HRSD SWIFT Research Center (SRC) Quarterly Report on SWIFT Water Quality Targets

This report documents SWIFT Water Quality results for recharge operations from October 1 – December 31, 2023. The compliance requirements are documented in HRSD's SWIFT Underground Injection Control Inventory Information Package (UIC-IIP) submitted to EPA Region III in January 2018. These requirements are noted in Tables 1-4 and reflect an update to the monitoring and compliance evaluation for Total coliform.

Figures 1 and 2 and Table 6 provide a summary of the data from the referenced quarter of operations relative to the SWIFT Water Quality Targets. Table 6 represents a summary of all analytes that were present above the laboratory reporting limit. A detailed table identifying the parameters monitored for the purpose of evaluating compliance with the SWIFT Water Quality Targets can be found as an Appendix to this report.

Parameter	Proposed Regulatory Limit	Non-Regulatory Action/Goal
EPA Drinking Water Primary Maximum Contaminant Levels (MCLs)	Meet all primary MCLs	N/A
Total Nitrogen	5 mg/L Monthly Average; 8 mg/L Max Daily	Secondary Effluent Critical Control Point (CCP) Action Limit for Total Inorganic Nitrogen (TIN) = 5 mg/L-N; CCP Action Limit for SWIFT Water Total Nitrogen (TN) = 5 mg/L-N
Turbidity	Individual Filter Effluent (IFE) < 0.15 NTU 95% of time and never >0.3 NTU in two consecutive 15 min measurements	CCP Action Limit IFE of 0.15 NTU to initiate backwash or place a filter in standby
Total Organic Carbon (TOC)[1]	4 mg/L Monthly Average; 6 mg/L Maximum Daily	Critical Operating Point (COP) Action Limit to Initiate Granular Activated Carbon (GAC) Regeneration
Total Coliform (TC)[2]	<2 CFU/100 mL for 95% of calendar month observations, applied as the 95th percentile	N/A
E.coli	Non-detect	N/A
TDS[3]	N/A	Monitor PAS Compatibility

Table 1: SRC Regulatory and Monitoring Limits for SWIFT Water

[1] Regulatory limit applies to the TOC laboratory analysis which is collected at a minimum frequency of 3 times per week.

[2] The TC monitoring and compliance evaluation reflects an update effective in January 2020 following consultation with the Virginia Department of Health and EPA Region III UIC staff.

[3] No limit for Total Dissolved Solids (TDS) proposed as the primary driver is aquifer compatibility. The concentration of TDS in SWIFT Water at the SRC generally ranges from 500-850 mg/L.

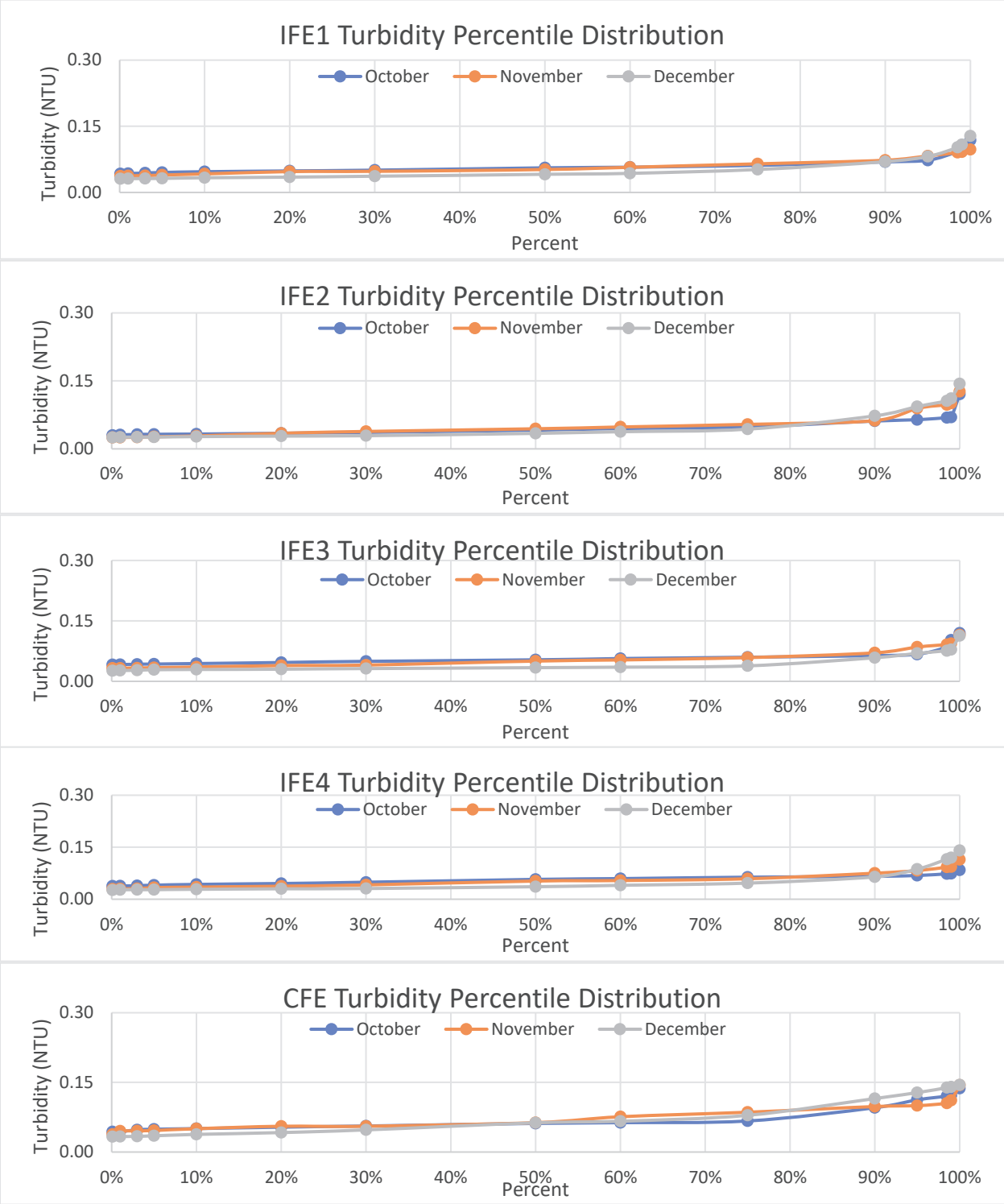

Figure 1: Percentile distribution of 15-minute average Individual Filter Effluent (IFE) Turbidities for Biofilters 1-4 (IFE1-4) and Biofilter Combined Filter Effluent (CFE). There were no 15-minute periods in this quarter with biofilter effluent turbidity values greater than 0.3 NTU. The 95% measured value for each biofilter IFE and the CFE was less than 0.15 NTU for each month in this quarter.

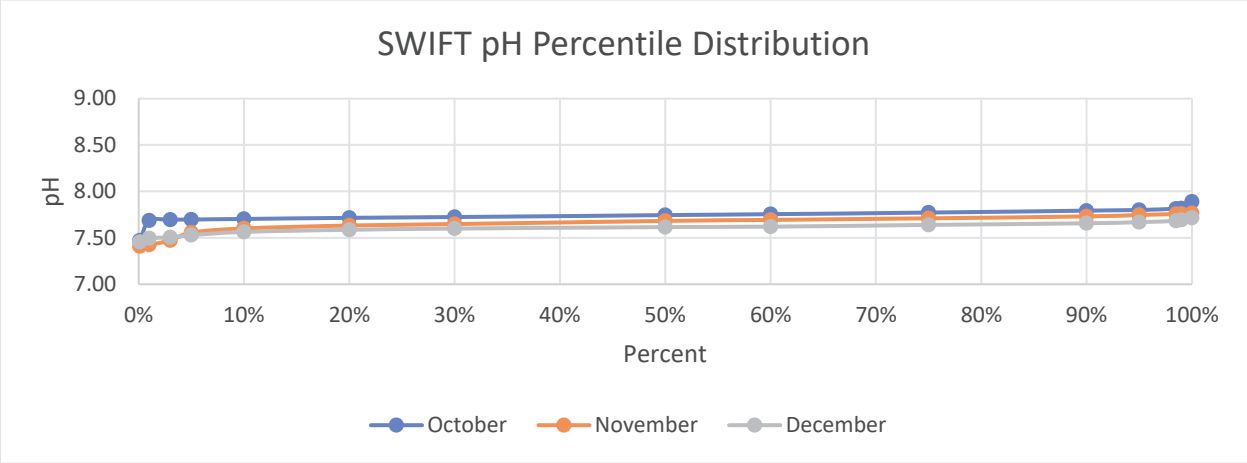

Figure 2: Distribution of Monthly SWIFT Water pH values.

