**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, 2021. Recharge operations ceased in early November to accommodate activities associated with installation of the new recharge well as described later in this report. 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 95$^{th}$ 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.

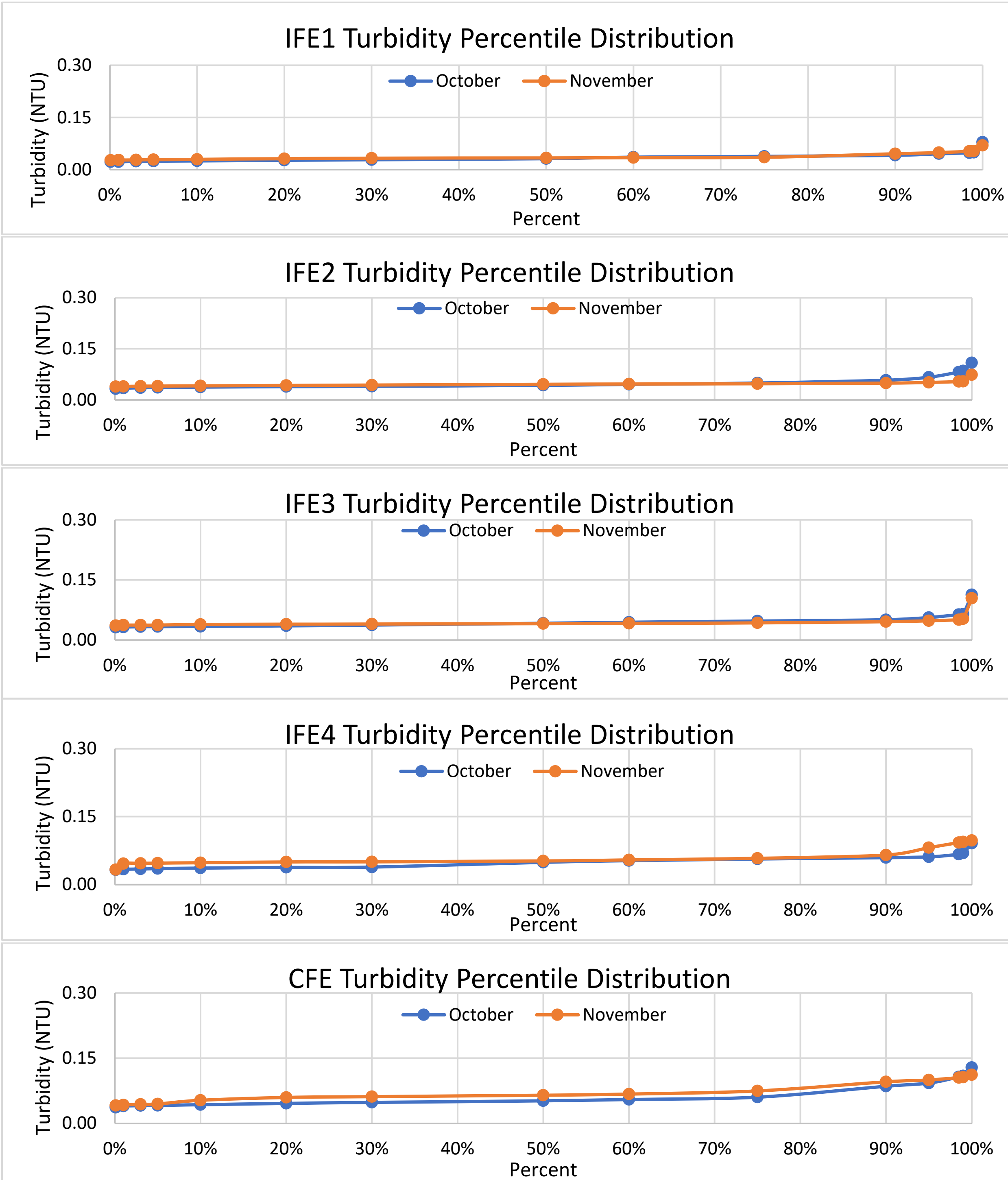


**Figure 1: Percentile distribution of 15-minute average Individual Filter Effluent (IFE) Turbidities for Biofilters 1-4 (IFE1-4) and Biofilter Combined Filter Effluent (CFE).** There were no 15-minute periods in this quarter with biofilter effluent turbidity values greater than 0.3 NTU. The 95% measured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

