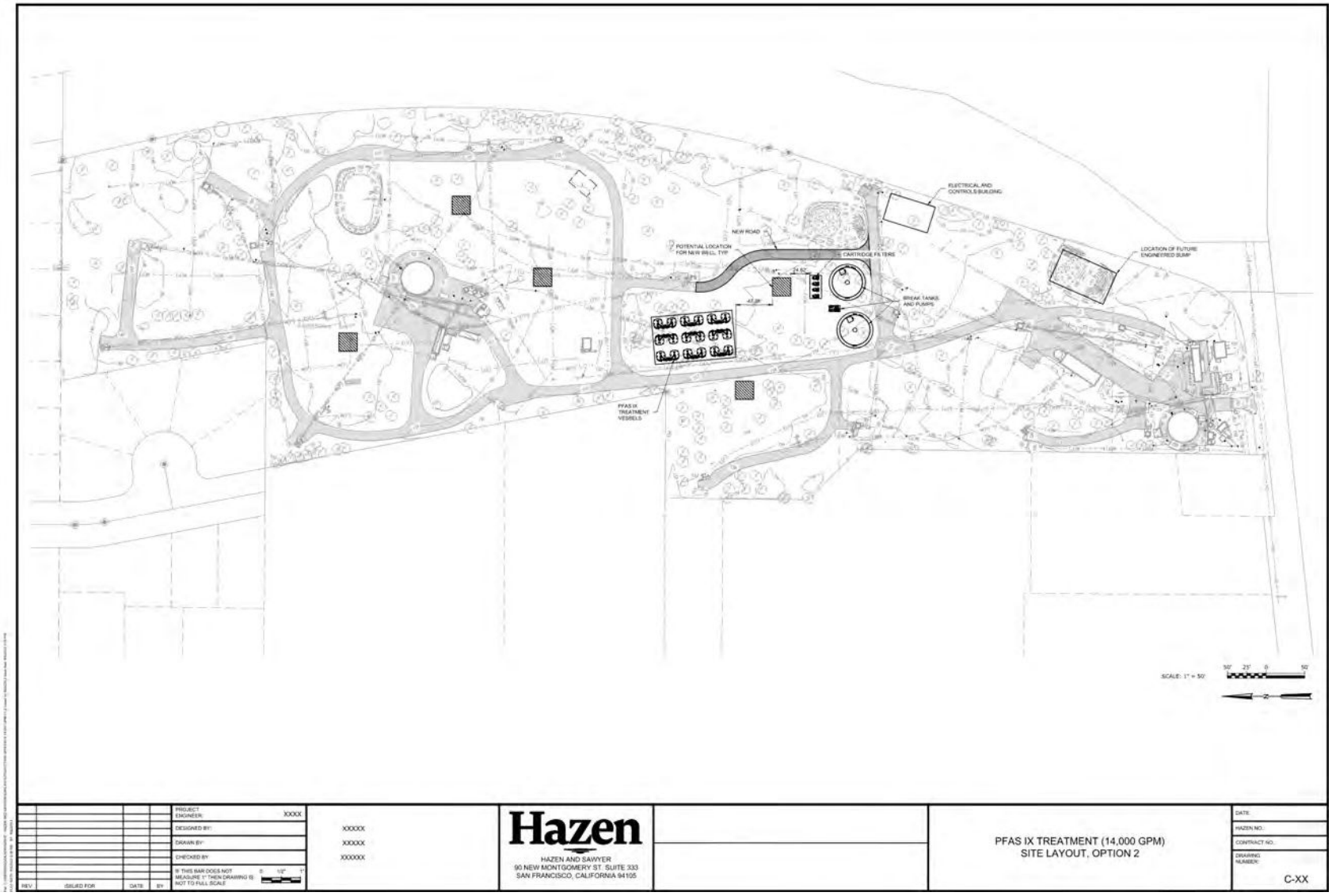


Figure 3-2: PFAS IX Treatment (14,000 gpm), Site Layout, Option 2

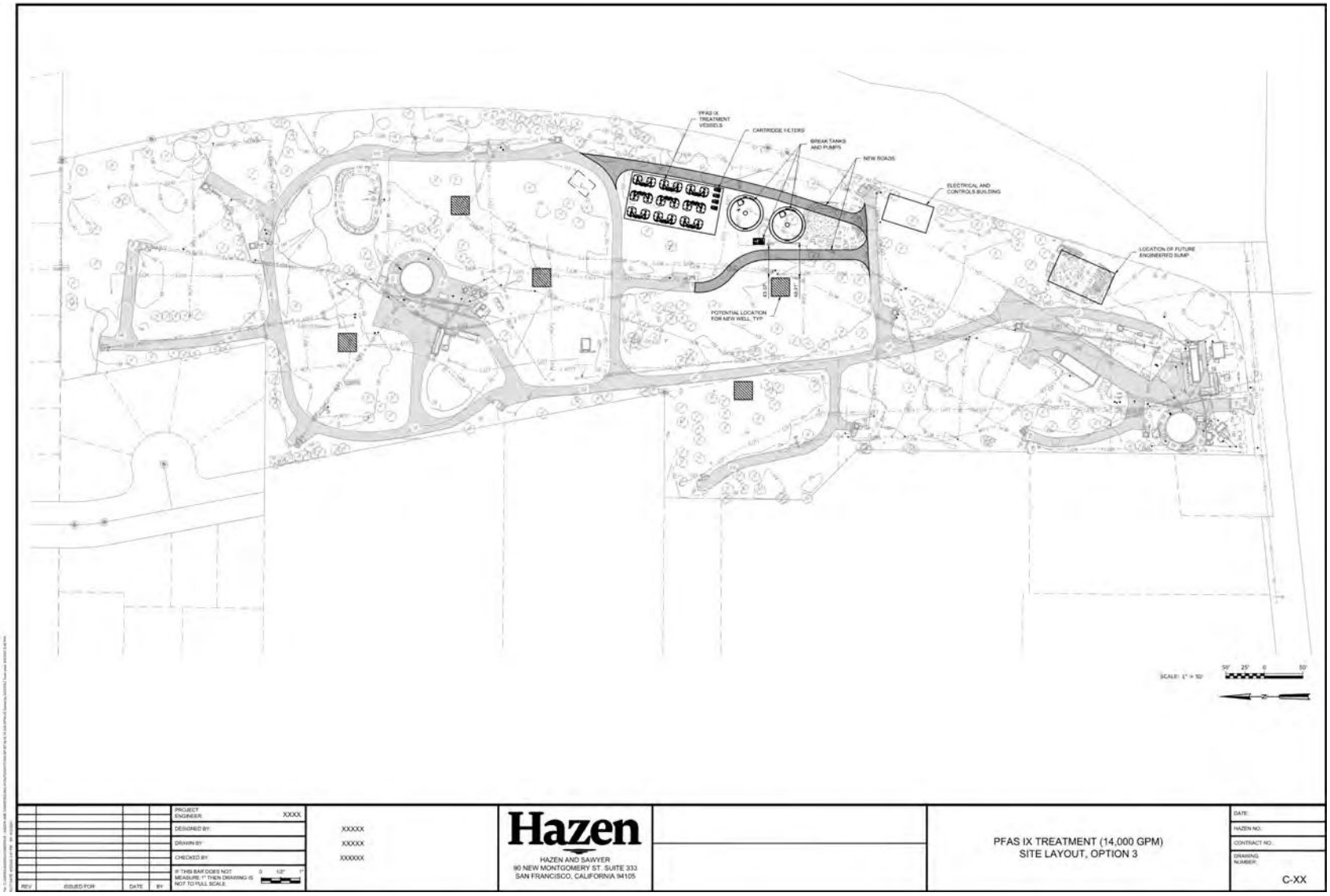


Figure 3-3: PFAS IX Treatment (14,000 gpm), Site Layout, Option 3

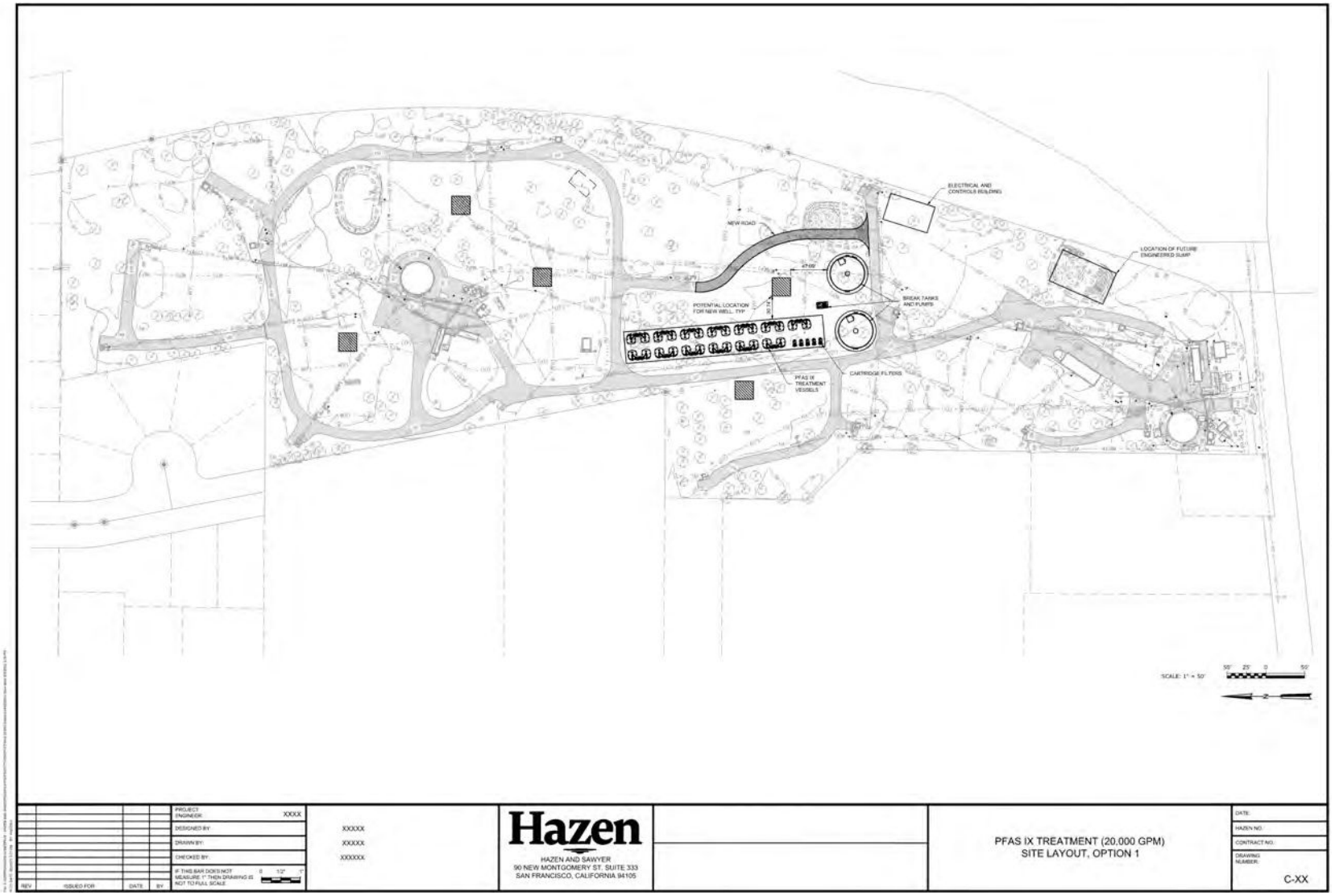


Figure 3-4: PFAS IX Treatment (20,000 gpm), Site Layout, Option 1

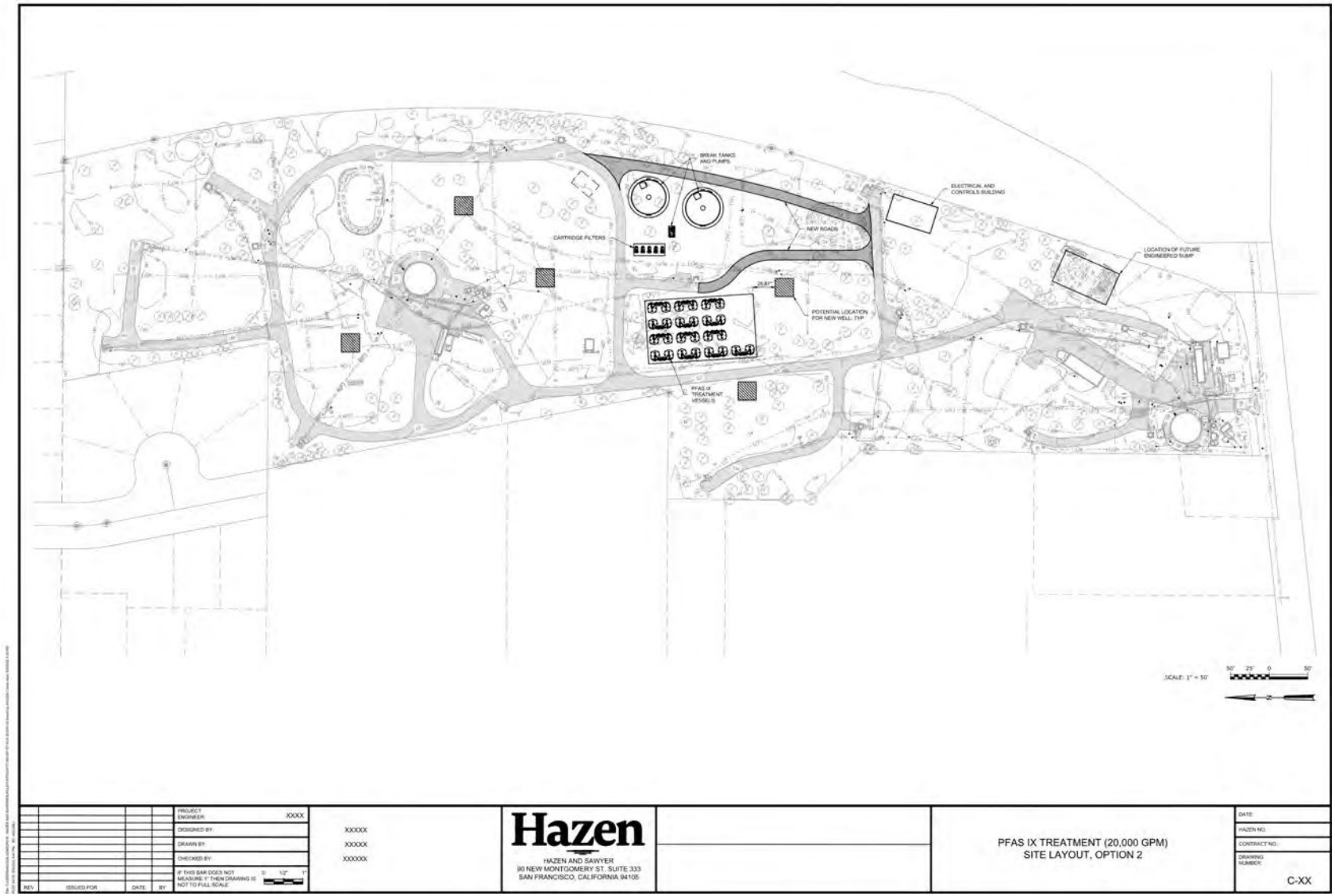


Figure 3-5: PFAS IX Treatment (20,000 gpm), Site Layout, Option 2

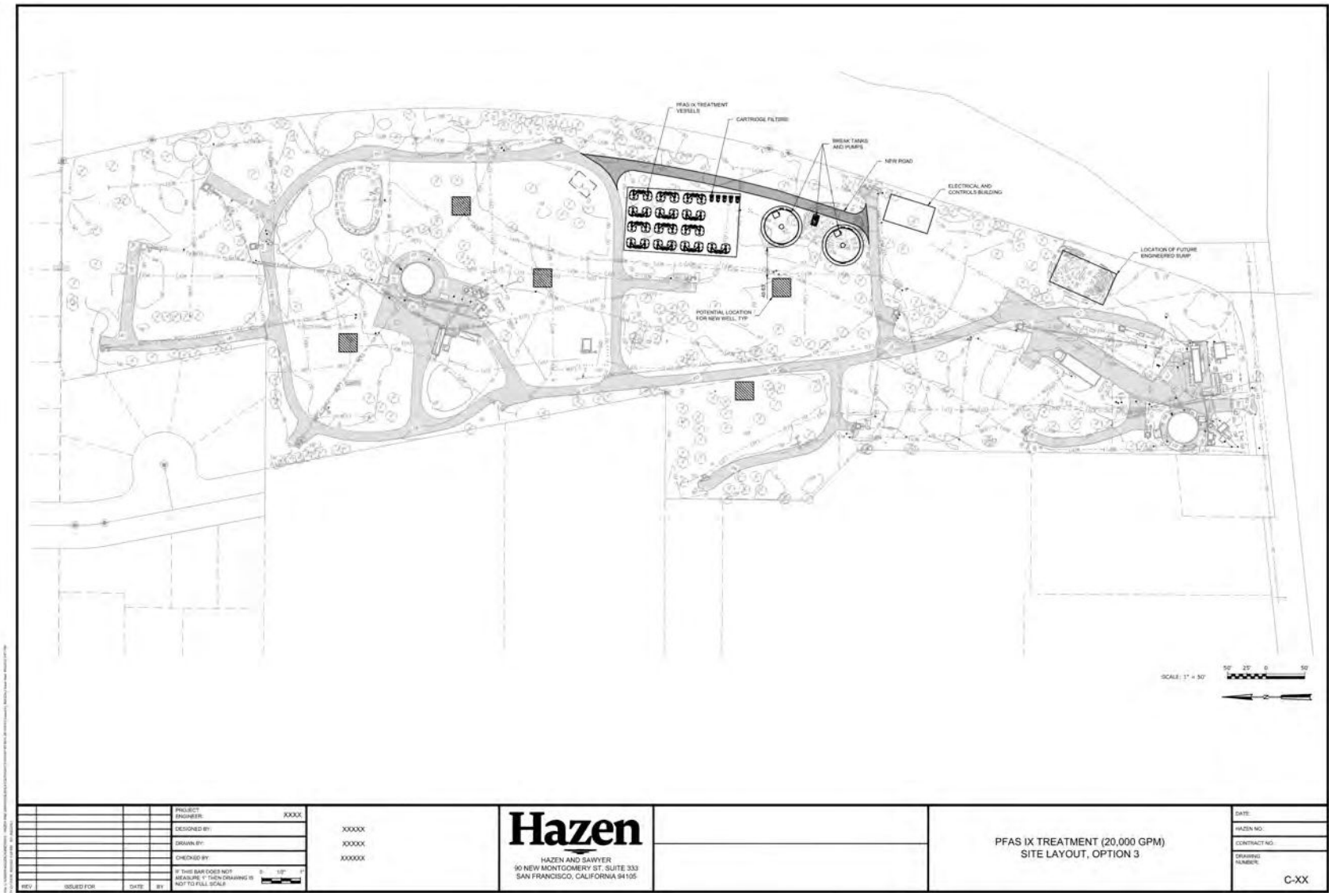


Figure 3-6: PFAS IX Treatment (20,000 gpm), Site Layout, Option 3

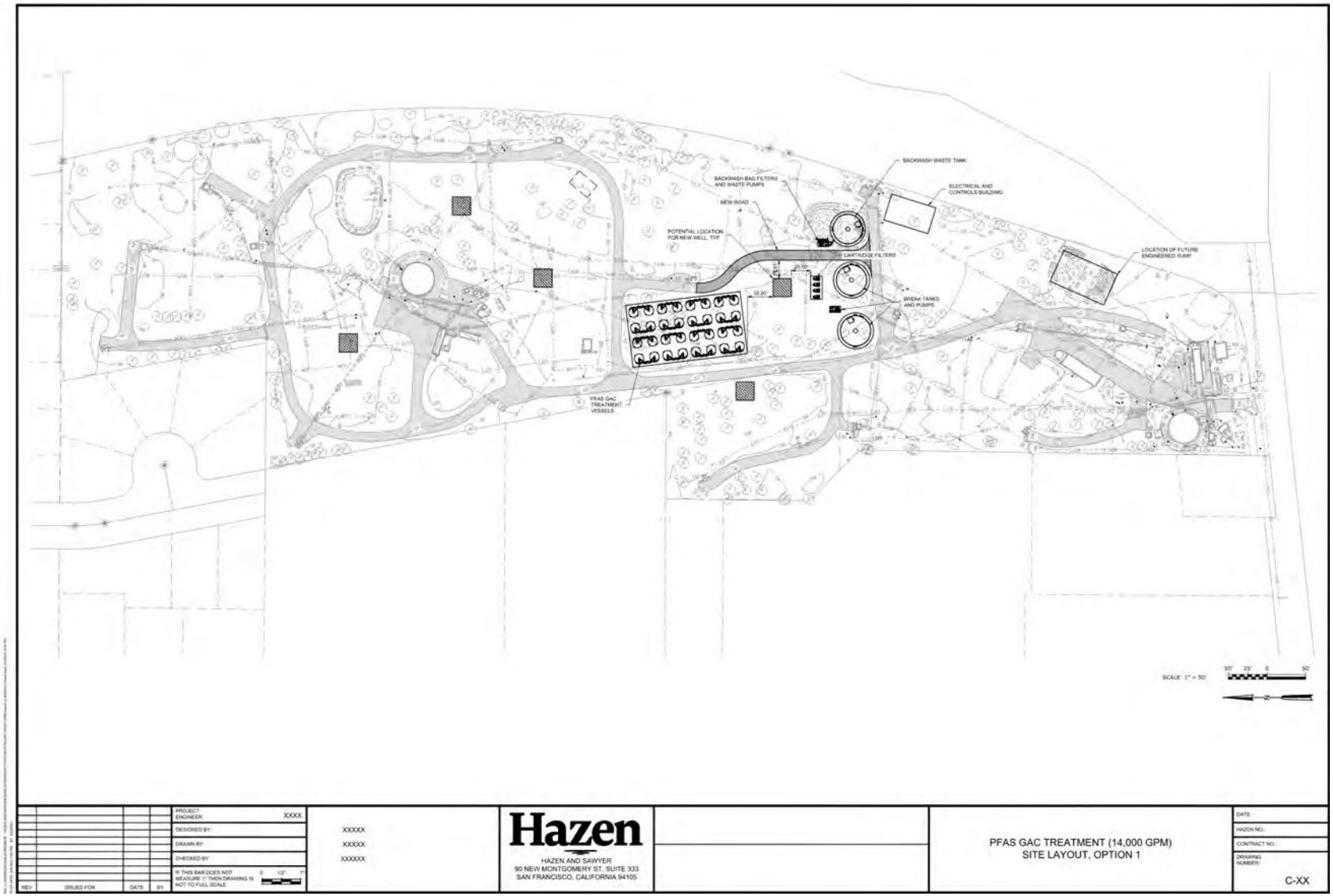


Figure 3-7: PFAS GAC Treatment (14,000 gpm), Site Layout, Option 1

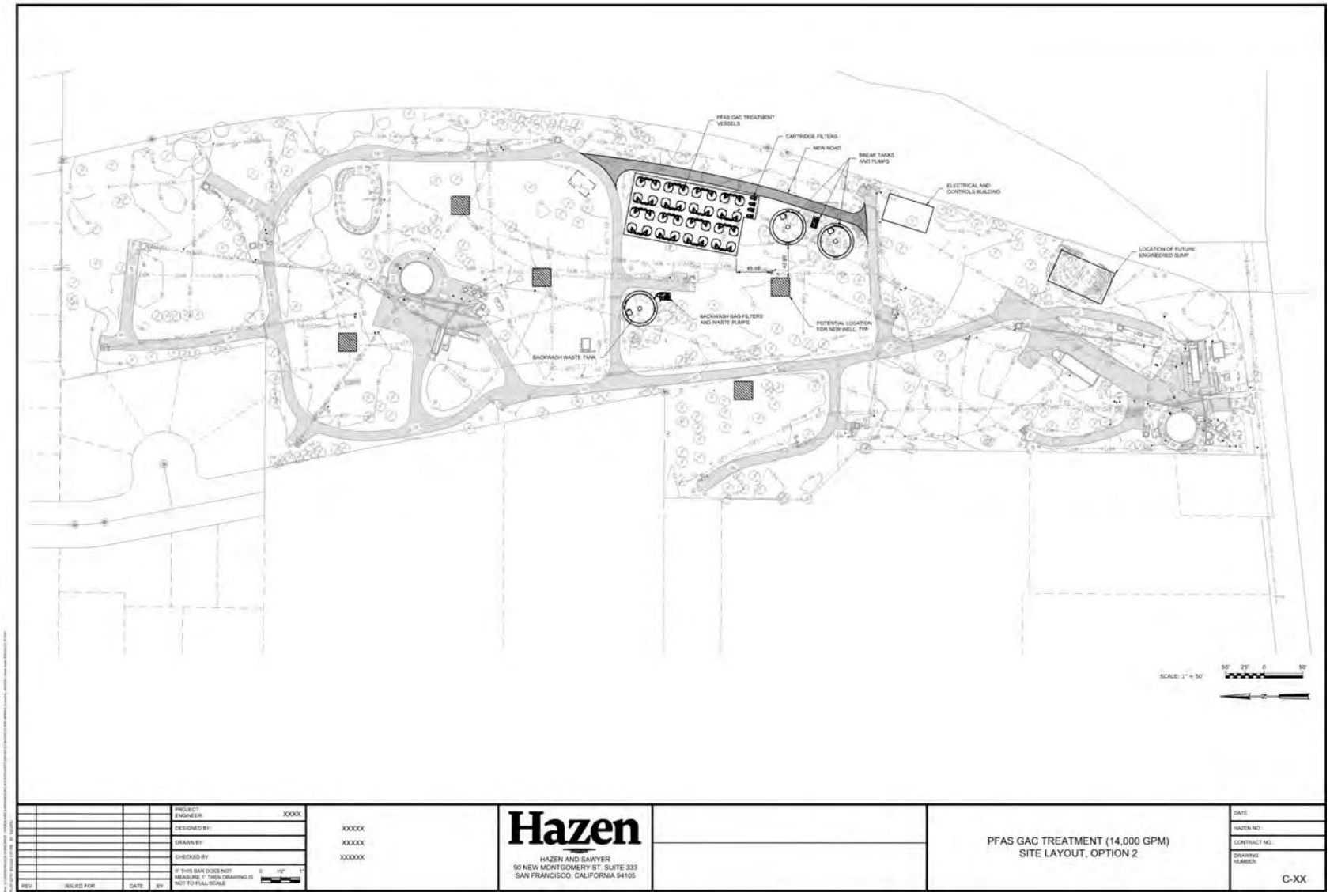


Figure 3-8: PFAS GAC Treatment (14,000 gpm), Site Layout, Option 2

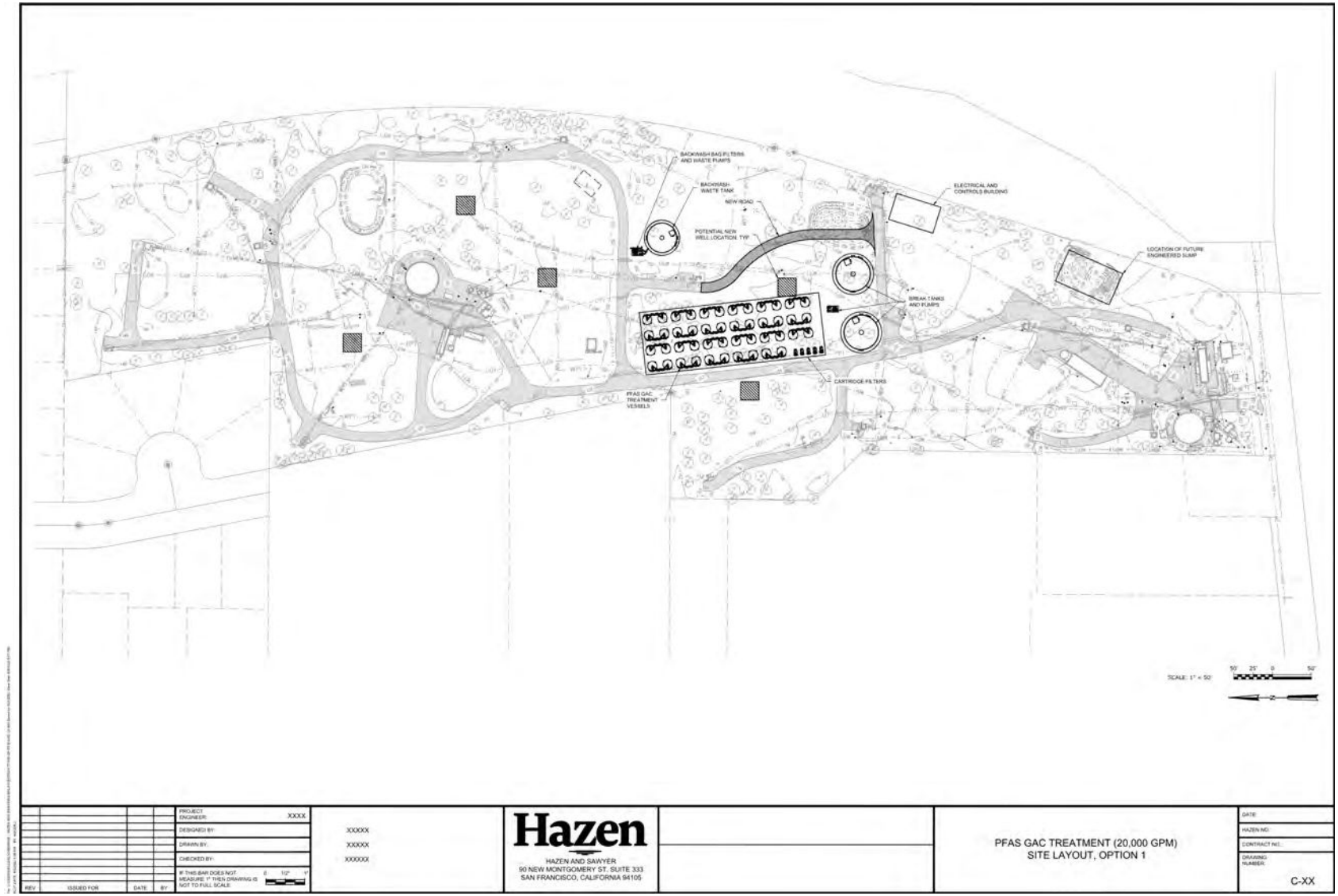


Figure 3-9: PFAS GAC Treatment (20,000 gpm), Site Layout, Option 1

4. Cost Estimate

The estimated probable construction cost is summarized in Table 4-2. The estimate is considered to be an AACE Class 4 cost estimate. Class 4 has a typical accuracy range of -30% on the low end and +50% on the high end. Cost assumptions were added to all line items and are described in Table 4-1.