Monitoring at the SRC also includes monitoring for performance indicators as documented in Table 2.

Constituent	Category	Trigger Value	Unit	Notes
1,4-Dioxane	Public Health	1	µg/L	CCL4; CA Notification Limit
17-β-Estradiol	Public Health	0.9[1]	ng/L	CCL4
DEET	Public Health	200	µg/L	MN Health Guidance Value
Ethinyl Estradiol	Public Health	280[1]	ng/L	CCL4
NDMA	Public Health	10	ng/L	CCL4; CA Notification Limit
Perchlorate	Public Health	6	µg/L	CA Notification Limit
PFOA+PFOS	Public Health	70	ng/L	CCL4; EPA Health Advisory
TCEP	Public Health	5	µg/L	MN Health Guidance Value
Cotinine	Treatment Effectiveness	1	µg/L	Surrogate for low molecular weight, partially charged cyclics
Primidone	Treatment Effectiveness	10	µg/L	
Phenytoin	Treatment Effectiveness	2	µg/L	
Meprobamate	Treatment Effectiveness	200	µg/L	High occurrence in wastewater treatment plant effluent
Atenolol	Treatment Effectiveness	4	µg/L	
Carbamazepine	Treatment Effectiveness	10	µg/L	Unique structure
Estrone	Treatment Effectiveness	320	ng/L	Surrogate for steroids
Sucralose	Treatment Effectiveness	150	mg/L	Surrogate for water soluble, uncharged chemicals with moderate molecular weight
Triclosan	Treatment Effectiveness	2,100	µg/L	Chemical of interest

[1] Identified as "To Be Determined" in the UIC-IIP. Since that time, threshold values were identified in *Monitoring Strategies for Constituents of Emerging Concern (CECs) in Recycled Water, Recommendations of a Science Advisory Panel, 2018; SCCWRP Technical Report 1032.*

Table 2: SRC Non-Regulatory Performance Indicators

Pathogen Log Removal Value (LRV) is not strictly regulated but the SRC has been

designed and is operated to achieve at least 12 LRV for viruses and 10 LRV for *Cryptosporidium* and *Giardia* through a combination of advanced treatment processes and soil aquifer treatment. Table 3 provides a treatment process pathogen LRV summary for recharge conditions. Table 4 provides additional monitoring that is being completed to document compliance with the LRVs for ozone and UV.

Parameter	Floc/Sed (+BAC)	Ozone	BAC+GAC	UV	Cl2	SAT	Total
Enteric Viruses	2	0-3 (TBD)	0	4	0-4	6	12-19
Cryptosporidium	4	0	0	6	0	6	16
Giardia	2.5	0-1.5 (TBD)	0	6	0	6	14.5-16

Table 3: SRC Pathogen LRV for Potomac Aquifer System (PAS) Recharge.

Ozone LRV
Ozone Influent Temperature
Ozone Influent Flow
Liquid Phase Ozone Concentration[1]
Contact Time
CT
UV LRV
UV Intensity, each reactor
UVT, GAC Combined Effluent
Reactor Flow, each
Calculated Dose, each Lamp
Status, each

[1] The ozone liquid phase probe is verified with lab grab samples performed at least once per week.

Table 4: Additional Monitoring to Support Ozone and UV LRV. All data are collected as continuous measurements. The 15-minute LRV data is submitted in Table 6.

Critical Control Points

The SRC incorporates Critical Control Points (CCP) throughout the treatment process, per Attachment G of UIC-IIP, to verify that treatment goals are being met at each of the individual processes. A violation of any CCP means that the SRC may not be producing water that meets the treatment goals and will trigger a diversion of the SWIFT Water so that it is not directed to the recharge well. In most instances, the SRC will continue to operate through the CCP violation, but the SWIFT Water will be diverted back to the Nansemond Plant chlorine contact tanks (CCT).

CCPs have alert values at which point the operator is expected to take action to correct the performance as well as the alarm values at which point an automated response will trigger action and prevent flow from going to the recharge well. Both the alert and alarm values will be measured consistently for a specified duration before action is taken so that blips in online analyzers do not trigger action. The specific values for the alert and alarm levels will be configured as adjustable set

points in the Distributed Control System (DCS) and optimized as needed to meet the water quality requirements.

Table 5 shows the current CCPs in effect at the SRC. Modifications have been made to the CCPs since startup as compared to the original design documents in order to optimize their performance. No modifications to the CCPs were made this quarter. Each of the modifications from previous quarters was discussed in the relevant quarterly report for the period.

Parameter	Alert Value	Alarm Value	Unit	Action
Critical Control Points (CCPs)				
Influent Pump Station Conductivity	1,400	1,600	microSiemens per centimeter	Place Biofilters in Filter To Waste
Influent Pump Station Total Inorganic Nitrogen	4.0	5.0	mg/L-N	Place Biofilters in Filter To Waste
Influent Pump Station Turbidity	3.5	5.0	NTU	Place Biofilters in Filter To Waste
Preformed Chloramine Failure on Injection	N/A	Failure	mg/L	Divert SWIFT Water
Total Chlorine Post Injection upstream of ozone	2.0	1.0	mg/L	Divert SWIFT Water
Chloramine injection upstream of ozone	2.0	1.0	mg/L	Divert SWIFT Water
Ozone Feed	N/A	Failure	N/A	Open Biofilter Backwash Waste Valve
Ozone Contactor Calculated LRV – Virus	<120% LRV Goal	≤110% LRV Goal	%	Open Biofilter Backwash Waste Valve
Biofilter Individual Effluent Turbidity	0.1	0.15	NTU	Place That Biofilter in Filter To Waste
Biofilter Combined Filter Effluent Turbidity	0.1	0.15	NTU	Place Biofilters in Filter To Waste
GAC Combined Effluent TOC, instantaneous online analyzer	4.0	5.0	mg/L	Divert SWIFT Water
UV Reactor Dose	<120% of Dose Setpoint	<105% of Dose Setpoint	%	Divert SWIFT Water
GAC Combined Effluent Nitrite	0.25	0.50	mg/L-N	Divert SWIFT Water
SWIFT Water TN	4.5	5.0	mg/L-N	Divert SWIFT Water
Ozone dose	70	80	lbs/day	Place Biofilters in Filter To Waste
Tasting System Free Chlorine CT	<110% of Required CT	<100% of Required CT	mg-min/L	Shut Down Tasting System
Tasting System Total Ammonia	0.1	0.3	mg/L-N	Shut Down Tasting System

Table 5. Critical Control Points for the SRC

Table 6. SWIFT Water Quality Monitoring. Results of Detected Analytes.

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	October 2023			November 2023			December 2023		
					Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples
Regulatory Parameters													
Total Nitrogen (TN)	mg/L	NA	0.50	Daily[3]	3.22	4.53	25	3.66	4.62	12	2.10	3.14	11
NO_3	mg/L	10	0.20	Daily[3]	3.18	3.94	23	3.64	4.62	10	2.05	3.14	9
Turbidity	NTU	NA	0.01	Continuous	**Figure 1**								
Total Organic Carbon (TOC)	mg/L	NA	1.00	3x/Wk[3]	0.69	1.47	18	1.71	1.71	2	2.09	2.43	9
pH		NA	NA	Continuous	**Figure 2**								
TDS[4]	mg/L	Potomac Aquifer System Range: 694-8,720	2.5	Monthly		516	1		560	1		562	1
Microorganisms													
Total Coliform	MPN/100 mL	MCLG = 0	1	Daily[3]	<1	1	23	<1	<1	10	<1	<1	9
Disinfection Byproducts[5]													
Bromate	µg/L	10	0.250	Monthly		<0.250	1		2.91	1		2.95	1
Trihalomethanes													
Bromodichloromethane	µg/L		1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Bromoform	µg/L		1.00	Monthly		<1.00	1		<1.00	1		2.25	1
Chloroform	µg/L		1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Dibromochloromethane	µg/L		1.00	Monthly		<1.00	1		<1.00	1		1.62	1
Total Trihalomethanes	µg/L	80				<1.00	1		<1.00	1		3.87	1
HAAs													
Dichloroacetic acid	µg/L		0.60	Monthly		<0.60	1		<0.60	1		<0.60	1
Trichloroacetic acid	µg/L		0.20	Monthly		<0.20	1		<0.20	1		<0.20	1
Monochloroacetic acid	µg/L		0.60	Monthly		<0.60	1		<0.60	1		<0.60	1
Bromoacetic acid	µg/L		0.40	Monthly		<0.40	1		0.46	1		0.5	1
Dibromoacetic acid	µg/L		0.20	Monthly		<0.20	1		3.53	1		3.61	1
Total Haloacetic Acids	µg/L	60				<0.60	1		3.99	1		4.11	1
Disinfectants[5]													
Monochloramine (as Cl_2)	mg/L	4		Continuous	0.03	0.05		0.01	0.04		0.03	0.06	
Chlorine (as Cl_2)	mg/L	4		Continuous	2.59	3.49		2.96	3.52		2.28	3.53	

Table 6. SWIFT Water Quality Monitoring. Results of Detected Analytes.