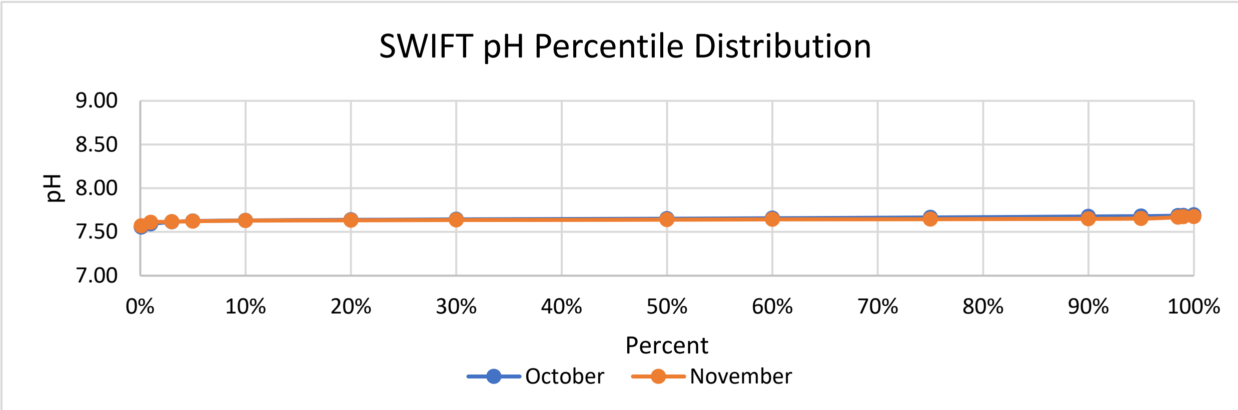


**Figure 2: Distribution of Monthly SWIFT Water pH values.**

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 | October 2021 | | | November 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Average[2] | Maximum | Numer of Samples | Average[2] | Maximum | Numer of Samples |
| **Regulatory Parameters** | | | | | | | | | | |
| Total Nitrogen (TN) | mg/L | NA | 0.50 | Daily[3] | **3.44** | **5.00** | **27** | **2.18** | **3.83** | **5** |
| $NO_3$ | mg/L | 10 | 0.01 | Daily[3] | **3.03** | **4.34** | **27** | **2.55** | **3.83** | **4** |
| $NO_2$ | mg/L | 1 | 0.01 | Daily[3] | **<0.01** | **<0.01** | **27** | **<0.01** | **<0.01** | **4** |
| Turbidity | NTU | NA | 0.01 | Continuous | | | | | **Figure 1** | |
| Total Organic Carbon (TOC) | mg/L | NA | 1.00 | 3x/Wk[3] | **2.82** | **3.45** | **19** | **1.53** | **2.91** | **4** |
| pH | | NA | NA | Continuous | | | | | **Figure 2** | |
| TDS[4] | mg/L | Potomac Aquifer System Range: 694-8,720 | 2.5 | Monthly | | **592** | **1** | | **640** | **1** |
| **Disinfection Byproducts** | | | | | | | | | | |
| Bromate | µg/L | 10 | 0.15 | Monthly | | **1.80** | **1** | | **1.15** | **1** |
| **Trihalomethanes** | | | | | | | | | | |
| Bromodichloromethane | µg/L | | 1 | Monthly | | **1.4** | **1** | | **<1** | **1** |
| Bromoform | µg/L | | 1 | Monthly | | **3.6** | **1** | | **<1** | **1** |
| Chloroform | µg/L | | 1 | Monthly | | **1.3** | **1** | | **<1** | **1** |
| Dibromochloromethane | µg/L | | 1 | Monthly | | **4.6** | **1** | | **<1** | **1** |
| Total Trihalomethanes | µg/L | 80 | | | | **11** | | | **<1** | |
| **HAAs** | | | | | | | | | | |
| Dichloroacetic acid | µg/L | | 0.6 | Monthly | | **1.36** | **1** | | **<0.6** | **1** |
| Trichloroacetic acid | µg/L | | 0.2 | Monthly | | **<0.2** | **1** | | **<0.2** | **1** |
| Monochloroacetic acid | µg/L | | 0.6 | Monthly | | **<0.6** | **1** | | **<0.6** | **1** |
| Bromoacetic acid | µg/L | | 0.4 | Monthly | | **0.96** | **1** | | **<0.4** | **1** |
| Dibromoacetic acid | µg/L | | 0.2 | Monthly | | **4.91** | **1** | | **1.25** | **1** |
| Total Haloacetic Acids | µg/L | 60 | | | | **7.2** | | | **1.3** | |
| **Disinfectants[5]** | | | | | | | | | | |
| Monochloramine (as $Cl_2$) | mg/L | 4 | | Continuous | **0.02** | **0.04** | | **0.02** | **0.02** | |