Table 4-1: Cost Assumptions Summary

Cost Assumption	Contingency Added
General Conditions	10%
Portion of Work Performed by Subcontractor	20%
Subcontractor Overhead and Profit	25%
Contractor Mark-up on Subcontractor Work	5%
Contractor Overhead	10%
Contractor Profit	10%
Escalation to Mid-Point of Construction	17%
Bond and Insurance	3%
Contingency (Except GAC and IX Vessels)	30%
Contingency (GAC and IX Vessels)	15%

There are differences in contigency between equipment. For all equipment excluding major equipment (i.e., IX and GAC vessels), the design contigency added is 30%, whereas the added design contingency for major equipment is 15%. The lower design contignecy for major equipment is due to more certainty in cost. Additionally, there are slight cost differences between estimated cartridge filter costs. The variable costs between options is due to changes in layouts, for example, earthwork pouring and construction of slabs for cartridge filters.

Table 4-2: Construction Cost Estimate Summary Table

Description	PFAS IX Option 1 (14,000 gpm)	PFAS IX Option 2 (14,000 gpm)	PFAS IX Option 3 (14,000 gpm)	PFAS IX Option 1 (20,000 gpm)	PFAS IX Option 2 (20,000 gpm)	PFAS IX Option 3 (20,000 gpm)	PFAS GAC Option 1 (14,000 gpm)	PFAS GAC Option 2 (14,000 gpm)	PFAS GAC Option 1 (20,000 gpm)
Demolition	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
Break Tank	$2,900,000	$2,900,000	$2,800,000	$3,600,000	$3,600,000	$3,700,000	$2,900,000	$2,900,000	$3,600,000
Feed Pump	$3,400,000	$3,400,000	$3,400,000	$4,400,000	$4,400,000	$4,400,000	$3,100,000	$3,100,000	$4,000,000
Cartridge Filters	$1,300,000	$1,300,000	$1,200,000	$1,800,000	$1,900,000	$1,800,000	$1,300,000	$1,300,000	$1,900,000
Ion Exchange	$17,700,000	$17,700,000	$17,900,000	$27,500,000	$27,100,000	$27,200,000	$0	$0	$0
GAC	$0	$0	$0	$0	$0	$0	$23,400,000	$23,400,000	$35,400,000
Backwash Waste Tank	$0	$0	$0	$0	$0	$0	$1,300,000	$1,300,000	$1,300,000
Backwash Waste Pump and Bag Filter	$0	$0	$0	$0	$0	$0	$400,000	$400,000	$400,000
Electrical Building	$1,300,000	$1,300,000	$1,300,000	$1,300,000	$1,300,000	$1,300,000	$1,300,000	$1,300,000	$1,300,000
Site Work	$600,000	$600,000	$700,000	$600,000	$800,000	$800,000	$700,000	$900,000	$700,000
Yard Piping	$2,300,000	$2,400,000	$2,400,000	$3,100,000	$3,400,000	$3,100,000	$2,500,000	$2,700,000	$3,700,000
Electrical and Instrumentation	$2,400,000	$2,500,000	$2,500,000	$3,100,000	$3,100,000	$3,200,000	$3,200,000	$3,200,000	$3,600,000
PROBABLE CONSTRUCTION COST	**$32,100,000**	**$32,300,000**	**$32,400,000**	**$45,600,000**	**$45,800,000**	**$45,700,000**	**$40,300,000**	**$40,700,000**	**$56,100,000**
Project Costs (Design & ESDC, PM, CM, Legal)	$9,700,000	$9,700,000	$9,800,000	$13,700,000	$13,800,000	$13,800,000	$12,100,000	$12,300,000	$16,900,000
PROBABLE PROJECT COST	**$41,800,000**	**$42,000,000**	**$42,200,000**	**$59,300,000**	**$59,600,000**	**$59,500,000**	**$52,400,000**	**$53,000,000**	**$73,000,000**

Estimated annual O&M costs are provided in Table 4-2 and reflect the level of design provided in this document. Estimated O&M costs were based on the annual average flow at Williams Station of 7 MGD. Given the new regulatory guidance for PFAS compounds, the difference in O&M costs for changeouts based on expected bed life performance for different PFAS compound loading was evaluated. The expected bed volumes for PFHxS were estimated to be 150,000 for GAC and 475,000 for IX. The expected bed volumes for PFOS were estimated to be 200,000 and 575,000. Additional detail on expected bed volumes and initial estimated annual O&M costs can be found in the Williams Station Facilities Plan Report.

Table 4-3: Total and Annual O&M Cost Estimate Summary Table

O&M Cost ($/MG)		
Cost	**PFAS IX**	**PFAS GAC**
Cartridge Filter Replacement	$70	$70
Resin/Media Replacement (PFHxS Driven)	$99	$58
Resin/Media Replacement (PFOS Driven)	$81	$43
Electricity	$81	$71
Labor	$78	$78
Analytical	$43	$43
Total O&M, PFHxS Driven ($/MG)	$371	$364
Total O&M, PFOS Driven ($/MG)	$354	$306
Annual O&M, PFHxS Driven ($/yr)	$950,000	$930,000
Annual O&M, PFOS Driven ($/yr)	$910,000	$790,000

Appendix I

Williams Station PFAS Treatment Plant Operational Expense (January 21, 2026)

CDM Smith

Client:	SJW	**Job No.:**	284565	**Computed By:**	E. Chang
Project:	Williams Road Station PFAS Treatment Facility	**Date Checked:**	1/21/2026	**Date:**	5/28/2025
Detail:	O&M (5000 gpm)	**Checked By:**	J. Yoshimura	**Page No.:**	1

Objective

Calculate estimated O&M costs for Williams Station PFAS Treatment System.

Givens/Assumptions

Daily Production	7.0	mgd	4,861 gpm
Annual Production	7,850	AFY	
Unit Power Cost	$0.34	/kWh	(based on 2023 average)

IX FEED PUMPING POWER COST

IX Feed Pumps Capacity	3,334	gpm at	210	ft TH
Average Pumping Rate	4,860	gpm at	40	ft minimum TH
			149	ft maximum TH
Number of IX Feed Pumps in Operation	2			
Flow Per Pump	2430	gpm at	95	ft TH
Pump Efficiency	70%			
Motor Efficiency	95%			
VFD Efficiency	96%			
Operating Motor Horsepower per Pump	91	hp		
Annual Operating Time	8,760	hrs/yr		
Annual Power Demand	1,194,686	kWh/yr		
IX Feed Pumping Power Cost	**$ 406,193**	**/year**		

ANCILLARY POWER COSTS

Process Drain Pumps Capacity	1,500	gpm at	37	ft TH
Operating Motor Horsepower per Pump	30	hp		
Annual Operating Time	876	hrs/yr	<-- Assuming 10% operation	
Annual Power Demand	19,605	kWh/yr		
Process Drain Pumping Power Cost	**$ 6,666**	**/year**		

		% Online	hrs/yr	kWh/yr
Electric Heaters (five at 2kW each)	2.0 kW	25%	2,190	4,380
Ventilation Fans (2 at 2hp each)	3.0 kW	25%	2,190	6,535
Air Conditioner (25kW)	25.0 kW	25%	2,190	54,750
Annual Power Demand	65,665	kWh/yr		
Building HVAC & Electrical Power Cost	**$ 22,326**	**/year**		

CARTRIDGE FILTER REPLACEMENT COST

No. of Cartridge Filter Vessels	5		
Cartridge Filters per Vessel	36		
Total No. of Cartridge Filters	180		
No. of Changeouts Operating at Average Flow	3	/year	<-- Assuming 0.5 mg/L of TSS
Cost per Cartridge Filter	$175		
Cartridge Filter Replacement Cost	**$ 94,500**	**/year**	

IX RESIN REPLACEMENT COST

Number of Lead IX Vessels	13	
IX Resin Volume per Lead Vessel	530	cf
Total Resin Volume (Lead Vessels Only)	6,890	cf
Bed Volumes Per Year	160,000	
Treatment Capacity per Lead Vessel	634,388,800	gal
Total Treatment Capacity (Two Lead Vessels)	8,247,054,400	gal
Average Time Between Changeouts of Both Lead	1,178	days
Vessels	3.2	years
Average Changeouts per Year	0.31	
IX Resin Unit Cost	$405	/cf
Resin Replacement Cost	**$ 864,305**	**/year**

Client: SJW	**Job No.:** 284565	**Computed By:** E. Chang
Project: Williams Road Station PFAS Treatment Facility	**Date Checked:** 1/21/2026	**Date:** 5/28/2025
Detail: O&M (5000 gpm)	**Checked By:** J. Yoshimura	**Page No.:** 2

Resin Disposal Cost		$65	/cf	Budgetary estimate from Evoqua
	Resin Disposal Cost	**$ 138,716**	**/year**	

SAMPLING			
Initial Startup	$	101,452	/year
Routine Sampling	$	134,192	/year
	Sampling Cost	**$ 235,644**	**/year**

LABOR COSTS			
Number of FTE Operators & Maintenance Staff		2	FTEs
Labor Cost (SJW T4 Operator + Burden)		$242,700	/year
	O&M Labor Cost	**$ 485,400**	**/year**

SUMMARY OF ANNUAL O&M COSTS			
Power - IX Feed Pumping	$406,193		
Power - Process Drain Pumping	$6,666		
Power - Ancillary (building HVAC, lighting)	$22,326		
Cartridge Filter Replacements	$94,500		
IX Resin Replacements	$1,003,021		
Sampling	$235,644		
Labor	$485,400		
TOTAL ANNUAL O&M COST	**$2,254,000**	**/yr**	**$287 /AF** **$882 /MG**

Appendix J

Williams Station PFAS Treatment Plant
Project OPCC (January 22, 2026)
CDM Smith

San Jose Water Company, CA
Williams Treatment PFAS Facility
Opinion of Probable Construction Cost, Jan 2026, 100% Design

Estimator	Jesus Quimpo
Labor rate table	CA26 San Jose
Equipment rate table	2026H1 $6Equip BOF
ENR CCI	JAN 2026: 14,118.53
AACEi Class	1
Estimate Type	OPCC
Design Level	100%
Notes	This is an Opinion of Probable Construction Cost only, as defined by the documents provided at the level of design indicated above. CDM Smith has no control over the cost of labor, materials, equipment, or services furnished, over schedules, over contractor's methods of determining prices, competitive bidding (at least 3 each - both prime bidders and major subcontractors), market conditions or negotiating terms. CDM Smith does not guarantee that this opinion will not vary from actual cost, or contractor's bids. There are not any costs provided for: Change Orders, Design Engineering, Construction Oversight, Client Costs, Finance or Funding Costs, Legal Fees, Land Acquisition or temporary/permanent Easements, Operations, or any other costs associated with this project that are not specifically part of the bidding contractor's proposed scope. This OPCC shall remain valid for 30 days. Beyond this date, CDM Constructors should be notified of design changes. The estimate will also be reviewed to reflect current market conditions. Assumptions: No money for COVID or Tariffs is included. No rock excavation is required. Only nominal dewatering is needed. No consideration for contaminated soils or hazardous materials is included (i.e. asbestos, lead, etc). Based on a 50 hour work week (with OT).
Report format	Sorted by 'Blank 1/Area/16CSI Sctn/Element/Assembly' 'Assembly' summary Allocate addons Paginate