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	October 2023			November 2023			December 2023		
					Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples
Inorganic Chemical													
Arsenic	µg/L	10	0.40	Monthly		1.46	1		<0.40	1		0.34	1
Barium	mg/L	2	0.005	Monthly		0.012	1		0.006	1		0.006	1
Fluoride	mg/L	4.0	0.050	Monthly	0.961	1.04	25	0.886	1.05	12		0.935	11
Radionuclides													
Beta particles and photon emitters	pCi/L	4 mrem/yr[6]	1.72^	Monthly		10.8	1		13.7	1		17.2, F	1
Strontium-90	pCi/L	NA	0.827^	Monthly		<0.287, U	1		<0.323, U *	1		12.1	1
Tritium	pCi/L	NA	330^	Monthly		395	1		393	1		<184, U	1
Non-regulatory Performance Indicators													
Public Health Indicators		**Trigger Limits**											
1,4-dioxane	µg/L	1	0.06	Quarterly	<0.06	0.1	4	0.13	0.14	2	0.14	0.15	2
Treatment Efficacy Indicators		**Trigger Limits**											
Sucralose	ng/L	150,000,000	100	Quarterly		370, H	1		190	1		220	1
Additional Monitoring (Ozone & UV LRV)					**Average**	**Minimum**		**Average**	**Minimum**		**Average**	**Minimum**	
Ozone Virus LRV				Continuous	4.51	3.98		4.51	4.03		4.51	4.18	
Ozone Giardia LRV				Continuous	2.17	1.86		2.30	2.02		2.27	2.06	
UV Dose Reactor 1	mJ/cm^2			Continuous	>186	>186		>186	>186		>186	>186	
UV Virus LRV Reactor 1				Continuous	>4	>4		>4	>4		>4	>4	
UV Dose Reactor 2	mJ/cm^2			Continuous	>186	>186		>186	>186		>186	>186	
UV Virus LRV Reactor 2				Continuous	>4	>4		>4	>4		>4	>4	

[1] When minimum reporting limits varied during the quarter, the highest minumum reporting limit used is identified.

[2] Analytical results less than the reporting limit were treated as zero for the purposes of the averaging calculation.

[3] Daily samples are typically not collected on days in which there is no or limited recharge. TOC sample collection occurs routinely on Monday through Friday when recharging. Limited or inconsistent recharge impacts the collection of daily samples, particularly for the microbiological samples collected for total coliform and E coli which have limited holding time requirements. In October, limited or no recharge impacted 8 days of sampling. In November, limited or no recharge impacted 21 days of sampling. In December, limited or no recharge impacted 22 days of sampling.

[4] TDS of the Potomac Aquifer System is based on the averages within the upper, middle and lower Potomac Aquifer as determined during baseline montioring.

[5] The maximum residual disinfectant level (or MRDL) MCL for monochloramine and chlorine are based on annual averages.

[6] The measurement unit for beta particles and photon emitters is pCi/L while the MCL is expressed as mrem/yr. Per EPA's Implementation Guidance for Radionuclides (EPA 816-F-00-002, March 2002), the screening threshold for beta particles and photon emitters is 50 pCi/L. If sample concentrations exceed 50 pCi/L, each individual beta particle and photon emitter is converted from pCi/L to mrem using the EPA designated conversion tables, currently available in the referenced document.

^ MDC - Minimum Detectable Concentration (Radiochemistry).

Contract Laboratory Flags:

* : LCS and/or LCSD is outside acceptance limits.
F : MS/MSD Recovery and/or RPD exceeds the control limits.
U : Result is less than the sample detection limit.

Recharge Statistics

The total volume recharged during this operational period was 26.0 million gallons. The backflushed volume was 7.9 million gallons for a net recharge of 18.1 million gallons (Figure 3). Brief backflushing periods occur as part of routine well maintenance on an approximate daily basis. From the start of operation through the end of this reporting period, the SRC has recharged a total volume of 799.3 million gallons.

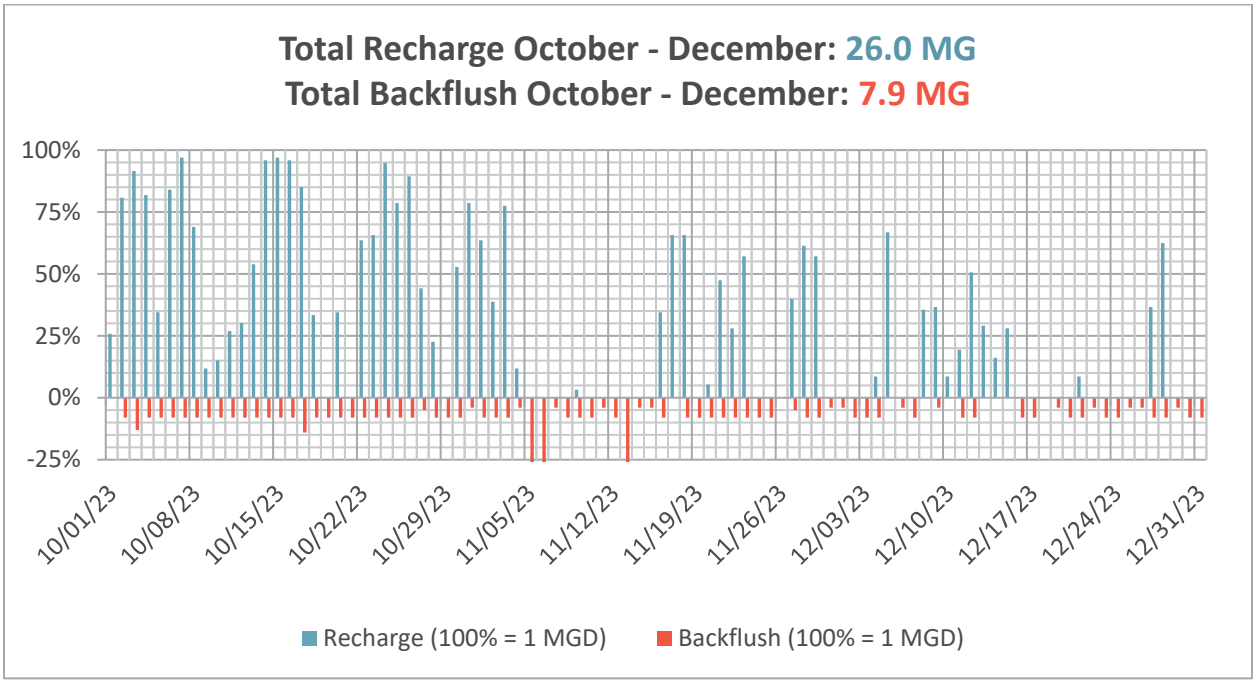

Figure 3: Recharge and Backflush Volumes, October 1 – December 31, 2023

HRSD has developed an internal target to recharge 75% of a SWIFT facility's operational capacity. This is a particularly relevant planning target for full-scale operations and HRSD is striving to meet this target at the SRC. Operational redundancies will exist at full-scale facilities (e.g., multiple recharge wells) which will likely result in a higher rate of recharge at full-scale. Integration of the new well, NP_MAR_01 into the SRC system is complete and the new well has been in operation since November 1, 2022. The recharge rate for NP_MAR_01 is currently 650 gpm (0.94 MGD).

Figure 4 depicts the operational activity for this monitoring period identifying the percentage of operational time spent in recharge as well as the general factors precluding recharge.

