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

This report documents SWIFT Water Quality results for recharge operations from July 1 – September 30, 2021. 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 GAC Regeneration
Total Coliform[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 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.

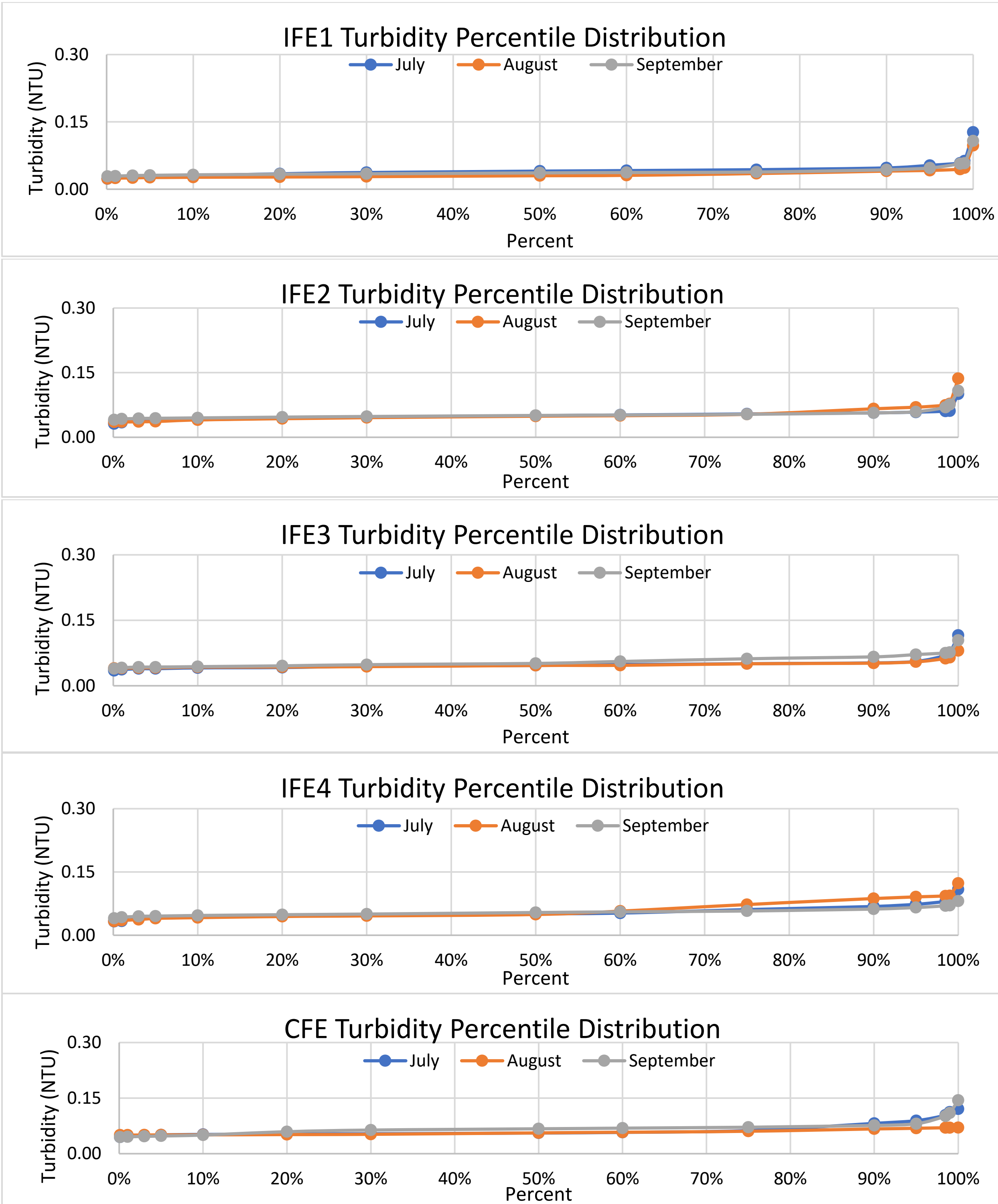


Figure 1: Percentile distribution of 15-minute average Individual Filter Effluent (IFE) Turbidities for Biofilters 1-4 (IFE1-4) and Biofilter Combined Filter Effluent (CFE). There were no 15-minute periods in this quarter with biofilter effluent turbidity values greater than 0.3 NTU. The 95% measured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

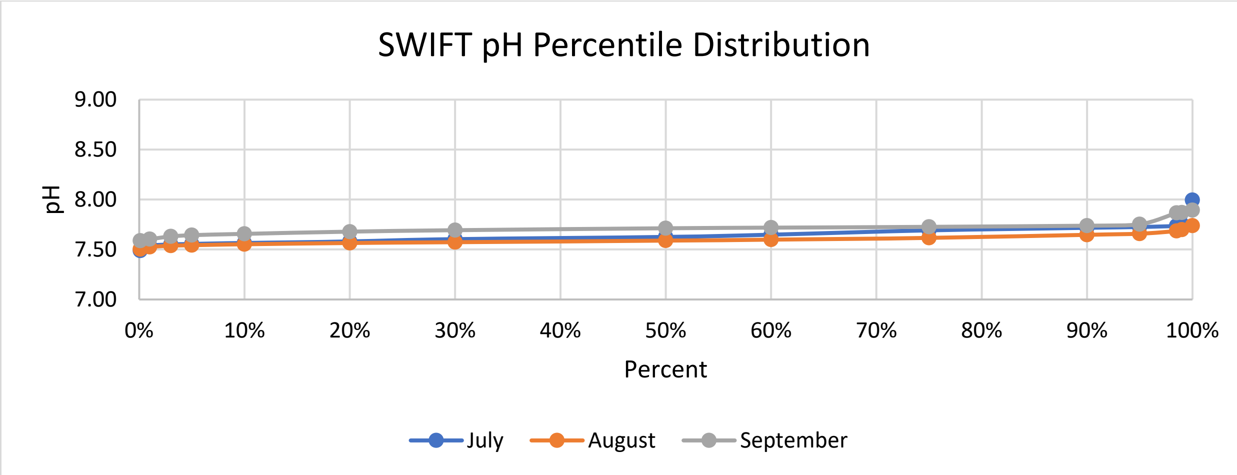


Figure 2: Distribution of Monthly SWIFT Water pH values.