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
1	**00 Base Bid - 100% OPCC per CDM Drawings**								
2	005 SITE CLEARING AND DEMOLITION								
3	01-59-00 Security/Traffic & Pollution Control								
4	005.015900.91.005 SWPPP and Tree Protection System								
5	01-59-00.015 Erosion Control (Pick List)	1.00 ls	86,155	22,627	26,466			135,247.61 /ls	135,248
	005.015900.91.005 SWPPP and Tree Protection System		86,155	22,627	26,466			/ls	135,248
	01-59-00 Security/Traffic & Pollution Control		86,155	22,627	26,466				135,248
6	01-61-00 Survey								
7	005.016100.91.005 Underground Pipe Utility Locating								
8	01-61-00.005 Underground Pipe Utilities Locating	1.00 ls					23,514	23,513.96 /ls	23,514
	005.016100.91.005 Underground Pipe Utility Locating						23,514	/ls	23,514
	01-61-00 Survey						23,514		23,514
9	02-41-19 Selective Demolition								
10	005.024119.91.005 Demo Underground Pipe Line								
11	02-41-19.010 24" RW Utility Pipe Demolition *	4.00 lf	301		173		11	121.48 /lf	486
12	02-41-19.010 16" RW Utility Pipe Demolition *	4.00 lf	281		154		11	111.61 /lf	446
13	02-41-19.010 20" RW Utility Pipe Demolition *	300.00 lf	21,767		12,196		846	116.03 /lf	34,809
14	02-41-19.010 12" W Utility Pipe Demolition *	440.00 lf	19,215		10,484		1,242	70.32 /lf	30,940
15	02-41-19.010 10" BO Utility Pipe Demolition *	600.00 lf	25,784		13,902		705	67.32 /lf	40,392
16	02-41-19.010 Electrical Line E(P) Utility Pipe Demolition *	600.00 lf	20,019		10,549		705	52.12 /lf	31,274
17	02-41-19.010 Irrigation PVC Pipe Line Utility Pipe Demolition *	770.00 lf	25,692		13,538			50.95 /lf	39,230
18	02-41-19.010 18" RW Utility Pipe Demolition *	18.00 lf	1,284		711		51	113.70 /lf	2,047
19	31-23-00.305 --- Trenching for Yard Piping*	2,736.00 lf	134,078	28,670	77,928			87.97 /lf	240,676
	005.024119.91.005 Demo Underground Pipe Line		248,422	28,670	139,636		3,572	/lf	420,300
20	005.024119.91.010 Demo of Existing Pavement								
21	02-41-13.020 Asphalt Pavement Demolition from Well#6 Area to West Road*	3,150.00 sf	25,200	71	21,795		23,410	22.37 /sf	70,475
22	02-41-13.020 Asphalt Pavement Demolition at new driveway*	850.00 sf	9,059	101	7,349		6,317	26.85 /sf	22,827
	005.024119.91.010 Demo of Existing Pavement		34,259	172	29,144		29,726	/sf	93,302
	02-41-19 Selective Demolition		282,681	28,842	168,780		33,299		513,602
23	26-05-10 Selective Demolition for Electrical								
24	010.260510.01.001 Demo Electrical Ductbank								
25	02-41-19.010 Electrical Line (ductbank) Demolition	700.00 lf	23,356		12,307		823	52.12 /lf	36,486
	010.260510.01.001 Demo Electrical Ductbank		23,356		12,307		823	/ls	36,486
	26-05-10 Selective Demolition for Electrical		23,356		12,307		823		36,486
26	31-11-00 Clearing and Grubbing								
27	005.311100.91.005 Site Clearing and Tree Removal								
28	31-11-00.000 Site Clearing	1.00 ls	7,572		4,820			12,392.32 /ls	12,392
29	31-11-00.000 Tree Removal	51.00 ea	128,722		81,947			4,130.76 /ea	210,669
	005.311100.91.005 Site Clearing and Tree Removal		136,294		86,767			/ac	223,061
	31-11-00 Clearing and Grubbing		136,294		86,767				223,061
	005 SITE CLEARING AND DEMOLITION	1.00 ls	528,485	51,469	294,320		57,636	931,910.22 /ls	931,910
30	010 ENTRANCE MODIFICATION								
31	03-11-11 Concrete Curbs								
32	010.031111.93.005 Concrete Curb at Enterance Modification								
33	03-11-11.100 Concrete Curb	3.24 cy	51,244	6,719	200			17,951.58 /cy	58,163
	010.031111.93.005 Concrete Curb at Enterance Modification		51,244	6,719	200			/lf	58,163
	03-11-11 Concrete Curbs		51,244	6,719	200				58,163
34	32-12-16 Asphalt Paving								
35	010.321216.93.005 Asphalt at Enterance Renovation								
36	32-12-16.005 4" Asphalt Pavement w/ 12" AB	132.22 sy	1,734	11,035	1,227	32,047		348.22 /sy	46,043
	010.321216.93.005 Asphalt at Enterance Renovation		1,734	11,035	1,227	32,047		/sf	46,043
	32-12-16 Asphalt Paving		1,734	11,035	1,227	32,047			46,043
	010 ENTRANCE MODIFICATION	1.00 ls	52,978	17,754	1,427	32,047		104,205.89 /ls	104,206
37	015 SITE GRADING AND PAVING								
38	03-00-00 Concrete								
39	015.030000.91.005 Concrete V-Ditch 4'Wx6"D								
40	03-11-11.000 --- Vee gutter, 3'x6" W/ Agg Base*	35.93 cy	71,573	47,203	3,944	2,034	445	3,484.93 /cy	125,200
	015.030000.91.005 Concrete V-Ditch 4'Wx6"D		71,573	47,203	3,944	2,034	445	/lf	125,200
	03-00-00 Concrete		71,573	47,203	3,944	2,034	445		125,200
41	03-11-11 Concrete Curbs								
42	015.031111.91.015 Concrete Curb								
43	03-11-11.100 Concrete Curb	7.29 cy	113,215	14,871	450			17,629.38 /cy	128,536
44	32-16-13.130 --- Curb & Gutters*	797.00 lf				82,381		103.36 /lf	82,381
	015.031111.91.015 Concrete Curb		113,215	14,871	450	82,381		/lf	210,917
	03-11-11 Concrete Curbs		113,215	14,871	450	82,381			210,917
45	03-11-12 Concrete Retaining Wall								
46	015.031112.91.005 Concrete Raining Wall								
47									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	03-11-11.000 --- SOG Form, Place & Finish*	12.84 cy	33,877	17,005	1,483	675	155	4,142.60 /cy	53,195
48	03-11-12.035 Concrete Retaining Wall Bioretention Pond Concrete Retaining Walls- Lumber Formed*	17.78 cy	253,182	53,377	1,968	1,563	228	17,455.11 /cy	310,317
49	31-23-00.005 --- Structure Excavation & Backfill	1,771.69 cy	19,450		19,477			21.97 /cy	38,927
50	33-42-11.800 --- HDPE Corrugated N-12 Dual Wall Drainage Pipe(3" to 60")*	160.00 lf	7,573	1,731	1,358	145		67.53 /lf	10,806
	015.031112.91.005 Concrete Raining Wall		314,081	72,112	24,286	2,383	383	/lf	413,245
	03-11-12 Concrete Retaining Wall		314,081	72,112	24,286	2,383	383		413,245
51	31-22-00 Basin Excavation								
52	015.312200.91.005 Site Grading - Fill to Grade								
53	31-22-00.025 Site Grading - Fill to Grade - Excluding import asphalt AB	2,618.00 cy	21,631	336,830	19,828	74,622		173.00 /cy	452,910
	015.312200.91.005 Site Grading - Fill to Grade		21,631	336,830	19,828	74,622		/cy	452,910
	31-22-00 Basin Excavation		21,631	336,830	19,828	74,622			452,910
54	32-12-16 Asphalt Paving								
55	015.321216.91.005 4" Asphalt Pavement w/ 12" AB								
56	32-12-16.005 4" Asphalt Pavement w/ 12" AB	5,096.78 sy	66,836	425,355	47,311	132,757		131.90 /sy	672,259
	015.321216.91.005 4" Asphalt Pavement w/ 12" AB		66,836	425,355	47,311	132,757		/sf	672,259
	32-12-16 Asphalt Paving		66,836	425,355	47,311	132,757			672,259
	015 SITE GRADING AND PAVING	1.00 ls	587,337	896,371	95,818	294,176	828	1,874,530.26 /ls	1,874,530
57	020 SITE WORK - MISCELLANEOUS								
58	03-11-10 Concrete Encasement								
59	020.031110.91.005 Site Pipe Bollards								
60	03-11-10.100 Site Pipe Bollards	30.00 ea	81,548	89,758	28,037			6,644.78 /ea	199,343
	020.031110.91.005 Site Pipe Bollards		81,548	89,758	28,037			/ea	199,343
61	020.031110.91.010 Equipment Protection Pipe Bollards								
62	03-11-10.100 Equipment Protection Pipe Bollards	56.00 ea	152,223	167,549	52,335			6,644.78 /ea	372,108
	020.031110.91.010 Equipment Protection Pipe Bollards		152,223	167,549	52,335			/ea	372,108
	03-11-10 Concrete Encasement		233,771	257,308	80,372				571,451
63	26-05-18.050 Feeders								
64	020.260515.01.001 UTIL Feeder - PG&E Pole to PGE&E XFMR via DB								
65	26-05-33.225 PVC-CTD-GRC Riser & Cu Str- pge pole to pge xfmr via db	350.00 lf	206,617	197,733	756			1,157.45 /lf	405,106
	020.260515.01.001 UTIL Feeder - PG&E Pole to PGE&E XFMR via DB		206,617	197,733	756			/lf	405,106
66	020.260516.01.001 LV Feeder - MSB to ATS-1 via DB								
67	26-05-33.225 PVC-CTD-GRC Riser & Cu Str- msb to ats-1 via db	120.00 lf	106,405	79,522				1,549.40 /lf	185,928
	020.260516.01.001 LV Feeder - MSB to ATS-1 via DB		106,405	79,522				/lf	185,928
68	020.260516.01.002 LV Feeder - MSB to ATS-2 via DB								
69	26-05-33.225 PVC-CTD-GRC Riser & Cu Str- msb to ats-2 via db	100.00 lf	92,515	70,787				1,633.03 /lf	163,303
	020.260516.01.002 LV Feeder - MSB to ATS-2 via DB		92,515	70,787				/lf	163,303
70	020.260516.01.003 LV Feeder - MSB to Active Harmonic Filter								
71	26-05-33.484 S40 PVC & Cu Str- msb to active harmonic filter	10.00 lf	9,459	5,036				1,449.47 /lf	14,495
72	26-05-33.484 S40 PVC & Cu Str- msb to active harmonic filter, spare	10.00 lf	5,342	1,616				695.80 /lf	6,958
	020.260516.01.003 LV Feeder - MSB to Active Harmonic Filter		14,801	6,652				/lf	21,453
73	020.260516.01.004 LV Feeder - ATS-1 to Generator via DB								
74	26-05-33.225 PVC-CTD-GRC Riser & Cu Str- ats-1 to generator via db	120.00 lf	127,666	104,872				1,937.81 /lf	232,537
	020.260516.01.004 LV Feeder - ATS-1 to Generator via DB		127,666	104,872				/lf	232,537
75	020.260516.01.005 LV Feeder - ATS-2 to Generator via DB								
76	26-05-33.225 PVC-CTD-GRC Riser & Cu Str- ats-2 to generator via db	100.00 lf	105,630	86,341				1,919.71 /lf	191,971
	020.260516.01.005 LV Feeder - ATS-2 to Generator via DB		105,630	86,341				/lf	191,971
77	020.260516.01.006 LV Feeder - LP-1 to Generator via DB								
78	26-05-33.225 PVC-CTD-GRC Riser & Cu Str- lp-1 to generator via db	20.00 lf	11,188	4,842				801.51 /lf	16,030
	020.260516.01.006 LV Feeder - LP-1 to Generator via DB		11,188	4,842				/lf	16,030
79	020.260519.01.001 LV Feeder - PGE&E XFMR to MSB via Bussduct								
80	26-25-00.000 Bussduct- pge xfmr to msb	20.00 lf	37,940		989			1,946.45 /lf	38,929
	020.260519.01.001 LV Feeder - PGE&E XFMR to MSB via Bussduct		37,940		989			/lf	38,929
	26-05-18.050 Feeders		702,762	550,750	1,745				1,255,257
81	26-05-18.100 Branch Circuits								
82	020.260511.01.001 Pole-Mounted Site Lighting Branch								
83	26-05-33.484 S40 PVC & Cu Str- pole-mtd site ltg branch	1,000.00 lf	46,631	3,985	4,496			55.11 /lf	55,112
	020.260511.01.001 Pole-Mounted Site Lighting Branch		46,631	3,985	4,496			/lf	55,112
	26-05-18.100 Branch Circuits		46,631	3,985	4,496				55,112
84	26-05-26 Grounding & Bonding for Electrical Systems								
85	020.260526.01.001 Grounding - Generator								
86	26-05-26.000 Cu Grounding- gen	200.00 lf	7,911	6,976	242			75.65 /lf	15,130
	020.260526.01.001 Grounding - Generator		7,911	6,976	242			/lf	15,130
	26-05-26 Grounding & Bonding for Electrical Systems		7,911	6,976	242				15,130
87	26-05-43.010 Electrical Ductbank & Underground								
88	020.260533.01.001 Electrical Direct-Bury Underground								
89	26-05-00.105 Precast Electrical Concrete- vaults	4.00 ea	72,800	39,600	38,032			37,608.00 /ea	150,432
90	26-05-00.105 Precast Electrical Handholes-	13.00 ea	34,897	22,291	4,934			4,778.64 /ea	62,122
91	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db a	20.00 lf	36,208	3,985	1,529			2,086.12 /lf	41,722
92									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db b	135.00 lf	41,885	4,866	2,296			363.31 /lf	49,047
93	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db c	160.00 lf	118,432	13,030	6,128			859.94 /lf	137,591
94	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db d	40.00 lf	40,392	4,366	1,628			1,159.67 /lf	46,387
95	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db e	430.00 lf	120,711	15,673	5,547			330.07 /lf	141,931
96	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db f	290.00 lf	68,670	8,135	3,861			278.16 /lf	80,666
97	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db g	70.00 lf	131,714	17,644	4,638			2,199.94 /lf	153,996
98	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db i	110.00 lf	94,657	11,345	3,566			996.07 /lf	109,567
99	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db p501/c602	110.00 lf	6,076	559	701			66.69 /lf	7,336
100	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db p501/p502	30.00 lf	1,690	159	191			68.00 /lf	2,040
101	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db c106	135.00 lf	9,871	1,251	875			88.87 /lf	11,997
102	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db p601,602,c604,605a,605b	150.00 lf	19,340	2,075	1,610			153.51 /lf	23,026
103	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db p601,604	10.00 lf	594	63	64			72.09 /lf	721
104	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db 602,605a,605b	10.00 lf	851	92	87			102.91 /lf	1,029
105	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db c604,605a,605b	30.00 lf	2,459	242	261			98.73 /lf	2,962
106	26-05-33.425 Sch40 PVC Electrical Ductbank Conduit w/Excavation- db c801,802,803,804a,b,c,d,805a,b,c,d,p105,204,468,470	10.00 lf	3,762	475	221			445.87 /lf	4,459
107	26-05-33.484 S40 PVC & Cu Str- mcc-,dp-,lp- to evault 1,2, spare 1"	2,880.00 lf	102,850	11,548				39.72 /lf	114,398
108	26-05-33.484 S40 PVC & Cu Str- mcc-,dp-,lp- to evault 1,2, spare 2"	2,880.00 lf	159,729	23,121				63.49 /lf	182,849
109	26-05-33.484 S40 PVC & Cu Str- backmcc to eh, 1"	440.00 lf	13,844	1,442				34.74 /lf	15,286
110	26-05-33.484 S40 PVC & Cu Str- backmcc to eh, 2"	440.00 lf	21,429	2,901				55.29 /lf	24,330
111	26-05-33.484 S40 PVC & Cu Str- lp-b / 480v panel to eh, 2"	680.00 lf	36,109	5,148				60.67 /lf	41,256
112	26-05-33.484 S40 PVC & Cu Str- lp-b, 480v panel to eh, 1"	340.00 lf	11,524	1,259				37.60 /lf	12,783
	020.260533.01.001 Electrical Direct-Bury Underground		**1,150,494**	**191,270**	**76,169**			**/lf**	**1,417,933**
	26-05-43.010 Electrical Ductbank & Underground		1,150,494	191,270	76,169				1,417,933
113	26-20-01 Service & Distribution								
114	**020.262000.01.001 Active Harmonic Filter**								
115	26-23-13.005 Active Harmonic Filter- 300a	1.00 ea	18,355		2,377			20,732.40 /ea	20,732
	020.262000.01.001 Active Harmonic Filter		**18,355**		**2,377**			**/ea**	**20,732**
116	**020.262000.01.002 Main Service Switchboard (MSB)**								
117	26-23-13.000 Switchboard- msb	1.00 ea	129,436	2,106,495	13,702			2,249,633.16 /ea	2,249,633
	020.262000.01.002 Main Service Switchboard (MSB)		**129,436**	**2,106,495**	**13,702**			**/ea**	**2,249,633**
	26-20-01 Service & Distribution		147,792	2,106,495	16,079				2,270,366
118	26-50-00 Lighting								
119	**020.265600.01.001 Pole-Mounted Site Lighting**								
120	26-56-13.000 G Pole-mounted area lighting	5.00 ea	47,169	46,154	1,080			18,880.44 /ea	94,402
	020.265600.01.001 Pole-Mounted Site Lighting		**47,169**	**46,154**	**1,080**			**/ea**	**94,402**
	26-50-00 Lighting		47,169	46,154	1,080				94,402
121	27-00-00 Communications								
122	**020.270000.01.001 Fiber Optic - PFAC-PLC to Front PLC**								
123	27-13-23.115 Fiber Optic Cable- pfas-plc to front plc via db	415.00 lf	52,461	4,480	735			138.98 /lf	57,676
	020.270000.01.001 Fiber Optic - PFAC-PLC to Front PLC		**52,461**	**4,480**	**735**			**/lf**	**57,676**
124	**020.270000.01.002 Fiber Optic - PFAC-PLC to Back PLC**								
125	27-13-23.115 Fiber Optic Cable- pfas-plc to back plc via db	285.00 lf	51,540	4,302	735			198.52 /lf	56,577
	020.270000.01.002 Fiber Optic - PFAC-PLC to Back PLC		**51,540**	**4,302**	**735**			**/lf**	**56,577**
	27-00-00 Communications		104,001	8,782	1,471				114,253
	020 SITE WORK - MISCELLANEOUS	1.00 ls	2,440,532	3,171,718	181,654			5,793,903.95 /ls	5,793,904
126	025 DRAINAGE - DETENTION BASIN								
127	03-11-12 Concrete Retaining Wall								
128	**025.031112.91.005 Concrete Retaining Wall Bioretention Pond**								
129	03-11-11.000 --- SOG Form, Place & Finish*	20.47 cy	53,174	26,915	2,348	786	247	4,078.47 /cy	83,470
130	03-11-12.035 Concrete Retaining Wall Bioretention Pond Concrete Retaining Walls- Lumber Formed*	28.33 cy	399,309	84,201	3,131	2,200	363	17,266.24 /cy	489,204
131	31-23-00.005 --- Structure Excavation & Backfill	2,689.63 cy	27,948		27,251			20.52 /cy	55,199
132	33-42-11.800 --- HDPE Corrugated N-12 Dual Wall Drainage Pipe(3" to 60")*	255.00 lf	12,046	2,652	2,150	212		66.90 /lf	17,059
	025.031112.91.005 Concrete Retaining Wall Bioretention Pond		**492,477**	**113,768**	**34,880**	**3,197**	**610**	**/lf**	**644,933**
	03-11-12 Concrete Retaining Wall		492,477	113,768	34,880	3,197	610		644,933
133	31-05-19 HDPE Liner								
134	**025.310519.91.005 HDPE Liner for Retention Basin Bottom**								
135	31-05-19.005 --- HDPE Liner *	6,500.00 sf				138,601		21.32 /sf	138,601
	025.310519.91.005 HDPE Liner for Retention Basin Bottom					**138,601**		**/sf**	**138,601**
	31-05-19 HDPE Liner					138,601			138,601
136	31-22-00 Basin Excavation								
137	**025.312200.91.005 Pond Grading - Cut to Grade**								
138	31-22-00.010 Pond Grading - Cut to Grade - Site Excavation-Cut to Stockpile*	606.00 cy	31,559		40,986			119.71 /cy	72,545
	025.312200.91.005 Pond Grading - Cut to Grade		**31,559**		**40,986**			**/cy**	**72,545**
139	**025.312200.93.005 Bioretention media, base, and excavation**								
140	31-22-00.005 --- Site Topsoil- Cut/Stockpile/Replace & Spoil*	455.00 cy	28,761	69,060	35,841	5,986		306.92 /cy	139,648
	025.312200.93.005 Bioretention media, base, and excavation		**28,761**	**69,060**	**35,841**	**5,986**		**/cy**	**139,648**
	31-22-00 Basin Excavation		60,320	69,060	76,827	5,986			212,193
141	32-80-00 Irrigation								
142									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
142	025.328000.93.005 Bioretention Pond Irrigation								
143	* unassigned *		2,441	23,564					26,005
144	26-05-19.130 --- THHN Stranded Copper Conductors (Pick List)*	1,400.00 lf	2,684	316				2.14 /lf	3,000
145	40-05-31.131 --- PVC Sch 40 Solvent Weld Pipe & Fittings (1/4" to 24")*	1,245.00 lf	63,170	17,559	8,459			71.64 /lf	89,188
146	40-05-31.131 --- Flow Sensor (1/4" to 24")*	1.00 ea	419	1,238			306	1,962.93 /ea	1,963
147	40-05-58.005 --- Valve - Quickcoupler, 1/2" to 72"	2.00 ea	2,072	3,521	185		47	2,912.58 /ea	5,825
148	40-05-58.005 --- Valve - Master Valve, 1/2" to 72"	1.00 ea	1,082	2,026	103		24	3,233.95 /ea	3,234
149	40-05-61.035 --- Gate Valve - PVC, 1/2" to 14"	3.00 ea	3,383	3,804	359		141	2,562.75 /ea	7,688
	025.328000.93.005 Bioretention Pond Irrigation		75,252	52,028	9,106		518	/sf	136,903
	32-80-00 Irrigation		75,252	52,028	9,106		518		136,903
150	32-92-16 Planting								
151	025.329216.91.005 Bioretention Pond Planting								
152	32-91-13.260 --- Planting Beds*	9,400.00 sf	65,840	48,284		7,917		12.98 /sf	122,041
	025.329216.91.005 Bioretention Pond Planting		65,840	48,284		7,917		/sf	122,041
	32-92-16 Planting		65,840	48,284		7,917			122,041
153	33-42-00 Stormwater Conveyance								
154	025.334200.93.005 Bioretention Outfall Structure								
155	03-11-11.000 --- SOG Form, Place & Finish*	4.04 cy	7,273	4,702	381	548	49	3,203.88 /cy	12,953
156	03-11-12.000 --- Lumber Formed Concrete Walls*	2.25 cy	17,880	7,366	299	1,604	32	12,064.52 /cy	27,181
157	05-53-00.000 --- Steel Grating*	65.00 sf	4,271	13,799	1,384			299.30 /sf	19,455
158	31-23-00.005 --- Structure Excavation & Backfill	292.65 cy	3,245	1,272	3,109	231		26.85 /cy	7,857
	025.334200.93.005 Bioretention Outfall Structure		32,669	27,139	5,174	2,383	81	/ea	67,446
159	025.334211.93.005 Perforated Drain Pipe in Bioretention								
160	33-42-11.800 --- HDPE Corrugated N-12 Dual Wall Drainage Pipe(3" to 60")*	255.00 lf	13,087	1,715	2,122			66.37 /lf	16,923
	025.334211.93.005 Perforated Drain Pipe in Bioretention		13,087	1,715	2,122			/lf	16,923
161	025.334233.93.005 Overflow Structure in Bioretention Basin								
162	33-42-33.000 --- Rectangular Catch Basins w/ Excavation & Backfill*	1.00 ea	2,468	2,227	906			5,600.71 /ea	5,601
	025.334233.93.005 Overflow Structure in Bioretention Basin		2,468	2,227	906			/ea	5,601
	33-42-00 Stormwater Conveyance		48,225	31,081	8,201	2,383	81		89,971
	025 DRAINAGE - DETENTION BASIN	1.00 ls	742,113	314,221	129,015	158,084	1,209	1,344,641.66 /ls	1,344,642
163	035 YARD PIPING								
164	03-48-00 Precast Concrete Specialties								
165	035.034800.91.005 Raw Water Tank 1 & 2 Catch Basin								
166	03-48-00.005 Raw Water Tank 1 & 2 10'x6'x6' Catch Basin	2.00 ea	6,964	69,372	7,419			41,877.68 /ea	83,755
167	05-56-00.000 10'x6' Metal Castings (Pick List)*	2.00 ls	1,623	8,483	679			5,392.31 /ls	10,785
168	31-23-00.005 RWT1 & 2 10'x6'x6' Catch Basin Excavation & Backfill	195.21 cy	5,259	278	6,611	74		62.61 /cy	12,222
	035.034800.91.005 Raw Water Tank 1 & 2 Catch Basin		13,846	78,133	14,709	74		/ea	106,762
169	035.034800.93.005 Raw Water Tank 1&2 Precast Catch Basins								
170	33-42-33.000 --- Rectangular Catch Basins w/ Excavation & Backfill*	2.00 ea	20,170	20,316	16,842	13		28,670.44 /ea	57,341
	035.034800.93.005 Raw Water Tank 1&2 Precast Catch Basins		20,170	20,316	16,842	13		/ea	57,341
	03-48-00 Precast Concrete Specialties		34,016	98,449	31,551	87			164,103
171	33-05-61 Concrete Manholes								
172	035.330561.93.005 Storm Drain manholes								
173	33-05-61.025 --- Manholes, Storm/Air Relief (Each) *	3.00 ea	39,473	37,611	37,477	210		38,257.13 /ea	114,771
	035.330561.93.005 Storm Drain manholes		39,473	37,611	37,477	210		/ea	114,771
	33-05-61 Concrete Manholes		39,473	37,611	37,477	210			114,771
174	33-14-19 Fire Hydrants								
175	035.331419.91.005 Fire Hydrant								
176	33-14-19.000 Fire Hydrants *	1.00 ea	10,366	17,170	3,836			31,371.67 /ea	31,372
	035.331419.91.005 Fire Hydrant		10,366	17,170	3,836			/ea	31,372
	33-14-19 Fire Hydrants		10,366	17,170	3,836				31,372
177	33-42-33 Storm Drain Inlets								
178	035.334233.91.005 4'x4' Storm Drain Inlet and headwall								
179	33-42-33.000 --- Rectangular Catch Basins w/ Excavation & Backfill*	3.00 ea	25,229	22,259	21,848	25		23,120.35 /ea	69,361
	035.334233.91.005 4'x4' Storm Drain Inlet and headwall		25,229	22,259	21,848	25		/ea	69,361
180	035.334233.91.010 Raw Water Tank 1 & 2 Catch Basin								
181	05-56-00.000 2'x3' Metal Castings	2.00 ls	162	848	68			539.23 /ls	1,078
182	33-42-33.000 RW-Tanks 1 & 2 2'x3'x3' Rectangular Catch Basins w/ Excavation & Backfill*	2.00 ea	12,286	5,111	16,100	2		16,748.90 /ea	33,498
	035.334233.91.010 Raw Water Tank 1 & 2 Catch Basin		12,448	5,959	16,168	2		/ea	34,576
	33-42-33 Storm Drain Inlets		37,677	28,218	38,015	27			103,937
183	40-05-17 Copper Pipe								
184	035.400517.91.005 2" UG Cu-W Pipe from existing line to WHS								
185	40-05-17.000 2" UG-Cu Pipe & Fittings 1/4" to 8" *	100.00 lf	5,757	10,918	364	1		170.40 /lf	17,040
186	40-05-31.131 2" UG-Cu Pipe Trenching	4.01 cy	1,786	259	831			717.28 /cy	2,876
	035.400517.91.005 2" UG Cu-W Pipe from existing line to WHS		7,544	11,177	1,195	1		/lf	19,916
	40-05-17 Copper Pipe		7,544	11,177	1,195	1			19,916
187	40-05-19 Ductile Iron Pipe								
188	035.400519.91.005 UG IXE-DI Pipe from FW Tank 2 to FW Tank 3								
189									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	40-05-19.300 18" IXE-DI to Finish Water Tank FWT#2	12.00 lf	38,185	56,006	16,665	678		9,294.53 /lf	111,534
190	40-05-19.300 30" IXE-DI From FW T2 to FW T3 (STA 11+00 to 20+00)	942.00 lf	415,118	1,603,200	158,589	4,728	11,769	2,328.45 /lf	2,193,404
191	40-05-19.300 16" IXE-DI to Finish Water Tank FWT#3	30.00 lf	36,168	50,223	14,852	396	5,884	3,584.09 /lf	107,523
	035.400519.91.005 UG IXE-DI Pipe from FW Tank 2 to FW Tank 3		**489,471**	**1,709,429**	**190,106**	**5,802**	**17,653**	**/lf**	**2,412,461**
192	**035.400519.91.010 UG IXE-DI Pipe from 36"IXE-DI Pipe to Treat Area BLDG.**								
193	40-05-19.300 36" IXE-DI Underground Pipe to Treatment Area Bldg. RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	42.00 lf	96,865	333,841	40,661	919	4,837	11,360.08 /lf	477,123
	035.400519.91.010 UG IXE-DI Pipe from 36"IXE-DI Pipe to Treat Area BLDG.		**96,865**	**333,841**	**40,661**	**919**	**4,837**	**/lf**	**477,123**
194	**035.400519.91.020 UG RW-DI Pipe from 36"RW-DI Pipe to Raw Water Tank 1&2**								
195	40-05-19.300 42" RW-DI Underground Pipe (10+00 to 10+17) RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	44.00 lf	132,408	386,055	55,744	347	4,837	13,167.97 /lf	579,391
196	40-05-19.300 36" RW-DI UG Pipe to AG Pipe RAW Water T1 & T2 RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	303.00 lf	215,351	713,010	72,580	1,831	5,884	3,328.90 /lf	1,008,656
	035.400519.91.020 UG RW-DI Pipe from 36"RW-DI Pipe to Raw Water Tank 1&2		**347,759**	**1,099,065**	**128,324**	**2,178**	**10,721**	**/lf**	**1,588,047**
197	**035.400519.91.025 UG RW-DI Pipe from Raw Water Tank 1&2 to Pump Bldg.**								
198	40-05-06.110 20" Dresser #38 Couplings (Pick List)*	7.00 ea	15,544	23,510				5,579.16 /ea	39,054
199	40-05-06.320 20" Restrained Coupling Adapter M-11 Harness Restraints (Pick List)*	7.00 ea	12,245	89,977				14,603.09 /ea	102,222
200	40-05-19.300 42" RW-DI UG Pipe from Pump Station to Raw Water T1 & T2 RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	72.00 lf	304,358	1,367,429	127,867	565	4,837	25,070.21 /lf	1,805,055
201	40-05-19.300 36" RW-DI UG Pipe to AG Pipe From Pump Station to RAW Water T1 & T2 RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	21.00 lf	47,576	143,499	12,964	121	2,418	9,837.06 /lf	206,578
202	40-05-64.025 20" RW-DI Butterfly Valve from Raw Water T1&T2 to Pump Station - CI/DI, AWWA, Mechanical Joint, 3" to 48"	7.00 ea	75,147	188,090	43,117		287	43,805.79 /ea	306,641
	035.400519.91.025 UG RW-DI Pipe from Raw Water Tank 1&2 to Pump Bldg.		**454,870**	**1,812,504**	**183,947**	**686**	**7,542**	**/lf**	**2,459,550**
203	**035.400519.91.030 UG RW-DI Pipe from Pump Bldg to Treatment Area Bldg**								
204	40-05-19.300 36" RW-DI from Pump Bldg to Treatment Area, RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	127.00 lf	113,388	435,604	40,918	2,871		4,667.57 /lf	592,782
	035.400519.91.030 UG RW-DI Pipe from Pump Bldg to Treatment Area Bldg		**113,388**	**435,604**	**40,918**	**2,871**		**/lf**	**592,782**
205	**035.400519.91.040 UG DR-DI Pipe from 74'x42' sump to Drain Pump Station**								
206	40-05-06.320 12" Restrained Coupling Adapter M-11 Harness Restraints (Pick List)*	1.00 ea	1,050	5,218				6,267.92 /ea	6,268
207	40-05-19.300 14" DR-DI from Engineer Sump to Drain Pump Station RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	382.00 lf	117,744	262,950	54,787	3,853	5,884	1,165.49 /lf	445,218
208	40-05-19.300 12" DR-DI from Engineer Sump to Drain Pump Station RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	14.00 lf	8,074	12,499	850	5		1,530.60 /lf	21,428
	035.400519.91.040 UG DR-DI Pipe from 74'x42' sump to Drain Pump Station		**126,868**	**280,667**	**55,638**	**3,858**	**5,884**	**/lf**	**472,914**
209	**035.400519.91.045 UG BO-DI Pipe from Engineerd Sump Pipe to Existing Pipe Connection.**								
210	40-05-19.300 12" BO-DI Pipe from Engineered Sump Pipe to Existing Pipe Connection.	241.00 lf	74,515	115,351	15,995	474	4,837	876.23 /lf	211,171
	035.400519.91.045 UG BO-DI Pipe from Engineerd Sump Pipe to Existing Pipe Connection.		**74,515**	**115,351**	**15,995**	**474**	**4,837**	**/lf**	**211,171**
211	**035.400519.91.046 UG BO-DI Pipe from Well 14 to Existing Pipe Connection**								
212	40-05-19.300 12" BO-DI Pipe from Engineered Sump Pipe to Existing Pipe Connection.	301.00 lf	63,275	123,391	21,094	636	11,769	731.45 /lf	220,165
	035.400519.91.046 UG BO-DI Pipe from Well 14 to Existing Pipe Connection		**63,275**	**123,391**	**21,094**	**636**	**11,769**	**/lf**	**220,165**
213	**035.400519.91.050 UG W-DI Pipe Rerouted Section**								
214	40-05-19.300 12" W-DI Pipe Rerouted Section RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	561.00 lf	159,075	250,587	39,965	4,165	4,837	817.52 /lf	458,629
	035.400519.91.050 UG W-DI Pipe Rerouted Section		**159,075**	**250,587**	**39,965**	**4,165**	**4,837**	**/lf**	**458,629**
215	**035.400519.91.060 AG IXE-DI Pipe at FW Tank 3**								
216	40-05-07.025 24" IXE Pipe Hangers - Stanchion/Support (Anvil 259/63)*	3.00 ea	19,373	8,427				9,266.94 /ea	27,801
217	40-05-19.100 24" IXE-DI Aboveground Pipe to Finish Water Tank FWT#3.	30.00 lf	44,752	145,293	2,977	48		6,435.70 /lf	193,071
218	40-05-19.100 30"x24" IXE-DI 90 fitting Reducer	1.00 ea	6,963	162,056	71			169,089.78 /ea	169,090
219	40-05-64.005 24" IXE-DI Motorized Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	7,644	26,532	4,600		20,555	59,330.87 /ea	59,331
220	40-05-64.005 24" IXE-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	7,644	26,532	4,600		41	38,816.96 /ea	38,817
221	40-70-00.030 24" IXR-DI FE- Flow Elements	1.00 ea	7,115	44,461	190		306	52,071.91 /ea	52,072
	035.400519.91.060 AG IXE-DI Pipe at FW Tank 3		**93,491**	**413,301**	**12,438**	**48**	**20,902**	**/lf**	**540,181**
222	**035.400519.91.065 AG IXE-DI Pipe at FW Tank 2**								
223	40-05-07.025 24" IXE Pipe Hangers - Stanchion/Support (Anvil 259/63)*	4.00 ea	25,831	11,236				9,266.86 /ea	37,067
224	40-05-19.100 24" IXE-DI Aboveground Pipe to Finish Water Tank FWT#3	60.00 lf	80,106	259,606	5,934	97		5,762.37 /lf	345,742
225	40-05-19.100 30"x24" IXE-DI 90 fitting Reducer	1.00 ea	6,963	162,056	71			169,089.79 /ea	169,090
226	40-05-61.025 24" IXE-DI Gate Valve - Resilient Wedge, Flanged, 4" to 48"	1.00 ea	6,266	109,820	3,741		41	119,867.77 /ea	119,868
227	40-05-64.005 24" IXE-DI Motorized Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	7,644	26,532	4,600		20,555	59,330.89 /ea	59,331
228	40-05-64.005 24" IXE-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	7,644	26,532	4,600		41	38,816.92 /ea	38,817
229	40-70-00.030 24" IXR-DI FE- Flow Elements	1.00 ea	7,115	44,461	190		306	52,071.93 /ea	52,072
	035.400519.91.065 AG IXE-DI Pipe at FW Tank 2		**141,568**	**640,243**	**19,136**	**97**	**20,943**	**/lf**	**821,987**
	40-05-19 Ductile Iron Pipe		2,161,144	7,213,983	748,223	21,735	109,926		10,255,010
230	40-05-31 PVC Plastic Pipe								
231	**035.400531.91.005 18" DR-PVC from RW Tank1&2 to Drain Pump Station**								
232	40-05-06.125 Flexible Elastomeric PVC Couplings (Pick List) (Fernco) *	2.00 ea	1,313	1,819				1,565.86 /ea	3,132
233	40-05-31.139 18" DR-PVC from DRain Pump Station to RWT1 and RWT2 - PVC SDR Gravity Sewer/Drainage Pipe (4" to 48")*	180.00 lf	39,789	218,489	10,847	489	11,769	1,563.23 /lf	281,382
	035.400531.91.005 18" DR-PVC from RW Tank1&2 to Drain Pump Station		**41,101**	**220,308**	**10,847**	**489**	**11,769**	**/lf**	**284,514**
234	**035.400531.91.010 18" DR-PVC from Treatment Area Bldg to Drain Pump Station.**								
235	40-05-06.125 Flexible Elastomeric PVC Couplings (Pick List) (Fernco) *	2.00 ea	1,313	1,819				1,565.85 /ea	3,132
236	40-05-31.139 18" DR-PVC from Treatment Area Bldg to Drain Pump Station. - PVC SDR Gravity Sewer/Drainage Pipe (4" to 48")*	20.00 lf	12,375	78,540	9,237	220		5,018.61 /lf	100,372
	035.400531.91.010 18" DR-PVC from Treatment Area Bldg to Drain Pump Station.		**13,688**	**80,359**	**9,237**	**220**		**/lf**	**103,504**
237	**035.400531.91.015 6" DR-PVC from Pump Station Bldg to Drain Pump Station.**								
238	40-05-06.125 6" DR-PVC Flexible Elastomeric PVC Couplings (Pick List) (Fernco) *	1.00 ea	186	119				304.88 /ea	305
239	40-05-31.139 6" DR-PVC from Pump Station Bldg to Drain Pump Station. - PVC SDR Gravity Sewer/Drainage Pipe (4" to 48")*	50.00 lf	8,363	24,186	3,366	476		727.80 /lf	36,390
	035.400531.91.015 6" DR-PVC from Pump Station Bldg to Drain Pump Station.		**8,549**	**24,304**	**3,366**	**476**		**/lf**	**36,695**
240	**035.400531.91.016 1-1/2" DR-PVC from Pump Station to Drain Pump**								
241									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	40-05-06.125 1-1/2" DR-PVC Flexible Elastomeric PVC Couplings (Pick List) (Fernco) *	1.00 ea	81	30				111.17 /ea	111
242	40-05-31.139 1-1/2" DR-PVC from Pump Station Bldg to Drain Pump Station. - PVC SDR Gravity Sewer/Drainage Pipe (4" to 48")*	115.00 lf	14,089	49,618	7,260	753		623.64 /lf	71,719
	035.400531.91.016 1-1/2" DR-PVC from Pump Station to Drain Pump		14,169	49,648	7,260	753		/lf	71,830
243	035.400531.91.020 12" UG STM-PVC From Existing SD Line to Bioretention Basin								
244	40-05-06.125 12" Flexible Elastomeric PVC Couplings (Pick List) (Fernco) *	4.00 ea	1,249	1,278				631.70 /ea	2,527
245	40-05-31.139 12" STM-PVC From Inlets to Bioretention Basin PVC SDR Gravity Sewer/Drainage Pipe (4" to 48")*	300.00 lf	33,779	75,539	13,024	2,099	11,769	454.03 /lf	136,209
	035.400531.91.020 12" UG STM-PVC From Existing SD Line to Bioretention Basin		35,028	76,816	13,024	2,099	11,769	/lf	138,736
246	035.400531.91.025 2" UG IR-PVC Pipe Reroute Irrigation System								
247	40-05-31.132 2" UG IR-PVC Pipe Reroute Irrigation System PVC Sch 80 Solvent Weld Pipe & Fittings (1/4" to 24")*	880.00 lf	45,446	20,485	4,868			80.45 /lf	70,799
	035.400531.91.025 2" UG IR-PVC Pipe Reroute Irrigation System		45,446	20,485	4,868			/lf	70,799
248	035.400531.93.005 10" DR-PVC from RW Tank 1&2 to Drain Pump Station								
249	40-05-06.125 Flexible Elastomeric PVC Couplings (Pick List) (Fernco) *	2.00 ea	608	547				577.75 /ea	1,155
250	40-05-31.139 10" DR-PVC from DRain Pump Station to RWT1 and RWT2 - PVC SDR Gravity Sewer/Drainage Pipe (4" to 48")*	100.00 lf	13,415	45,177	4,505	169	11,769	750.35 /lf	75,035
	035.400531.93.005 10" DR-PVC from RW Tank 1&2 to Drain Pump Station		14,023	45,725	4,505	169	11,769	/lf	76,191
	40-05-31 PVC Plastic Pipe		172,005	517,645	53,108	4,205	35,306		782,269
	035 YARD PIPING	1.00 ls	2,462,225	7,924,253	913,405	26,264	145,232	11,471,378.80 /ls	11,471,379
251	040 RAW WATER TANK NO. 1 AND 2								
252	01-00-00 GENERAL REQUIREMENTS								
253	040.010000.90.001 RW Tank 1&2 Special Inspections								
254	01-00-00.010 --- General Conditions Checklist*	1.00 ls					23,514	23,513.95 /ls	23,514
	040.010000.90.001 RW Tank 1&2 Special Inspections						23,514	/ls	23,514
	01-00-00 GENERAL REQUIREMENTS						23,514		23,514
255	03-11-13.130 Equipment Pad/Curbs/Misc								
256	040.031112.90.001 RW Tank 1&2 - Concrete Saddle Pipe Support (4 Locations)								
257	03-11-11.115 --- Concrete Pipe Supports*	3.94 cy	4,544	3,737	90	2,733	46	2,829.48 /cy	11,151
	040.031112.90.001 RW Tank 1&2 - Concrete Saddle Pipe Support (4 Locations)		4,544	3,737	90	2,733	46	/ea	11,151
	03-11-13.130 Equipment Pad/Curbs/Misc		4,544	3,737	90	2,733	46		11,151
258	03-31-02 Foundation Place/Finish								
259	040.031110.90.101 RW Tank 1 - Ringwall Foundation - 2'x3'x 135'								
260	03-11-10.135 --- Continuous Footings*	30.00 cy	89,317	52,883	9,507	1,718	353	5,125.93 /cy	153,778
	040.031110.90.101 RW Tank 1 - Ringwall Foundation - 2'x3'x 135'		89,317	52,883	9,507	1,718	353	/cy	153,778
261	040.031110.90.201 RW Tank 2 - Ringwall Foundation - 2'x3'x 135'								
262	03-11-10.135 --- Continuous Footings*	30.00 cy	89,317	52,883	9,507	1,718	353	5,125.93 /cy	153,778
	040.031110.90.201 RW Tank 2 - Ringwall Foundation - 2'x3'x 135'		89,317	52,883	9,507	1,718	353	/cy	153,778
	03-31-02 Foundation Place/Finish		178,635	105,765	19,014	3,437	705		307,556
263	03-60-00 GROUT								
264	040.036000.90.101 RW Tank 1 - Tank Grout Pad - R 23.5' @ 1-1/2" Non Shrink Grout / Cane Joint Filler								
265	03-60-00.000 --- Place Grout (Pick List)*	303.00 cf	164,019	299,875				1,531.00 /cf	463,893
	040.036000.90.101 RW Tank 1 - Tank Grout Pad - R 23.5' @ 1-1/2" Non Shrink Grout / Cane Joint Filler		164,019	299,875				/cf	463,893
266	040.036000.90.201 RW Tank 2 - Tank Grout Pad - R 23.5' @ 1-1/2" Non Shrink Grout / Cane Joint Filler								
267	03-60-00.000 --- Place Grout (Pick List)*	303.00 cf	164,019	299,875				1,531.00 /cf	463,893
	040.036000.90.201 RW Tank 2 - Tank Grout Pad - R 23.5' @ 1-1/2" Non Shrink Grout / Cane Joint Filler		164,019	299,875				/cf	463,893
	03-60-00 GROUT		328,037	599,750					927,787
268	26-05-18.050 Feeders								
269	040.260516.01.001 LV Feeder - LP-1 to RW Tank Lighting via DB								
270	26-05-33.484 S40 PVC & Cu Str- lp-1 to ix rw tank lighting via db & ug	160.00 lf	15,980	5,178				132.23 /lf	21,157
	040.260516.01.001 LV Feeder - LP-1 to RW Tank Lighting via DB		15,980	5,178				/lf	21,157
271	040.260516.01.002 LV Feeder - LP-1 to RW Tank Recept, & AIT- via DB								
272	26-05-33.225 PVC-CTD-GRC Riser & Cu Str- db to rw tank ait's	80.00 lf	10,017	3,846				173.28 /lf	13,863
273	26-05-33.484 S40 PVC & Cu Str- lp-1 to ix rw tank recp, ait- via db & ug	160.00 lf	9,859	1,576				71.47 /lf	11,435
	040.260516.01.002 LV Feeder - LP-1 to RW Tank Recept, & AIT- via DB		19,876	5,422				/lf	25,298
	26-05-18.050 Feeders		35,856	10,599					46,455
274	26-05-83 Wiring Connections								
275	040.260584.01.001 I&C Connect & Feed - Raw Water Tank No. 1, 2								
276	26-05-02.000 I&C Instrument Connections- lsh-501,-502	2.00 ea	3,016	545				1,780.90 /ea	3,562
277	26-05-02.000 I&C Instrument Connections- ait-,pit-501,-502	4.00 ea	8,826	3,090				2,979.17 /ea	11,917
278	26-05-33.080 N4X Enclosures-	4.00 ea	3,451	7,311				2,690.69 /ea	10,763
279	26-05-33.225 PVC-CTD-GRC & Cu Str- pfas-plc to lsh, riser & AG at tank	100.00 lf	12,728	5,121				178.49 /lf	17,849
280	26-05-33.225 PVC-CTD-GRC & Cu Str- pfas-plc to pit, riser & AG at tank	100.00 lf	12,555	5,846				184.01 /lf	18,401
281	26-05-33.225 PVC-CTD-GRC & Cu Str- pfas-plc to ait, riser & AG at tank	100.00 lf	12,555	5,846				184.01 /lf	18,401
282	26-05-33.225 PVC-CTD-GRC & Cu Str- lp-1 to ait, riser & AG at tank	100.00 lf	12,877	5,177				180.54 /lf	18,054
283	26-05-33.484 S40 PVC & Cu Str- pfas-plc to rwt no 1, 2 lsh via ug & db, control	220.00 lf	9,660	859				47.81 /lf	10,519
284	26-05-33.484 S40 PVC & Cu Str- pfas-plc to rwt no 1, 2 pit via ug & db, signal	220.00 lf	8,778	3,647				56.48 /lf	12,425
285	26-05-33.484 S40 PVC & Cu Str- pfas-plc to rwt no 1, 2 ait via ug & db, signal	220.00 lf	8,778	3,647				56.48 /lf	12,425
286	26-05-33.484 S40 PVC & Cu Str- pfas-plc to rwt no 1, 2 lsh via ug & db, control	220.00 lf	9,660	859				47.81 /lf	10,519
287	26-05-33.484 S40 PVC & Cu Str- lp-1 to rwt no 1, 2 ait via ug & db, power	320.00 lf	13,169	1,361				45.40 /lf	14,529
	040.260584.01.001 I&C Connect & Feed - Raw Water Tank No. 1, 2		116,054	43,310				/ea	159,364