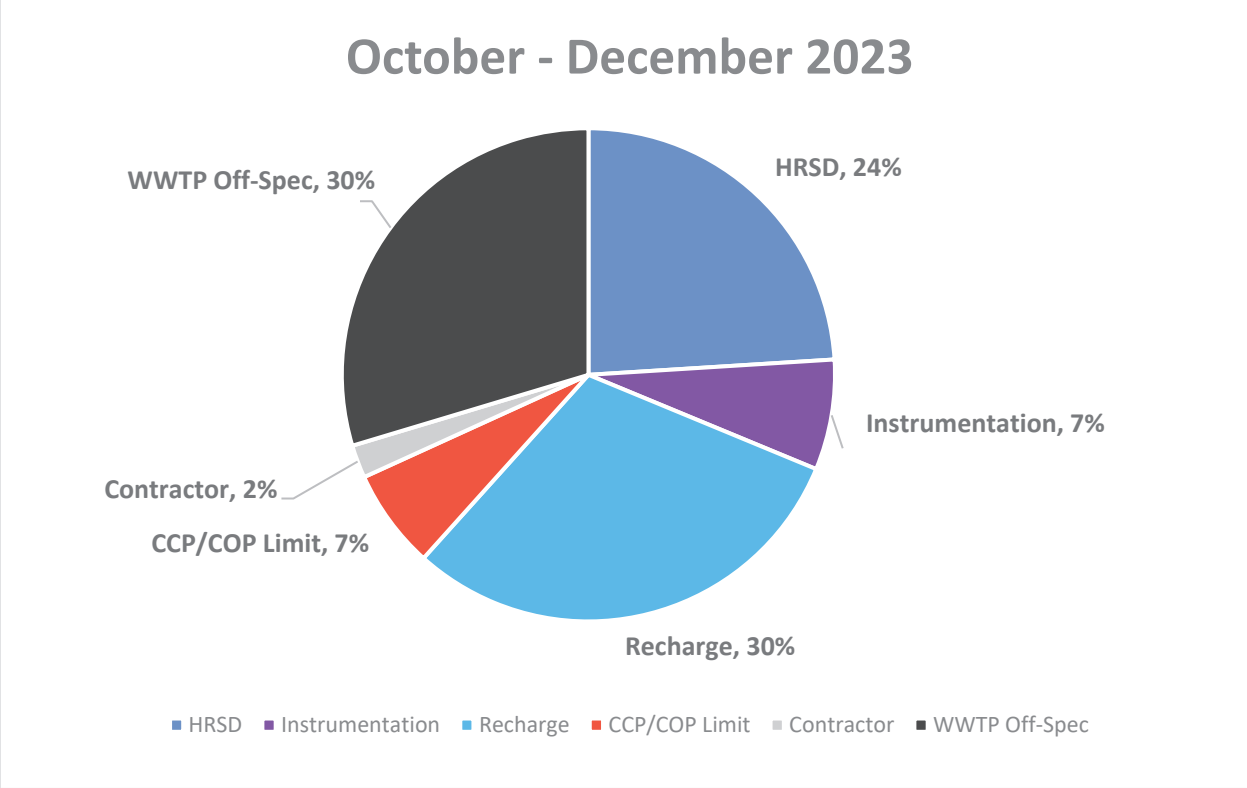

Figure 4: Operational activity for monitoring period. Notes: *HRSD*: Broad category covering activity within SWIFT facility that may lead to shut-down (e.g., maintenance and repairs, operational problems); *Instrumentation*: On-line analyzer and/or instrumentation maintenance and repair; *Recharge*: Recharge of SWIFT Water; *CCP/COP:* Critical Control Point/Critical Operating Parameter threshold triggered, diverting SWIFT Water from recharge well (e.g. elevated conductivity on SRC influent, elevated TOC/TN in SWIFT Water, low LRV, etc.) *Contractor:* Recharge suspended to accommodate contractor activity at the AWT and/or recharge well; *WWTP Off-Spec*: Influent to the SWIFT facility (wastewater facility secondary clarifier effluent) does not meet influent quality requirements (e.g., elevated TOC or TN, or WWTP repairs).

Conventional Monitoring Wells

The conventional monitoring wells located in the upper, middle and lower zones of the Potomac Aquifer (MW-UPA, MW-MPA, and MW-LPA, respectively) are located approximately 400 – 500 ft from the recharge well and have been routinely monitored to detect the arrival of the recharge front. Based upon TOC observations, the recharge front reached MW-UPA in late fall 2020 and MW-MPA in mid-late summer 2021 (Figure 5).

Travel time to MW-UPA was confirmed through a bromide tracer study initiated in July of 2020. Bromide from this tracer study was identified in MW-UPA beginning in April 2022. Travel time in days is difficult to estimate due to the frequent recharge stoppages. We can, however, relate travel time to a recharge volume equivalent. From July 2020 until the bromide appeared in MW-UPA in April 2022, approximately 230 million gallons of SWIFT Water was recharged.

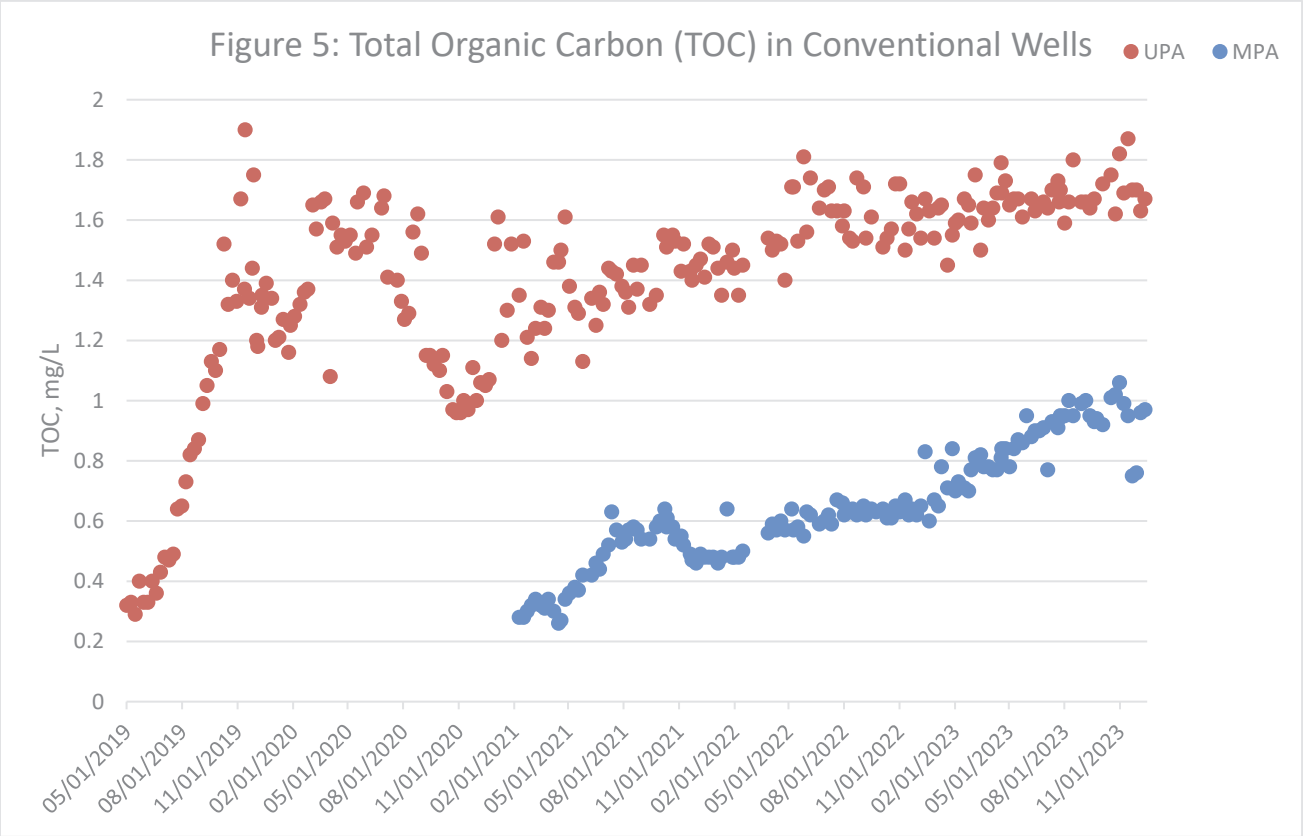

Figure 5: TOC concentration in the Upper and Middle Potomac conventional monitoring wells, MW-UPA and MW-MPA. Based on travel time studies using a conservative tracer, SWIFT Water recharged in the 1st quarter of 2022 roughly approximates the groundwater represented in this quarter's conventional well monitoring. The SWIFT Water average TOC concentration for January - March 2022 was 2.78 mg/L, with a maximum of 3.33 mg/L (n = 50).