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 range	CCL4
DEET	Public Health	200	µg/L	MN Health Guidance Value
Ethinyl Estradiol	Public Health	280[1]	ng/L range	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: Summary of regulatory monitoring for SWIFT Water

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	July 2021			August 2021			September 2021		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Regulatory Parameters													
Total Nitrogen (TN)	mg/L	NA	0.50	Daily[3]	**2.99**	**4.72**	**19**	**2.02**	**3.29**	**26**	**2.96**	**4.91**	**28**
NO_3	mg/L	10	0.01	Daily[3]	**2.91**	**4.45**	**19**	**1.81**	**2.74**	**25**	**2.79**	**4.41**	**27**
NO_2	mg/L	1	0.01	Daily[3]	**<0.01**	**<0.01**	**19**	**<0.01**	**<0.01**	**25**	**<0.01**	**<0.01**	**27**
Turbidity	NTU	NA	0.01	Continuous					**Figure 1**				
Total Organic Carbon (TOC)	mg/L	NA	1.00	3x/Wk[3]	**3.21**	**3.47**	**14**	**3.22**	**4.03**	**19**	**2.95**	**3.47**	**20**
pH		NA	NA	Continuous					**Figure 2**				
TDS[4]	mg/L	Potomac Aquifer System Range: 694-8,720	2.5	Monthly		**618**	**1**		**550**	**1**		**648**	**1**
Disinfection Byproducts													
Bromate	µg/L	10	0.15	Monthly		**3.08**	**1**		**1.37**	**1**		**2.10**	**1**
Trihalomethanes													
Bromodichloromethane	µg/L		1.0	Monthly		**2.3**	**1**		**3.1**	**1**		**3.4**	**1**
Bromoform	µg/L		1.0	Monthly		**7.1**	**1**		**4.6**	**1**		**4.9**	**1**
Chloroform	µg/L		1.0	Monthly		**1.1**	**1**		**1.3**	**1**		**1.5**	**1**
Dibromochloromethane	µg/L		1.0	Monthly		**7.2**	**1**		**7.6**	**1**		**8.3**	**1**
Total Trihalomethanes	µg/L	80				**18**			**17**			**18**	
HAAs													
Dichloroacetic acid	µg/L		0.60	Monthly		**1.52**	**1**		**1.80**	**1**		**1.64**	**1**
Trichloroacetic acid	µg/L		0.20	Monthly		**<0.20**	**1**		**0.66**	**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		**1.21**	**1**		**0.71**	**1**		**0.93**	**1**
Dibromoacetic acid	µg/L		0.20	Monthly		**8.77**	**1**		**6.59**	**1**		**5.91**	**1**
Total Haloacetic Acids	µg/L	60				**12**			**9.8**			**8.5**	
Disinfectants[5, 6]													
Monochloramine (as Cl_2)	mg/L	4		Continuous	**0.01**	**0.02**		**0.01**	**0.03**		**0.14**	**3.34**	
Chlorine (as Cl_2)	mg/L	4		Continuous	**2.67**	**3.41**		**2.41**	**3.04**		**2.95**	**3.59**	
Inorganic Chemical													
Arsenic	µg/L	10	1.0	Monthly		**<1.0**	**1**		**0.5**	**1**		**<0.8**	**1**
Barium	mg/L	2	0.005	Monthly		**0.006**	**1**		**<0.005**	**1**		**0.005**	**1**
Fluoride	mg/L	4.0	0.050	Monthly	**0.912**	**0.997**	**19**	**0.845**	**0.938**	**26**	**0.854**	**0.964**	**28**
Radionuclides													
Beta particles and photon emitters	pCi/L	4 mrem/yr[7]	3	Monthly		**16**	**1**		**14**	**1**		**23**	**1**
Radium 228	pCi/L	5 (226+228)	1	Monthly		**<1**	**1**		**<1**	**1**		**1**	**1**

Table 6: Summary of regulatory monitoring for SWIFT Water

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	July 2021			August 2021			September 2021		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Non-regulatory Performance Indicators													
Public Health Indicators		**Trigger Limits**											
1,4-dioxane	µg/L	1	0.06	Quarterly	**0.34**	**0.35**	**3**	**0.29**	**0.33**	**5**	**0.35**	**0.40**	**4**
DEET	ng/L	200,000	100	Quarterly		**120 (HA)**	**1**						
s(2-carboxyethyl)phosphine (TCEP)	ng/L	5,000	10	Quarterly		**47**	**1**						
Perchlorate	µg/L	6	0.50	Quarterly		**0.56**	**1**						
Perfluorooctanoic Acid (PFOA)	ng/L	70 (PFOA+PFOS)	2.0	Quarterly		**8.5**	**1**						
erfluorooctanesulfonic Acid (PFOS)	ng/L	70 (PFOA+PFOS)	2.0	Quarterly		**3.1**	**1**						
Treatment Efficacy Indicators		**Trigger Limits**											
Cotinine	ng/L	1,000	10	Quarterly		**13 (R7)**	**1**						
Primidone	ng/L	10,000	5.0	Quarterly		**9.8**	**1**						
Sucralose	ng/L	150,000,000	1000	Quarterly		**24000**	**1**		**19000**	**1**		**2400**	**1**
Additional Monitoring (Ozone & UV LRV)					**Average**	**Minimum**		**Average**	**Minimum**		**Average**	**Minimum**	
Ozone Virus LRV				Continuous	**4.52**	**3.60**		**4.63**	**3.38**		**4.66**	**3.42**	
Ozone Giardia LRV				Continuous	**2.11**	**1.68**		**2.16**	**1.58**		**2.18**	**1.60**	
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 July, limited or no recharge impacted ten days of sampling. In August, limited recharge impacted five days of sampling. In September, limited recharge impacted two days of sampling. An additional day of sampling in July was impacted due to a disruption in sample delivery and receipt. An additional day of sampling in August was impacted for the short holding time samples: nitrate, nitrite and microbiological analyses. Recharge was disrupted before these samples could be collected. An additional data point for nitrate and nitrite is missing for September due to invalid data as a result of sample analysis outside of the sample holding time requirements.

[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 maximum monochloramine concentration was below the MRDL but higher than typically seen in SWIFT Water while free chlorinating. This occurred following an extended shutdown and cessation of flow to the Granular Activated Carbon vessels. After resuming flow, ammonia in the SWIFT Water was elevated, resulting in monochloramine formation. Both total coliform and E. coli were non-detect.

[7] 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.

<u>Contract Laboratory Flags</u>

(HA) - Initial analysis within holding time. Reanalysis was past holding time.
(U) - Result is less then the sample detection limit.
(R7) - LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.

Recharge Statistics

The total volume recharged during this operational period was 40.8 million gallons. The backflushed volume was 6.5 million gallons for a net recharge of 34.3 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 516.2 million gallons.