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	26-05-83 Wiring Connections		116,054	43,310					159,364
288	26-27-26 Devices & Accessories								
289	040.262726.01.001 Receptacles								
290	26-27-26.000 Receptacles- raw water tanks	2.00 ea	1,166	344				755.00 /ea	1,510
	040.262726.01.001 Receptacles		1,166	344				/ea	1,510
	26-27-26 Devices & Accessories		1,166	344					1,510
291	26-50-00 Lighting								
292	040.265600.01.001 Pole-Mounted Site Lighting								
293	26-56-13.000 G Pole-mounted area lighting	2.00 ea	18,867	18,462	432			18,880.43 /ea	37,761
	040.265600.01.001 Pole-Mounted Site Lighting		18,867	18,462	432			/ea	37,761
	26-50-00 Lighting		18,867	18,462	432				37,761
294	31-23-16.16 Foundation Excavation								
295	040.312316.90.101 RW Tank 1 - Tank Pad Excavation - R 23.5' @ 15"								
296	31-23-00.005 --- Structure Excavation & Backfill	128.51 cy	19,610	3,675	26,864	916		397.35 /cy	51,065
	040.312316.90.101 RW Tank 1 - Tank Pad Excavation - R 23.5' @ 15"		19,610	3,675	26,864	916		/cy	51,065
297	040.312316.90.201 RW Tank 2 - Tank Pad Excavation - R 23.5' @ 15"								
298	31-23-00.005 --- Structure Excavation & Backfill	128.51 cy	19,611	3,675	26,864	916		397.35 /cy	51,065
	040.312316.90.201 RW Tank 2 - Tank Pad Excavation - R 23.5' @ 15"		19,611	3,675	26,864	916		/cy	51,065
	31-23-16.16 Foundation Excavation		39,221	7,350	53,727	1,832			102,130
299	32-12-16 Asphalt Paving								
300	040.321540.90.101 RW Tank 1 - Tank Pad Sand - R 23.5' @ 3" W/ Geofabric								
301	32-15-00.005 --- Aggregate Surfacing*	161.33 sy	1,450	6,659	727	772		59.55 /sy	9,607
	040.321540.90.101 RW Tank 1 - Tank Pad Sand - R 23.5' @ 3" W/ Geofabric		1,450	6,659	727	772		/sf	9,607
302	040.321540.90.201 RW Tank 2 - Tank Pad Sand - R 23.5' @ 3" W/ Geofabric								
303	32-15-00.005 --- Aggregate Surfacing*	161.33 sy	1,450	6,659	727	772		59.55 /sy	9,607
	040.321540.90.201 RW Tank 2 - Tank Pad Sand - R 23.5' @ 3" W/ Geofabric		1,450	6,659	727	772		/sf	9,607
	32-12-16 Asphalt Paving		2,899	13,318	1,454	1,544			19,215
304	33-16-11 Welded Steel Water Storage Tanks								
305	040.020010.67.001 Raw Water Tanks (45' Dia x 24'H Welded Steel) - Tank Erection Crane Support								
306	02-00-10.000 Raw Water Tank - Paso Robles Quote 08/15/23, 45' dia x 24' H Adder for Crane Support	2.00 ls	95,165		68,401			81,782.77 /ls	163,566
	040.020010.67.001 Raw Water Tanks (45' Dia x 24'H Welded Steel) - Tank Erection Crane Support		95,165		68,401				163,566
307	040.020010.67.002 Raw Water Tanks (45' Dia x 24'H Welded Steel) - Tank Coating Manlift Support								
308	02-00-10.000 --- Labor & Equipment Resource Assembly (Pick List)	0.00			174,778			/ls	174,778
	040.020010.67.002 Raw Water Tanks (45' Dia x 24'H Welded Steel) - Tank Coating Manlift Support				174,778				174,778
309	040.099656.67.001 Raw Water Tank - Paso Robles Quote 08/15/23, 45' dia x 24' H Int/Ext Coat Excluded								
310	09-96-56.010 Raw Water Tank - Paso Robles Quote 08/15/23, 45' dia x 24' H Painting Excluded	16,412.00 sf	15,605	11,119		963,866		60.36 /sf	990,589
	040.099656.67.001 Raw Water Tank - Paso Robles Quote 08/15/23, 45' dia x 24' H Int/Ext Coat Excluded		15,605	11,119		963,866			990,589
311	040.331613.91.001 Raw Water Tanks (45' Dia x 24'H Welded Steel) - 255K Gallons, Paso Robles -Q								
312	33-16-13.000 Raw Water Tank - Paso Robles Quote 08/15/23, 45' dia x 24' H	2.00 ea	6,423	9,783		4,308,777		2,162,491.40 /ea	4,324,983
	040.331613.91.001 Raw Water Tanks (45' Dia x 24'H Welded Steel) - 255K Gallons, Paso Robles -Q		6,423	9,783		4,308,777			4,324,983
	33-16-11 Welded Steel Water Storage Tanks		117,192	20,901	243,178	5,272,643			5,653,915
313	40-05-19 Ductile Iron Pipe								
314	040.400519.91.005 36" AG RW-DI to RW Tank 1								
315	40-05-06.225 Force Balance Flext-Tend	1.00 ea	3,573	19,583				23,156.27 /ea	23,156
316	40-05-07.025 36" RW Pipe Hangers - Stanchion/Support (Anvil 259/63)*	1.00 ea	9,255	3,968				13,222.37 /ea	13,222
317	40-05-19.100 36" RW-DI Above Ground to FWT#1	25.00 lf	36,873	359,375	3,667	81		15,999.83 /lf	399,996
318	40-05-64.005 36" RW-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	11,506	119,276	6,519		2,810	140,110.24 /ea	140,110
	040.400519.91.005 36" AG RW-DI to RW Tank 1		61,206	502,201	10,186	81	2,810	/lf	576,485
319	040.400519.91.010 36" AG RW-DI to RW Tank 2								
320	40-05-06.225 Force Balance Flext-Tend	1.00 ea	3,573	19,583				23,156.25 /ea	23,156
321	40-05-07.025 36" RW Pipe Hangers - Stanchion/Support (Anvil 259/63)*	1.00 ea	9,255	3,968				13,222.41 /ea	13,222
322	40-05-19.100 36" RW-DI Above Ground to FWT#1	25.00 lf	36,873	359,375	3,667	81		15,999.83 /lf	399,996
323	40-05-64.005 36" RW-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	11,506	119,276	6,519		2,810	140,110.25 /ea	140,110
	040.400519.91.010 36" AG RW-DI to RW Tank 2		61,206	502,201	10,186	81	2,810	/lf	576,485
324	040.400519.91.015 24" AG OF-DI from RW Tank 1								
325	40-05-19.100 24" OF-DI Pipe FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	20.00 lf	20,625	91,265	1,978	32		5,694.99 /lf	113,900
326	40-05-65.025 24" OF Check Valve - Cast Iron/DI, Ball Check, Flanged, 2" to 30"	1.00 ea	6,620	160,107	3,962		41	170,729.69 /ea	170,730
	040.400519.91.015 24" AG OF-DI from RW Tank 1		27,244	251,372	5,940	32	41	/lf	284,629
327	040.400519.91.020 24" AG OF-DI from RW Tank 2								
328	40-05-19.100 24" OF-DI Pipe FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	20.00 lf	20,625	91,265	1,978	32		5,694.99 /lf	113,900
329	40-05-65.025 24" OF Check Valve - Cast Iron/DI, Ball Check, Flanged, 2" to 30"	1.00 ea	6,620	160,107	3,962		41	170,729.68 /ea	170,730
	040.400519.91.020 24" AG OF-DI from RW Tank 2		27,244	251,372	5,940	32	41	/lf	284,629
330	040.400519.91.025 36" AG RW-DI from RW Tank 1 to IX Feed Pumps								
331	40-05-06.225 Force Balance Flext-Tend	1.00 ea	3,573	19,583				23,156.28 /ea	23,156
332	40-05-07.025 36" RW Pipe Hangers - Stanchion/Support (Anvil 259/63)*	1.00 ea	9,255	3,968				13,222.38 /ea	13,222
333	40-05-19.100 36" RW-DI Above Ground to FWT#1	26.00 lf	43,721	413,886	3,851	84		17,751.60 /lf	461,542
334	40-05-64.005 36" RW-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	11,506	119,276	6,519		2,810	140,110.27 /ea	140,110
	040.400519.91.025 36" AG RW-DI from RW Tank 1 to IX Feed Pumps		68,054	556,712	10,370	84	2,810	/lf	638,030
335	040.400519.91.030 36" AG RW-DI from RW Tank 2 to IX Feed Pumps								

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	40-05-06.225 Force Balance Flext-Tend	1.00 ea	3,573	19,583				23,156.24 /ea	23,156
337	40-05-07.025 36" RW Pipe Hangers - Stanchion/Support (Anvil 259/63)*	1.00 ea	9,255	3,968				13,222.39 /ea	13,222
338	40-05-19.100 36" RW-DI Above Ground to FWT#1	26.00 lf	43,721	413,886	3,851	84		17,751.60 /lf	461,542
339	40-05-64.005 36" RW-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	11,506	119,276	6,519		2,810	140,110.25 /ea	140,110
	040.400519.91.030 36" AG RW-DI from RW Tank 2 to IX Feed Pumps		68,054	556,712	10,370	84	2,810	/lf	638,030
340	040.400519.91.035 3" AG RW-DI Blind Flange to connect GV RW T1& 2								
341	40-05-19.100 3" AG RW-DI Cleanout RW Tank 1 and 2 FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	2.00 ea	800	2,652	1			1,726.13 /ea	3,452
	040.400519.91.035 3" AG RW-DI Blind Flange to connect GV RW T1& 2		800	2,652	1			/ea	3,452
	40-05-19 Ductile Iron Pipe		313,810	2,623,223	52,991	394	11,324		3,001,741
342	40-05-51 VALVES								
343	040.400551.91.005 4" Gate Valve Flush Cleanout FWT1								
344	40-05-61.025 4" Gate Valve - Resilient Wedge, Flanged, 4" to 48"	2.00 ea	1,920	5,724	404		82	4,064.86 /ea	8,130
345	40-05-61.025 4" Nozzle	2.00 ea	1,115	5,717	202		41	3,537.59 /ea	7,075
	040.400551.91.005 4" Gate Valve Flush Cleanout FWT1		3,035	11,441	606		123	/ea	15,205
346	040.400551.91.010 4" Ball Valve Flush Cleanout FWT2								
347	40-05-61.025 4" Nozzle	2.00 ea	1,115	5,717	202		41	3,537.59 /ea	7,075
348	40-05-63.010 4" Ball Valve - Carbon Steel, Flanged, 2" to 12"	2.00 ea	2,074	11,016	426		82	6,799.21 /ea	13,598
	040.400551.91.010 4" Ball Valve Flush Cleanout FWT2		3,189	16,733	628		123	/ea	20,674
349	040.400551.93.015 6" Gate Valve Flush Cleanout RW Tank 1								
350	40-05-61.025 6" Gate Valve - Resilient Wedge, Flanged, 4" to 48"	1.00 ea	1,365	4,394	267		41	6,067.09 /ea	6,067
351	40-05-61.025 6" Nozzle	1.00 ea	552	4,386	65			5,003.25 /ea	5,003
	040.400551.93.015 6" Gate Valve Flush Cleanout RW Tank 1		1,917	8,780	332		41	/ea	11,070
352	040.400551.93.020 6" Gate Valve Flush Cleanout RW Tank 2								
353	40-05-61.025 6" Gate Valve - Resilient Wedge, Flanged, 4" to 48"	1.00 ea	1,365	4,394	267		41	6,067.11 /ea	6,067
354	40-05-61.025 6" Nozzle	1.00 ea	552	4,386	65			5,003.18 /ea	5,003
	040.400551.93.020 6" Gate Valve Flush Cleanout RW Tank 2		1,917	8,780	332		41	/ea	11,070
355	040.400551.93.025 4" AVRV RW Tank 1								
356	40-05-78.260 --- Vacuum Relief Valve - 1/2" to 3"	1.00 ea	946	5,834	205		21	7,005.56 /ea	7,006
	040.400551.93.025 4" AVRV RW Tank 1		946	5,834	205		21	/ea	7,006
357	040.400551.93.030 4" AVRV RW Tank 2								
358	40-05-78.260 --- Vacuum Relief Valve - 1/2" to 3"	1.00 ea	946	5,834	205		20	7,005.55 /ea	7,006
	040.400551.93.030 4" AVRV RW Tank 2		946	5,834	205		20	/ea	7,006
	40-05-51 VALVES		11,951	57,402	2,309		369		72,030
359	40-70-00 Instrumentation for Process Systems								
360	040.407000.01.001 I&C Instruments								
361	40-70-00.010 I&C Instruments- rw tanks	4.00 ea	14,342		759		1,226	4,081.72 /ea	16,327
	040.407000.01.001 I&C Instruments		14,342		759		1,226	/ea	16,327
	40-70-00 Instrumentation for Process Systems		14,342		759		1,226		16,327
	040 RAW WATER TANK NO. 1 AND 2	1.00 ls	1,182,574	3,504,160	373,954	5,282,582	37,184	10,380,455.82 /ls	10,380,456
362	045 IX FEED PUMP STATION								
363	01-00-00 GENERAL REQUIREMENTS								
364	045.010000.90.001 Feed Pump Station - Special Inspections								
365	01-00-00.010 --- General Conditions Checklist*	1.00 ls					23,514	23,513.93 /ls	23,514
	045.010000.90.001 Feed Pump Station - Special Inspections						23,514	/ls	23,514
	01-00-00 GENERAL REQUIREMENTS						23,514		23,514
366	03-11-10 Concrete Encasement								
367	045.031110.91.001 IX Feed Pump Can Concrete Encasement								
368	03-11-10.010 IX Feed Pump Can Concrete Encasement 19.91'x60"	95.76 cy	277,690	180,958	45,810			5,267.83 /cy	504,458
	045.031110.91.001 IX Feed Pump Can Concrete Encasement		277,690	180,958	45,810				504,458
369	045.031110.91.005 36" UG RW-DI Encased Pipe								
370	03-11-10.005 36" UG RW-DI Encased Pipe	21.91 cy	60,751	29,231	12,902	1,374	258	4,770.44 /cy	104,516
	045.031110.91.005 36" UG RW-DI Encased Pipe		60,751	29,231	12,902	1,374	258	/cy	104,516
371	045.031110.91.010 20" UG RW-DI Encased Pipe								
372	03-11-10.005 20" UG RW-DI Encased Pipe Horizontal Concrete Encasement*	40.00 cy	106,545	53,002	24,854	5,207	470	4,751.47 /cy	190,078
	045.031110.91.010 20" UG RW-DI Encased Pipe		106,545	53,002	24,854	5,207	470	/cy	190,078
	03-11-10 Concrete Encasement		444,986	263,191	83,566	6,581	728		799,052
373	03-11-14 Concrete								
374	045.031114.90.301 IX Pump Station Building - Entry Stairs & Landing (3 Steps) (2 Locations)								
375	03-11-11.010 --- Solid Concrete Steps*	5.33 cy	16,286	8,819	415	1,056	63	4,995.03 /cy	26,638
	045.031114.90.301 IX Pump Station Building - Entry Stairs & Landing (3 Steps) (2 Locations)		16,286	8,819	415	1,056	63	/cy	26,638
	03-11-14 Concrete		16,286	8,819	415	1,056	63		26,638
376	03-31-02 Foundation Place/Finish								
377	045.033102.90.001 IX Pump Station Building - Perimiter Wall Strip Footing - 4'-4"x2' (319 LF)								
378	03-11-10.135 --- Continuous Footings*	102.32 cy	116,889	114,137	8,261	4,195	1,203	2,391.47 /cy	244,685
	045.033102.90.001 IX Pump Station Building - Perimiter Wall Strip Footing - 4'-4"x2' (319 LF)		116,889	114,137	8,261	4,195	1,203	/cy	244,685
	03-31-02 Foundation Place/Finish		116,889	114,137	8,261	4,195	1,203		244,685
379	03-31-04 Slab-on-Grade Place/Fin								
380	045.031111.90.001 IX Pump Station Building - Pump Can SOG - 7'x7' (7 Locations)								
381									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	03-11-11.000 --- SOG Form, Place & Finish*	12.70 cy	26,760	24,785	1,061	3,791	153	4,451.38 /cy	56,550
	045.031111.90.001 IX Pump Station Building - Pump Can SOG - 7'x7' (7 Locations)		26,760	24,785	1,061	3,791	153	/cy	56,550
382	045.031111.90.002 IX Pump Station Building - Pump Discharge Sump SOG - 12'x76'								
383	03-11-11.000 --- SOG Form, Place & Finish*	41.52 cy	55,856	53,429	2,756	1,572	499	2,748.44 /cy	114,113
	045.031111.90.002 IX Pump Station Building - Pump Discharge Sump SOG - 12'x76'		55,856	53,429	2,756	1,572	499	/cy	114,113
384	045.031111.90.003 IX Pump Station Building - Building SOG - 4,361 SF'								
385	03-11-11.000 --- SOG Form, Place & Finish*	196.70 cy	236,361	249,636	13,058	5,641	2,364	2,577.78 /cy	507,060
	045.031111.90.003 IX Pump Station Building - Building SOG - 4,361 SF'		236,361	249,636	13,058	5,641	2,364	/cy	507,060
386	045.031111.90.004 IX Pump Station Building - Dewatering Pad 16'x28'								
387	03-11-11.000 --- SOG Form, Place & Finish*	22.82 cy	37,216	30,316	1,768	1,056	274	3,095.74 /cy	70,629
	045.031111.90.004 IX Pump Station Building - Dewatering Pad 16'x28'		37,216	30,316	1,768	1,056	274	/cy	70,629
388	045.031111.90.005 IX Pump Station Building - MCC SOG - 11.8'x22'								
389	03-11-11.000 --- SOG Form, Place & Finish*	11.02 cy	13,865	14,048	749	786	133	2,683.78 /cy	29,581
	045.031111.90.005 IX Pump Station Building - MCC SOG - 11.8'x22'		13,865	14,048	749	786	133	/cy	29,581
390	045.031111.90.006 IX Pump Station Building - ACU1 SOG - 11.5'x21'								
391	03-11-11.000 --- SOG Form, Place & Finish*	10.57 cy	13,272	13,454	719	770	127	2,680.38 /cy	28,342
	045.031111.90.006 IX Pump Station Building - ACU1 SOG - 11.5'x21'		13,272	13,454	719	770	127	/cy	28,342
	03-31-04 Slab-on-Grade Place/Fin		383,331	385,667	20,111	13,617	3,550		806,275
392	03-31-05 Equip Pad/Base/Curb Pl/Fn								
393	045.031111.58.010 Pump Concrete Pad								
394	03-11-11.105 Equipment/Pump Concrete Pad	8.30 cy	43,368	12,480	161	4,027	98	7,248.45 /cy	60,133
	045.031111.58.010 Pump Concrete Pad		43,368	12,480	161	4,027	98	/cy	60,133
	03-31-05 Equip Pad/Base/Curb Pl/Fn		43,368	12,480	161	4,027	98		60,133
395	03-31-06 Wall Place/Finish								
396	045.033106.90.101 IX Pump Station Building - Pump Discharge Sump Walls - 6'x74'x2.6' (E. Wall)								
397	03-11-12.000 --- Lumber Formed Concrete Walls*	43.85 cy	88,326	60,517	3,030	3,136	524	3,546.79 /cy	155,534
	045.033106.90.101 IX Pump Station Building - Pump Discharge Sump Walls - 6'x74'x2.6' (E. Wall)		88,326	60,517	3,030	3,136	524	/cy	155,534
398	045.033106.90.102 IX Pump Station Building - Pump Discharge Sump Walls - 6'x74'x1' (W. Wall)								
399	03-11-12.000 --- Lumber Formed Concrete Walls*	16.44 cy	67,139	32,254	1,710	1,482	202	6,250.74 /cy	102,787
	045.033106.90.102 IX Pump Station Building - Pump Discharge Sump Walls - 6'x74'x1' (W. Wall)		67,139	32,254	1,710	1,482	202	/cy	102,787
400	045.033106.90.103 IX Pump Station Building - Pump Discharge Sump Walls - 6'x7.83'x3.58' (N & S. Wall)								
401	03-11-12.000 --- Lumber Formed Concrete Walls*	12.47 cy	21,160	16,099	795	1,732	148	3,202.35 /cy	39,933
	045.033106.90.103 IX Pump Station Building - Pump Discharge Sump Walls - 6'x7.83'x3.58' (N & S. Wall)		21,160	16,099	795	1,732	148	/cy	39,933
402	045.033106.90.201 IX Pump Station Building - Stem Wall @ Strip Footing - 2.5'x1'x350'								
403	03-11-12.000 --- Lumber Formed Concrete Walls*	32.41 cy	143,445	75,325	3,370	2,446	422	6,943.20 /cy	225,008
	045.033106.90.201 IX Pump Station Building - Stem Wall @ Strip Footing - 2.5'x1'x350'		143,445	75,325	3,370	2,446	422	/cy	225,008
	03-31-06 Wall Place/Finish		320,070	184,196	8,905	8,795	1,297		523,263
404	04-22-00 Concrete Unit Masonry								
405	045.042200.90.001 IX Feed Pump Station - Exterior Masonry Walls (08" Precision Face , No Color)								
406	04-22-00.000 --- Concrete Masonry Units (CMU Blocks)*	3,431.00 sf	367,832	83,543	25,658	29,365		147.59 /sf	506,398
	045.042200.90.001 IX Feed Pump Station - Exterior Masonry Walls (08" Precision Face , No Color)		367,832	83,543	25,658	29,365		/sf	506,398
407	045.042200.90.002 IX Feed Pump Station - Interior Masonry Walls (08" Precision Face , No Color)								
408	04-22-00.000 --- Concrete Masonry Units (CMU Blocks)*	1,018.00 sf	76,276	21,390	7,604	29,365		132.25 /sf	134,634
	045.042200.90.002 IX Feed Pump Station - Interior Masonry Walls (08" Precision Face , No Color)		76,276	21,390	7,604	29,365		/sf	134,634
409	045.042200.93.003 IX Feed Pump Station - Exterior Masonry Wall Soffit Covers (08" Precision Face, No Color)								
410	04-22-00.000 --- Concrete Masonry Units (CMU Blocks)*	525.00 sf	39,457	17,733	9,556	29,365		183.07 /sf	96,110
	045.042200.93.003 IX Feed Pump Station - Exterior Masonry Wall Soffit Covers (08" Precision Face, No Color)		39,457	17,733	9,556	29,365		/sf	96,110
	04-22-00 Concrete Unit Masonry		483,566	122,665	42,817	88,094			737,142
411	05-12-00 STRUCTURAL STEEL								
412	045.051200.90.001 IX Feed Pump Station - Structural Steel (HSS Roof Truss Mounting)								
413	05-12-00.020 --- Miscellaneous Steel Tube*	1,116.24 lf	27,117	165,061	20,364			190.41 /lf	212,542
	045.051200.90.001 IX Feed Pump Station - Structural Steel (HSS Roof Truss Mounting)		27,117	165,061	20,364			/lbs	212,542
414	045.051200.90.002 IX Feed Pump Station - Structural Steel (Channel Roof Truss Mounting)								
415	05-12-00.025 --- Miscellaneous Amer.Stnd. Channels*	570.00 lf	10,243	62,350	7,692			140.85 /lf	80,286
	045.051200.90.002 IX Feed Pump Station - Structural Steel (Channel Roof Truss Mounting)		10,243	62,350	7,692			/lbs	80,286
	05-12-00 STRUCTURAL STEEL		37,360	227,411	28,056				292,827
416	05-21-23 Joist Girders								
417	045.052123.90.001 IX Feed Pump Station - Trusses								
418	05-21-00.010 --- LH Series- Open Web Steel Joist*	765.00 lf	99,505	263,586	74,725			572.31 /lf	437,816
	045.052123.90.001 IX Feed Pump Station - Trusses		99,505	263,586	74,725			/lf	437,816
	05-21-23 Joist Girders		99,505	263,586	74,725				437,816
419	05-30-00 Metal Decking								
420	045.053000.90.001 IX Feed Pump Station - Metal Decking								
421	05-30-00.005 --- Metal Roof Deck*	11,832.00 sf	29,314	111,523	22,014			13.76 /sf	162,852
	045.053000.90.001 IX Feed Pump Station - Metal Decking		29,314	111,523	22,014			/sf	162,852
	05-30-00 Metal Decking		29,314	111,523	22,014				162,852
422	05-53-00 Metal Gratings								
423	045.055300.90.001 IX Pump Station Building - Pump Discharge Sump Grating - 8'x67'								
424									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	05-53-00.005 --- Aluminum Grating*	536.00 sf	35,223	162,324	11,416			389.86 /sf	208,964
	045.055300.90.001 IX Pump Station Building - Pump Discharge Sump Grating - 8'x67'		35,223	162,324	11,416			/sf	208,964
	05-53-00 Metal Gratings		35,223	162,324	11,416				208,964
425	05-58-00 Formed Metal Fabrications								
426	045.055800.90.001 IX Feed Pump Station - Handrails (Entry Stair Handrails) 2 Locations								
427	05-52-00.000 --- Pipe Railing Handrails- Horizontal Railing*	52.34 lf	4,325	17,614			114	421.34 /lf	22,054
	045.055800.90.001 IX Feed Pump Station - Handrails (Entry Stair Handrails) 2 Locations		4,325	17,614			114	/lf	22,054
	05-58-00 Formed Metal Fabrications		4,325	17,614			114		22,054
428	07-22-00 Insulation - Roof and Deck								
429	045.072200.90.001 IX Feed Pump Station - Roof Deck Insulation R-30								
430	07-22-00.000 --- Roof & Deck Insulation & Cover Boards (Pick List)*	11,832.00 sf	37,809	110,224				12.51 /sf	148,033
	045.072200.90.001 IX Feed Pump Station - Roof Deck Insulation R-30		37,809	110,224				/sf	148,033
	07-22-00 Insulation - Roof and Deck		37,809	110,224					148,033
431	07-41-00 Roof Panels								
432	045.074100.90.001 IX Feed Pump Station - Standing Seam Metal Roof Panels								
433	07-41-00.000 --- Metal Roof Panels*	6,118.00 sf	174,893	319,335		9,788		82.38 /sf	504,016
	045.074100.90.001 IX Feed Pump Station - Standing Seam Metal Roof Panels		174,893	319,335		9,788		/sf	504,016
434	045.074100.90.002 IX Feed Pump Station - Standing Seam Meatal Roof - Eave Soffit								
435	07-41-00.000 --- Metal Roof Panels*	1,000.00 sf	16,472	31,934				48.41 /sf	48,405
	045.074100.90.002 IX Feed Pump Station - Standing Seam Meatal Roof - Eave Soffit		16,472	31,934				/sf	48,405
	07-41-00 Roof Panels		191,364	351,269		9,788			552,421
436	07-71-00 Roof Specialties								
437	045.077100.90.001 IX Feed Pump Station - Roof Specialties (Downspouts & Gutters)								
438	07-71-00.030 --- Gutters, Downspouts & Accessories*	1.00 ls	17,331	22,132				39,462.53 /ls	39,463
	045.077100.90.001 IX Feed Pump Station - Roof Specialties (Downspouts & Gutters)		17,331	22,132				/ls	39,463
	07-71-00 Roof Specialties		17,331	22,132					39,463
439	07-72-33 Roof Hatches								
440	045.077233.90.001 IX Feed Pump Station - Roof Hatch								
441	07-72-00.005 --- Roof Accessories Hatches/Vents/Snow Guards(Pick List)*	7.00 ea	13,488	58,716	6,641			11,263.49 /ea	78,844
	045.077233.90.001 IX Feed Pump Station - Roof Hatch		13,488	58,716	6,641			/ea	78,844
	07-72-33 Roof Hatches		13,488	58,716	6,641				78,844
442	07-84-00 Firestopping								
443	045.078400.90.001 IX Feed Pump Station - Firestopping								
444	07-84-00.005 --- Firestopping (Pick List)*	1.00 ls	9,161	7,193				16,354.11 /ls	16,354
	045.078400.90.001 IX Feed Pump Station - Firestopping		9,161	7,193				/ls	16,354
	07-84-00 Firestopping		9,161	7,193					16,354
445	07-92-00 Joint Sealants								
446	045.079200.90.001 IX Feed Pump Station - Joint Sealants								
447	07-92-00.000 --- Joint Sealants*	2,500.00 lf	29,444	14,714				17.66 /lf	44,159
	045.079200.90.001 IX Feed Pump Station - Joint Sealants		29,444	14,714				/lf	44,159
	07-92-00 Joint Sealants		29,444	14,714					44,159
448	08-11-00 Hollow Metal Doors & Frames								
449	045.081100.90.001 IX Feed Pump Station - Exterior Doors 30x86 w/ single light								
450	08-11-00.005 --- Hollow Metal Door Frames*	4.00 ea	36,752	58,370			30	23,787.94 /ea	95,152
	045.081100.90.001 IX Feed Pump Station - Exterior Doors 30x86 w/ single light		36,752	58,370			30	/ea	95,152
451	045.081100.90.002 IX Feed Pump Station - Exterior Doors 60x86 w/ single light								
452	08-11-00.005 --- Hollow Metal Door Frames*	1.00 ea	10,027	16,920			7	26,954.60 /ea	26,955
	045.081100.90.002 IX Feed Pump Station - Exterior Doors 60x86 w/ single light		10,027	16,920			7	/ea	26,955
453	045.081100.90.101 IX Feed Pump Station - Interior Doors 30x86 w/ single light								
454	08-11-00.005 --- Hollow Metal Door Frames*	2.00 ea	17,071	29,185			15	23,135.39 /ea	46,271
	045.081100.90.101 IX Feed Pump Station - Interior Doors 30x86 w/ single light		17,071	29,185			15	/ea	46,271
	08-11-00 Hollow Metal Doors & Frames		63,850	104,475			52		168,377
455	08-33-23 Overhead Coiling Doors								
456	045.083323.90.001 IX Feed Pump Station - OH Coiling Doors 10x10 w/ motor operator								
457	08-36-13.000 --- Coiling Overhead Steel Doors *	1.00 ea	10,241	16,835	680		1,270	29,025.23 /ea	29,025
	045.083323.90.001 IX Feed Pump Station - OH Coiling Doors 10x10 w/ motor operator		10,241	16,835	680		1,270	/ea	29,025
458	045.083323.90.002 IX Feed Pump Station - OH Coiling Doors 8 x10 w/ motor operator								
459	08-36-13.000 --- Coiling Overhead Steel Doors *	1.00 ea	9,968	14,903	680		1,270	26,819.92 /ea	26,820
	045.083323.90.002 IX Feed Pump Station - OH Coiling Doors 8 x10 w/ motor operator		9,968	14,903	680		1,270	/ea	26,820
	08-33-23 Overhead Coiling Doors		20,208	31,737	1,360		2,540		55,845
460	08-41-13 Aluminum-Framed Entrances and Storefronts								
461	045.084113.90.001 IX Feed Pump Station - Exterior Storefront window								
462	08-41-13.000 --- Aluminum Storefronts (Pick List)*	18.00 sf	692	1,311				111.26 /sf	2,003
	045.084113.90.001 IX Feed Pump Station - Exterior Storefront window		692	1,311				/sf	2,003
463	045.084113.90.002 IX Feed Pump Station - Interior Storefront window								
464	08-41-13.000 --- Aluminum Storefronts (Pick List)*	12.00 sf	507	781				107.27 /sf	1,287
	045.084113.90.002 IX Feed Pump Station - Interior Storefront window		507	781				/sf	1,287
	08-41-13 Aluminum-Framed Entrances and Storefronts		1,199	2,091					3,290
465	08-90-00 Louvers & Vents								
466	2025-04 SJW Williams Treatment PFAS Facility-100								