| Chlorine (as $Cl_2$) | mg/L | 4 | | Continuous | **2.92** | **3.51** | | **2.82** | **3.02** | |
| **Inorganic Chemical** | | | | | | | | | | |
| Barium | mg/L | 2 | 0 | Monthly | | **0.006** | **1** | | **0.028** | **1** |
| Fluoride | mg/L | 4.0 | 0.05 | Monthly | **0.932** | **1.07** | **27** | **0.908** | **0.961** | **5** |
| **Radionuclides** | | | | | | | | | | |
| Beta particles and photon emitters | pCi/L | 4 mrem/yr[6] | 3 | Monthly | | **16** | **1** | | **16** | **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 | October 2021 Average[2] | October 2021 Maximum | October 2021 Numer of Samples | November 2021 Average[2] | November 2021 Maximum | November 2021 Numer of Samples |
|---|---|---|---|---|---|---|---|---|---|---|
| **Non-regulatory Performance Indicators** | | | | | | | | | | |
| **Public Health Indicators** | | **Trigger Limits** | | | | | | | | |
| 1,4-dioxane | µg/L | 1 | 0.06 | Quarterly | **0.32** | **0.36** | **4** | **0.16** | **0.31** | **2** |
| **Treatment Efficacy Indicators** | | **Trigger Limits** | | | | | | | | |
| Sucralose | ng/L | 150,000,000 | 100 | Quarterly | | **2200** | **1** | | **450** | **1** |
| **Additional Monitoring (Ozone & UV LRV)** | | | | | | **Minimum** | | | **Minimum** | |
| Ozone Virus LRV | | | | Continuous | **4.50** | **4.15** | | **4.65** | **3.42** | |
| Ozone Giardia LRV | | | | Continuous | **2.12** | **1.94** | | **2.34** | **1.71** | |
| UV Dose Reactor 1 | $mJ/cm^2$ | | | Continuous | **>186** | **>186** | | **>186** | **>186** | |
| UV Virus LRV Reactor 1 | | | | Continuous | **>4** | **>4** | | **>4** | **>4** | |
| UV Dose Reactor 2 | $mJ/cm^2$ | | | Continuous | **>186** | **>186** | | **>186** | **>186** | |
| UV Virus LRV Reactor 2 | | | | Continuous | **>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 recharge impacted four days of sampling. In November, limited recharge impacted 25 days of sampling. Recharge did not resume until January 2022 (recharge was halted to accommodate installation of the new recharge well, NP-MAR-01, as described elsewhere in this report).

[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.

### Recharge Statistics

The total volume recharged during this operational period was 15.3 million gallons. The backflushed volume was 6.5 million gallons for a net recharge of 12.6 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 531.5 million gallons.