In this monitoring period, three indicator compounds were observed in both conventional monitoring wells, MW-UPA and MW-MPA: 1,4-dioxane, sucralose, and PFOA. 1,4-Dioxane and sucralose have been observed frequently in MW-UPA since November 2019 while PFOA was first observed in MW-UPA in Quarter 2 of 2022. PFOA was observed for the first time in MW-MPA during the 2nd quarter of 2023, with the maximum value reported as 3.0 ng/L. The reported values for 1,4-dioxane and sucralose are less than the action thresholds ("trigger values") identified in Table 2 of this report. Results for all regulatory parameters are less than the Primary Maximum Contaminant Level (PMCL) and all regulated organics are non-detect. Arsenic observations are described in further detail in a subsequent section.

Previous transient detections of 1,4-dioxane in MW-LPA were not repeated this quarter. HRSD will continue to monitor MW-LPA to evaluate the arrival of SWIFT Water.

Using 230 million gallons of recharge volume as a proxy for travel time, we can estimate that the SWIFT Water appearing in MW-UPA was recharged at some point during Quarter 1 of 2022. For 1,4-dioxane, the average concentration observed in SWIFT

Water during this time period was 0.26 µg/L. The decreasing trend observed in MW-UPA (Figure 6) is consistent with the reduction seen in SWIFT Water associated with early efforts to optimize 1,4-dioxane removal through the biofilters. Since that time, HRSD has further improved 1,4-dioxane removal in SWIFT Water, with results in this reporting quarter of < 0.15 µg/L (Table 6).

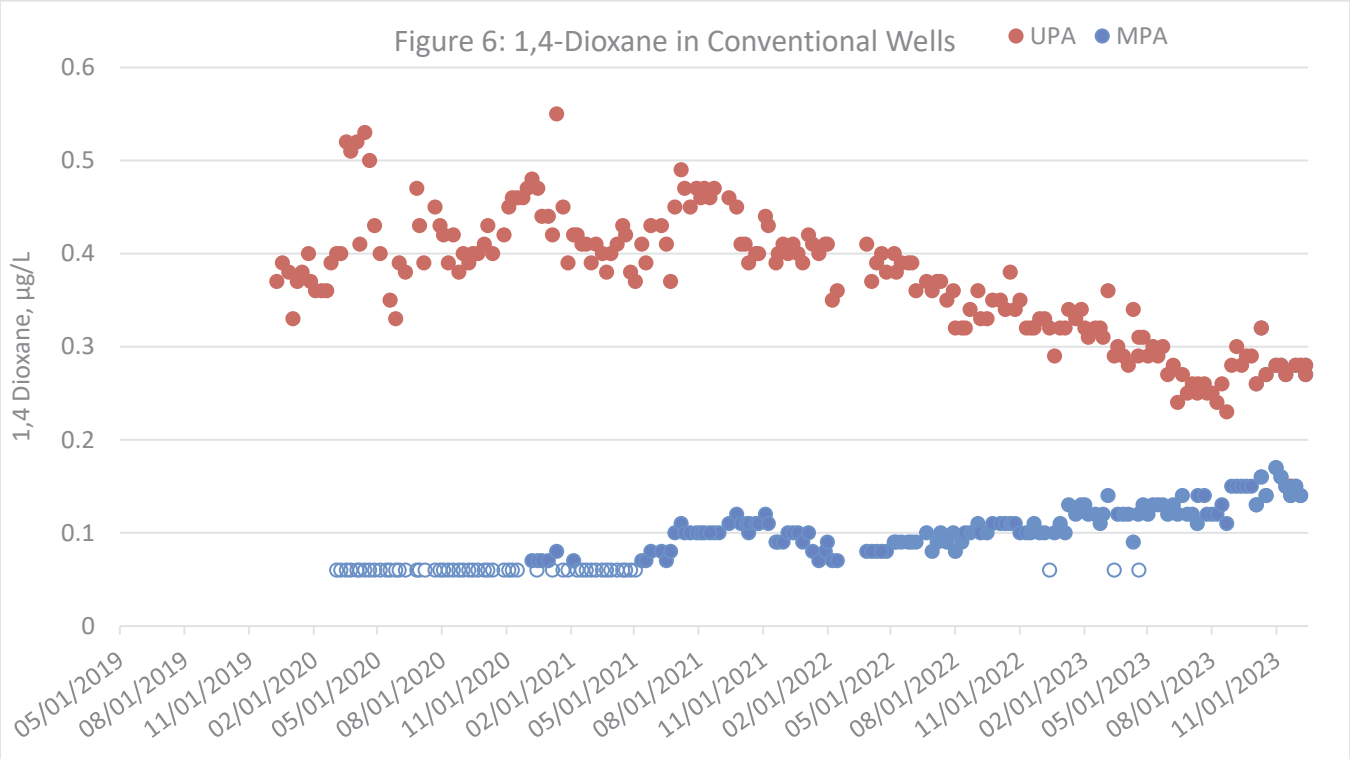

Figure 6: 1,4-Dioxane trending in MW-UPA and MW-MPA. Open circles represent data that is less than the reporting limit. Based on travel time studies using a conservative tracer, SWIFT Water recharged in the 1st quarter of 2022 roughly approximates the groundwater represented in this quarter's conventional well monitoring. The SWIFT Water average 1,4-dioxane concentration for January - March 2022 was 0.26 µg/L, with a maximum value of 0.32 µg/L (n = 11). More recently, the SWIFT Advanced Water Treatment system has been optimized to enhance the removal of 1,4-dioxane, routinely achieving concentrations of ≤ 0.15 µg/L.

In Quarter 1 of 2022, the available data on sucralose and PFOA in SWIFT Water is much more limited, with three data points for sucralose and a single monthly data point for PFOA. The trends for sucralose and PFOA in MW-UPA and MW-MPA is presented in Figures 7 and 8, respectively.

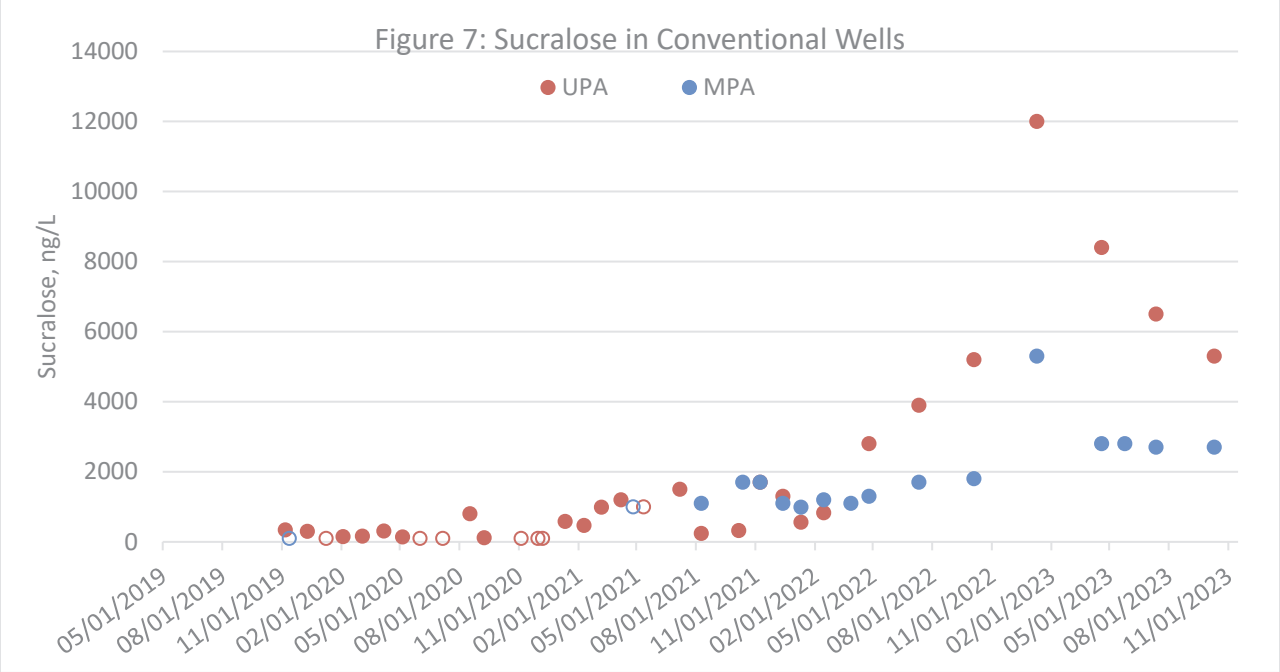

Figure 7: Sucralose trending in MW-UPA and MW-MPA. Open circles represent data that is less than the reporting limit. Based on travel time studies using a conservative tracer, SWIFT Water recharged in the 1st quarter of 2022 roughly approximates the groundwater represented in this quarter's conventional well monitoring. The SWIFT Water average sucralose concentration for January – March 2022 was 4,567 ng/L, with a maximum value of 8,100 ng/L (n = 3).