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
466	**045.089000.90.001 IX Feed Pump Station - Louvers 5x5**								
467	08-90-00.010 --- Aluminum Louvers - SF Reference (Pick List)*	2.00 ea	27,299	28,249	16,640			36,093.68 /ea	72,187
	045.089000.90.001 IX Feed Pump Station - Louvers 5x5		**27,299**	**28,249**	**16,640**			**/ea**	**72,187**
468	**045.089000.90.002 IX Feed Pump Station - Louvers 2x2**								
469	08-90-00.010 --- Aluminum Louvers - SF Reference (Pick List)*	1.00 ea	2,743	4,684	1,331			8,757.39 /ea	8,757
	045.089000.90.002 IX Feed Pump Station - Louvers 2x2		**2,743**	**4,684**	**1,331**			**/ea**	**8,757**
	08-90-00 Louvers & Vents		30,041	32,933	17,971				80,945
470	09-91-00.20 Painting Structural Metals								
471	**045.099100.90.001 IX Feed Pump Station - Structural Steel Paint Touch up**								
472	09-96-00.015 --- Structural Steel Touch Up (Field Services)*	2,333.33 sf	11,093	20,970				13.74 /sf	32,063
	045.099100.90.001 IX Feed Pump Station - Structural Steel Paint Touch up		**11,093**	**20,970**				**/sf**	**32,063**
	09-91-00.20 Painting Structural Metals		11,093	20,970					32,063
473	09-91-13 Painting - Exterior								
474	**045.099113.90.001 IX Feed Pump Station - Exterior Painting**								
475	09-91-00.005 --- Architectural Painting*	4,971.00 sf	39,443	26,852				13.34 /sf	66,295
	045.099113.90.001 IX Feed Pump Station - Exterior Painting		**39,443**	**26,852**				**/sf**	**66,295**
	09-91-13 Painting - Exterior		39,443	26,852					66,295
476	09-91-23 Painting - Interior								
477	**045.099123.90.001 IX Feed Pump Station - Interior Painting**								
478	09-91-00.005 --- Architectural Painting*	12,587.00 sf	89,248	65,985				12.33 /sf	155,233
	045.099123.90.001 IX Feed Pump Station - Interior Painting		**89,248**	**65,985**				**/sf**	**155,233**
	09-91-23 Painting - Interior		89,248	65,985					155,233
479	10-14-00 Signage								
480	**045.101400.90.001 IX Feed Pump Station - Interior Signage**								
481	10-14-00.000 --- Signage- (Pick-List)*	49.00 ea	6,248	6,360				257.31 /ea	12,608
	045.101400.90.001 IX Feed Pump Station - Interior Signage		**6,248**	**6,360**				**/ea**	**12,608**
	10-14-00 Signage		6,248	6,360					12,608
482	10-22-13 Wire Mesh Partitions								
483	**045.102213.93.005 Wire Mesh Partition in Electrical Room**								
484	10-22-13.000 --- Wire Mesh Partitions (Pick List)*	20.00 lf	2,323	4,171				324.70 /lf	6,494
	045.102213.93.005 Wire Mesh Partition in Electrical Room		**2,323**	**4,171**				**/lf**	**6,494**
	10-22-13 Wire Mesh Partitions		2,323	4,171					6,494
485	10-44-00 Fire Protection Specialties								
486	**045.104400.90.001 IX Feed Pump Station - Fire Extinguishers (20lb In Cabinet)**								
487	10-44-00.000 --- Fire Extinguishers & Cabinets (Pick List)*	6.00 ea	1,651	7,281				1,488.64 /ea	8,932
	045.104400.90.001 IX Feed Pump Station - Fire Extinguishers (20lb In Cabinet)		**1,651**	**7,281**				**/ea**	**8,932**
	10-44-00 Fire Protection Specialties		1,651	7,281					8,932
488	22-00-00 Plumbing								
489	**055.220000.84.001 Drain Pipe**								
490	22-11-16.035 3" - V - PVC	60.00 lf	19,502	2,841				372.39 /lf	22,343
491	22-11-16.035 6" - Drain - PVC	90.00 lf	24,679	8,763				371.57 /lf	33,442
492	22-11-16.035 4" - Drain - PVC	150.00 lf	27,860	2,808				204.45 /lf	30,668
493	22-11-16.060 4" Floor Sinks	16.00 ea	19,475	53,703				4,573.63 /ea	73,178
	055.220000.84.001 Drain Pipe		**91,516**	**68,115**				**/lf**	**159,631**
	22-00-00 Plumbing		91,516	68,115					159,631
494	23-05-93 Automatic Temperature Control/Test & Balance								
495	**055.230593.84.001 Automatic Temperature Controls**								
496	23-05-93.005 Automatic Temperature Controls	1.00 ea				104,303		104,303.34 /ea	104,303
	055.230593.84.001 Automatic Temperature Controls					**104,303**			**104,303**
497	**055.230593.84.003 Test & Balance**								
498	23-05-93.005 Test & Balance	1.00 ea	6,162			4,649		10,811.81 /ea	10,812
	055.230593.84.003 Test & Balance		**6,162**			**4,649**			**10,812**
	23-05-93 Automatic Temperature Control/Test & Balance		6,162			108,953			115,115
499	23-31-13 Metal Ductwork								
500	**055.233113.84.001 Rectangular Galvanized Steel Ductwork**								
501	23-31-13.010 36"x36" - EA - Galvanized Steel	50.00 lf	33,512	18,282	885			1,053.57 /lf	52,678
502	23-31-13.010 24"x24" - EA - Galvanized Steel	35.00 lf	16,120	9,070	507			734.22 /lf	25,698
503	23-31-13.010 40"x24" - RA - Galvanized Steel	5.00 lf	8,019	5,089	47			2,630.95 /lf	13,155
504	23-31-13.010 24"x47" - SA - Galvanized Steel	5.00 lf	6,184	5,664	47			2,379.22 /lf	11,896
	055.233113.84.001 Rectangular Galvanized Steel Ductwork		**63,835**	**38,105**	**1,487**				**103,427**
505	**055.233113.84.003 Round Galvanized Steel Ductwork**								
506	23-31-13.020 30" - SA - Galv. Steel	70.00 lf	24,355	49,405	411			1,059.58 /lf	74,171
	055.233113.84.003 Round Galvanized Steel Ductwork		**24,355**	**49,405**	**411**				**74,171**
	23-31-13 Metal Ductwork		88,189	87,510	1,898				177,597
507	23-33-00 Ductwork Accessories								
508	**055.233300.84.001 Louvers**								
509	23-37-15.005 Louvers (OAL-1-2)	2.00 ea	35,123	47,044	6,187			44,177.22 /ea	88,354
510	23-37-15.005 Louver (OAL-3)	1.00 ea	4,133	7,995	495			12,622.63 /ea	12,623

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	055.233300.84.001 Louvers		39,256	55,039	6,682				100,977
	23-33-00 Ductwork Accessories		39,256	55,039	6,682				100,977
511	23-34-00 HVAC Fans								
512	055.233400.84.001 Fans								
513	23-34-00.005 Fans (VF-1-2)	2.00 ea	18,321	20,684	1,501			20,253.38 /ea	40,507
	055.233400.84.001 Fans		18,321	20,684	1,501				40,507
	23-34-00 HVAC Fans		18,321	20,684	1,501				40,507
514	23-74-00 Packaged Outdoor HVAC Equipment								
515	055.237400.84.001 Packaged Air Conditioning Unit								
516	22-11-16.020 1" - CD - PVC	30.00 lf	3,844	1,621	10			182.51 /lf	5,475
517	23-74-00.010 Packaged Air Conditioning Unit (ACU-1)	1.00 ea	14,575	48,202	9,487			72,264.56 /ea	72,265
	055.237400.84.001 Packaged Air Conditioning Unit		18,419	49,824	9,497				77,740
	23-74-00 Packaged Outdoor HVAC Equipment		18,419	49,824	9,497				77,740
518	23-82-39 Unit Heaters								
519	055.238239.84.001 Electric Unit Heaters								
520	23-55-33.010 Electric Unit Heaters (EUH-1-5)	5.00 ea	20,192	22,788	2,117			9,019.41 /ea	45,097
	055.238239.84.001 Electric Unit Heaters		20,192	22,788	2,117				45,097
	23-82-39 Unit Heaters		20,192	22,788	2,117				45,097
521	26-05-18.050 Feeders								
522	045.260517.01.001 Ethernet Feeder - PFAS-PLC to Feed Pump VFDs								
523	26-05-33.484 S40 PVC & Cu Str- pfas-plc to feed pump vfd (in mcc)	175.00 lf	9,832	4,328				80.91 /lf	14,159
	045.260517.01.001 Ethernet Feeder - PFAS-PLC to Feed Pump VFDs		9,832	4,328				/lf	14,159
	26-05-18.050 Feeders		9,832	4,328					14,159
524	26-05-18.100 Branch Circuits								
525	045.260511.01.001 Building Lighting Branch								
526	26-05-33.205 GRC & Cu Str- ltg branch, ix feed ps	820.00 lf	62,891	9,326	823			89.07 /lf	73,040
	045.260511.01.001 Building Lighting Branch		62,891	9,326	823			/lf	73,040
527	045.260512.01.001 Building Receptacle Branch								
528	26-05-33.205 GRC & Cu Str- recp branch, ix feed ps	375.00 lf	32,155	4,336	301			98.11 /lf	36,792
	045.260512.01.001 Building Receptacle Branch		32,155	4,336	301			/lf	36,792
	26-05-18.100 Branch Circuits		95,046	13,661	1,124				109,832
529	26-05-26 Grounding & Bonding for Electrical Systems								
530	045.260526.01.001 Grounding - Pump Station								
531	26-05-26.000 Cu Grounding- pump station	2,000.00 lf	74,863	86,822	2,171			81.93 /lf	163,856
	045.260526.01.001 Grounding - Pump Station		74,863	86,822	2,171			/lf	163,856
	26-05-26 Grounding & Bonding for Electrical Systems		74,863	86,822	2,171				163,856
532	26-05-83 Wiring Connections								
533	045.260583.01.001 Equipment Connect & Feed - IX Feed Pumps								
534	26-05-33.225 PVC-CTD-GRC Riser & Cu Str- db to ix feed pumps	70.00 lf	53,017	35,013				1,257.56 /lf	88,029
535	26-05-33.484 S40 PVC & Cu Str- mcc-x (vfd) to ix feed pumps	560.00 lf	110,215	62,857	450			309.86 /lf	173,522
536	26-05-33.484 S40 PVC & Cu Str- mcc-x (vfd) to ix feed pumps, spare 1"	560.00 lf	25,260	3,264				50.94 /lf	28,524
537	26-05-33.484 S40 PVC & Cu Str- mcc-x (vfd) to ix feed pumps, spare 2"	560.00 lf	40,803	6,915				85.21 /lf	47,717
538	26-05-83.320 Equipment connection- ix feed pumps	7.00 ea	34,876	25,540				8,630.82 /ea	60,416
	045.260583.01.001 Equipment Connect & Feed - IX Feed Pumps		264,170	133,588	450			/ea	398,208
539	045.260583.01.002 Equipment Connect & Feed - EUH-1, 2, 3, 4, 5								
540	26-05-33.225 PVC-CTD-GRC & Cu Str- dp1 to euh-1,2,3,4,5	600.00 lf	48,664	16,764	401	362		110.32 /lf	66,191
541	26-05-83.320 Equipment connection- euh-	5.00 ea	5,219	2,119				1,467.73 /ea	7,339
	045.260583.01.002 Equipment Connect & Feed - EUH-1, 2, 3, 4, 5		53,883	18,883	401	362		/ea	73,530
542	045.260583.01.003 Equipment Connect & Feed - VF-1, 2								
543	26-05-33.225 PVC-CTD-GRC & Cu Str- dp1 to vf-1,2	400.00 lf	34,329	11,734	321	290		116.69 /lf	46,675
544	26-05-83.320 Equipment connection- vf-	4.00 ea	4,175	1,696				1,467.73 /ea	5,871
	045.260583.01.003 Equipment Connect & Feed - VF-1, 2		38,505	13,430	321	290		/ea	52,545
545	045.260583.01.004 Equipment Connect & Feed - ACU-1								
546	26-05-33.205 GRC & Cu Str- acu-1 to t-stat	50.00 lf	3,892	519	40	72		90.47 /lf	4,524
547	26-05-33.225 PVC-CTD-GRC & Cu Str- dp-1 to acu-1	70.00 lf	12,262	4,373	80	72		239.82 /lf	16,787
548	26-05-83.320 Equipment connection- acu-1	1.00 ea	3,761	3,181				6,941.39 /ea	6,941
549	26-28-16.105 NF Equipment Disconnect- acu-1	1.00 ea	5,062	9,091				14,152.80 /ea	14,153
	045.260583.01.004 Equipment Connect & Feed - ACU-1		24,977	17,163	120	145		/ea	42,405
550	045.260583.01.005 Equipment Connect & Feed - Sump Pump								
551	26-05-33.225 PVC-CTD-GRC & Cu Str- dp1 to sump pump	130.00 lf	10,308	3,562	80	72		107.87 /lf	14,023
552	26-05-83.320 Equipment connection- sump pump	1.00 ea	1,044	424				1,467.71 /ea	1,468
	045.260583.01.005 Equipment Connect & Feed - Sump Pump		11,352	3,986	80	72		/ea	15,491
553	045.260583.01.006 Equipment Connect & Feed - IX Feed Pump Heaters								
554	26-05-33.484 S40 PVC & Cu Str- lp-1 to ix feed pump heaters	2,730.00 lf	130,850	15,465				53.60 /lf	146,315
555	26-05-83.320 Equipment connection- ix feed pump heaters	7.00 ea	7,307	2,967				1,467.73 /ea	10,274
	045.260583.01.006 Equipment Connect & Feed - IX Feed Pump Heaters		138,157	18,432				/ea	156,589
556	045.260584.01.001 I&C Connect & Feed - IX Feed Pumps								
557	26-05-02.000 I&C Instrument Connections- ix feed pumps, control	7.00 ea	10,558	3,583				2,020.07 /ea	14,140
558									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	26-05-02.000 I&C Instrument Connections- ix feed pumps, signal	35.00 ea	48,426	22,656				2,030.92 /ea	71,082
559	26-05-33.484 S40 PVC & Cu Str- pfas-plc to ix feed pump psh-	560.00 lf	34,266	5,196				70.47 /lf	39,463
560	26-05-33.484 S40 PVC & Cu Str- pfas-plc to ix feed pump te-50xa	560.00 lf	43,568	17,826				109.63 /lf	61,394
561	26-05-33.484 S40 PVC & Cu Str- pfas-plc to ix feed pump vt-50x	560.00 lf	43,567	17,826				109.63 /lf	61,394
562	26-05-33.484 S40 PVC & Cu Str- pfas-plc to ix feed pump le50x	560.00 lf	33,259	8,905				75.29 /lf	42,165
563	26-05-33.484 S40 PVC & Cu Str- pfas-plc to ix feed pump pit/pe50x	560.00 lf	33,260	8,905				75.29 /lf	42,165
564	26-05-33.484 S40 PVC & Cu Str- pfas-plc to ix feed pump fit/fe50x	560.00 lf	33,259	8,905				75.29 /lf	42,165
565	26-05-33.484 S40 PVC & Cu Str- lp-1 to ix feed pump fit/fe 50x, power	490.00 lf	32,978	5,283				78.08 /lf	38,260
	045.260584.01.001 I&C Connect & Feed - IX Feed Pumps		**313,142**	**99,086**				**/ea**	**412,227**
566	**045.260584.01.002 I&C Connect & Feed - IX Feed Pump Discharge**								
567	26-05-02.000 I&C Instrument Connections- ix feed pump discharge	2.00 ea	2,767	1,295				2,030.94 /ea	4,062
568	26-05-33.484 S40 PVC & Cu Str- pfas-plc to ix feed pump discharge inst	220.00 lf	10,312	2,687				59.09 /lf	12,999
569	26-05-33.484 S40 PVC & Cu Str- lp-1 to ix feed pump discharge fit/fe510	100.00 lf	5,208	672				58.80 /lf	5,880
	045.260584.01.002 I&C Connect & Feed - IX Feed Pump Discharge		**18,287**	**4,654**				**/ea**	**22,941**
	26-05-83 Wiring Connections		862,473	309,222	1,373	869			1,173,936
570	26-27-26 Devices & Accessories								
571	**045.262726.01.001 Receptacles**								
572	26-27-26.000 Receptacles- ix feed ps	15.00 ea	8,743	2,582				755.00 /ea	11,325
	045.262726.01.001 Receptacles		**8,743**	**2,582**				**/ea**	**11,325**
573	**045.262728.01.001 Lighting Control - IX Feed Pump Station**								
574	26-27-26.070 Ltg control- ix feed ps	5.00 ea	3,969	1,258				1,045.39 /ea	5,227
	045.262728.01.001 Lighting Control - IX Feed Pump Station		**3,969**	**1,258**				**/ea**	**5,227**
	26-27-26 Devices & Accessories		12,713	3,839					16,552
575	26-50-00 Lighting								
576	**045.265100.01.001 Building Lighting - IX Feed Pump Station**								
577	26-51-00.005 Building Lighting Fixture Box & Attachment- exits, wall sconces	10.00 ea	3,643	1,175				481.80 /ea	4,818
578	26-51-00.155 D LED Architectural Exterior Wall Sconce Fixture	5.00 ea	2,397	9,701	201			2,459.73 /ea	12,299
579	26-51-00.165 A/A1 4' LED Linear Low-bay Fixture	26.00 ea	46,797	39,723	1,044			3,367.81 /ea	87,563
580	26-52-13.160 E Exit Fixtures	5.00 ea	1,917	2,529	201			929.37 /ea	4,647
	045.265100.01.001 Building Lighting - IX Feed Pump Station		**54,754**	**53,128**	**1,445**			**/ea**	**109,327**
	26-50-00 Lighting		54,754	53,128	1,445				109,327
581	31-23-16.16 Foundation Excavation								
582	**045.312316.90.001 IX Pump Station Building - Slab Over Ex - 5' Scarify & Recompact**								
583	31-23-00.005 --- Structure Excavation & Backfill	969.02 cy	10,284	10,023	8,213	2,511		32.02 /cy	31,031
	045.312316.90.001 IX Pump Station Building - Slab Over Ex - 5' Scarify & Recompact		**10,284**	**10,023**	**8,213**	**2,511**		**/cy**	**31,031**
584	**045.312316.90.002 IX Pump Station Building - Pump Can Sump Excavation - 60'x10'x20'**								
585	31-23-00.005 --- Structure Excavation & Backfill	1,534.44 cy	24,808	68,393	27,330	17,134		89.72 /cy	137,665
	045.312316.90.002 IX Pump Station Building - Pump Can Sump Excavation - 60'x10'x20'		**24,808**	**68,393**	**27,330**	**17,134**		**/cy**	**137,665**
586	**045.312316.90.003 IX Pump Station Building - Pump Discharge Sump Excavation - 75'x13'x10'**								
587	31-23-00.005 --- Structure Excavation & Backfill	962.28 cy	18,069	36,036	20,409	9,028		86.82 /cy	83,542
	045.312316.90.003 IX Pump Station Building - Pump Discharge Sump Excavation - 75'x13'x10'		**18,069**	**36,036**	**20,409**	**9,028**		**/cy**	**83,542**
	31-23-16.16 Foundation Excavation		53,161	114,452	55,952	28,672			252,238
588	40-05-19 Ductile Iron Pipe								
589	**045.400519.91.005 36" UG RW-DI Pipe Encased**								
590	40-05-19.300 36" UG RW-DI Encased Pipe Including Stub up RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	30.00 lf	27,372	86,087	6,992	94		4,018.17 /lf	120,545
	045.400519.91.005 36" UG RW-DI Pipe Encased		**27,372**	**86,087**	**6,992**	**94**		**/lf**	**120,545**
591	**045.400519.91.010 36" AG RW-DI from Vault**								
592	40-05-19.100 36" AG RW-DI from Vault FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	67.00 lf	112,703	777,309	9,759	217		13,432.65 /lf	899,988
593	40-05-64.005 36" RW- Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	2.00 ea	19,833	254,588	11,917		82	143,210.49 /ea	286,421
594	40-05-78.260 --- Vacuum Relief Valve - 1/2" to 3"	1.00 ea	946	5,834	205		21	7,005.56 /ea	7,006
595	40-70-00.030 36 FE- Flow Elements Only	1.00 ea	10,088	88,430	190		306	99,014.86 /ea	99,015
	045.400519.91.010 36" AG RW-DI from Vault		**143,571**	**1,126,162**	**22,071**	**217**	**409**	**/lf**	**1,292,429**
596	**045.400519.91.015 30" AG RW-DI at Vault**								
597	40-05-19.100 30" AG RW-DI at Vault FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	15.00 lf	25,214	155,170	2,162	48		12,172.96 /lf	182,594
	045.400519.91.015 30" AG RW-DI at Vault		**25,214**	**155,170**	**2,162**	**48**		**/lf**	**182,594**
598	**045.400519.91.020 24" AG RW-DI at Vault**								
599	40-05-19.100 24" AG RW-DI at Vault FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	8.00 lf	19,537	42,450	815	13		7,851.86 /lf	62,815
	045.400519.91.020 24" AG RW-DI at Vault		**19,537**	**42,450**	**815**	**13**		**/lf**	**62,815**
600	**045.400519.91.025 16" AG RW-DI at Vault**								
601	40-05-19.100 20" AG RW-DI at Vault FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	4.00 lf	4,894	9,697	252	3		3,711.57 /lf	14,846
	045.400519.91.025 16" AG RW-DI at Vault		**4,894**	**9,697**	**252**	**3**		**/lf**	**14,846**
602	**045.400519.91.030 16" RW-DI from VTP to Vault**								
603	40-05-07.025 16" RW Pipe Hangers - Stanchion/Support (Anvil 259/63)*	21.00 ea	58,511	50,355				5,184.07 /ea	108,865
604	40-05-19.100 16" AG RW-DI from VTP to Vault FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	238.00 lf	97,941	199,098	14,527	170		1,309.82 /lf	311,736
605	40-05-64.005 16" RW-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	7.00 ea	35,902	79,471	21,242		287	19,557.56 /ea	136,903
606	40-05-65.025 16" RW-DI Check Valve - Cast Iron/DI, Ball Check, Flanged, 2" to 30"	7.00 ea	32,821	368,849	19,321		287	60,182.58 /ea	421,278
607	40-70-00.030 16" RW-DI Propeller Meter - Flow Elements Only (Pick List)*	7.00 ea	188,337	1,624,905	1,329		15,015	261,369.38 /ea	1,829,586