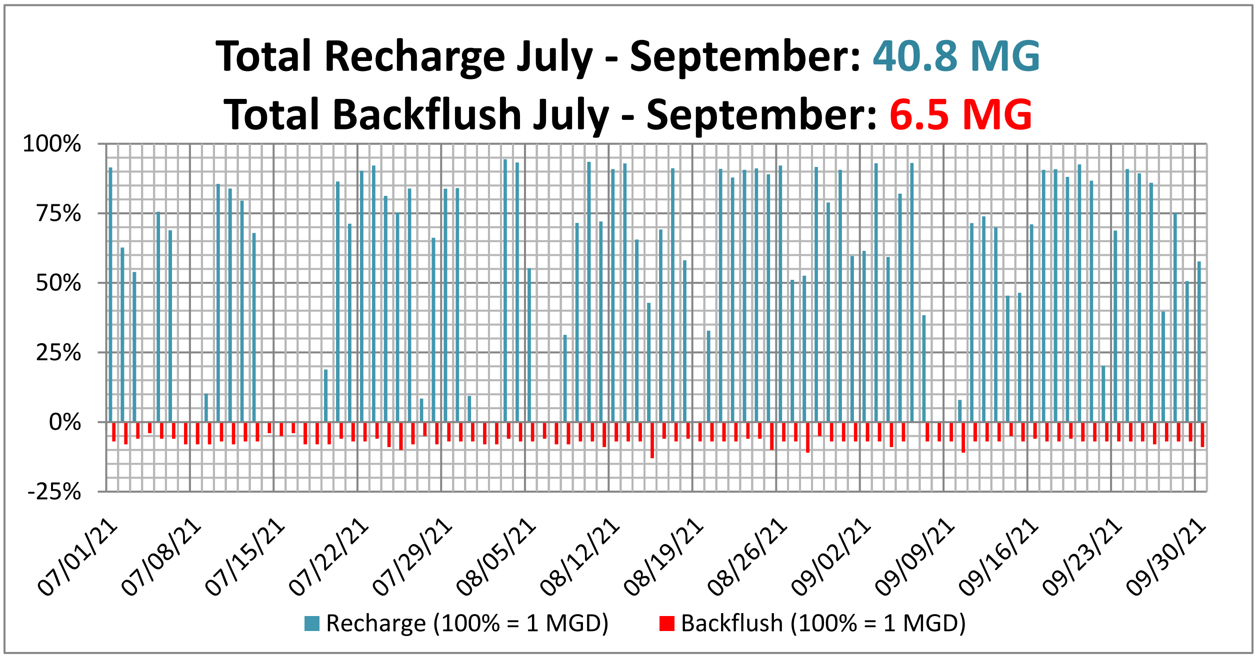


Figure 3: Recharge and Backflush Volumes, July 1 – September 30, 2021

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.

The well rehabilitation completed in Quarter 1 of 2021 was effective at cleaning the plugged well screens, however unable to restore full injection capacity of the recharge well. Given the downtime associated with additional rehabilitation activities and the desire to continue recharging for research purposes, the decision was made to delay further, more invasive rehabilitation activities until the new well (NP_MAR_01) is operational and online, anticipated in late first quarter 2022. At such time the SRC can maintain recharging through NP_MAR_01 while researching and evaluating rehabilitation techniques on TW-1.

The recharge capacity of TW-1 has slowly diminished since the well rehabilitation completed in Quarter 1 of 2021. To compensate for the reduced injectivity and preserve capacity until NP_MAR_01 is operational the recharge flow to TW-1 has been reduced. The well recharge target was initially adjusted to 600 gallons per minute (gpm, equivalent to 0.864 MGD), down from 700 gpm (~1 MGD) and more recently adjusted to 500 gpm (0.72 MGD). Recharge well capacity will continue to be monitored and the recharge flow will be adjusted as necessary; the SRC 75% target will be evaluated against the adjusted flow.

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.

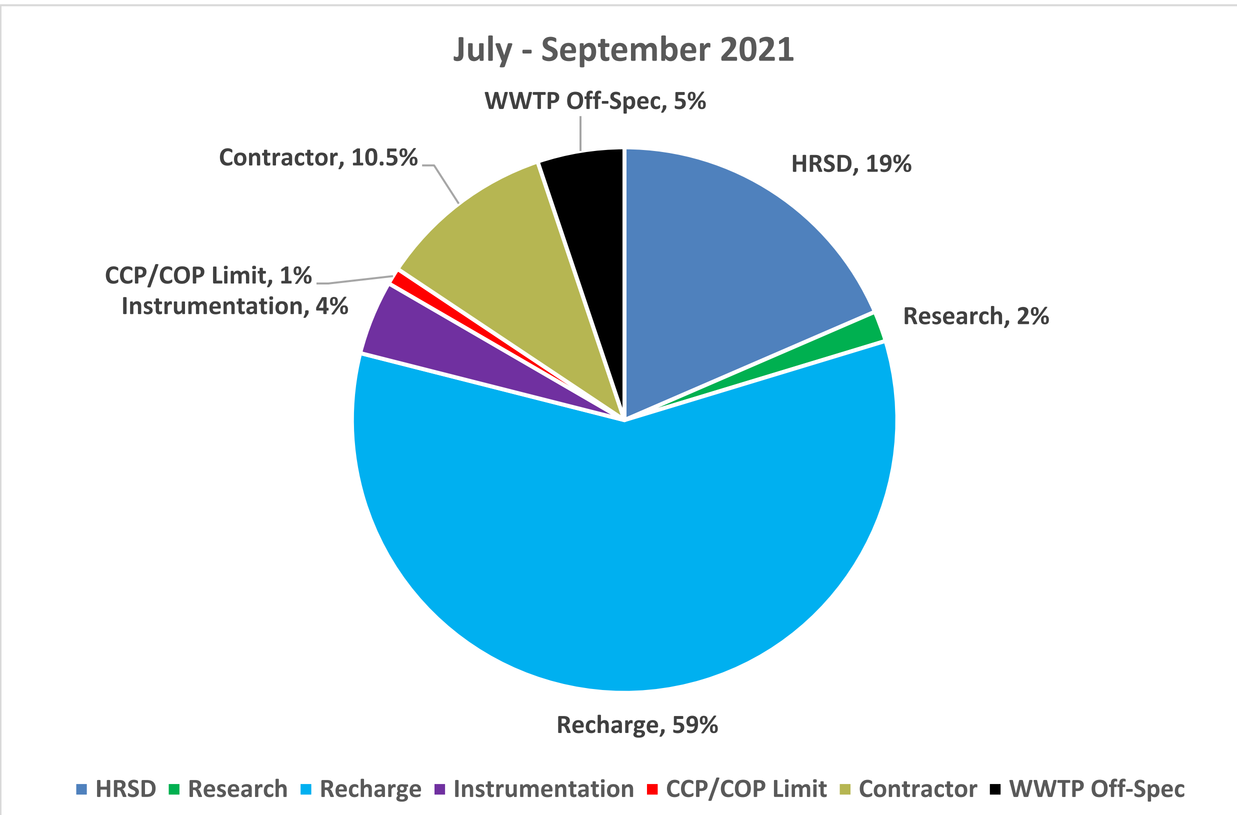


Figure 4: Operational activity for monitoring period. Notes: *Recharge*: Recharge of SWIFT Water; *WWTP Off-Spec*: Influent to the SWIFT facility (wastewater facility secondary clarifier effluent) does not meet influent quality requirements (e.g. elevated TOC or TN, or WWTP repairs; *HRSD*: Broad category covering activity within SWIFT facility that may lead to shut-down (e.g. maintenance and repairs, operational problems); *Contractor:* Recharge suspended to accommodate contractor activity at the AWT and/or recharge well. *CCP/COP limit*: 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.) *Instrumentation*: On-line analyzer and/or instrumentation maintenance and repair; *Research:* Recharge suspended to accommodate research activities.