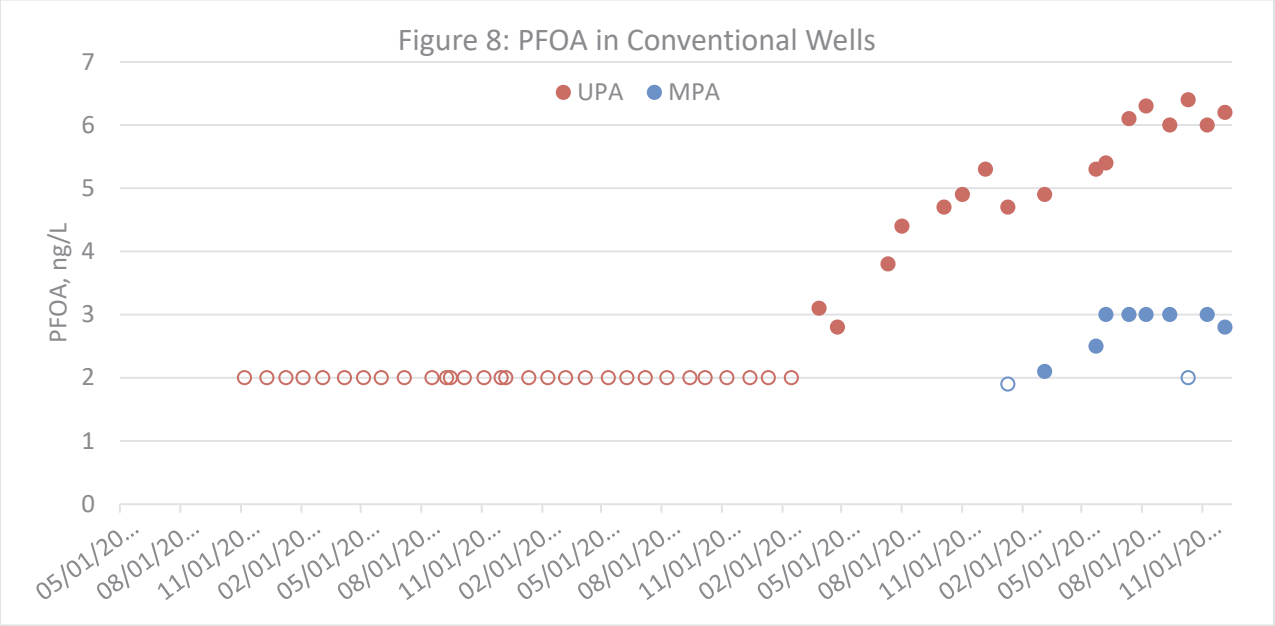

Figure 8: PFOA trending in MW-UPA. Open circles represent data that is less than the reporting limit. Based on travel time studies using a conservative tracer, SWIFT Water recharged in the 1st quarter of 2022 roughly approximates the groundwater represented in this quarter's conventional well monitoring. The SWIFT Water PFOA concentration for January - March 2022 was 4 ng/L (n = 1).

It is important to note that until July of 2022 when EPA released interim Health Advisory Limits (HAL) for PFOA and PFOS, HRSD's operational controls for these compounds were based upon the previous HAL of 70 ng/L PFOA+PFOS. HRSD is working to optimize GAC performance to maintain PFOA and PFOS below 4 ng/L, each (refer to Potomac Aquifer Recharge Oversight Committee Meeting Minutes December 2022 for additional information).

Arsenic in MW-SAT Update

Although MW_SAT is not sampled for regulatory compliance, it represents a location proximal to the recharge well providing a snapshot of transient geochemical reactions that might not otherwise be observed in more distal monitoring wells. HRSD continues to monitor arsenic (As) concentrations in MW-SAT, focusing on representative screen intervals 1, 2, 4, 9, 10 and 11. Concentrations continue to remain below the Safe Drinking Water Act (SDWA) and PMCL of 10 µg/L on a running annual average (RAA) basis. Screens 1, 2, 4, and 11 remain below 2 µg/L, consistent with typical concentrations observed in these screen zones.

Groundwater samples obtained from Screens 9 and 10 during the end of the first quarter through the end of the second quarter, however, showed elevated As trends. During these elevated events the running annual average As concentrations in screens has remained well below the SDWA PMCL. The current RAAs for screens 9 and 10 are 5.0 µg/L and 7.0 µg/L, respectively.

Weekly sampling of these screens in July indicated As returning to typical levels, however, no samples were collected in August or September due to sporadic recharge. Specific sampling criteria, which include operational conditions, must be met to ensure the samples are representative of recharge conditions and comparable across sample events. Sampling resumed in October, with results for the October 4th sample continuing the downward trend in both screens (Figure 10). The October 24th sample indicated an increase in both screens, however the value remains below 10 µg/L.

Screen 9

Samples from screen 9 indicated a steady return to concentrations consistent with historical levels during normal operations. The latest sample collected in the fourth quarter saw an increase relative to the previous sample, however it was in line with historic sample results.

Screen 10

Typical concentrations of As, below 2 µg/L, were observed in screen 10 during the first part of 2023 until a sample collected in May showed a significant increase to 7.12 µg/L, above historical concentrations. HRSD initiated weekly sampling for As in screen 10. Concentrations dropped steadily over subsequent sampling with a consistent downward trend through October 4th. The October 24th sample of 6.42 µg/L remains below the May result but represents a number out of the typical historical range for this screen.

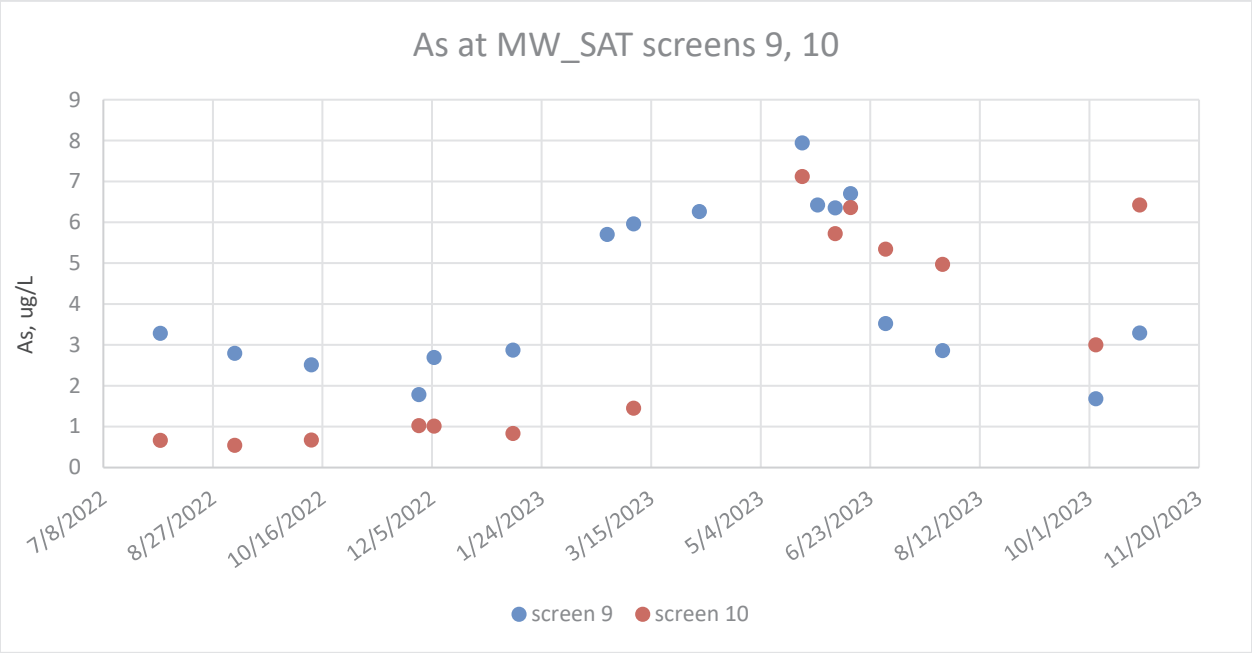

Figure 10, MW_SAT screens 9 and 10 arsenic concentration over 2023 sampling.
Recharge activities continue to be sporadic resulting in difficulty meeting sampling criteria for MW_SAT. Samples collection will continue to monitor As levels as operations allow. The latest sample was collected on January 25th and will be included in the 2024 Q1 quarterly report.