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	045.400519.91.030 16" RW-DI from VTP to Vault		413,512	2,322,678	56,419	170	15,589	/lf	2,808,368
608	045.400519.91.035 20" UG RW-DI Encased Pipe								
609	40-05-19.300 20" UG RW-DI Encased Pipe RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	133.00 lf	16,060	52,211	3,048	133		537.23 /lf	71,452
	045.400519.91.035 20" UG RW-DI Encased Pipe		16,060	52,211	3,048	133		/lf	71,452
	40-05-19 Ductile Iron Pipe		650,160	3,794,454	91,760	678	15,998		4,553,050
610	40-05-23 Stainless Steel Pipe								
611	045.400523.91.005 1" RW-SST from VTP to Vault Instrument Pipe								
612	40-05-23.205 1" SST to ARV for Instruments Schd 40 Pipe Threaded & Coupled (1/8" to 4")*	42.00 lf	8,880	4,717	25			324.33 /lf	13,622
613	40-05-78.210 1" Air Release Valve - Cast Iron/Stainless Steel, 1/2" to 6"	7.00 ea	3,248	10,652	699		144	2,106.11 /ea	14,743
	045.400523.91.005 1" RW-SST from VTP to Vault Instrument Pipe		12,127	15,370	724		144	/lf	28,365
614	045.400523.91.010 .5" RW-SST from VTP to Vault Instrument Pipe on 20" RW Pipe								
615	40-05-23.205 .5" SST to instruments Stainless Schd 40 Pipe Threaded & Coupled (1/8" to 4")*	56.00 lf	4,976	3,246	227			150.86 /lf	8,448
616	40-05-63.015 .5 Ball Valve - Stainless Steel, 1/2" to 12"	21.00 ea	5,069	15,042	1,232		862	1,057.32 /ea	22,204
	045.400523.91.010 .5" RW-SST from VTP to Vault Instrument Pipe on 20" RW Pipe		10,045	18,287	1,458		862	/lf	30,652
617	045.400523.91.015 .5" RW-SST Instrument Pipe on 36" RW Pipe								
618	40-05-23.205 .5 RW-SST to Instruments Stainless Schd 40 Pipe Threaded & Coupled (1/8" to 4")*	7.00 lf	847	375	2			174.85 /lf	1,224
619	40-05-63.015 .5" Ball Valve - Stainless Steel, 1/2" to 12"	2.00 ea	483	1,433	117		82	1,057.33 /ea	2,115
	045.400523.91.015 .5" RW-SST Instrument Pipe on 36" RW Pipe		1,330	1,807	119		82	/lf	3,339
	40-05-23 Stainless Steel Pipe		23,503	35,464	2,302		1,087		62,355
620	40-05-24 Steel Pipe								
621	045.400524.091.005 3" RW-Gal from to AVRF and Instruments								
622	40-05-24.310 3" RW-Galv from to AVRF and Instruments Galvanized A53 CW T&C Pipe & Malleable Fittings (1/8" to 6")*	35.00 lf	43,357	18,009	16			1,753.76 /lf	61,382
623	40-05-63.005 3" RW Ball Valve - Bronze, Threaded, 1/2" to 2-1/2"	7.00 ea	5,026	10,478	1,138		287	2,418.43 /ea	16,929
624	40-05-78.210 3" AVRF Air Release Valve - Cast Iron/Stainless Steel, 1/2" to 6"	7.00 ea	6,623	25,812	1,435		144	4,859.07 /ea	34,013
	045.400524.091.005 3" RW-Gal from to AVRF and Instruments		55,006	54,298	2,589		431	/lf	112,324
	40-05-24 Steel Pipe		55,006	54,298	2,589		431		112,324
625	40-05-31 PVC Plastic Pipe								
626	055.400531.84.001 Condensate Drain								
627	40-05-31.131 1" - CD	30.00 lf	4,345	2,204	507	112		238.95 /lf	7,168
	055.400531.84.001 Condensate Drain		4,345	2,204	507	112		/lf	7,168
	40-05-31 PVC Plastic Pipe		4,345	2,204	507	112			7,168
628	40-70-00 Instrumentation for Process Systems								
629	045.407000.01.001 I&C Instruments								
630	40-70-00.010 I&C Instruments- ix feed pumps	49.00 ea	93,819		9,300		17,160	2,454.67 /ea	120,279
	045.407000.01.001 I&C Instruments		93,819		9,300		17,160		120,279
	40-70-00 Instrumentation for Process Systems		93,819		9,300		17,160		120,279
631	43-24-11 Vertical Turbine Pumps								
632	045.432411.67.001 IX Feed Pumps (3,300 gpm @ 169'TDH, 200HP)								
633	43-24-11.010 IX Feed Pumps (3,300 gpm @ 169'TDH, 200HP)	7.00 ea	122,946	1,711,432	41,772		183,600	294,249.97 /ea	2,059,750
	045.432411.67.001 IX Feed Pumps (3,300 gpm @ 169'TDH, 200HP)		122,946	1,711,432	41,772		183,600		2,059,750
634	045.466133.67.001 IX Feed Pump Sound Enclosure with Fan								
635	23-34-00.005 IX Feed Pump Sound Enclosure Ventilation Fan	7.00 ea	97,058					13,865.38 /ea	97,058
636	33-14-23.000 --- Enclosures for Vertical Turbine Pumps	7.00 ea	85,422	602,059	18,636		82,299	112,630.93 /ea	788,417
	045.466133.67.001 IX Feed Pump Sound Enclosure with Fan		182,480	602,059	18,636		82,299		885,474
	43-24-11 Vertical Turbine Pumps		305,426	2,313,491	60,408		265,899		2,945,224
637	43-25-00 Submersible/Immersible Liquid Pumps								
638	045.432500.67.005 Submersible Sump Pump, 1/2 hp at IX Feed Pump Station								
639	43-25-00.005 GOULDS GSP0511, 1/2 HP	1.00 ea	3,579	3,357				6,936.41 /ea	6,936
	045.432500.67.005 Submersible Sump Pump, 1/2 hp at IX Feed Pump Station		3,579	3,357					6,936
	43-25-00 Submersible/Immersible Liquid Pumps		3,579	3,357					6,936
	045 IX FEED PUMP STATION	1.00 ls	5,158,860	9,833,397	577,046	275,437	333,732	16,178,472.02 /ls	16,178,472
640	050 IX TREATMENT								
641	01-00-00 GENERAL REQUIREMENTS								
642	050.010000.90.001 IX Treatment - Special Inspections								
643	01-00-00.010 --- General Conditions Checklist*	1.00 ls					23,514	23,513.97 /ls	23,514
	050.010000.90.001 IX Treatment - Special Inspections						23,514	/ls	23,514
	01-00-00 GENERAL REQUIREMENTS						23,514		23,514
644	03-11-10 Concrete Encasement								
645	050.031110.91.005 30" UG IXE-DI Encased Pipe.								
646	03-11-10.005 30" UG IXE-ID Encased Pipe. Horizontal Concrete Encasement*	130.19 cy	306,984	164,844	68,548	5,769	1,531	4,206.77 /cy	547,675
	050.031110.91.005 30" UG IXE-DI Encased Pipe.		306,984	164,844	68,548	5,769	1,531	/cy	547,675
647	050.031110.93.010 36" UG IXE-DI Encased Pipe.								
648	03-11-10.005 36" UG IXE-ID Encased Pipe. Horizontal Concrete Encasement*	68.12 cy	160,117	87,666	24,045	3,054	801	4,047.07 /cy	275,682
	050.031110.93.010 36" UG IXE-DI Encased Pipe.		160,117	87,666	24,045	3,054	801	/cy	275,682
	03-11-10 Concrete Encasement		467,101	252,509	92,593	8,823	2,332		823,358
649	03-31-04 Slab-on-Grade Place/Fin								
650	050.031111.90.001 IX Treatment Building - Slab on grade - 159'x105'x2'								
651	03-11-11.000 --- SOG Form, Place & Finish*	1,254.95 cy	1,072,934	1,451,603	85,739	18,669	14,951	2,106.77 /cy	2,643,896

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	050.031111.90.001 IX Treatment Building - Slab on grade - 159'x105'x2'		1,072,934	1,451,603	85,739	18,669	14,951	/cy	2,643,896
652	050.031111.90.101 IX Treatment Building - Sump Pits Slab on grade - 11'x7x2' (7 Locations)								
653	03-11-11.000 --- SOG Form, Place & Finish*	39.93 cy	68,532	61,132	3,146	4,289	476	3,445.75 /cy	137,575
	050.031111.90.101 IX Treatment Building - Sump Pits Slab on grade - 11'x7x2' (7 Locations)		68,532	61,132	3,146	4,289	476	/cy	137,575
	03-31-04 Slab-on-Grade Place/Fin		1,141,466	1,512,735	88,885	22,958	15,427		2,781,471
654	03-31-06 Wall Place/Finish								
655	050.031112.90.001 IX Treatment Building - Sump Pits Walls - 5'x20' (7 Locations)								
656	03-11-12.015 --- Hand Set Formed Concrete Walls*	25.93 cy	76,058	41,571	2,696	4,991	321	4,846.00 /cy	125,637
	050.031112.90.001 IX Treatment Building - Sump Pits Walls - 5'x20' (7 Locations)		76,058	41,571	2,696	4,991	321	/cy	125,637
	03-31-06 Wall Place/Finish		76,058	41,571	2,696	4,991	321		125,637
657	03-60-00 GROUT								
658	050.036000.90.001 IX Treatment Building - Sump Pits Grout Bed - 7'x3' (7 Locations)								
659	03-60-00.000 --- Place Grout (Pick List)*	273.00 cf	147,779	270,184				1,531.00 /cf	417,963
	050.036000.90.001 IX Treatment Building - Sump Pits Grout Bed - 7'x3' (7 Locations)		147,779	270,184				/cf	417,963
	03-60-00 GROUT		147,779	270,184					417,963
660	05-53-00 Metal Gratings								
661	050.055300.85.005 Metal Gratings								
662	05-53-00.005 Trench Drain Grating	275.00 sf	29,899	85,819	7,282			447.27 /sf	122,999
	050.055300.85.005 Metal Gratings		29,899	85,819	7,282			/sf	122,999
663	050.055300.90.001 IX Treatment Building - Sump Pits Grating - 7'-6"X3'-4" (7 Locations)								
664	05-53-00.005 Sump Grating	175.00 sf	15,385	73,970	4,159			534.36 /sf	93,513
	050.055300.90.001 IX Treatment Building - Sump Pits Grating - 7'-6"X3'-4" (7 Locations)		15,385	73,970	4,159			/sf	93,513
	05-53-00 Metal Gratings		45,283	159,789	11,440				216,512
665	07-22-00 Insulation - Roof and Deck								
666	050.072200.90.001 IX Treatment Building - MBS Canopy Insulation								
667	07-22-00.000 --- Roof & Deck Insulation & Cover Boards (Pick List)*	14,484.00 sf	46,283	134,930				12.51 /sf	181,213
	050.072200.90.001 IX Treatment Building - MBS Canopy Insulation		46,283	134,930				/sf	181,213
	07-22-00 Insulation - Roof and Deck		46,283	134,930					181,213
668	09-91-00.20 Painting Structural Metals								
669	050.099100.90.001 IX Treatment Building - MBS Canopy Paint Touch-up								
670	09-96-00.015 --- Structural Steel Touch Up (Field Services)*	1,202.83 sf	5,718	10,810				13.74 /sf	16,528
671	09-96-00.015 --- Structural Steel Touch Up (Field Services)*	1,000.00 sf	4,754	8,987				13.74 /sf	13,741
	050.099100.90.001 IX Treatment Building - MBS Canopy Paint Touch-up		10,472	19,798				/sf	30,270
	09-91-00.20 Painting Structural Metals		10,472	19,798					30,270
672	10-14-00 Signage								
673	050.101400.90.001 IX Treatment Building - Building Signage								
674	10-14-00.000 --- Signage- (Pick-List)*	26.00 ea	3,411	3,000				246.55 /ea	6,410
	050.101400.90.001 IX Treatment Building - Building Signage		3,411	3,000				/ea	6,410
	10-14-00 Signage		3,411	3,000					6,410
675	10-44-00 Fire Protection Specialties								
676	050.104400.90.001 IX Treatment Building - Fire Extinguishers								
677	10-44-00.000 --- Fire Extinguishers & Cabinets (Pick List)*	6.00 ea	1,651	7,281				1,488.64 /ea	8,932
	050.104400.90.001 IX Treatment Building - Fire Extinguishers		1,651	7,281				/ea	8,932
	10-44-00 Fire Protection Specialties		1,651	7,281					8,932
678	13-34-19 Metal Building Systems								
679	050.133419.90.001 IX Treatment Building - MBS Canopy (145'x105' 17')								
680	13-34-19.000 --- Pre-Engineered Metal Buildings*	15,225.00 sf				790,889		51.95 /sf	790,889
	050.133419.90.001 IX Treatment Building - MBS Canopy (145'x105' 17')					790,889		/sf	790,889
	13-34-19 Metal Building Systems					790,889			790,889
681	22-00-00 Plumbing								
682	045.220000.84.001 Hose Bibb								
683	22-11-19.000 1-1/2" RPBFP	1.00 ea	396	8,071				8,467.37 /ea	8,467
684	22-30-00.005 Wash Hose Stations	4.00 ea	12,442	21,443				8,471.39 /ea	33,886
	045.220000.84.001 Hose Bibb		12,839	29,514					42,353
685	045.220000.84.003 Drain Pipe								
686	22-11-16.035 2" - DR - PVC	200.00 lf	42,726	3,250				229.88 /lf	45,976
687	22-42-00.005 Floor Sinks	5.00 ea	3,016	19,116				4,426.52 /ea	22,133
688	40-05-32.040 6" - DR - HDPE	40.00 lf	10,133	5,098	621	2,582	1,411	496.12 /lf	19,845
689	40-05-32.040 4" - DR - HDPE	100.00 lf	22,823	15,004	1,434	9,836	7,054	561.51 /lf	56,151
690	40-05-63.020 2" Ball Valve	5.00 ea	2,054	2,947	483		235	1,143.66 /ea	5,718
	045.220000.84.003 Drain Pipe		80,752	45,415	2,538	12,418	8,700		149,823
	22-00-00 Plumbing		93,591	74,929	2,538	12,418	8,700		192,175
691	26-05-18.050 Feeders								
692	050.260516.01.001 LV Feeder - LP-1 to IX Treatment (Ltg & Recp circuits) via DB								
693	26-05-33.484 S40 PVC & Cu Str- lp-1 to ix treatment via db & ug	160.00 lf	32,038	4,850	719			235.05 /lf	37,607
	050.260516.01.001 LV Feeder - LP-1 to IX Treatment (Ltg & Recp circuits) via DB		32,038	4,850	719			/lf	37,607
	26-05-18.050 Feeders		32,038	4,850	719				37,607
694	26-05-18.100 Branch Circuits								
695	050.260511.01.001 Building Lighting Branch								

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	26-05-33.205 GRC & Cu Str- ltg branch, ix treatment	1,275.00 lf	87,227	13,514	1,023			79.82 /lf	101,764
	050.260511.01.001 Building Lighting Branch		**87,227**	**13,514**	**1,023**			**/lf**	**101,764**
697	**050.260512.01.001 Building Receptacle Branch**								
698	26-05-33.205 GRC & Cu Str- recp branch, ix treatment	525.00 lf	37,907	5,585	301			83.42 /lf	43,793
	050.260512.01.001 Building Receptacle Branch		**37,907**	**5,585**	**301**			**/lf**	**43,793**
	26-05-18.100 Branch Circuits		125,135	19,099	1,324				145,558
699	26-05-26 Grounding & Bonding for Electrical Systems								
700	**050.260526.01.001 Grounding**								
701	26-05-26.000 Cu Grounding- ix treatment	1,600.00 lf	67,951	71,057	1,911			88.07 /lf	140,919
	050.260526.01.001 Grounding		**67,951**	**71,057**	**1,911**				**140,919**
	26-05-26 Grounding & Bonding for Electrical Systems		67,951	71,057	1,911				140,919
702	26-05-83 Wiring Connections								
703	**050.260583.01.001 Equipment Connect & Feed - IX Train MOV**								
704	26-05-33.225 PVC-CTD-GRC & Cu Str- db/encl (dp-1) to ix train movs	1,960.00 lf	169,546	61,854				118.06 /lf	231,400
705	26-05-33.484 S40 PVC & Cu Str- dp-1 to ix train movs via ug, dg	2,240.00 lf	95,779	9,873				47.17 /lf	105,652
706	26-05-83.320 Equipment connection- ix train movs	14.00 ea	79,039	12,907				6,567.61 /ea	91,947
	050.260583.01.001 Equipment Connect & Feed - IX Train MOV		**344,364**	**84,635**				**/ea**	**428,998**
707	**050.260583.01.002 Equipment Connect & Feed - IX Train Discharge BFV**								
708	26-05-33.225 PVC-CTD-GRC & Cu Str- db/encl (dp-1) to ix train discharge bfv	280.00 lf	24,221	8,836				118.06 /lf	33,057
709	26-05-33.484 S40 PVC & Cu Str- dp-1 to ix train discharge bfv via ug, dg	320.00 lf	13,683	1,410				47.17 /lf	15,093
710	26-05-83.320 Equipment connection- ix train discharge bfv	2.00 ea	2,005	347				1,175.78 /ea	2,352
	050.260583.01.002 Equipment Connect & Feed - IX Train Discharge BFV		**39,908**	**10,593**				**/ea**	**50,502**
711	**050.260584.01.001 I&C Connect & Feed - Cartridge Filters**								
712	26-05-02.000 I&C Instrument Connections- cartridge filters	6.00 ea	8,302	2,449				1,791.76 /ea	10,751
713	26-05-33.225 PVC-CTD-GRC & Cu Str- db (pfas-plc) to cart filter press inst	360.00 lf	37,689	16,484				150.48 /lf	54,172
714	26-05-33.484 S40 PVC & Cu Str- pfas-plc to cart filter pressure inst	660.00 lf	24,516	8,360				49.81 /lf	32,876
	050.260584.01.001 I&C Connect & Feed - Cartridge Filters		**70,507**	**27,292**				**/ea**	**97,799**
715	**050.260584.01.002 I&C Connect & Feed - IX Trains Discharge**								
716	26-05-02.000 I&C Instrument Connections- ix treatment fit/fe532	1.00 ea	1,384	408				1,791.73 /ea	1,792
717	26-05-33.225 PVC-CTD-GRC & Cu Str- db (lp-1) to fit/fe532	160.00 lf	14,350	5,406				123.48 /lf	19,756
718	26-05-33.225 PVC-CTD-GRC & Cu Str- db (pfas-plc) to fit/fe532	160.00 lf	13,851	6,306				125.99 /lf	20,158
719	26-05-33.484 S40 PVC & Cu Str- pfas-plc to fit/fe532	110.00 lf	4,086	1,393				49.81 /lf	5,479
720	26-05-33.484 S40 PVC & Cu Str- lp-1 to fit/fe532	160.00 lf	6,082	584				41.67 /lf	6,666
	050.260584.01.002 I&C Connect & Feed - IX Trains Discharge		**39,753**	**14,098**				**/ea**	**53,851**
721	**050.260584.01.003 I&C Connect & Feed - Finished Water Tanks No. 2, 3**								
722	26-05-02.000 I&C Instrument Connections- finished water tanks no 2, 3, control	2.00 ea	4,742	702				2,721.86 /ea	5,444
723	26-05-02.000 I&C Instrument Connections- finished water tanks no 2, 3, signal	4.00 ea	6,762	2,331				2,273.11 /ea	9,092
724	26-05-33.225 PVC-CTD-GRC & Cu Str- lp-c to fit/fe534 via db	10.00 lf	4,191	1,279				547.02 /lf	5,470
725	26-05-33.225 PVC-CTD-GRC & Cu Str- pp-c to bfv534b via db	10.00 lf	4,192	1,279				547.03 /lf	5,470
726	26-05-33.484 S40 PVC & Cu Str- pfas-plc to fit/fe533 via db	10.00 lf	4,351	3,727	45			812.27 /lf	8,123
727	26-05-33.484 S40 PVC & Cu Str- pfas-plc to fit/fe534 via db	60.00 lf	6,584	4,560	270			190.24 /lf	11,414
728	26-05-33.484 S40 PVC & Cu Str- pfas-plc to bfv533b, signal via db	10.00 lf	4,247	3,727				797.36 /lf	7,974
729	26-05-33.484 S40 PVC & Cu Str- pfas-plc to bfv534b, signal via db	10.00 lf	4,646	4,160				880.63 /lf	8,806
730	26-05-33.484 S40 PVC & Cu Str- pfas-plc to bfv533b, control via db	10.00 lf	12,952	1,656				1,460.80 /lf	14,608
731	26-05-33.484 S40 PVC & Cu Str- pfas-plc to bfv534b, control via db	10.00 lf	14,522	1,871				1,639.30 /lf	16,393
732	26-05-33.484 S40 PVC & Cu Str- lp-b to fit/fe533 via db	50.00 lf	7,605	987	225			176.34 /lf	8,817
733	26-05-33.484 S40 PVC & Cu Str- 480v panel to bfv533b via db	50.00 lf	7,605	987	225			176.34 /lf	8,817
	050.260584.01.003 I&C Connect & Feed - Finished Water Tanks No. 2, 3		**82,400**	**27,264**	**764**			**/ea**	**110,428**
734	**050.260584.01.004 I&C Connect & Feed - IX Vessels**								
735	26-05-02.000 I&C Instrument Connections- ix vessels, control	28.00 ea	71,759	72,421				5,149.27 /ea	144,180
736	26-05-02.000 I&C Instrument Connections- ix vessels, signal	84.00 ea	132,329	222,082				4,219.19 /ea	354,412
737	26-05-33.080 N4X Enclosures-	2.00 ea	7,670	43,688				25,678.92 /ea	51,358
738	26-05-33.225 PVC-CTD-GRC & Cu Str- db/tc (pfas-plc) to ix vessel inst, control	3,920.00 lf	396,054	129,288				134.02 /lf	525,342
739	26-05-33.225 PVC-CTD-GRC & Cu Str- db/tc (pfas-plc) to ix vessel inst, signal	11,760.00 lf	937,387	431,397				116.39 /lf	1,368,784
740	26-05-33.225 PVC-CTD-GRC & Cu Str- db/tc (lp-1,dp-1) to ix vessel fit, mov, power	5,880.00 lf	508,637	185,563				118.06 /lf	694,200
741	26-05-33.484 S40 PVC & Cu Str- pfas-plc to ix vessels inst, control via ug, db	3,080.00 lf	213,140	21,668				76.24 /lf	234,808
742	26-05-33.484 S40 PVC & Cu Str- pfas-plc to ix vessels inst, signal via ug, db	9,240.00 lf	343,225	117,034				49.81 /lf	460,259
743	26-05-33.484 S40 PVC & Cu Str- lp-1,dp-1 to ix vessels fit & mov, power via ug, db	4,620.00 lf	219,287	22,546				52.34 /lf	241,834
	050.260584.01.004 I&C Connect & Feed - IX Vessels		**2,829,490**	**1,245,686**				**/ea**	**4,075,176**
	26-05-83 Wiring Connections		3,406,422	1,409,568	764				4,816,754
744	26-27-26 Devices & Accessories								
745	**050.262726.01.001 Receptacles**								
746	26-27-26.000 Receptacles- ix treatment	8.00 ea	4,663	1,377				754.99 /ea	6,040
	050.262726.01.001 Receptacles		**4,663**	**1,377**				**/ea**	**6,040**
747	**050.262728.01.001 Lighting Control**								
748	26-27-26.070 Ltg control- ix treatment	2.00 ea	2,539	938				1,738.30 /ea	3,477
	050.262728.01.001 Lighting Control		**2,539**	**938**				**/ea**	**3,477**