Conventional Monitoring Wells

The conventional monitoring well for the upper zone of the Potomac Aquifer (MW-UPA), located approximately 400 ft from the recharge well, has been routinely monitored to detect the arrival of the recharge front. The recharge front arrived at MW-UPA in the fall of 2019 as evidenced by increasing Total Organic Carbon (TOC) concentrations. TOC observations in the monitoring wells located in the middle and lower zones of the Potomac Aquifer (MW-MPA, MW-LPA) remain < 1.0 mg/L. However, a gradual increase in TOC has been observed in MW-MPA in 2021 and 1,4 dioxane has been detected near the reporting limit consistently since late December of 2020 in MW-MPA (Figure 5 and Table 7). This indicates that the recharge front has reached the MW-MPA. With the exception of the data presented in Table 7, all indicator data are less than the detection limit during this monitoring period. All reported values for these indicators are less than the action thresholds ("trigger values") identified in Table 2 of this report. Further, results for all regulatory parameters are less than the PMCL and all regulated organics were non-detect. Nitrite and arsenic observations are described in further detail in the sections below.

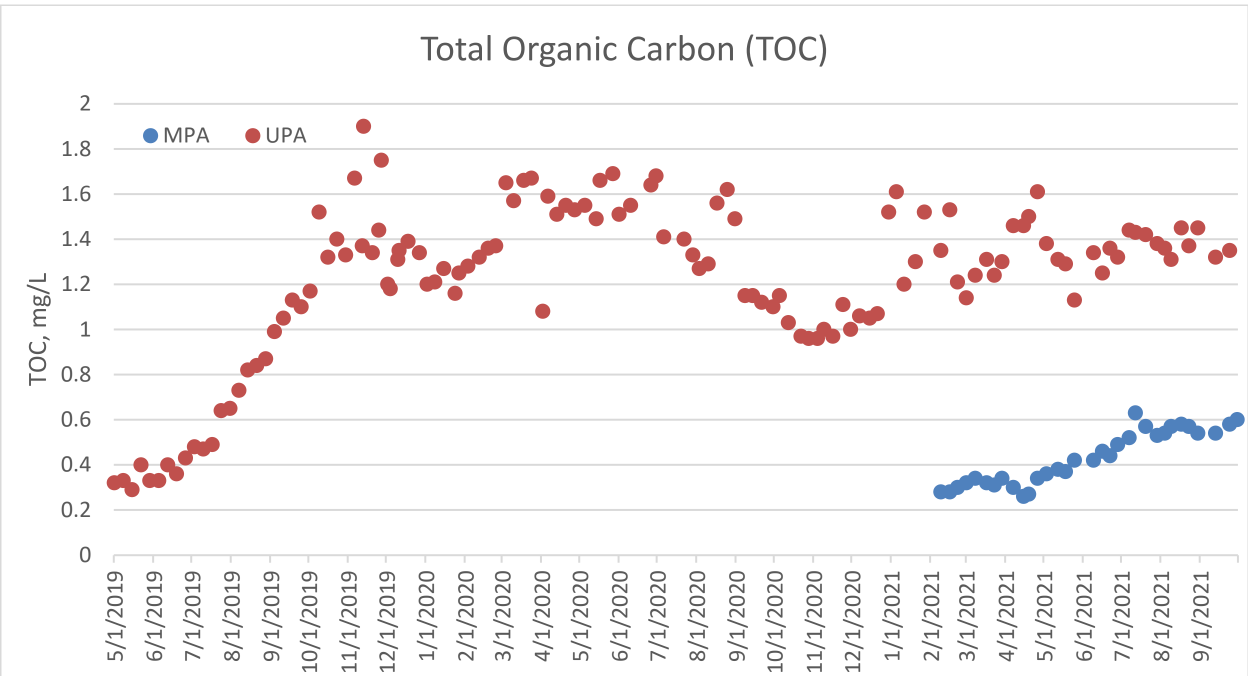


Figure 5: TOC concentration in the Upper and Middle Potomac conventional monitoring wells, MW-UPA and MW-MPA. Open symbols denote values < the detection limit of 0.2 mg/L.

Table 7: Indicator compounds quantified in MW-UPA and MW-MPA. Average values are not calculated when the maximum value reported represents a single sample. Contract Lab flagged data, R7: Lab Fortified Blank (LFB)/LFB Duplicate Relative Percent Difference (RPD) exceeded the laboratory acceptance limit. Recovery met acceptance criteria.

		MW-UPA				MW-MPA	
		Sucralose, ng/L	1,4-Dioxane, µg/L	NDMA, ng/L	DEET, ng/L	Sucralose, ng/L	1,4-Dioxane, µg/L
2020 SWIFT Water Concentration	Avg	11,000	0.33	<2	<10	11,000	0.33
Jan 2021	Max	580	0.55	2	-	-	0.08
	Avg	-	0.45	<2	-	-	0.07
Feb 2021	Max	470	0.42	<2	-	-	0.07
	Avg	-	0.42	<2	-	-	<0.06
Mar 2021	Max	990	0.41	<2	-	-	<0.06
	Avg	-	0.40	<2	-	-	<0.06
Apr 2021	Max	1,200	0.43	<2	-	-	<0.06
	Avg	-	0.41	<2	-	-	<0.06
May 2021	Max	<1,000	0.43	<2	-	-	0.08
	Avg	-	0.40	<2	-	-	0.07
Jun 2021	Max	680, R7	0.45	<2	-	-	0.1
	Avg	-	0.42	<2	-	-	0.08
Jul 2021	Max	1,500	0.49	2	-	-	0.1
	Avg	-	0.47	<2	-	-	0.1
Aug 2021	Max	-	0.47	2	12	1,100	0.1
	Avg	-	0.47	2	-	-	0.1
Sep 2021	Max	-	0.46	<2	-	-	0.1
	Avg	-	0.44	<2	-	-	0.1

Nitrite in MW-SAT Update

HRSD continues to monitor nitrite levels within the monitoring well located 50 ft from the recharge well, MW-SAT, and the conventional wells to better understand the occurrence of in situ partial denitrification and the potential for nitrite migration with the recharge front. Nitrite concentration in all screen intervals is < 0.1 mg/L. Nitrite remains < 0.01 mg/L in MW-UPA and nitrite concentration in SWIFT Water during this operational period is < 0.01 mg/L (Table 6).

Arsenic in MW-SAT Update

As documented in the previous Quarterly Report, the SRC has observed a recent increasing arsenic (As) trend in samples collected from screen interval 9, one of the 11 discretely monitored intervals of MW-SAT, the monitoring well located 50 ft from the recharge well (Figure 6). The sample result from October 11 was 10.1 µg/L and the most recent result was 8.74 µg/L (October 21). The Virginia Waterworks regulation identifies that compliance with the arsenic MCL of 10.0 µg/L is based on a running annual average (RAA). Currently, the RAA of the monthly data generated since last October is 4.3 µg/L, including the recent elevated sample results.