Discussion

The trends in As observed in screens 9 and 10 of MW_SAT over the first two quarters of 2023 are coincident with the start-up of the new full-scale recharge well, NP_MAR_01. Drilling activities, aquifer conditioning specifically, along with a new flow path to MW_SAT are likely to be the cause of the minor, short-term increases in As concentrations.

Conditioning the aquifer with aluminum chlorohydrate (ACH) is performed to stabilize naturally occurring clays within the aquifer matrix. This conditioning fluid has a pH significantly lower than the pH of the SWIFT Water and the native environment. This depressed pH can dissolve the hydrous ferric oxide (HFO) coatings that passivate aquifer minerals resulting in the release of As.

Recharge water entering the aquifer from a new location may also play a role. Recharging shifted from well TW-1 to well NP_MAR_01 starting in November 2022. The recharge water flows past different aquifer sediments which likely contain some aquifer material that acts as a source of As for the sand lenses associated with screen 10. This may also result in new “typical” levels observed at MW-SAT. Time recharging and continued sampling will allow for testing of this hypothesis. A more detailed discussion of how these two factors can affect As concentrations was included in the 2023 Q3 quarterly report.

The elevated As concentrations observed in MW_SAT screens 9 and 10 are well below the SDWA PMCL running annual average and have not been observed in the corresponding MW_MPA or MW_LPA conventional monitoring wells (As concentrations remain below 1 µg/L). HRSD will continue to monitor and evaluate As in these representative screen intervals of MW-SAT.

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	October 2023			November 2023			December 2023		
					Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples
Regulatory Parameters													
Total Nitrogen (TN)	mg/L	NA	0.50	Daily[3]	3.22	4.53	25	3.66	4.62	12	2.10	3.14	11
NO_3	mg/L	10	0.20	Daily[3]	3.18	3.94	23	3.64	4.62	10	2.05	3.14	9
NO_2	mg/L	1	0.01	Daily[3]	<0.01	<0.01	23	<0.01	<0.01	10	<0.01	<0.01	9
Turbidity	NTU	NA	0.01	Continuous	**Figure 1**								
Total Organic Carbon (TOC)	mg/L	NA	1.00	3x/Wk[3]	0.69	1.47	18	1.71	1.71	2	2.09	2.43	9
pH		NA	NA	Continuous	**Figure 2**								
TDS[4]	mg/L	Potomac Aquifer System Range: 694-8,720	2.5	Monthly		516	1		560	1		562	1
Microorganisms													
Total Coliform	MPN/100 mL	MCLG = 0	1	Daily[3]	<1	1	23	<1	<1	10	<1	<1	9
E. coli	MPN/100 mL	NA	1	Weekly	<1	<1	23	<1	<1	10	<1	<1	9
Cryptosporidium	oocysts/L	Treatment Technique, MCLG = 0	0.0976	Quarterly		<0.0976	1						
Giardia lamblia	oocysts/L	Treatment Technique, MCLG = 0	0.0976	Quarterly		<0.0976	1						
Legionella	MPN/100 mL	Treatment Technique, MCLG = 0	1.0	Quarterly		<1.00	1						
Disinfection Byproducts[5]													
Bromate	µg/L	10	0.250	Monthly		<0.250	1		2.91	1		2.95	1
Chlorite	mg/L	1.0	0.100	Monthly		<0.100	1		<0.100	1		<0.100	1
Trihalomethanes													
Bromodichloromethane	µg/L		1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Bromoform	µg/L		1.00	Monthly		<1.00	1		<1.00	1		2.25	1
Chloroform	µg/L		1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Dibromochloromethane	µg/L		1.00	Monthly		<1.00	1		<1.00	1		1.62	1
Total Trihalomethanes	µg/L	80				<1.00	1		<1.00	1		3.87	1
HAAs													
Dichloroacetic acid	µg/L		0.60	Monthly		<0.60	1		<0.60	1		<0.60	1
Trichloroacetic acid	µg/L		0.20	Monthly		<0.20	1		<0.20	1		<0.20	1
Monochloroacetic acid	µg/L		0.60	Monthly		<0.60	1		<0.60	1		<0.60	1
Bromoacetic acid	µg/L		0.40	Monthly		<0.40	1		0.46	1		0.5	1
Dibromoacetic acid	µg/L		0.20	Monthly		<0.20	1		3.53	1		3.61	1
Total Haloacetic Acids	µg/L	60				<0.60	1		3.99	1		4.11	1

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	October 2023			November 2023			December 2023		
					Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples
Disinfectants[5]													
Monochloramine (as Cl_2)	mg/L	4		Continuous	0.03	0.05		0.01	0.04		0.03	0.06	
Chlorine (as Cl_2)	mg/L	4		Continuous	2.59	3.49		2.96	3.52		2.28	3.53	
Inorganic Chemical													
Antimony	µg/L	6	0.50	Monthly		<0.50	1		<0.50	1		<0.50	1
Arsenic	µg/L	10	0.40	Monthly		1.46	1		<0.40	1		0.34	1
Asbestos	MFL	7	0.18	Monthly		<0.18	1		<0.18	1		<0.18	1
Barium	mg/L	2	0.005	Monthly		0.012	1		0.006	1		0.006	1
Beryllium	µg/L	4	0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
Cadmium	µg/L	5	0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
Chromium (total)	µg/L	100	2.50	Monthly		<2.50	1		<1.00	1		<2.50	1
Copper	mg/L	1.3 (action level)	0.005	Monthly		<0.005	1		<0.005	1		<0.005	1
Cyanide (total)	µg/L	200	5	Monthly		<5	1		<5	1		<5	1
Fluoride	mg/L	4.0	0.050	Monthly	0.961	1.04	25	0.886	1.05	12		0.935	11
Lead	µg/L	15 (action level)	0.50	Monthly		<0.10	1		<0.10	1		<0.50	1
Mercury	µg/L	2	0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
Selenium	µg/L	50	5.00	Monthly		<5.00	1		<5.00	1		<5.00	1
Thallium	µg/L	2	0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
Organic Chemicals													
Acrylamide	µg/L	Treatment Technique, MCLG = 0	0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
Alachlor	µg/L	2	0.10	Monthly		<0.049	1		<0.05	1		<0.05	1
Atrazine	µg/L	3	0.050	Monthly		<0.049	1		<0.05	1		<0.05	1
Benzo(a)pyrene (PAHs)	µg/L	0.2	0.020	Monthly		<0.02	1		<0.02	1		<0.02	1
Di(2-ethylhexyl) adipate	µg/L	400	0.60	Monthly		<0.59	1		<0.60	1		<0.59	1
Di(2-ethylhexyl) phthalate	µg/L	6	0.60	Monthly		<0.59	1		<0.60	1		<0.59	1
Hexachlorocyclopentadiene	µg/L	50	0.050	Monthly		<0.049	1		<0.050	1		<0.050	1
Hexachlorobenzene	µg/L	1	0.050	Monthly		<0.049	1		<0.050	1		<0.050	1
Simazine	µg/L	4	0.050	Monthly		<0.049	1		<0.050	1		<0.050	1
Carbofuran	µg/L	40	5.0	Monthly		<5.0	1		<5.0	1		<5.0	1
Oxamyl (Vydate)	µg/L	200	5.0	Monthly		<5.0	1		<5.0	1		<5.0	1
Chlordane	µg/L	2	0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
Endrin	µg/L	2	0.010	Monthly		<0.010	1		<0.010	1		<0.010	1
Heptachlor	µg/L	0.4	0.010	Monthly		<0.010	1		<0.010	1		<0.010	1
Heptachlor Epoxide	µg/L	0.2	0.010	Monthly		<0.010	1		<0.010	1		<0.010	1
Lindane	µg/L	0.2	0.010	Monthly		<0.010	1		<0.010	1		<0.010	1
Methoxychlor	µg/L	40	0.051	Monthly		<0.050	1		<0.050	1		<0.051	1
Toxaphene	µg/L	3	0.51	Monthly		<0.50	1		<0.50	1		<0.51	1