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	26-27-26 Devices & Accessories		7,202	2,315					9,517
749	26-50-00 Lighting								
750	050.265100.01.01.001 Building Lighting								
751	26-51-00.005 Building Lighting Fixture Box & Attachment- canopy lights	45.00 ea	16,394	5,287				481.80 /ea	21,681
752	26-51-00.305 C Ceiling-mounted, suspended LED Canopy Fixture	45.00 ea	25,885	108,955	1,806			3,036.58 /ea	136,646
	050.265100.01.01.001 Building Lighting		42,279	114,242	1,806			/ea	158,327
	26-50-00 Lighting		42,279	114,242	1,806				158,327
753	31-23-16.16 Foundation Excavation								
754	050.312316.90.001 IX Treatment Building - Slab Over Ex - 5' Scarify & Recompact								
755	31-23-00.005 --- Structure Excavation & Backfill	3,496.50 cy	48,684	41,482	46,576	13,399		42.94 /cy	150,141
	050.312316.90.001 IX Treatment Building - Slab Over Ex - 5' Scarify & Recompact		48,684	41,482	46,576	13,399		/cy	150,141
756	050.312316.90.101 IX Treatment Building - Sump Pit Excavation - 15'x15'x10'								
757	31-23-00.005 --- Structure Excavation & Backfill	2,216.67 cy	101,788	116,125	133,434	29,189		171.67 /cy	380,537
	050.312316.90.101 IX Treatment Building - Sump Pit Excavation - 15'x15'x10'		101,788	116,125	133,434	29,189		/cy	380,537
	31-23-16.16 Foundation Excavation		150,472	157,607	180,011	42,589			530,679
758	40-05-07 Hangers and Supports for Process Piping								
759	090.400507.67.001 Pipe Supports - Non Engineered								
760	05-05-00.005 Stanchion Pipe Supports - Wedge Anchors	500.00 ea	37,982	21,967				119.90 /ea	59,950
761	05-05-00.010 Unistrut Pipe Supports - Adhesive Anchors	294.00 ea	35,877	10,925				159.19 /ea	46,802
762	09-90-00.000 Pipe Supports - Subcontractor- Painting*	1.00 ls	12,826	12,819	12,792	10,650	12,792	61,877.16 /ls	61,877
763	40-05-07.025 --- Pipe Hangers - Stanchion/Support (Anvil 259/63)*	125.00 ea	454,030	170,710				4,997.92 /ea	624,740
764	40-05-07.045 --- Pipe Hangers - Unistrut w/Clamp*	147.00 ea	38,861	19,114				394.38 /ea	57,974
	090.400507.67.001 Pipe Supports - Non Engineered		579,576	235,534	12,792	10,650	12,792		851,343
765	090.400507.67.002 Pipe Supports - Special Engineered								
766	01-00-00.010 Engineered Pipe Supports - Design and PE Stamp	1.00 ls					61,542	61,541.84 /ls	61,542
767	05-05-00.010 Engineered Supports - Epoxy Anchors	25.00 ea	30,508	12,621				1,725.15 /ea	43,129
768	09-90-00.000 Pipe Supports - Subcontractor- Painting*	1.00 ls	5,894	5,891	5,878	4,894	5,878	28,436.18 /ls	28,436
769	40-05-07.050 Engineered Pipe Supports	25.00 ea	24,834	107,961				5,311.79 /ea	132,795
	090.400507.67.002 Pipe Supports - Special Engineered		61,236	126,473	5,878	4,894	67,420		265,902
	40-05-07 Hangers and Supports for Process Piping		640,812	362,007	18,670	15,544	80,212		1,117,245
770	40-05-19 Ductile Iron Pipe								
771	050.400519.91.005 30" UG IXE-DI Encased Pipe								
772	40-05-19.300 30" UG IXE-DI Encased Pipe RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	112.00 lf	78,177	258,076	29,048	277		3,264.09 /lf	365,579
	050.400519.91.005 30" UG IXE-DI Encased Pipe		78,177	258,076	29,048	277		/lf	365,579
773	050.400519.91.010 30" AG IXE-DI Pipe Inside IX Bldg.								
774	40-05-19.100 30" AG IXE-DI Pipe to IX Vessels. FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	30.00 lf	42,570	221,937	3,976	75		8,951.93 /lf	268,558
775	40-05-19.100 10" AG IXE-DI Blind Flange for Future Expansion Pipe Inside IX Bldg. FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	1.00 ea	1,029	3,871	2			4,901.19 /ea	4,901
776	40-05-64.005 30" AG IXE-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	3.00 ea	26,081	212,976	15,680		123	84,953.37 /ea	254,860
777	40-70-00.030 30" FE- Flow Elements Only	1.00 ea	8,718	62,638	190		306	71,852.03 /ea	71,852
	050.400519.91.010 30" AG IXE-DI Pipe Inside IX Bldg.		78,397	501,422	19,847	75	430	/lf	600,171
778	050.400519.91.015 30" AG IXE-DI Exterior Pipe to Encased Pipe from Yard Piping								
779	40-05-19.100 30" AG IXE-DI Exterior Pipe to Encased Pipe from Yard Piping FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	16.64 lf	28,702	172,876	2,229	42		12,250.56 /lf	203,849
	050.400519.91.015 30" AG IXE-DI Exterior Pipe to Encased Pipe from Yard Piping		28,702	172,876	2,229	42		/lf	203,849
780	050.400519.91.020 24" AG IXE-DI Pipe Header								
781	40-05-19.100 24" AG IXE-DI Pipe - FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	180.00 lf	65,578	165,309	16,984	290		1,378.67 /lf	248,161
	050.400519.91.020 24" AG IXE-DI Pipe Header		65,578	165,309	16,984	290		/lf	248,161
782	050.400519.91.025 16" AG IXE-DI Pipe to IXE Header Tee and Reducer								
783	40-05-19.100 16" AG IXE-DI Pipe FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	13.50 lf	24,027	63,215	865	10		6,527.16 /lf	88,117
	050.400519.91.025 16" AG IXE-DI Pipe to IXE Header Tee and Reducer		24,027	63,215	865	10		/lf	88,117
784	050.400519.91.030 8" AG IXE-DI Pipe from IX Skid to IXE Header (IX Vessel 3,4,9,10)								
785	40-05-19.100 8" AG IXE-DI Pipe From IX Skid to IXE Header Reducer 16"x8" FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	48.00 lf	23,335	56,940	1,964	9		1,713.49 /lf	82,247
786	40-05-62.010 8" AG IXE-DI MPV Plug Valve - 100% Port, Flanged, CI/DI, 3" to 72"	4.00 ea	9,758	28,262	1,981		41,192	20,298.30 /ea	81,193
787	40-05-64.005 8" AG IXE-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	4.00 ea	9,758	14,928	1,981		164	6,707.91 /ea	26,832
788	40-05-65.011 8" AG IXE-DI GCV Check Valve - Silent, Globe Style, Flanged, 2" to 48"	4.00 ea	7,192	19,880	1,422		164	7,164.24 /ea	28,657
	050.400519.91.030 8" AG IXE-DI Pipe from IX Skid to IXE Header (IX Vessel 3,4,9,10)		50,043	120,009	7,348	9	41,520	/lf	218,929
789	050.400519.91.035 8" AG DR-DI Pipe from IX Skid to Process Drain (IX Vessel 3,4,9,10)								
790	40-05-19.100 8" AG DR-DI Pipe from IX Skid to Process Drain (IX Vessel 3,4,9,10) FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	56.00 lf	24,271	62,261	2,286	10		1,586.22 /lf	88,828
	050.400519.91.035 8" AG DR-DI Pipe from IX Skid to Process Drain (IX Vessel 3,4,9,10)		24,271	62,261	2,286	10		/lf	88,828
791	050.400519.91.040 8" AG IXI-DI Pipe to IX Skid from IXI Header (IX Vessel 3,4,9,10)								
792	40-05-19.100 8" AG IXI-DI Pipe to IX Skid from IXI Header (IX Vessel 3,4,9,10) FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	48.00 lf	12,126	33,724	1,947	9		995.94 /lf	47,805
793	40-05-64.005 8" IXI-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	4.00 ea	9,758	14,928	1,981		164	6,707.91 /ea	26,832
794	40-70-00.030 8" IXI-DI FE- Flow Elements Only (Pick List)*	4.00 ea	9,073	83,517	759		1,226	23,643.90 /ea	94,576
	050.400519.91.040 8" AG IXI-DI Pipe to IX Skid from IXI Header (IX Vessel 3,4,9,10)		30,958	132,169	4,687	9	1,390	/lf	169,212
795	050.400519.91.045 8" AG IXE-DI Pipe from IX Skid to IXE Header (IX Vessel1,2,5,6,7,8,11,12)								
796	40-05-19.100 8" AG IXE-DI Pipe From IX Skid to IXE Header Cross 24"x8" FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	104.00 lf	47,453	118,355	4,251	19		1,635.36 /lf	170,077
797	40-05-62.010 8" AG IXE-DI MPV Plug Valve - 100% Port, Flanged, CI/DI, 3" to 72"	8.00 ea	19,517	56,523	3,962		82,384	20,298.30 /ea	162,386
798	40-05-64.005 8" AG IXE-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	8.00 ea	19,517	29,856	3,962		328	6,707.91 /ea	53,663
799									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	40-05-65.011 8" AG IXE-DI GCV Check Valve - Silent, Globe Style, Flanged, 2" to 48"	8.00 ea	14,383	39,759	2,843		328	7,164.23 /ea	57,314
	050.400519.91.045 8" AG IXE-DI Pipe from IX Skid to IXE Header (IX Vessel1,2,5,6,7,8,11,12)		100,869	244,493	15,019	19	83,040	/lf	443,441
800	050.400519.91.050 8" AG DR-DI Pipe from IX Skid to Process Drain (IX Vessel 1,2,5,6,7,8,11,12)								
801	40-05-19.100 8" AG DR-DI Pipe from IX Skid to Process Drain (IX Vessel 3,4,9,10) FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	112.00 lf	48,542	124,522	4,573	20		1,586.22 /lf	177,657
	050.400519.91.050 8" AG DR-DI Pipe from IX Skid to Process Drain (IX Vessel 1,2,5,6,7,8,11,12)		48,542	124,522	4,573	20		/lf	177,657
802	050.400519.91.055 8" AG IXI-DI Pipe to IX Skid from IXI Header (IX Vessel 1,2,5,6,7,8,11,12)								
803	40-05-19.100 8" AG IXI-DI Pipe to IX Skid from IXI Header FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	104.00 lf	25,025	71,949	4,217	19		973.16 /lf	101,209
804	40-05-64.005 8" IXI-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	4.00 ea	9,758	14,928	1,981		164	6,707.91 /ea	26,832
805	40-70-00.030 8" IXI-DI FE- Flow Elements Only (Pick List)*	8.00 ea	18,147	167,035	1,518		2,451	23,643.90 /ea	189,151
	050.400519.91.055 8" AG IXI-DI Pipe to IX Skid from IXI Header (IX Vessel 1,2,5,6,7,8,11,12)		52,930	253,912	7,716	19	2,615	/lf	317,192
806	050.400519.91.060 8" AG IXE-DI Pipe from IX Skid to IXE Header (IX Vessel13)								
807	40-05-19.100 8" AG IXE-DI Pipe From IX Skid to IXE Header Cross 30"x8" FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	13.00 lf	5,932	14,794	531	2		1,635.36 /lf	21,260
808	40-05-62.010 8" AG IXE-DI MPV Plug Valve - 100% Port, Flanged, CI/DI, 3" to 72"	1.00 ea	2,440	7,065	495		10,298	20,298.30 /ea	20,298
809	40-05-64.005 8" AG IXE-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	2,440	3,732	495		41	6,707.94 /ea	6,708
810	40-05-65.011 8" AG IXE-DI GCV Check Valve - Silent, Globe Style, Flanged, 2" to 48"	1.00 ea	1,798	4,970	355		41	7,164.23 /ea	7,164
	050.400519.91.060 8" AG IXE-DI Pipe from IX Skid to IXE Header (IX Vessel13)		12,609	30,562	1,877	2	10,380	/lf	55,430
811	050.400519.91.065 8" AG DR-DI Pipe from IX Skid to Process Drain (IX Vessel 13)								
812	40-05-19.100 8" AG DR-DI Pipe from IX Skid to Process Drain (IX Vessel 3,4,9,10) FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	14.00 lf	6,068	15,565	572	3		1,586.22 /lf	22,207
	050.400519.91.065 8" AG DR-DI Pipe from IX Skid to Process Drain (IX Vessel 13)		6,068	15,565	572	3		/lf	22,207
813	050.400519.91.070 8" AG IXI-DI Pipe to IX Skid from IXI Header (IX Vessel 13)								
814	40-05-19.100 8" AG IXI-DI Pipe to IX Skid from IXI Header FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	13.00 lf	3,128	8,994	527	2		973.16 /lf	12,651
815	40-05-64.005 8" IXI-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	1.00 ea	2,440	3,732	495		41	6,707.93 /ea	6,708
816	40-70-00.030 8" IXI-DI FE- Flow Elements Only (Pick List)*	1.00 ea	2,268	20,879	190		306	23,643.88 /ea	23,644
	050.400519.91.070 8" AG IXI-DI Pipe to IX Skid from IXI Header (IX Vessel 13)		7,836	33,605	1,212	2	347	/lf	43,003
817	050.400519.91.075 24" AG IXI-DI Pipe Header to IX Vessels								
818	40-05-19.100 24" AG IXI-DI Pipe Header to IX Vessels FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	220.00 lf	114,447	393,981	20,930	354		2,407.78 /lf	529,712
	050.400519.91.075 24" AG IXI-DI Pipe Header to IX Vessels		114,447	393,981	20,930	354		/lf	529,712
819	050.400519.91.080 18" AG IXI-DI from CF1-CF5 to 24" IXI Pipe Header								
820	40-05-19.100 18" AG IXI-DI from CF1-CF5 to 24" IXI Pipe Header FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	21.05 lf	69,420	157,352	1,398	19		10,840.34 /lf	228,189
821	40-05-64.005 18" IXI-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	5.00 ea	36,812	76,881	20,022		11,426	29,028.27 /ea	145,141
	050.400519.91.080 18" AG IXI-DI from CF1-CF5 to 24" IXI Pipe Header		106,232	234,233	21,420	19	11,426	/lf	373,330
822	050.400519.91.085 30" AG IXI-DI Pipe Header to IX Vessels								
823	40-05-19.100 30" AG IXI-DI Pipe Header to IX Vessels FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	45.00 lf	39,069	172,977	5,848	113		4,844.59 /lf	218,007
	050.400519.91.085 30" AG IXI-DI Pipe Header to IX Vessels		39,069	172,977	5,848	113		/lf	218,007
824	050.400519.91.090 30" UG IXI-DI Pipe Header to IX Vessels								
825	40-05-19.300 30" UG IXI-DI Pipe Header to IX Vessels RESTRAINED JOINT Ductile Iron Pipe (3" to 64") & MJ Fittings (3" to 48") *	70.00 lf	63,388	247,925	22,927	363		4,780.02 /lf	334,602
	050.400519.91.090 30" UG IXI-DI Pipe Header to IX Vessels		63,388	247,925	22,927	363		/lf	334,602
826	050.400519.91.100 36" AG RW-DI Pipe Header to IX Vessels.								
827	40-05-19.100 36" AG RW-DI Pipe Header to IX Vessels. FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	53.00 lf	40,859	484,447	7,617	171		10,058.39 /lf	533,095
	050.400519.91.100 36" AG RW-DI Pipe Header to IX Vessels.		40,859	484,447	7,617	171		/lf	533,095
828	050.400519.91.105 18" AG RW-DI Pipe Header to IX Vessels.								
829	40-05-19.100 18" AG RW-DI Pipe Header to IX Vessels. FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	12.00 lf	34,199	67,638	773	11		8,551.76 /lf	102,621
830	40-05-64.005 18" RW-DI Butterfly Valve - CI/DI, AWWA, Flanged, Class 150, 3" to 108"	5.00 ea	36,812	76,881	20,022		11,426	29,028.27 /ea	145,141
	050.400519.91.105 18" AG RW-DI Pipe Header to IX Vessels.		71,012	144,519	20,795	11	11,426	/lf	247,762
	40-05-19 Ductile Iron Pipe		1,044,014	3,856,079	213,799	1,817	162,576		5,278,284
831	40-05-23 Stainless Steel Pipe								
832	050.400523.91.005 .5" IXI-SST Instrument Pipe Line								
833	40-05-23.205 .5" IXI-SST Instrument Pipe Line Stainless Schd 40 Pipe Threaded & Coupled (1/8" to 4")*	30.00 lf	2,468	1,239	6			123.78 /lf	3,713
834	40-05-63.015 .5" IXI-SST Ball Valve to Instruments - Stainless Steel, 1/2" to 12"	11.00 ea	2,655	7,879	645		451	1,057.33 /ea	11,631
	050.400523.91.005 .5" IXI-SST Instrument Pipe Line		5,124	9,118	651		451	/lf	15,344
835	050.400523.91.010 .5" V-SSTCartridge Filter Vent Pipe								
836	40-05-23.205 .5" V-SSTCartridge Filter Vent Pipe Stainless Schd 40 Pipe Threaded & Coupled (1/8" to 4")*	20.00 lf	486	244	4			36.74 /lf	735
837	40-05-63.015 .5" V-SSTCartridge Filter Vent Pipe Ball Valve - Stainless Steel, 1/2" to 12"	10.00 ea	2,414	7,163	586		410	1,057.33 /ea	10,573
	050.400523.91.010 .5" V-SSTCartridge Filter Vent Pipe		2,900	7,407	590		410	/lf	11,308
	40-05-23 Stainless Steel Pipe		8,024	16,525	1,242		862		26,652
838	40-05-24 Steel Pipe								
839	050.400524.91.005 4"AG IXE Galv from AIR/VAC Valve at 30" IXE Anti-Siphon Loop								
840	40-05-24.310 --- Galvanized A53 CW T&C Pipe & Malleable Fittings (1/8" to 6")*	30.00 lf	5,509	8,764	13			476.20 /lf	14,286
841	40-05-78.230 4" IXE - Combination Air/Vacuum Valve (CAV) - 1/2" to 14"	1.00 ea	1,269	9,121	264		21	10,673.49 /ea	10,673
	050.400524.91.005 4"AG IXE Galv from AIR/VAC Valve at 30" IXE Anti-Siphon Loop		6,777	17,885	277		21	/lf	24,960
842	050.400524.91.010 4" AG IXI-Galv Drain Pipe at 8" IXI Pipe								
843	40-05-24.310 4" AG IXI-Gal Drain Pipe Galvanized A53 CW T&C Pipe & Malleable Fittings (1/8" to 6")*	26.00 lf	13,297	9,930	127			898.23 /lf	23,354
844	40-05-63.015 4" IXI Ball Valve - Stainless Steel, 1/2" to 12"	13.00 ea	1,816	140	377		533	220.52 /ea	2,867
	050.400524.91.010 4" AG IXI-Galv Drain Pipe at 8" IXI Pipe		15,113	10,070	505		533	/lf	26,221
845	050.400524.91.015 2" AG RW-Galv from AIR/VAC Valve at 36" RW Pipe								
846	40-05-24.310 2" AG RW-Galv from AIR/VAC Valve at 36" RW Pipe Galvanized A53 CW T&C Pipe & Malleable Fittings (1/8" to 6")*	20.00 lf	886	1,184	75			107.26 /lf	2,145
847	40-05-78.260 2" RW- Vacuum Relief Valve - 1/2" to 3"	1.00 ea	587	3,428	127		21	4,161.79 /ea	4,162

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	050.400524.91.015 2" AG RW-Galv from AIR/VAC Valve at 36" RW Pipe		1,472	4,613	202		21	/lf	6,307
	40-05-24 Steel Pipe		23,362	32,567	983		574		57,487
848	40-05-31 PVC Plastic Pipe								
849	050.400531.91.005 2" DR-PVC Cartdrige Filter 1-5								
850	40-05-31.132 2" DR-PVC Cartdrige Filter 1-5 PVC Sch 80 Solvent Weld Pipe & Fittings (1/4" to 24")*	45.00 lf	7,559	3,453	177	0		248.64 /lf	11,189
851	40-05-63.020 2" DR-PVC Cartdrige Filter 1-5 Ball Valve - PVC Socket Weld, 1/2" to 6"	10.00 ea	3,922	4,709	842		410	988.30 /ea	9,883
	050.400531.91.005 2" DR-PVC Cartdrige Filter 1-5		11,480	8,162	1,019	0	410	/lf	21,072
	40-05-31 PVC Plastic Pipe		11,480	8,162	1,019	0	410		21,072
852	40-70-00 Instrumentation for Process Systems								
853	050.407000.01.001 I&C Instruments - Cartridge Filters								
854	40-70-00.010 I&C Instruments- cartridge filters	15.00 ea	26,459		2,847		4,596	2,260.16 /ea	33,902
855	40-70-00.010 I&C Instruments- cartridge filters 2	3.00 ea	5,829		569		919	2,439.12 /ea	7,317
	050.407000.01.001 I&C Instruments - Cartridge Filters		32,288		3,416		5,516	/ea	41,220
856	050.407000.01.002 I&C Instruments - IX Trains								
857	40-70-00.010 I&C Instruments- ix train overview	3.00 ea	24,318		569		919	8,602.32 /ea	25,807
	050.407000.01.002 I&C Instruments - IX Trains		24,318		569		919	/ea	25,807
858	050.407000.01.003 I&C Instruments - IX Vessels								
859	40-70-00.010 I&C Instruments- ix vessels	98.00 ea	179,928		18,599		30,030	2,332.21 /ea	228,557
	050.407000.01.003 I&C Instruments - IX Vessels		179,928		18,599		30,030	/ea	228,557
	40-70-00 Instrumentation for Process Systems		236,534		22,585		36,465		295,584
860	46-61-00 Filtration Equipment								
861	050.466121.67.001 IX Vessels, Loose Process Piping, Resin and Trees (Vendor Supplied)								
862	46-61-21.130 IX Vessels, Loose Process Piping, Resin and Trees (Vendor Supplied)	13.00 ea	564,078	25,100,455	153,733		105,647	1,994,147.15 /ea	25,923,913
863	46-61-21.130 IX Vessels, Loose Process Piping, Resin and Trees (Vendor Supplied)	1.00 ea	33,747	1,930,804	7,267		5,128	1,976,946.48 /ea	1,976,946
	050.466121.67.001 IX Vessels, Loose Process Piping, Resin and Trees (Vendor Supplied)		597,824	27,031,260	161,000		110,775		27,900,859
864	050.466153.67.001 Cartridge Filter Vessels (5' Dia x 5'L, GLH Series)								
865	46-61-53.000 Cartridge Filter Vessels (5' Dia x 5'L, GLH Series)	5.00 ea	274,143	1,032,088	30,084		56,413	278,545.84 /ea	1,392,729
	050.466153.67.001 Cartridge Filter Vessels (5' Dia x 5'L, GLH Series)		274,143	1,032,088	30,084		56,413		1,392,729
	46-61-00 Filtration Equipment		871,968	28,063,348	191,084		167,189		29,293,589
	050 IX TREATMENT	1.00 ls	8,700,788	36,594,151	834,070	900,027	498,580	47,527,616.81 /ls	47,527,617
866	055 PROCESS DRAIN PUMP STATION								
867	01-00-00 GENERAL REQUIREMENTS								
868	055.010000.90.001 Special Testing and Inspection								
869	01-00-00.010 --- General Conditions Checklist*	1.00 ls					11,757	11,756.96 /ls	11,757
	055.010000.90.001 Special Testing and Inspection						11,757	/ls	11,757
	01-00-00 GENERAL REQUIREMENTS						11,757		11,757
870	03-31-02 Foundation Place/Finish								
871	055.033102.58.005 Foundation for Pre-cast Wet Well								
872	03-11-11.000 Foundation for Pre-cast Wet Well	5.70 cy	7,834	7,608	403	653	69	2,905.80 /cy	16,566
	055.033102.58.005 Foundation for Pre-cast Wet Well		7,834	7,608	403	653	69	/cy	16,566
	03-31-02 Foundation Place/Finish		7,834	7,608	403	653	69		16,566
873	03-31-04 Slab-on-Grade Place/Fin								
874	055.031111.90.001 Process Drain Pump Station - Headworks SOG 28'x14'								
875	03-11-11.000 --- SOG Form, Place & Finish*	16.62 cy	23,681	21,569	1,194	937	200	2,863.37 /cy	47,581
	055.031111.90.001 Process Drain Pump Station - Headworks SOG 28'x14'		23,681	21,569	1,194	937	200	/cy	47,581
	03-31-04 Slab-on-Grade Place/Fin		23,681	21,569	1,194	937	200		47,581
876	03-61-00 Cementitious Grouting								
877	055.036100.58.005 Place Grout - Bottom of Pre-cast Wetwell								
878	03-60-00.000 Place Grout - Bottom of Pre-cast Wetwell	72.00 cf	23,385	33,932				796.07 /cf	57,317
879	03-60-00.000 Place Grout - Bottom of Pre-cast Wetwell	8.00 cf	2,598	3,770				796.07 /cf	6,369
	055.036100.58.005 Place Grout - Bottom of Pre-cast Wetwell		25,983	37,702				/cy	63,685
	03-61-00 Cementitious Grouting		25,983	37,702					63,685
880	05-51-33 Metal Ladder								
881	055.055133.85.005 Metal Ladder								
882	05-51-33.005 Straight Metal Ladder	15.00 lf	4,944	4,820				650.90 /lf	9,763
	055.055133.85.005 Metal Ladder		4,944	4,820				/lf	9,763
	05-51-33 Metal Ladder		4,944	4,820					9,763
883	05-58-00 Formed Metal Fabrications								
884	055.055800.90.001 Process Drain Pump Station - Wet Well Handrails								
885	05-52-00.000 --- Pipe Railing Handrails- Horizontal Railing*	40.00 lf	3,914	20,654			190	618.95 /lf	24,758
	055.055800.90.001 Process Drain Pump Station - Wet Well Handrails		3,914	20,654			190	/lf	24,758
886	055.055900.93.005 3'x3'x5' Galvanized Steel Cage around Flow Meter								
887	05-59-00.010 --- Miscellaneous Steel Fabrications (ea)*	1,807.32 ea	2,633	38	210			1.59 /ea	2,881
	055.055900.93.005 3'x3'x5' Galvanized Steel Cage around Flow Meter		2,633	38	210				2,881
	05-58-00 Formed Metal Fabrications		6,547	20,692	210		190		27,639
888	05-58-05 Aluminum Floor Doors								
889	055.055805.91.005 4'x6' Access Door								
890	05-58-05.005 Aluminum Floor Doors	1.00 ea	924	12,371	213			13,508.11 /ea	13,508

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	055.055805.91.005 4'x6' Access Door		924	12,371	213			/ea	13,508
	05-58-05 Aluminum Floor Doors		924	12,371	213				13,508
891	26-05-83 Wiring Connections								
892	055.260583.01.001 Equipment Connect & Feed - Drain Pumps No. 1, 2								
893	26-05-33.225 PVC-CTD-GRC Riser & Cu Str- db to drain pumps	40.00 lf	7,842	3,084				273.16 /lf	10,926
894	26-05-33.484 S40 PVC & Cu Str- mcc-1,-2 to drain pumps no 1, 2 via db	250.00 lf	25,148	5,932	562			126.57 /lf	31,642
895	26-05-83.320 Equipment connection- drain pumps no 1, 2	2.00 ea	4,739	5,379				5,058.96 /ea	10,118
	055.260583.01.001 Equipment Connect & Feed - Drain Pumps No. 1, 2		37,730	14,395	562			/ea	52,687
896	055.260584.01.001 I&C Connect & Feed - Process Drain Pump Station								
897	26-05-02.000 I&C Instrument Connections- process drain ps inst, control	9.00 ea	15,300	22,575				4,208.33 /ea	37,875
898	26-05-02.000 I&C Instrument Connections- process drain ps inst, signal	3.00 ea	4,726	7,931				4,219.18 /ea	12,658
899	26-05-33.080 N4X Enclosures-	3.00 ea	2,589	5,484				2,690.69 /ea	8,072
900	26-05-33.484 S40 PVC & Cu Str- pfas-plc to drain pump vfds	60.00 lf	5,415	1,995				123.50 /lf	7,410
901	26-05-33.484 S40 PVC & Cu Str- pfas-plc to lit/le535 via ug, db	110.00 lf	6,674	2,747				85.65 /lf	9,421
902	26-05-33.484 S40 PVC & Cu Str- pfas-plc to lsll535,lshh535	220.00 lf	13,963	1,938				72.28 /lf	15,901
903	26-05-33.484 S40 PVC & Cu Str- lp-1 to lit/le535,fit/fe538 via ug,db	160.00 lf	13,625	2,034				97.87 /lf	15,659
904	26-05-33.484 S40 PVC & Cu Str- drain pump vfds (mcc) to psh-,msh-,tsh-536/537	840.00 lf	48,457	6,549				65.48 /lf	55,006
905	26-05-33.484 S40 PVC & Cu Str- drain pump vfds to te536/537a,b,c	280.00 lf	23,883	15,063				139.10 /lf	38,947
906	26-05-33.484 S40 PVC & Cu Str- pfas-plc to fit/fe538 via ug,db	110.00 lf	6,674	2,747				85.65 /lf	9,421
	055.260584.01.001 I&C Connect & Feed - Process Drain Pump Station		141,306	69,064				/ea	210,371
	26-05-83 Wiring Connections		179,036	83,459	562				263,057
907	33-05-61 Concrete Manholes								
908	055.330561.91.005 Process Drain Pump Station 14'x23' Precast Manhole, Sanitary (Each) *								
909	33-05-61.010 Process Drain Pump Station 14'x23' Precast Manhole, Sanitary (Each) *	1.00 ea	27,342	311,550	22,458	87,806		449,157.29 /ea	449,157
	055.330561.91.005 Process Drain Pump Station 14'x23' Precast Manhole, Sanitary (Each) *		27,342	311,550	22,458	87,806		/ea	449,157
	33-05-61 Concrete Manholes		27,342	311,550	22,458	87,806			449,157
910	40-05-19 Ductile Iron Pipe								
911	055.400519.91.005 12" AG DR-DI from Engineer Sump to Process DR Pump Stn.								
912	40-05-06.205 12" DR-DI Flange Coupling Adapters*	2.00 ea	2,886	9,418				6,152.07 /ea	12,304
913	40-05-06.220 --- 6" Quick Connect Couplings (Cam-Lok) (Pick List)*	1.00 ea	1,092	2,687				3,778.86 /ea	3,779
914	40-05-07.005 Pipe Hangers - Wall Brackets w/U-Bolt (Anvil 194/195/199)*	4.00 ea	2,077	568				661.10 /ea	2,644
915	40-05-07.025 12" DR Pipe Hangers - Stanchion/Support (Anvil 259/63)*	7.00 ea	15,480	8,153				3,376.11 /ea	23,633
916	40-05-19.100 12" DR-ID Pipe FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	110.00 lf	37,708	83,505	4,458	44		1,142.87 /lf	125,715
917	40-05-62.005 12" & 6" DR Plug Valve - Flanged, CI/DI, 3" to 72"	5.00 ea	15,785	64,079	3,256		205	16,665.23 /ea	83,326
918	40-05-65.025 12" DR Check Valve - Cast Iron/DI, Ball Check, Flanged, 2" to 30"	2.00 ea	5,493	50,222	1,123		82	28,459.96 /ea	56,920
919	40-70-00.030 --- 12" Flow Meter*	1.00 ea	3,104	22,353			306	25,763.48 /ea	25,763
	055.400519.91.005 12" AG DR-DI from Engineer Sump to Process DR Pump Stn.		83,624	240,986	8,838	44	594	/lf	334,085
920	055.400519.91.010 8" AG V-DI Process DR Pump Stn.								
921	40-05-19.100 8" V-DI FLANGED Ductile Iron Pipe (3" to 64") (No Trenching)*	4.00 lf	5,035	5,086	129			2,562.41 /lf	10,250
	055.400519.91.010 8" AG V-DI Process DR Pump Stn.		5,035	5,086	129				10,250
	40-05-19 Ductile Iron Pipe		88,659	246,072	8,967	44	594		344,335
922	40-05-24 Steel Pipe								
923	055.400524.91.005 2" Galv CARV Line								
924	40-05-07.045 Pipe Hangers - Unistrut w/Clamp*	2.00 ea	666	287				476.10 /ea	952
925	40-05-24.310 2" CARV Galvanized A53 CW T&C Pipe & Malleable Fittings (1/8" to 6")*	30.00 lf	4,782	3,062	4			261.61 /lf	7,848
926	40-05-63.015 2" CARV Ball Valve - Stainless Steel, 1/2" to 12"	5.00 ea	2,507	8,549	540		205	2,360.11 /ea	11,801
927	40-05-78.230 2" CARV Combination Air/Vacuum Valve (CAV) - 1/2" to 14"	3.00 ea	1,760	15,886	380		62	6,028.98 /ea	18,087
	055.400524.91.005 2" Galv CARV Line		9,714	27,783	924		267	/lf	38,688
	40-05-24 Steel Pipe		9,714	27,783	924		267		38,688
928	40-70-00 Instrumentation for Process Systems								
929	055.407000.01.001 I&C Instruments								
930	40-70-00.010 I&C Instruments- process drain ps	16.00 ea	23,691		3,037		4,903	1,976.90 /ea	31,630
	055.407000.01.001 I&C Instruments		23,691		3,037		4,903	/ea	31,630
	40-70-00 Instrumentation for Process Systems		23,691		3,037		4,903		31,630
931	43-25-00 Submersible/Immersible Liquid Pumps								
932	055.432500.67.001 Process Drain Pump Station, Duplex 5HP, Constant Speed								
933	43-25-00.010 Process Drain Pump Station, Duplex 5HP, Constant Speed	2.00 ea	14,817	22,859	9,345		5,128	26,074.92 /ea	52,150
	055.432500.67.001 Process Drain Pump Station, Duplex 5HP, Constant Speed		14,817	22,859	9,345		5,128		52,150
	43-25-00 Submersible/Immersible Liquid Pumps		14,817	22,859	9,345		5,128		52,150
	055 PROCESS DRAIN PUMP STATION	1.00 ls	413,172	796,485	47,312	89,441	23,108	1,369,517.65 /ls	1,369,518
934	060 ELECTRICAL BUILDING								
935	26-05-18.050 Feeders								
936	060.260516.01.001 LV Feeder - ATS-1 to MCC-1								
937	26-05-33.484 S40 PVC & Cu Str- ats-1 to mcc-1	60.00 lf	68,406	40,607	45			1,817.64 /lf	109,058
	060.260516.01.001 LV Feeder - ATS-1 to MCC-1		68,406	40,607	45			/lf	109,058
938	060.260516.01.002 LV Feeder - ATS-2 to MCC-2								
939	26-05-33.484 S40 PVC & Cu Str- ats-2 to mcc-2	50.00 lf	56,725	33,559	45			1,806.59 /lf	90,330