Following the first well rehabilitation effort in 2019, this same screen interval experienced a transient elevation in arsenic concentration. In May 2019, the arsenic concentration reached 18.1 µg/L and steadily declined, dropping to less than 5 µg/L by mid-July. We expect that the current arsenic increase is similarly temporary and that the RAA will remain below 10.0 µg/L. It is worth noting that, although SWIFT Water has migrated past conventional monitoring wells MW-UPA and MW-MPA, approximately 300 – 500 feet from recharge well TW-1, arsenic has not been detected in these wells since operation began. To provide further context, MW-SAT Screen 9 represents a deep isolated section in the middle zone of the Potomac aquifer, 1,050 to 1,090 feet below the ground surface. The depth discrete sampling portals in MW-SAT do not represent typical production well construction.

Arsenic mobility in groundwater is a complex subject. Multiple mechanisms can promote arsenic releases from aquifer minerals during aquifer recharge operations. The recharge water can react with the aquifer matrix and dissolve minerals, leaching their elemental components. Recharge water containing dissolved oxygen (DO) above anoxic concentrations, like SWIFT Water produced at the SRC, will react with common, reduced metal-bearing minerals like pyrite (FeS_2) and siderite ($FeCO_3$), to release iron and other metals that occupy sites in the mineral structure. Oxidation of arseninian pyrite can release arsenic, mobilizing arsenic in the migrating recharge water and potentially elevating arsenic above Safe Drinking Water Act maximum contaminant levels (SDWA MCL).

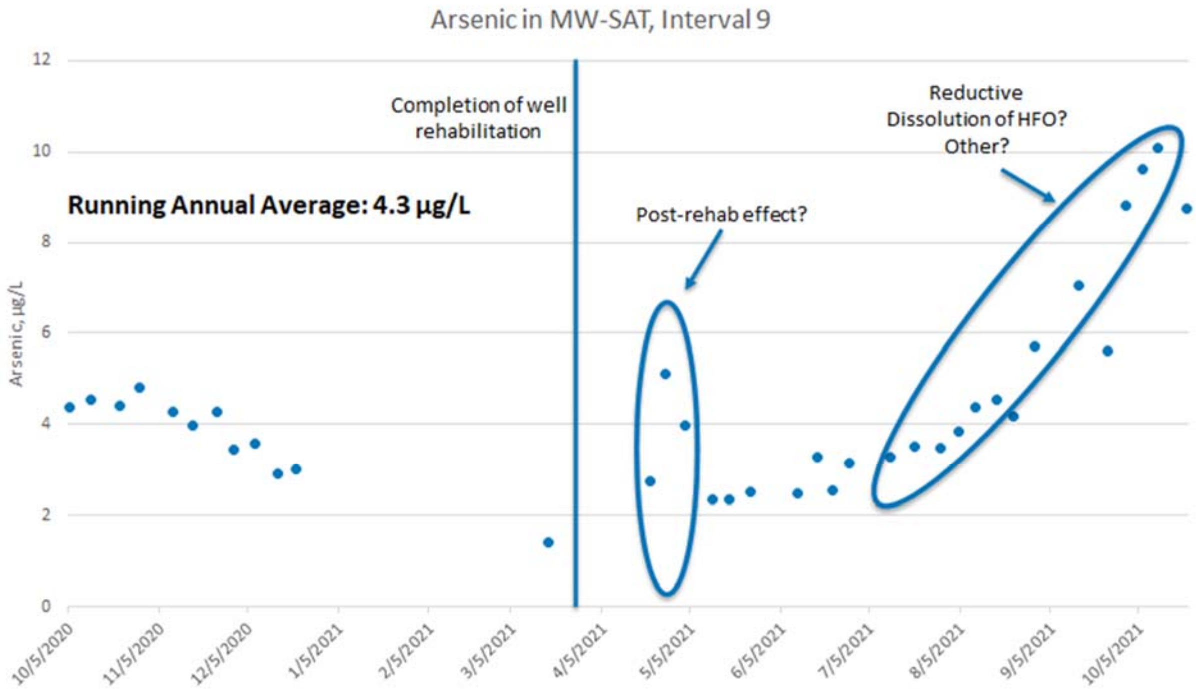


Figure 6: Arsenic concentration in MW-SAT Screen 9, values are in ug/L.

Source:

Since arsenic concentration in SWIFT Water remains < 1 µg/L, the source for the arsenic must originate within the aquifer, between the recharge well and MW-SAT. However, minerals associated with arsenic were not identified in any of the sandy drill cuttings or cores collected during drilling of the wells at Nansemond. Geologic samples submitted to a mineralogical laboratory for extensive analyses showed pyrite abundances of less than 1 percent of the whole rock matrix in only one or two of the confining unit samples. The intervals containing those fine-grained units are sealed off from the recharge well using screen blanks.

At the recommendation of DEQ, HRSD will examine the geophysical logs for gamma spikes within the depth interval of Screen 9, which might indicate the presence, and specific depth, of the arsenic bearing unit. This may prove to be a useful tool for future recharge well installations. Where arsenic bearing strata are positively observed at a specific depth interval the interval will be sealed off from recharge activities.

SWIFT arsenic mitigation approach

The ability to detect potentially undesirable minerals in an aquifer is limited locationally to the boreholes associated with well installation and the drill cuttings, core samples and geophysical log data obtained from those boreholes. This results in an inherently limited dataset and a potential source of arsenic may not be detected.

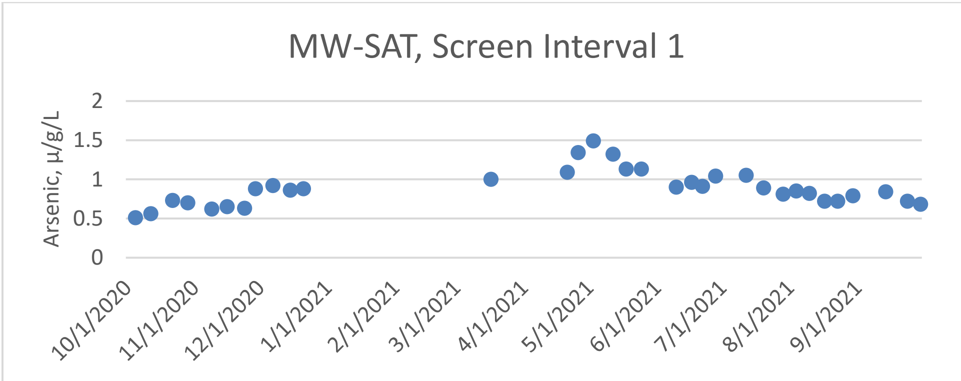
For this reason, HRSD's approach has always been to operate as if arsenic is present in the aquifer matrix. The process involves increasing the recharge water pH above the solubility limit of iron, buffering the dissolution of iron-bearing minerals, and precipitating hydrous ferric oxide (HFO) on the surface of these minerals, which performs the following:

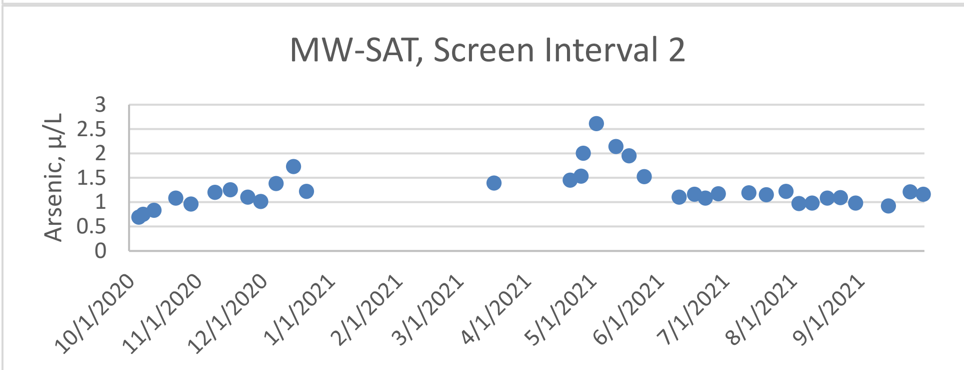
1. Precipitates HFO on the surface of reduced metal-bearing minerals inhibiting the reactivity of the minerals (passivate)
2. Adsorbs arsenic migrating in the aquifer.
3. Increases the availability of HFO sites for adsorbing arsenic and potential competitive oxyanions.

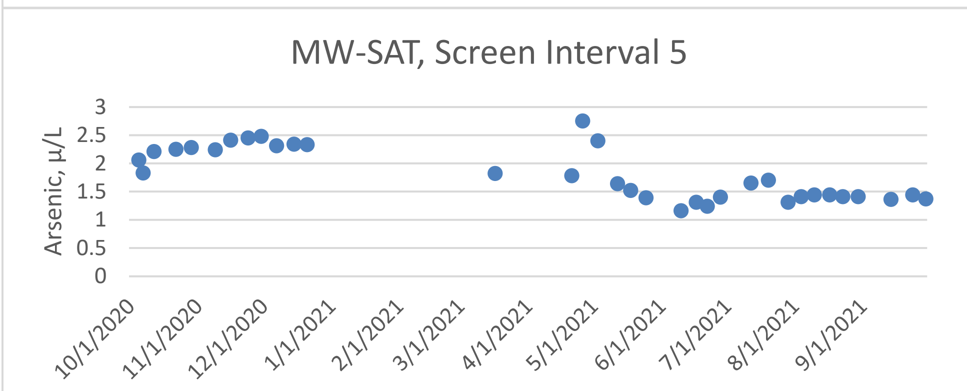
The approach works well in sand or sandstone aquifers rich in iron-bearing minerals and redox-transitional zones, like that of the Potomac aquifer in the Nansemond area.

Recent arsenic trends

Two episodes of elevated arsenic are observed in the recent data (Figure 6). The first spike, with arsenic reaching slightly over 5 μg/L and then falling back to just above 2 μg/L, was short lived and follows the more recent well rehabilitation of the recharge well. This same signature can be observed in several MW-SAT screen intervals to varying magnitudes (Figures 7, 8 and 9). The timing of the rise, detected several weeks after the re-start of recharging, is coincident with the travel time of migrating water from the recharge well to MW-SAT and may be attributed to the chemical rehabilitation process, which incorporates both a phosphorous based surfactant as well as acidification to remove particles from the well screen and gravel pack. These chemicals depress the pH and provide a source of phosphorus both of which can play a role in releasing arsenic.







Figures 7, 8 and 9: Arsenic concentration in MW-SAT Screen 1, 2 and 5, respectively, values are in µg/L.

Based upon our experience with an increase in arsenic following the first well rehabilitation effort, HRSD implemented an extended period of withdrawal and monitoring following the recent rehabilitation to mitigate the impact on arsenic mobilization. Recharge operations did not resume until the water withdrawn reached a steady pH above 6.8, successfully dampening the transient effects of rehabilitation fluids on arsenic concentration.

The second increasing trend, starting in early July, occurred three months post-rehabilitation and is not likely related to the that effort. Concentration steadily rose over the period of two months, reaching slightly above 10 µg/L before showing signs of falling. Potential causes of elevated arsenic concentration in Screen 9 include the following:

- Pyrite oxidation – pyrite oxidation tends to occur at the leading edge of the migrating recharge water. The SWIFT Water plume, however, has long since passed the location of MW-SAT. In addition to releasing arsenic, pyrite oxidation creates sulfuric acid, lowering the pH, dissolved oxygen (DO) and alkalinity while increasing iron and sulfate. Chemical evidence of pyrite oxidation appeared in Screens 1 through 5 weeks after initiating recharge operations at the SRC in Summer 2018 but has not been observed in Screen 9. These reactions did not linger in the screens, instead the reaction lasted over several days to weeks of sampling and then dissipated. The signs of pyrite oxidation are not present in the samples from MW-SAT and it is not likely the mechanism for the elevated arsenic.
- Competitive desorption – other oxy-anions like phosphate and carbonate successfully compete with arsenic on hydrous ferric oxide (HFO) surfaces replacing arsenic which leaches into the migrating recharge. The reaction creates a subtle geochemical signature including decreasing phosphate coincident with increasing arsenic. The recharge water needs to carry a phosphate concentration exceeding 0.2 mg/L. Phosphate typically attenuates during migration in an aquifer as it adsorbs to available HFO surfaces while advancing away from the recharge well. Thus, at monitoring wells, arsenic leaching from competitive desorption likely occurs later during recharge operations, with the timing depending on the distance of the monitoring well from the recharge well.
- Reductive dissolution – reductive dissolution results from lowered pH or reducing redox conditions that dissolve the protective HFO or other metal oxide surfaces, resulting in the release of arsenic. Declining DO, or increasing reactive organic carbon, in the SWIFT Water could produce redox conditions reducing enough to dissolve HFO. DO in the SWIFT Water declined to less than 1 mg/L coincident with modestly increasing concentrations of total organic carbon ranging from 2.7 to 3.7 mg/L, and the rapidly increasing arsenic. The drop in DO could result in reducing conditions, dissolving HFO surfaces and releasing arsenic. Arsenate (As V) adsorbs more readily to HFO than arsenite (As III). Arsenic speciation can therefore be an important analysis to evaluate reductive dissolution as the origin of arsenic. Additionally, collecting samples from an extended withdrawal cycle for microbial community analysis can help to better understand the role of microbial transformation and mobilization. HRSD is evaluating DO through the SWIFT treatment train to better understand the recent trends.

The following field and laboratory analytical efforts are being conducted to support the evaluation of the arsenic increase in Screen 9 and offer insights into mitigation strategies:

1. Continue weekly measurement of field chemistry from Screen 9 including temperature, pH, specific conductance, DO, ORP, Fe+2, sulfate, and sulfide
2. Arsenic speciation
3. Organic carbon analyses
4. Microbial community analysis

Some of these data will also be used to model the geochemical relationships between arsenic, redox chemistry, organic carbon and pH in groundwater and adsorbed to mineral surfaces to provide a better understanding of the conditions that promote mobilization and stabilization of arsenic.