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	October 2023			November 2023			December 2023		
					Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples
PCB Arochlor1016	µg/L		0.071	Monthly		<0.070	1		<0.070	1		<0.071	1
PCB Arochlor1221	µg/L		0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
PCB Arochlor1232	µg/L		0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
PCB Arochlor1242	µg/L		0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
PCB Arochlor1248	µg/L		0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
PCB Arochlor1254	µg/L		0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
PCB Arochlor1260	µg/L		0.071	Monthly		<0.070	1		<0.070	1		<0.071	1
Total Polychlorinated Biphenyls (PCBs)	µg/L	0.5				<0.10	1		<0.10	1		<0.10	1
2,4-D	µg/L	70	0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
Dalapon	µg/L	200	1.0	Monthly		<1.0	1		<1.0	1		<1.0	1
Picloram	µg/L	500	0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
2,4,5-TP (Silvex)	µg/L	50	0.20	Monthly		<0.20	1		<0.20	1		<0.20	1
Dinoseb	µg/L	7	0.20	Monthly		<0.20	1		<0.20	1		<0.20	1
Pentachlorophenol	µg/L	1	0.040	Monthly		<0.040	1		<0.040	1		<0.040	1
Dioxin (2,3,7,8-TCDD)	pg/L	30	5.0	Monthly		<4.8	1		<4.8	1		<5.0	1
Diquat	µg/L	20	0.40	Monthly		<0.39	1		<0.40	1		<0.40	1
Endothall	µg/L	100	5.0	Monthly		<5.0	1		<5.0, H	1		<5.0	1
Epichlorohydrin	µg/L	Treatment Technique, MCLG = 0	2.0	Monthly		<2.0	1		<2.0	1		<2.0	1
Glycophosphate	µg/L	700	6.0	Monthly		<6.0	1		<6.0	1		<6.0	1
Benzene	µg/L	5	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Carbon Tetrachloride	µg/L	5	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Chlorobenzene	µg/L	100	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
1,2-dibromo-3-chloropropane (DBCP)	µg/L	0.2	0.02	Monthly		<0.02	1		<0.02	1		<0.02	1
o-Dichlororbenzene	µg/L	600	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
p-Dichlorobenzene	µg/L	75	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
1,2-Dichloroethane	µg/L	5	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
1,1-Dichlororethylene	µg/L	7	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
cis-1,2-Dichloroethylene	µg/L	70	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
trans-1,2-Dichloroethylene	µg/L	100	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Dichloromethane	µg/L	5	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
1,2-Dichloropropane	µg/L	5	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Ethylbenzene	µg/L	700	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Ethylene Dibromide (EDB)	µg/L	0.05	0.02	Monthly		<0.02	1		<0.02	1		<0.02	1
Styrene	µg/L	100	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Tetrachloroethylene	µg/L	5	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Toluene	µg/L	1,000	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
1,2,4-Trichlorobenzene	µg/L	70	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
1,1,1-Trichloroethane	µg/L	200	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
1,1,2-Trichloroethane	µg/L	5	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Trichloroethylene	µg/L	5	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Vinyl Chloride	µg/L	2	1.00	Monthly		<1.00	1		<1.00	1		<1.00	1
Total Xylene	µg/L	10,000	3.00	Monthly		<3.00	1		<3.00	1		<3.00	1

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	October 2023			November 2023			December 2023		
					Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples
Radionuclides													
Alpha particles	pCi/L	15	6.48^	Monthly		<6.48, U G	1		<4.97, U G	1		<5.11, U G	1
Beta particles and photon emitters	pCi/L	4 mrem/yr[6]	1.72^	Monthly		10.8	1		13.7	1		17.2, F	1
Radium 226	pCi/L	5 (226+228)	0.279^	Monthly		<0.119, U	1		<0.277, U	1		<0.279, U	1
Radium 228	pCi/L	5 (226+228)	0.488^	Monthly		<0.488, U	1		<0.451, U	1		<0.473, U	1
Uranium	µg/L	30	0.10	Monthly		<0.10	1		<0.10	1		<0.10	1
Strontium-90	pCi/L	NA	0.827^	Monthly		<0.287, U	1		<0.323, U *	1		12.1	1
Tritium	pCi/L	NA	330^	Monthly		395	1		393	1		<184, U	1
Non-regulatory Performance Indicators													
Public Health Indicators		**Trigger Limits**											
1,4-dioxane	µg/L	1	0.06	Quarterly	<0.06	0.1	4	0.13	0.14	2	0.14	0.15	2
17-β-estradiol	ng/L	0.9	10	Quarterly		<10, H	1						
DEET	ng/L	200,000	10	Quarterly		<10, H	1						
Ethinyl estradiol	ng/L	280	10	Quarterly		<10, H	1						
Tris(2-carboxyethyl)phosphine (TCEP)	ng/L	5,000	10	Quarterly		<10, H	1						
NDMA	ng/L	10	2.00	Quarterly	<2.00	<2.00	2	<2.00	<2.00	1	<2.00	<2.00	1
Perchlorate	µg/L	6	0.50	Quarterly		<0.50	1						
Perfluorooctanoic Acid (PFOA)	ng/L	70 (PFOA+PFOS)	2.0	Quarterly		<2.0	1		<2.0	1		<1.7	1
Perfluorooctanesulfonic Acid (PFOS)	ng/L	70 (PFOA+PFOS)	2.0	Quarterly		<2.0	1		<2.0	1		<1.7	1
Treatment Efficacy Indicators		**Trigger Limits**											
Cotinine	ng/L	1,000	5.0	Quarterly		<5.0, H	1						
Primidone	ng/L	10,000	5.0	Quarterly		<5.0, H	1						
Phenytoin (Dilantin)	ng/L	2,000	10	Quarterly		<10, H	1		<10	1			
Meprobamate	ng/L	200,000	5.0	Quarterly		<5.0, H	1						
Atenolol	ng/L	4,000	5.0	Quarterly		<5.0, H	1						
Carbamazepine	ng/L	10,000	5.0	Quarterly		<5.0, H	1						
Estrone	ng/L	320	5.0	Quarterly		<5.0, H	1		<5.0	1			
Sucralose	ng/L	150,000,000	100	Quarterly		370, H	1		190	1		220	1
Triclosan	ng/L	210,000	50	Quarterly		<50, H	1		<50	1		<50	1
Additional Monitoring (Ozone & UV LRV)					**Average**	**Minimum**		**Average**	**Minimum**		**Average**	**Minimum**	
Ozone Virus LRV				Continuous	4.51	3.98		4.51	4.03		4.51	4.18	
Ozone Giardia LRV				Continuous	2.17	1.86		2.30	2.02		2.27	2.06	
UV Dose Reactor 1	mJ/cm^2			Continuous	>186	>186		>186	>186		>186	>186	
UV Virus LRV Reactor 1				Continuous	>4	>4		>4	>4		>4	>4	
UV Dose Reactor 2	mJ/cm^2			Continuous	>186	>186		>186	>186		>186	>186	
UV Virus LRV Reactor 2				Continuous	>4	>4		>4	>4		>4	>4	

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	October 2023			November 2023			December 2023		
					Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples	Average[2]	Maximum	Number of Samples

[1] When minimum reporting limits varied during the quarter, the highest minumum reporting limit used is identified.

[2] Analytical results less than the reporting limit were treated as zero for the purposes of the averaging calculation.

[3] Daily samples are typically not collected on days in which there is no or limited recharge. TOC sample collection occurs routinely on Monday through Friday when recharging. Limited or inconsistent recharge impacts the collection of daily samples, particularly for the microbiological samples collected for total coliform and E coli which have limited holding time requirements. In October, limited or no recharge impacted 8 days of sampling. In November, limited or no recharge impacted 21 days of sampling. In December, limited or no recharge impacted 22 days of sampling.

[4] TDS of the Potomac Aquifer System is based on the averages within the upper, middle and lower Potomac Aquifer as determined during baseline montioring.

[5] The maximum residual disinfectant level (or MRDL) MCL for monochloramine and chlorine are based on annual averages.

[6] The measurement unit for beta particles and photon emitters is pCi/L while the MCL is expressed as mrem/yr. Per EPA's Implementation Guidance for Radionuclides (EPA 816-F-00-002, March 2002), the screening threshold for beta particles and photon emitters is 50 pCi/L. If sample concentrations exceed 50 pCi/L, each individual beta particle and photon emitter is converted from pCi/L to mrem using the EPA designated conversion tables, currently available in the referenced document.

^ MDC - Minimum Detectable Concentration (Radiochemistry).

Contract Laboratory Flags:

* : LCS and/or LCSD is outside acceptance limits.
F : MS/MSD Recovery and/or RPD exceeds the control limits.
G : The sample MDC is greater than the requested RL.
H : Sample was prepped or analyzed beyond the specified holding time
U : Result is less than the sample detection limit.