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	060.260516.01.002 LV Feeder - ATS-2 to MCC-2		56,725	33,559	45			/lf	90,330
940	060.260516.01.003 LV Feeder - MCC-2 to DP-1								
941	26-05-33.484 S40 PVC & Cu Str- mcc-2 to dp-1	25.00 lf	9,280	4,023				532.13 /lf	13,303
	060.260516.01.003 LV Feeder - MCC-2 to DP-1		9,280	4,023				/lf	13,303
942	060.260516.01.004 LV Feeder - MCC-2 to XFMR-1								
943	26-05-33.484 S40 PVC & Cu Str- mcc-2 to xfmr-1	30.00 lf	6,887	1,883	135			296.83 /lf	8,905
	060.260516.01.004 LV Feeder - MCC-2 to XFMR-1		6,887	1,883	135			/lf	8,905
944	060.260516.01.005 LV Feeder - LP-1 to PFAS-PLC								
945	26-05-33.484 S40 PVC & Cu Str- lp-1 to pfas-plc	50.00 lf	4,063	728				95.82 /lf	4,791
	060.260516.01.005 LV Feeder - LP-1 to PFAS-PLC		4,063	728				/lf	4,791
	26-05-18.050 Feeders		145,362	80,800	225				226,387
946	26-05-18.100 Branch Circuits								
947	060.260513.01.001 I&C Branch - PFAS-PLC to MCC-1,-2								
948	26-05-33.484 S40 PVC & Cu Str- pfas-plc to mcc-1,-2	50.00 lf	5,432	2,133				151.30 /lf	7,565
	060.260513.01.001 I&C Branch - PFAS-PLC to MCC-1,-2		5,432	2,133				/lf	7,565
949	060.260513.01.002 I&C Branch - PFAS-PLC to Generator Control Panel via DB								
950	26-05-33.484 S40 PVC & Cu Str- pfas-plc to gen cp via db, signal	25.00 lf	4,116	2,019				245.39 /lf	6,135
951	26-05-33.484 S40 PVC & Cu Str- pfas-plc to gen cp via db, control	25.00 lf	8,631	1,138				390.76 /lf	9,769
	060.260513.01.002 I&C Branch - PFAS-PLC to Generator Control Panel via DB		12,747	3,157				/lf	15,904
	26-05-18.100 Branch Circuits		18,179	5,290					23,469
952	26-05-26 Grounding & Bonding for Electrical Systems								
953	060.260526.01.001 Service Equipment Grounding								
954	26-05-26.000 Cu Grounding- serv equip grdg, in ug conduit	200.00 lf	17,704	3,787				107.46 /lf	21,492
	060.260526.01.001 Service Equipment Grounding		17,704	3,787				/lf	21,492
	26-05-26 Grounding & Bonding for Electrical Systems		17,704	3,787					21,492
955	26-05-83 Wiring Connections								
956	060.260584.01.001 I&C Connect & Feed - Electrical and Pump Rooms								
957	26-05-02.000 I&C Instrument Connections- elec & pump rooms	5.00 ea	10,034	2,375				2,481.79 /ea	12,409
958	26-05-33.484 S40 PVC & Cu Str- pfas-plc to tsh543,566,565a/b	150.00 lf	10,998	1,504				83.35 /lf	12,502
	060.260584.01.001 I&C Connect & Feed - Electrical and Pump Rooms		21,032	3,879				/ea	24,911
	26-05-83 Wiring Connections		21,032	3,879					24,911
959	26-20-01 Service & Distribution								
960	060.262000.01.002 Automatic Transfer Switches								
961	26-28-16.110 Automatic Transfer Switch- ats-1	1.00 ea	16,209	92,085				108,293.44 /ea	108,293
962	26-28-16.110 Automatic Transfer Switch- ats-2	1.00 ea	16,209	92,085				108,293.46 /ea	108,293
	060.262000.01.002 Automatic Transfer Switches		32,417	184,170				/ea	216,587
963	060.262000.01.003 Motor Control Center - MCC-1								
964	26-24-19.000 Low Voltage MCC- mcc-1	1.00 ea	105,051	1,316,671	6,333			1,428,055.37 /ea	1,428,055
	060.262000.01.003 Motor Control Center - MCC-1		105,051	1,316,671	6,333			/ea	1,428,055
965	060.262000.01.004 Motor Control Center - MCC-2								
966	26-24-19.000 Low Voltage MCC- mcc-2	1.00 ea	88,880	1,316,646	6,333			1,411,859.05 /ea	1,411,859
	060.262000.01.004 Motor Control Center - MCC-2		88,880	1,316,646	6,333			/ea	1,411,859
967	060.262000.01.005 Distribution Transformer & Panelboards								
968	* unassigned *		0	92,681					92,681
969	26-22-00.005 480V Transformers- xfmr-1	1.00 ea	8,792	2,770				11,562.66 /ea	11,563
970	26-24-16.000 MCB Panelboards- lp-1, section 1	1.00 ea	8,038					8,037.79 /ea	8,038
971	26-24-16.000 MLO Panelboards- lp-1, section 2	1.00 ea	7,827	7,181				15,008.36 /ea	15,008
972	26-24-16.000 MCB Panelboards- dp-1, section 1	1.00 ea	6,634					6,634.26 /ea	6,634
973	26-24-16.000 MLO Panelboards- dp-1, section 2	1.00 ea	7,397	1,152				8,549.84 /ea	8,550
	060.262000.01.005 Distribution Transformer & Panelboards		38,689	103,785				/ea	142,474
	26-20-01 Service & Distribution		265,037	2,921,272	12,667				3,198,976
	060 ELECTRICAL BUILDING	1.00 ls	467,314	3,015,028	12,891			3,495,233.60 /ls	3,495,234
974	065 EMERGENCY GENERATOR AND TRANSFORMER								
975	01-00-00 GENERAL REQUIREMENTS								
976	065.010000.90.001 Testing and Inspection								
977	01-00-00.010 --- General Conditions Checklist*	1.00 ls					23,514	23,513.96 /ls	23,514
	065.010000.90.001 Testing and Inspection						23,514	/ls	23,514
	01-00-00 GENERAL REQUIREMENTS						23,514		23,514
978	03-31-02 Foundation Place/Finish								
979	065.033102.58.005 Concrete Foundation for Platforms and Stairs for Generator								
980	03-11-11.105 Concrete Foundation for Platforms and Stairs for Generator	7.90 cy	36,907	12,207	173	1,062	93	6,384.14 /cy	50,441
	065.033102.58.005 Concrete Foundation for Platforms and Stairs for Generator		36,907	12,207	173	1,062	93	/cy	50,441
	03-31-02 Foundation Place/Finish		36,907	12,207	173	1,062	93		50,441
981	03-31-04 Slab-on-Grade Place/Fin								
982	065.031111.90.001 Emergency Generator & Tansformer - Generator SOG 20'x44'								
983	03-11-11.000 --- SOG Form, Place & Finish*	55.48 cy	64,791	70,195	4,632	2,728	663	2,577.62 /cy	143,009
	065.031111.90.001 Emergency Generator & Tansformer - Generator SOG 20'x44'		64,791	70,195	4,632	2,728	663	/cy	143,009
984	065.031111.90.102 Emergency Generator & Tansformer - Transformer SOG 10'x10'								
985									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	03-11-11.000 --- SOG Form, Place & Finish*	7.41 cy	11,122	9,646	561	702	88	2,986.32 /cy	22,120
	065.031111.90.102 Emergency Generator & Tansformer - Transformer SOG 10'x10'		11,122	9,646	561	702	88		22,120
	03-31-04 Slab-on-Grade Place/Fin		75,912	79,841	5,194	3,431	751		165,129
986	03-61-00 Cementitious Grouting								
987	065.036100.85.005 Grouting Under Platform								
988	03-60-00.000 Place Grout	1.80 cf	1,643	1,502				1,747.68 /cf	3,146
	065.036100.85.005 Grouting Under Platform		1,643	1,502				/cf	3,146
	03-61-00 Cementitious Grouting		1,643	1,502					3,146
989	05-51-00 Metal Stairs								
990	065.055100.85.005 Metal Stairs & Platform								
991	05-51-13.000 --- Metal Pan Stairs & Landings*	24.00 trd	135,878	5,589	91,575			9,710.09 /trd	233,042
	065.055100.85.005 Metal Stairs & Platform		135,878	5,589	91,575				233,042
	05-51-00 Metal Stairs		135,878	5,589	91,575				233,042
992	26-22-00 Outdoor Transformers								
993	065.262200.67.001 Outdoor Transformers (480V/277V) - Supply and Install By PG&E								
994	26-22-00.205 Outdoor Transformers (480V/277V)	1.00 ea	39,661	480,307				519,967.98 /ea	519,968
	065.262200.67.001 Outdoor Transformers (480V/277V) - Supply and Install By PG&E		39,661	480,307					519,968
	26-22-00 Outdoor Transformers		39,661	480,307					519,968
995	26-32-13 Engine Generators								
996	065.263213.67.001 Emergency Generator (3,000kW with 20K Gal Subbase Fuel Tank), 55dBA								
997	26-32-13.130 Emergency Diesel Generator 3000kw w/ Fuel Tank	1.00 ea	234,526	6,368,546	31,651		99,282	6,734,003.65 /ea	6,734,004
	065.263213.67.001 Emergency Generator (3,000kW with 20K Gal Subbase Fuel Tank), 55dBA		234,526	6,368,546	31,651		99,282		6,734,004
	26-32-13 Engine Generators		234,526	6,368,546	31,651		99,282		6,734,004
998	31-23-16.16 Foundation Excavation								
999	065.312316.90.001 Emergency Generator & Tansformer - Slab Over Ex - 5' Scarify & Recompact								
1000	31-23-00.005 --- Structure Excavation & Backfill - Generator Pad	195.56 cy	2,126	3,708	1,704	929		43.30 /cy	8,467
	065.312316.90.001 Emergency Generator & Tansformer - Slab Over Ex - 5' Scarify & Recompact		2,126	3,708	1,704	929		/cy	8,467
	31-23-16.16 Foundation Excavation		2,126	3,708	1,704	929			8,467
	065 EMERGENCY GENERATOR AND TRANSFORMER	1.00 ls	526,653	6,951,700	130,296	5,421	123,639	7,737,710.22 /ls	7,737,710
1001	075 UTILITY TIE-IN METERING VAULT								
1002	03-40-00 PRECAST CONCRETE								
1003	075.034800.67.001 Precast Concrete Vault for Utility Tie-In								
1004	03-48-00.005 Precast Concrete Vault for Gas Tie-In	1.00 ea	6,344	30,727	4,560			41,631.75 /ea	41,632
	075.034800.67.001 Precast Concrete Vault for Utility Tie-In		6,344	30,727	4,560				41,632
	03-40-00 PRECAST CONCRETE		6,344	30,727	4,560				41,632
1005	26-20-01 Service & Distribution								
1006	075.261800.67.001 Utility Metering								
1007	* unassigned *		78,231	33,597					111,828
	075.261800.67.001 Utility Metering		78,231	33,597					111,828
	26-20-01 Service & Distribution		78,231	33,597					111,828
1008	31-23-00 Excavation and Fill								
1009	075.312316.67.001 Precast Concrete Vault for Utility Tie-In EX/BF								
1010	31-23-00.005 Precast Concrete Vault for Gas Tie-In EX/BF	166.65 cy	24,664	20,068	33,775	4,446		497.78 /cy	82,953
	075.312316.67.001 Precast Concrete Vault for Utility Tie-In EX/BF		24,664	20,068	33,775	4,446			82,953
	31-23-00 Excavation and Fill		24,664	20,068	33,775	4,446			82,953
	075 UTILITY TIE-IN METERING VAULT	1.00 ls	109,239	84,393	38,335	4,446		236,412.27 /ls	236,412
1011	100 INSTRUMENTATION AND CONTROLS								
1012	40-60-00 Process Control and Enterprise Management Systems								
1013	100.406000.01.001 PFAS-PLC Control Panel								
1014	40-67-00.025 I&C Control Panels (w/PLC/Cabinets/Accessories)- pfas-plc	1.00 ea	40,445	417,587		5,677	306	464,015.83 /ea	464,016
	100.406000.01.001 PFAS-PLC Control Panel		40,445	417,587		5,677	306	/ls	464,016
1015	100.406000.01.002 Pressure Cabinets								
1016	* unassigned *			383,198					383,198
	100.406000.01.002 Pressure Cabinets			383,198				/ls	383,198
	40-60-00 Process Control and Enterprise Management Systems		40,445	800,785		5,677	306		847,213
1017	40-70-00 Instrumentation for Process Systems								
1018	100.407000.01.001 Instrumentation								
1019	* unassigned *			982,558					982,558
	100.407000.01.001 Instrumentation			982,558				/ls	982,558
1020	100.407000.01.002 Professional Services								
1021	* unassigned *						2,804,396		2,804,396
	100.407000.01.002 Professional Services						2,804,396	/ls	2,804,396
	40-70-00 Instrumentation for Process Systems			982,558			2,804,396		3,786,954
	100 INSTRUMENTATION AND CONTROLS	1.00 ls	40,445	1,783,343		5,677	2,804,702	4,634,167.56 /ls	4,634,168
	00 Base Bid - 100% OPCC per CDM Drawings	**1.00 LS**	**23,412,717**	**74,938,441**	**3,629,543**	**7,073,604**	**4,025,852**	**113,080,156.73 /LS**	**113,080,157**

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
1022	**01 Offsite Improvements per Siegfried Drawings**								
1023	200 OFFSITE IMPROVEMENTS								
1024	01-59-00 Security/Traffic & Pollution Control								
1025	**200.015900.93.005 Traffic Control**								
1026	01-59-00.005 --- Temporary Traffic Control (Pick List+)	1.00 ls	317			3,915	6,757	10,989.79 /ls	10,990
	200.015900.93.005 Traffic Control		317			3,915	6,757		10,990
	01-59-00 Security/Traffic & Pollution Control		317			3,915	6,757		10,990
1027	02-41-19 Selective Demolition								
1028	**200.024119.93.005 Demo Sidewalk**								
1029	02-41-13.005 --- Sidewalk Demolition*	1,730.00 sf	9,442	56	10,319		12,053	18.42 /sf	31,870
	200.024119.93.005 Demo Sidewalk		9,442	56	10,319		12,053	/sf	31,870
1030	**200.024119.93.010 Demo Curb and Gutters**								
1031	02-41-13.000 --- Site Concrete Demolition - 24" Curb and Gutter	250.00 lf	3,332	3	2,878		5,225	45.75 /lf	11,438
1032	02-41-13.000 --- Site Concrete Demolition - 6" A Curb	35.00 lf	732	2	765		244	49.79 /lf	1,743
	200.024119.93.010 Demo Curb and Gutters		4,064	5	3,642		5,469	/lf	13,180
1033	**200.024119.93.015 Demo Asphalt**								
1034	02-41-13.025 --- Asphalt Pavement Demolition*	4,080.00 sf	28,926	361	24,351		0	13.15 /sf	53,638
1035	31-22-00.010 --- Site Excavation-Cut to Stockpile/Haul-off*	150.00 cy	13,329		17,958			208.58 /cy	31,287
	200.024119.93.015 Demo Asphalt		42,255	361	42,309		0	/sf	84,925
1036	**200.024119.93.020 Demo Fencing**								
1037	02-41-13.015 --- Selective Site Demolition- N.O.C.*	26.11 cy	6,769		4,517		898	466.60 /cy	12,183
	200.024119.93.020 Demo Fencing		6,769		4,517		898	/lf	12,183
1038	**200.024119.93.025 Demo Utilities**								
1039	02-41-19.010 --- Utility Pipe Demolition - Storm Drainage	10.00 lf	444		247		3	69.40 /lf	694
1040	31-23-00.305 --- Trenching for Yard Piping*	10.00 lf	1,248	484	867			259.89 /lf	2,599
	200.024119.93.025 Demo Utilities		1,692	484	1,114		3	/lf	3,293
1041	**200.024119.93.030 Demo Street Light and Feed**								
1042	02-41-13.015 --- Demo Street Light	2.00 cy	18,012		9,771		153	13,967.99 /cy	27,936
1043	26-05-05.000 --- Electrical Demolition- Conduit & Wire*	1.00 ls	2,510		102		33	2,645.47 /ls	2,645
1044	31-23-00.305 --- Trenching for Yard Piping*	104.00 lf	7,025	1,159	3,844			115.65 /lf	12,028
	200.024119.93.030 Demo Street Light and Feed		27,547	1,159	13,717		186	/ea	42,610
1045	**200.024119.93.035 Demo Signage and Striping**								
1046	02-41-13.015 --- Selective Site Demolition- N.O.C.*	4.00 cy	4,753		856		2	1,402.73 /cy	5,611
	200.024119.93.035 Demo Signage and Striping		4,753		856		2	/ls	5,611
	02-41-19 Selective Demolition		96,522	2,065	76,474		18,611		193,672
1047	03-00-00 Concrete								
1048	**200.031111.93.005 Bioretention Basin Pads**								
1049	03-11-11.000 --- Rectangular Bio-Retention Pad	8.89 cy	22,593	16,498	532	2,901	89	4,793.80 /cy	42,612
1050	03-11-11.000 --- Irregular Bio-Retention Pad	4.94 cy	28,881	18,705	340	2,815	49	10,285.73 /cy	50,791
	200.031111.93.005 Bioretention Basin Pads		51,474	35,204	872	5,716	138	/cy	93,403
1051	**200.031111.93.010 Bioretention Basin Walls**								
1052	03-11-12.015 --- Rectangular Bio-Retention Walls	9.72 cy	54,657	25,470	1,189	3,586	97	8,745.63 /cy	84,999
1053	03-11-12.015 --- Irregular Bio-Retention Walls	8.89 cy	59,161	32,602	1,089	3,511	89	10,850.64 /cy	96,451
	200.031111.93.010 Bioretention Basin Walls		113,818	58,072	2,277	7,096	186	/cy	181,450
	03-00-00 Concrete		165,292	93,276	3,149	12,813	324		274,853
1054	26-00-00 Electrical								
1055	**200.034800.93.005 PGE #5 Pull Boxes**								
1056	03-48-00.005 --- 3x5x3.5 Vault (City)	4.00 ea	8,998	57,595	6,027			18,154.99 /ea	72,620
1057	03-48-00.005 --- 3x5x3.5 Vault (County)	2.00 ea	3,599	23,038	2,411			14,523.99 /ea	29,048
1058	31-23-00.005 --- Structure Excavation & Backfill (City)	9.72 cy	18,253		25,959			4,547.55 /cy	44,211
1059	31-23-00.005 --- Structure Excavation & Backfill (County)	3.89 cy	7,301		10,384			4,547.33 /cy	17,685
	200.034800.93.005 PGE #5 Pull Boxes		38,150	80,633	44,780			/ea	163,564
1060	**200.260533.93.005 Branch Circuitry**								
1061	26-05-33.490 --- 2-1/2" PVC 3#3/0 from Secondary Pull Box to CSJ Pull Box	2.00 lf	1,552	968	9			1,264.21 /lf	2,528
1062	26-05-33.490 --- 2-1/2" PVC 3#3/0 from CSJ Pull Box to Service Cabinet	2.00 lf	1,552	968	9			1,264.22 /lf	2,528
1063	26-05-33.490 --- 2" PVC 2#8. 2#10. 1#8G from CSJ Service Cabinet to Secondary Pull Box	92.00 lf	7,518	1,211	414			99.37 /lf	9,142
1064	26-05-33.490 --- 2" PVC 2#8, 1#8G from Secondary Pull Box to Street Light	4.00 lf	1,071	174	18			315.67 /lf	1,263
1065	26-05-33.490 --- 3/4" PVC 2#10, 1#8G from Secondary Pull Box to Irrigation Controller	8.00 lf	995	135	36			145.75 /lf	1,166
1066	26-05-33.490 --- 2" PVC 2#6 2#20 1#6G from P.O.C. to Secondary Pull Box	164.00 lf	8,781	1,220	369			63.23 /lf	10,369
1067	26-05-33.490 --- 2" PVC 2#6 1#6G from Secondary Pull Box to Street Light	15.00 lf	1,869	342	67			151.91 /lf	2,279
1068	26-05-33.490 --- 3/4" PVC 2#10 1#8G from Secondary Pull Box to Irrigation Controller	150.00 lf	9,721	1,127	674			76.82 /lf	11,523
	200.260533.93.005 Branch Circuitry		33,058	6,144	1,596			/lf	40,798
1069	**200.262416.93.005 Type IIIM Service Cabinet**								
1070	26-23-13.000 --- Type iiiM Sercive Cabinet	1.00 ea	46,198	170,990	1,331			218,519.55 /ea	218,520
	200.262416.93.005 Type IIIM Service Cabinet		46,198	170,990	1,331			/ea	218,520
1071	**200.265613.93.005 Street Lights**								
1072	26-56-13.000 --- Street Light (City)	1.00 ea	9,050	8,813				17,862.79 /ea	17,863
1073									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	26-56-13.000 --- Street Light (County)	1.00 ea	9,050	6,405				15,454.85 /ea	15,455
	200.265613.93.005 Street Lights		18,100	15,217				/ea	33,318
	26-00-00 Electrical		135,507	272,985	47,708				456,199
1074	31-11-00 Clearing and Grubbing								
1075	200.311100.93.005 Clearing and Grubbing								
1076	31-11-00.000 --- Site Clearing	2,073.00 sf	4,694		3,032			3.73 /sf	7,726
	200.311100.93.005 Clearing and Grubbing		4,694		3,032			/sf	7,726
	31-11-00 Clearing and Grubbing		4,694		3,032				7,726
1077	31-20-00 Earthwork								
1078	200.312000.93.005 Bioretention Basin Excavation & Backfill								
1079	31-23-00.005 --- Structure Excavation & Backfill	339.45 cy	19,911		26,243			135.97 /cy	46,153
	200.312000.93.005 Bioretention Basin Excavation & Backfill		19,911		26,243			/cy	46,153
1080	200.312000.93.010 Bioretention Basin Fill								
1081	31-05-19.000 --- Membrane Liners/Clay Liners/Filter Fabric/Geogrid (Pick List)*	540.00 sf				4,420		8.19 /sf	4,420
1082	31-22-00.025 --- Bio-retention Soil & Class II Base	30.00 cy	14,449	10,928	20,544	892		1,560.42 /cy	46,813
	200.312000.93.010 Bioretention Basin Fill		14,449	10,928	20,544	5,312		/cy	51,233
	31-20-00 Earthwork		34,360	10,928	46,787	5,312			97,386
1083	32-12-16 Asphalt Paving								
1084	200.321216.93.005 AC Deep Lift								
1085	32-12-16.000 --- Asphalt Paving- Deep Lift	158.00 sy	1,290	22,618	641	62,423		550.45 /sy	86,971
	200.321216.93.005 AC Deep Lift		1,290	22,618	641	62,423		/sf	86,971
1086	200.321216.93.010 Road Repair								
1087	32-01-16.710 --- Cold Plane/ Milling Asphalt Pavement (Roadway)*	121.44 sy	1,358		1,852			26.43 /sy	3,210
1088	32-12-16.015 --- Asphalt Patching*	122.89 sy	2,570	3,096	1,592	260		61.18 /sy	7,518
	200.321216.93.010 Road Repair		3,929	3,096	3,444	260		/sf	10,728
1089	200.321216.93.015 Bike Path								
1090	32-12-16.010 --- Asphalt Paving- Bike Path	102.78 sy	3,149	4,859	1,850	680		102.52 /sy	10,537
	200.321216.93.015 Bike Path		3,149	4,859	1,850	680		/sf	10,537
	32-12-16 Asphalt Paving		8,368	30,573	5,934	63,362			108,237
1091	32-13-13 Concrete Paving								
1092	200.321313.93.005 Concrete Driveway								
1093	32-13-13.010 --- Concrete Paving (Plant Roads and Small Areas)*	40.00 sy	641	2,225	232	8,247		283.63 /sy	11,345
	200.321313.93.005 Concrete Driveway		641	2,225	232	8,247		/sf	11,345
	32-13-13 Concrete Paving		641	2,225	232	8,247			11,345
1094	32-15-40 Crushed Stone Surfacing								
1095	200.321540.93.005 Cobble Swales								
1096	32-15-00.005 --- Aggregate Surfacing*	25.00 sf	328	515	140	9		39.71 /sf	993
	200.321540.93.005 Cobble Swales		328	515	140	9		/sf	993
	32-15-40 Crushed Stone Surfacing		328	515	140	9			993
1097	32-16-00 Concrete Curbs, Valley Gutter, SD Inlets								
1098	200.321623.93.005 Sidewalk								
1099	31-22-00.025 --- Aggregate Base	20.00 cy	7,417	3,049	10,458	570		1,074.72 /cy	21,494
1100	32-16-23.000 --- Sidewalks (Subcontract)*	2,480.00 sf	27	24		48,865		19.72 /sf	48,916
	200.321623.93.005 Sidewalk		7,443	3,073	10,458	49,435		/sf	70,410
1101	200.321623.93.010 Curbs and Gutters								
1102	32-13-13.010 --- 12" Flush Curb	146.00 lf	240	490	77	3,285		28.03 /lf	4,093
1103	32-13-13.010 --- 6" Flush Curb	88.00 lf	762	1,395	23	239		27.49 /lf	2,419
1104	32-16-13.130 --- 24" Curb & Gutter (Subcontract)*	288.00 lf				26,978		93.67 /lf	26,978
1105	32-16-13.130 --- 6" A Curb (Subcontract)*	130.00 lf				5,889		45.30 /lf	5,889
	200.321623.93.010 Curbs and Gutters		1,003	1,885	100	36,391		/lf	39,379
	32-16-00 Concrete Curbs, Valley Gutter, SD Inlets		8,446	4,958	10,559	85,827			109,789
1106	32-17-23 Pavement Markings								
1107	200.321723.93.005 Pavement Markings and Signage								
1108	32-17-23.000 --- Pavement Markings & Signs*	1.00 ls				9,788		9,787.80 /ls	9,788
	200.321723.93.005 Pavement Markings and Signage					9,788		/ls	9,788
	32-17-23 Pavement Markings					9,788			9,788
1109	32-31-13 Chain Link Fences & Gates								
1110	200.323113.93.005 Chainlink Fence and Gate								
1111	32-31-13.000 --- Chain Link Fencing*	280.00 lf	4,574	14,156	1,393	37,519		205.87 /lf	57,643
	200.323113.93.005 Chainlink Fence and Gate		4,574	14,156	1,393	37,519		/sf	57,643
	32-31-13 Chain Link Fences & Gates		4,574	14,156	1,393	37,519			57,643
1112	32-80-00 Irrigation								
1113	200.328000.93.005 Irrigation								
1114	32-84-23.000 --- Irrigation Systems (SF)*	1,250.00 sf	39,772	5,158		8,937		43.09 /sf	53,867
	200.328000.93.005 Irrigation		39,772	5,158		8,937		/sf	53,867
	32-80-00 Irrigation		39,772	5,158		8,937			53,867
1115	32-92-16 Planting								
1116	200.329000.93.005 Planting								
1117									

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
	32-91-13.260 --- Planting Beds*	930.00 sf	3,428	3,774		2,321		10.24 /sf	9,523
1118	32-91-13.260 --- Bio Retention Beds*	320.00 sf	601	1,493		153		7.02 /sf	2,248
	200.329000.93.005 Planting		4,029	5,267		2,474		/sf	11,771
	32-92-16 Planting		4,029	5,267		2,474			11,771
1119	33-14-00 Water Utility Transmission & Distribution								
1120	200.331400.93.005 Water Utility Pipe, Meter, and Backflow Preventers								
1121	22-11-19.000 --- Backflow Preventers*	2.00 ea	583	10,655				5,618.93 /ea	11,238
1122	33-14-13.000 --- Water Service Laterals, Corporation, Curb Stops & Water Meter*	20.00 lf	3,532	9,518	666			685.83 /lf	13,717
	200.331400.93.005 Water Utility Pipe, Meter, and Backflow Preventers		4,115	20,173	666			/lf	24,954
	33-14-00 Water Utility Transmission & Distribution		4,115	20,173	666				24,954
1123	33-42-00 Stormwater Conveyance								
1124	200.330505.93.005 12"-SD-C900								
1125	33-05-05.410 --- 12"-Storm Drain-C900 from Catch Basins to Manhole	130.00 lf	14,155	14,467	5,296	58,729	10,605	794.24 /lf	103,252
	200.330505.93.005 12"-SD-C900		14,155	14,467	5,296	58,729	10,605	/lf	103,252
1126	200.334211.93.005 6"-SD-N-12								
1127	33-42-11.800 --- 6"-SD-N-12 at Bio-retention Basins	64.00 lf	5,334	1,383	532			113.27 /lf	7,250
	200.334211.93.005 6"-SD-N-12		5,334	1,383	532			/lf	7,250
	33-42-00 Stormwater Conveyance		19,489	15,849	5,829	58,729	10,605		110,501
1128	33-42-33 Storm Drain Inlets								
1129	200.334233.93.005 18"x18" Catch Basins								
1130	33-42-33.000 --- Rectangular Catch Basins w/ Excavation & Backfill*	2.00 ea	4,926	5,761	1,798			6,242.38 /ea	12,485
	200.334233.93.005 18"x18" Catch Basins		4,926	5,761	1,798			/ea	12,485
1131	200.334233.93.010 3"x17" Curb-o-Let								
1132	33-42-33.000 --- Rectangular Catch Basins w/ Excavation & Backfill*	1.00 ea	2,438	1,244	868			4,550.37 /ea	4,550
	200.334233.93.010 3"x17" Curb-o-Let		2,438	1,244	868			/ea	4,550
	33-42-33 Storm Drain Inlets		7,364	7,006	2,665				17,035
	200 OFFSITE IMPROVEMENTS	1.00 ls	533,819	485,134	204,567	296,932	36,297	1,556,748.54 /ls	1,556,749
	01 Offsite Improvements per Siegfried Drawings	**1.00 LS**	**533,819**	**485,134**	**204,567**	**296,932**	**36,297**	**1,556,748.54 /LS**	**1,556,749**

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
1133	**02 Fire Sprinkler System AG / UG ROM No Drawings**								
1134	035 YARD PIPING								
1135	33-05-10.120 DIP- Mechanical Joint Pipe & Fittings								
1136	035.330510.93.005 Fire Sprinkler Feed Pipe								
1137	33-05-05.115 --- 6"-FIRE-DI	25.00 lf	5,324	9,646	2,507	29,508		1,879.39 /lf	46,985
	035.330510.93.005 Fire Sprinkler Feed Pipe		5,324	9,646	2,507	29,508		/lf	46,985
	33-05-10.120 DIP- Mechanical Joint Pipe & Fittings		5,324	9,646	2,507	29,508			46,985
	035 YARD PIPING	1.00 ls	5,324	9,646	2,507	29,508		46,984.79 /ls	46,985
1138	050 IX TREATMENT								
1139	21-10-00 Water-Based Fire-Suppression Systems								
1140	050.211000.93.005 Fire Suppression System								
1141	21-11-00.000 --- Fire Protection	1.00 ls				246,663		246,663.27 /ls	246,663
	050.211000.93.005 Fire Suppression System					246,663		/ls	246,663
	21-10-00 Water-Based Fire-Suppression Systems					246,663			246,663
	050 IX TREATMENT	1.00 ls				246,663		246,663.27 /ls	246,663
	02 Fire Sprinkler System AG / UG ROM No Drawings	**1.00 LS**	**5,324**	**9,646**	**2,507**	**276,172**		**293,648.06 /LS**	**293,648**

	Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
1142	**03 Fire Alarm System ROM No Drawings**								
1143	050 IX TREATMENT								
1144	28-46-00 Fire Detection & Alarm								
1145	050.284600.93.005 Fire Alarm System								
1146	26-05-19.505 --- Low Voltage Power Cable AC-90 Steel Armored (Pick List)*	1,000.00 lf	9,587	1,708				11.29 /lf	11,295
1147	26-05-29.105 --- Conduit Hangers, Lay-in (J) or Clevis Hangers - Steel/Beam Attach*	100.00 ea	22,817	4,211				270.28 /ea	27,028
1148	28-46-00.000 --- Fire Alarm & Detection (Pick List)*	1.00 ls	17,474	13,650				31,124.10 /ls	31,124
	050.284600.93.005 Fire Alarm System		49,879	19,568				/ls	69,447
	28-46-00 Fire Detection & Alarm		49,879	19,568					69,447
	050 IX TREATMENT	1.00 ls	49,879	19,568				69,446.83 /ls	69,447
	03 Fire Alarm System ROM No Drawings	**1.00 LS**	**49,879**	**19,568**				**69,446.83 /LS**	**69,447**

Estimate Totals

Description	Amount	Totals	Hours	Rate	
Labor	24,001,738		82,934 hrs		
Material	75,452,789				
Subcontract	7,646,707				
Equipment	3,836,617		11,552 hrs		
Other	4,062,149				
Total Cost in Today's Dollars	115,000,000	115,000,000			100.00%
Escalation to Mid Point Constr By Owner					
		115,000,000			100.00%
	Total	***115,000,000***			

"This Opinion of Probable Construction Cost is produced in accordance with CDM Smith's Firmwide Quality policies and best practices as described in CDM Smith's Estimating Manual Dated 01/03/23 Section 10 titled Quality Control. I hereby acknowledge that the Cost Estimating policies and procedures were followed in preparation of the Opinion of Probable Cost".

Estimator initials - JQ, CB, LL, TL, JB 1/22/2026

Estimate Reviewer - TL 1/19/2026