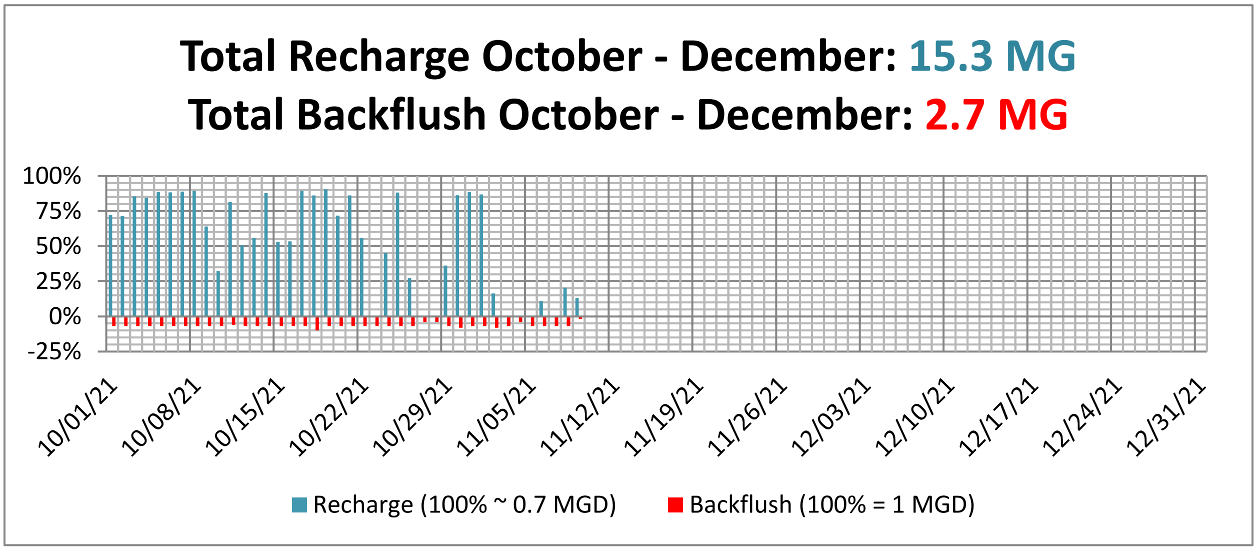


**Figure 3: Recharge and Backflush Volumes, October 1 – December 31, 2021**

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 original recharge well (TW-1) was temporarily taken offline in November to accommodate sensitive testing and conditioning activities associated with the installation of the full-scale recharge well, NP_MAR_01. Step drawdown testing followed by a 24-hr constant rate test and 8-hr recovery period were conducted on NP_MAR_01 the week of November 8$^{th}$. Recharge was ceased on November 9, 2021 to both avoid hydraulic interference and to utilize TW-1 as an observation well during the withdrawal testing of NP_MAR_01. Following the testing activities, the aquifer zones screened by NP_MAR_01 were conditioned with aluminum chlorohydrate (ACH) to stabilize clay particles for recharging. The ACH was introduced into the aquifer zones through NP_MAR_01 in stages using inflatable packers. Each zone conditioning required two weeks retention time prior to withdrawing the spent fluid. Zone conditioning was completed, and a post-conditioning step test conducted the last week of December. TW-1 was backflushed on January 5, 2022 and recharge resumed January 6.

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.