MW-SAT continues to provide unique opportunities to understand these complex geochemical interactions that occur in close proximity to the recharge well. The SRC's conventional well monitoring within the middle and upper zones of the Potomac aquifer system continue to indicate that the arsenic release is a more localized phenomenon.

Table 6: Summary of regulatory monitoring for SWIFT Water

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	July 2021			August 2021			September 2021		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Regulatory Parameters													
Total Nitrogen (TN)	mg/L	NA	0.50	Daily[3]	**2.99**	**4.72**	**19**	**2.02**	**3.29**	**26**	**2.96**	**4.91**	**28**
NO_3	mg/L	10	0.01	Daily[3]	**2.91**	**4.45**	**19**	**1.81**	**2.74**	**25**	**2.79**	**4.41**	**27**
NO_2	mg/L	1	0.01	Daily[3]	**<0.01**	**<0.01**	**19**	**<0.01**	**<0.01**	**25**	**<0.01**	**<0.01**	**27**
Turbidity	NTU	NA	0.01	Continuous					**Figure 1**				
Total Organic Carbon (TOC)	mg/L	NA	1.00	3x/Wk[3]	**3.21**	**3.47**	**14**	**3.22**	**4.03**	**19**	**2.95**	**3.47**	**20**
pH		NA	NA	Continuous					**Figure 2**				
TDS[4]	mg/L	Potomac Aquifer System Range: 694-8,720	2.5	Monthly		**618**	**1**		**550**	**1**		**648**	**1**
Microorganisms													
Total Coliform	MPN/100 mL	MCLG = 0	1	Daily[3]	**<1**	**<1**	**19**	**<1**	**<1**	**25**	**<1**	**<1**	**28**
E. coli	MPN/100 mL	NA	1	Weekly	**<1**	**<1**	**19**	**<1**	**<1**	**25**	**<1**	**<1**	**28**
Cryptosporidium	oocysts/L	Treatment Technique, MCLG = 0	0.095	Quarterly		**<0.095**	**1**						
Giardia lamblia	oocysts/L	Treatment Technique, MCLG = 0	0.095	Quarterly		**<0.095**	**1**						
Legionella	MPN/100 mL	Treatment Technique, MCLG = 0	1	Quarterly		**<1**	**1**						
Disinfection Byproducts													
Bromate	µg/L	10	0.15	Monthly		**3.08**	**1**		**1.37**	**1**		**2.10**	**1**
Chlorite	mg/L	1.0	0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
Trihalomethanes													
Bromodichloromethane	µg/L		1.0	Monthly		**2.3**	**1**		**3.1**	**1**		**3.4**	**1**
Bromoform	µg/L		1.0	Monthly		**7.1**	**1**		**4.6**	**1**		**4.9**	**1**
Chloroform	µg/L		1.0	Monthly		**1.1**	**1**		**1.3**	**1**		**1.5**	**1**
Dibromochloromethane	µg/L		1.0	Monthly		**7.2**	**1**		**7.6**	**1**		**8.3**	**1**
Total Trihalomethanes	µg/L	80				**18**			**17**			**18**	
HAAs													
Dichloroacetic acid	µg/L		0.60	Monthly		**1.52**	**1**		**1.80**	**1**		**1.64**	**1**
Trichloroacetic acid	µg/L		0.20	Monthly		**<0.20**	**1**		**0.66**	**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		**1.21**	**1**		**0.71**	**1**		**0.93**	**1**
Dibromoacetic acid	µg/L		0.20	Monthly		**8.77**	**1**		**6.59**	**1**		**5.91**	**1**
Total Haloacetic Acids	µg/L	60				**12**			**9.8**			**8.5**	
Disinfectants[5, 6]													
Monochloramine (as Cl_2)	mg/L	4		Continuous	**0.01**	**0.02**		**0.01**	**0.03**		**0.14**	**3.34**	
Chlorine (as Cl_2)	mg/L	4		Continuous	**2.67**	**3.41**		**2.41**	**3.04**		**2.95**	**3.59**	
Inorganic Chemical													
Antimony	µg/L	6	0.5	Monthly		**<0.5**	**1**		**<0.5**	**1**		**<0.5**	**1**
Arsenic	µg/L	10	1.0	Monthly		**<1.0**	**1**		**0.5**	**1**		**<0.8**	**1**
Asbestos	MFL	7	0.2	Monthly		**<0.2**	**1**		**<0.2**	**1**		**<0.2**	**1**

Table 6: Summary of regulatory monitoring for SWIFT Water

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	July 2021			August 2021			September 2021		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Barium	mg/L	2	0.005	Monthly		0.006	1		<0.005	1		0.005	1
Beryllium	µg/L	4	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Cadmium	µg/L	5	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Chromium (total)	µg/L	100	5.0	Monthly		<5.0	1		<5.0	1		<1.0	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	10	Monthly		<10	1		<10	1		<10	1
Fluoride	mg/L	4.0	0.050	Monthly	0.912	0.997	19	0.845	0.938	26	0.854	0.964	28
Lead	µg/L	15 (action level)	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Mercury	µg/L	2	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Selenium	µg/L	50	5	Monthly		<5	1		<5	1		<5	1
Thallium	µg/L	2	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Organic Chemicals													
Acrylamide	µg/L	Treatment Technique, MCLG = 0	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Alachlor	µg/L	2	0.054	Monthly		<0.054	1		<0.050	1		<0.050	1
Atrazine	µg/L	3	0.054	Monthly		<0.054	1		<0.050	1		<0.050	1
Benzo(a)pyrene (PAHs)	µg/L	0.2	0.022	Monthly		<0.022	1		<0.020	1		<0.020	1
Di(2-ethylhexyl) adipate	µg/L	400	0.65	Monthly		<0.65	1		<0.60	1		<0.60	1
Di(2-ethylhexyl) phthalate	µg/L	6	0.65	Monthly		<0.65	1		<0.60	1		<0.60	1
Hexachlorocyclopentadiene	µg/L	50	0.054	Monthly		<0.054	1		<0.050	1		<0.050	1
Hexachlorobenzene	µg/L	1	0.054	Monthly		<0.054	1		<0.050	1		<0.050	1
Simazine	µg/L	4	0.054	Monthly		<0.054	1		<0.050	1		<0.050	1
Carbofuran	µg/L	40	0.5	Monthly		<0.5	1		<0.5	1		<0.5	1
Oxamyl (Vydate)	µg/L	200	0.5	Monthly		<0.5	1		<0.5	1		<0.5	1
Chlordane	µg/L	2	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Endrin	µg/L	2	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Heptachlor	µg/L	0.4	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Heptachlor Epoxide	µg/L	0.2	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Lindane	µg/L	0.2	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Methoxychlor	µg/L	40	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Toxaphene	µg/L	3	0.5	Monthly		<0.5	1		<0.5	1		<0.5	1
PCB Arochlor1016	µg/L		0.08	Monthly		<0.08	1		<0.08	1		<0.08	1
PCB Arochlor1221	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1232	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1242	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1248	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1254	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
PCB Arochlor1260	µg/L		0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Total Polychlorinated Biphenyls (PCBs)	µg/L	0.5				<0.1			<0.1			<0.1	
2,4-D	µg/L	70	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Dalapon	µg/L	200	1	Monthly		<1	1		<1	1		<1	1
Picloram	µg/L	500	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
2,4,5-TP (Silvex)	µg/L	50	0.2	Monthly		<0.2	1		<0.2	1		<0.2	1