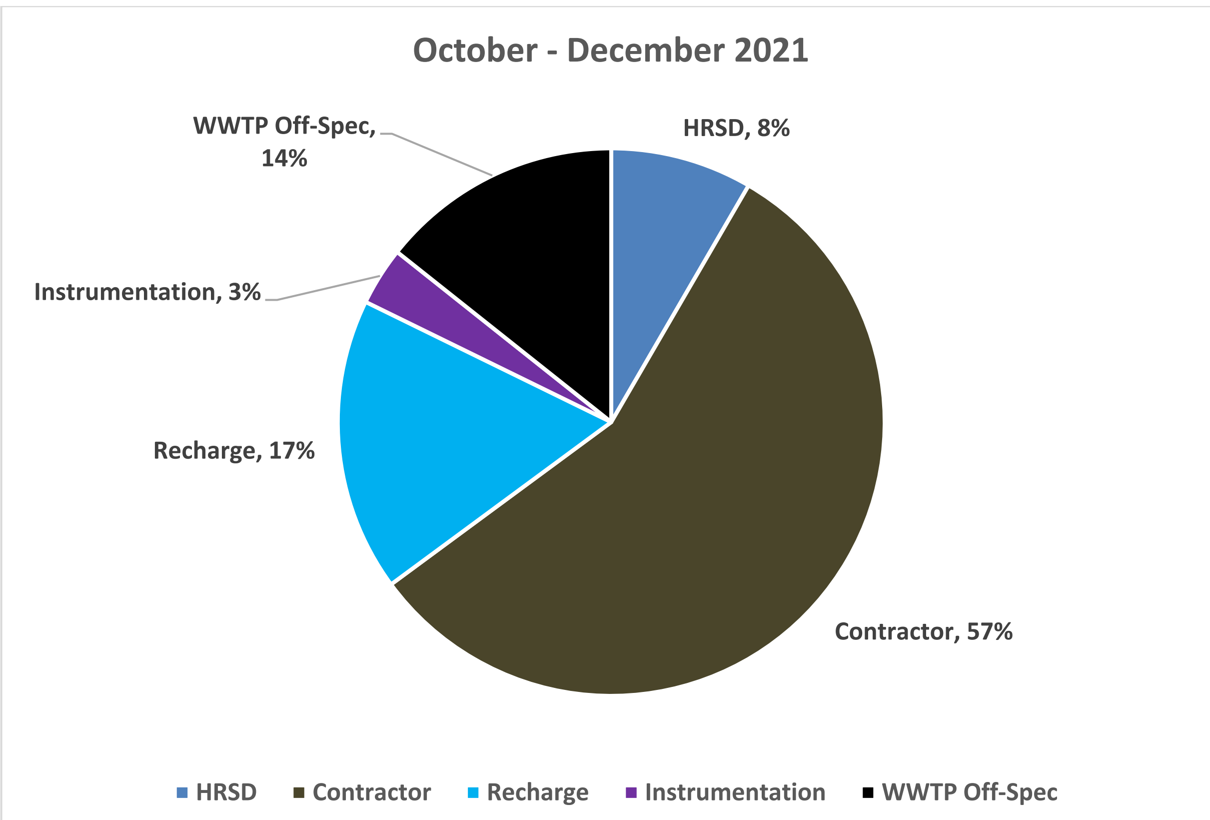


**Figure 4: Operational activity for monitoring period.** Notes: *Recharge*: Recharge of SWIFT Water; *WWTP Off-Spec*: Influent to the SWIFT facility (wastewater facility secondary clarifier effluent) does not meet influent quality requirements (e.g. elevated TOC or TN, or WWTP repairs; *HRSD*: Broad 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. *Instrumentation*: On-line analyzer and/or instrumentation maintenance and repair.