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					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Dinoseb	µg/L	7	0.2	Monthly		**<0.2**	**1**		**<0.2**	**1**		**<0.2**	**1**
Pentachlorophenol	µg/L	1	0.04	Monthly		**<0.04**	**1**		**<0.04**	**1**		**<0.04**	**1**
Dioxin (2,3,7,8-TCDD)	pg/L	30	5	Monthly		**<5**	**1**		**<5**	**1**		**<5**	**1**
Diquat	µg/L	20	0.4	Monthly		**<0.4**	**1**		**<0.4**	**1**		**<0.4**	**1**
Endothall	µg/L	100	5	Monthly		**<5**	**1**		**<5**	**1**		**<5**	**1**
Epichlorohydrin	µg/L	Treatment Technique, MCLG = 0	0.4	Monthly		**<0.4**	**1**		**<0.4**	**1**		**<0.4**	**1**
Glycophosphate	µg/L	700	6	Monthly		**<6**	**1**		**<6**	**1**		**<6**	**1**
Benzene	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Carbon Tetrachloride	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Chlorobenzene	µg/L	100	1	Monthly		**<1**	**1**		**<1**	**1**		**<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	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
p-Dichlorobenzene	µg/L	75	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,2-Dichloroethane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,1-Dichlororethylene	µg/L	7	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
cis-1,2-Dichloroehtylene	µg/L	70	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
trans-1,2-Dichloroethylene	µg/L	100	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Dichloromethane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,2-Dichloropropane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Ethylbenzene	µg/L	700	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**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	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Tetrachloroethylene	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Toluene	µg/L	1,000	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,2,4-Trichlorobenzene	µg/L	70	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,1,1-Trichloroethane	µg/L	200	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,1,2-Trichloroethane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Trichloroethylene	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Vinyl Chloride	µg/L	2	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Total Xylene	µg/L	10,000	3	Monthly		**<3**	**1**		**<3**	**1**		**<3**	**1**
Radionuclides													
Alpha particles	pCi/L	15	3	Monthly		**<3**	**1**		**<3**	**1**		**<3**	**1**
Beta particles and photon emitters	pCi/L	4 mrem/yr[6]	3	Monthly		**16**	**1**		**14**	**1**		**23**	**1**
Radium 226	pCi/L	5 (226+228)	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Radium 228	pCi/L	5 (226+228)	1	Monthly		**<1**	**1**		**<1**	**1**		**1**	**1**
Uranium	µg/L	30	0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
Strontium-90	pCi/L	NA	0.897	Monthly		**<0.421**	**1**		**<0.265**	**1**		**<0.897**	**1**
Tritium	pCi/L	NA	1000	Monthly		**<397**	**1**		**<375**	**1**		**<1000 (U)**	**1**
Non-regulatory Performance Indicators													
Public Health Indicators		**Trigger Limits**											
1,4-dioxane	µg/L	1	0.06	Quarterly	**0.34**	**0.35**	**3**	**0.29**	**0.33**	**5**	**0.35**	**0.40**	**4**
17-β-estradiol	ng/L	0.9	0.42	Quarterly		**<0.42**	**1**						
DEET	ng/L	200,000	100	Quarterly		**120 (HA)**	**1**						

Table 6: Summary of regulatory monitoring for SWIFT Water

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	July 2021			August 2021			September 2021		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Ethinyl estradiol	ng/L	280	0.954	Quarterly		**<0.954**	**1**						
s(2-carboxyethyl)phosphine (TCEP)	ng/L	5,000	10	Quarterly		**47**	**1**						
NDMA	ng/L	10	2	Quarterly	**<2**	**<2**	**3**	**<2**	**<2**	**5**	**<2**	**<2**	**4**
Perchlorate	µg/L	6	0.50	Quarterly		**0.56**	**1**						
Perfluorooctanoic Acid (PFOA)	ng/L	70 (PFOA+PFOS)	2.0	Quarterly		**8.5**	**1**						
erfluorooctanesulfonic Acid (PFOS)	ng/L	70 (PFOA+PFOS)	2.0	Quarterly		**3.1**	**1**						
Treatment Efficacy Indicators		**Trigger Limits**											
Cotinine	ng/L	1,000	10	Quarterly		**13 (R7)**	**1**						
Primidone	ng/L	10,000	5.0	Quarterly		**9.8**	**1**						
Phenytoin (Dilantin)	ng/L	2,000	20	Quarterly		**<20**	**1**						
Meprobamate	ng/L	200,000	50	Quarterly		**<50**	**1**						
Atenolol	ng/L	4,000	5	Quarterly		**<5**	**1**						
Carbamazepine	ng/L	10,000	5	Quarterly		**<5**	**1**						
Estrone	ng/L	320,000	2.1	Quarterly		**<2.1**	**1**						
Sucralose	ng/L	150,000,000	1000	Quarterly		**24000**	**1**		**19000**	**1**		**2400**	**1**
Triclosan	ng/L	210,000	25	Quarterly		**<25**	**1**		**<25**	**1**		**<25**	**1**
Additional Monitoring (Ozone & UV LRV)					**Average**	**Minimum**		**Average**	**Minimum**		**Average**	**Minimum**	
Ozone Virus LRV				Continuous	**4.52**	**3.60**		**4.63**	**3.38**		**4.66**	**3.42**	
Ozone Giardia LRV				Continuous	**2.11**	**1.68**		**2.16**	**1.58**		**2.18**	**1.60**	
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 July, limited or no recharge impacted ten days of sampling. In August, limited recharge impacted five days of sampling. In September, limited recharge impacted two days of sampling. An additional day of sampling in July was impacted due to a disruption in sample delivery and receipt. An additional day of sampling in August was impacted for the short holding time samples: nitrate, nitrite and microbiological analyses. Recharge was disrupted before these samples could be collected. An additional data point for nitrate and nitrite is missing for September due to invalid data as a result of sample analysis outside of the sample holding time requirements.

[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 maximum monochloramine concentration was below the MRDL but higher than typically seen in SWIFT Water while free chlorinating. This occurred following an extended shutdown and cessation of flow to the Granular Activated Carbon vessels. After resuming flow, ammonia in the SWIFT Water was elevated, resulting in monochloramine formation. Both total coliform and E. coli were non-detect.

[7] 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.

<u>Contract Laboratory Flags</u>

(HA) - Initial analysis within holding time. Reanalysis was past holding time.
(U) - Result is less then the sample detection limit.
(R7) - LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.