## 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 was 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.

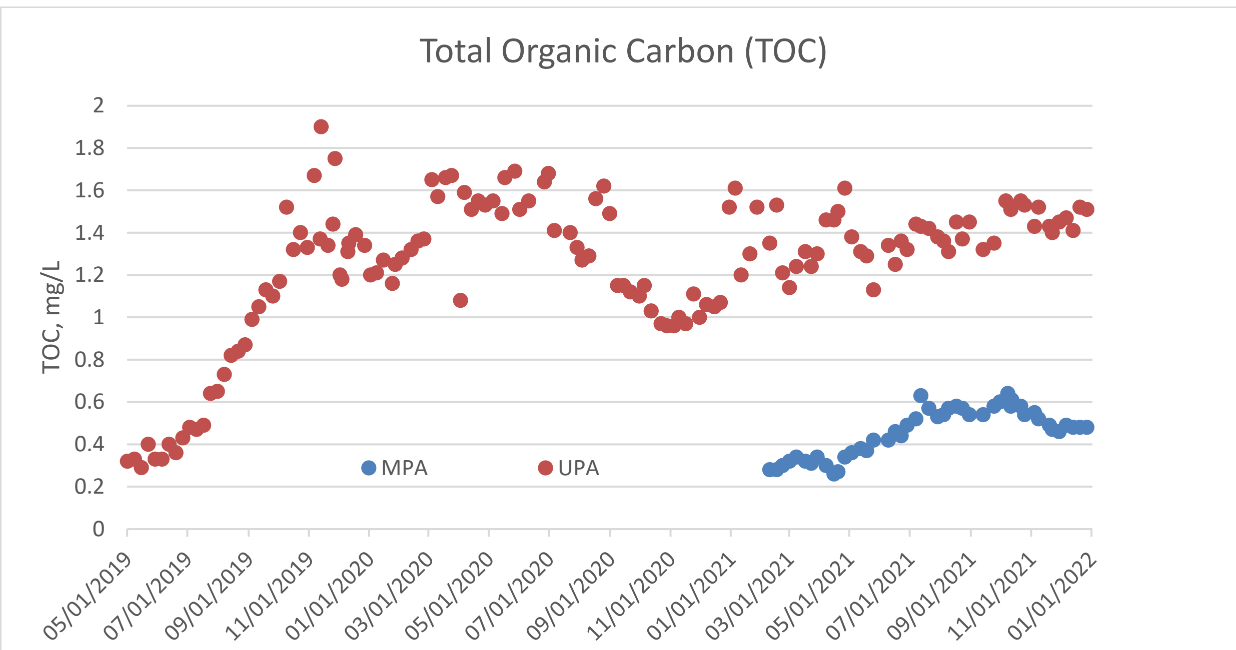


**Figure 5: TOC concentration in the Upper and Middle Potomac conventional monitoring wells, MW-UPA and MW-MPA.**

**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. NS: Contract lab samples were not collected in December because we were not recharging. 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 |
| Oct 2021 | Max | 320 | 0.41 | <2 | - | 1700 | 0.11 |
| | Avg | - | 0.40 | <2 | - | - | 0.11 |
| Nov 2021 | Max | 1700 | 0.44 | <2 | - | 1700 | 0.12 |
| | Avg | - | 0.41 | <2 | - | - | 0.11 |
| Dec 2021 | Max | NS | 0.41 | <2 | NS | NS | 0.10 |
| | Avg | NS | 0.40 | <2 | NS | NS | 0.10 |

**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). Future quarterly regulatory updates will only report on nitrite if the concentration increases above the MCL in SWIFT Water or at the conventional wells. If we observe increasing trends in groundwater below the MCL, HRSD will report on those observations in a research report and/or as part of a PAROC update.

**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). Two separate spikes in As in screen 9 are present and represent two separate root causes.

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 in 2021 is 4.0 µg/L, including the recent elevated sample results.

A minor spike in As occurred in May 2021 and is attributed to a rehabilitation event that immediately preceded it (Figure 6). Chemicals used to perform rehabilitation, including acid and surfactant, can temporarily liberate As bound to the aquifer matrix. To mitigate for this the rehabilitation procedure included an extended period of withdrawal to remove the spent chemicals. 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.

A more pronounced rise in As was observed in early July and continued until mid-October, peaking at 10.1 µg/L. There has been a steady decrease in As observed since the October 11 sample, with values returning to approximately 2 µg/L in mid-November and staying at that value for the next 6 consecutive samples (through the end of December). The timing of this second spike in As is well after any residual rehabilitation fluids would have migrated past MW-SAT. This spike is attributed to deterioration of the hydrous ferric oxide (HFO) surfaces due to SWIFT Water DO dropping below 3 mg/L and is discussed in more detail below.

These spikes are transient in nature and represent extremely isolated occurrences. The SWIFT Water recharge front has migrated past conventional monitoring wells MW-UPA and MW-MPA, approximately 300 – 500 feet from recharge well TW-1 and 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.

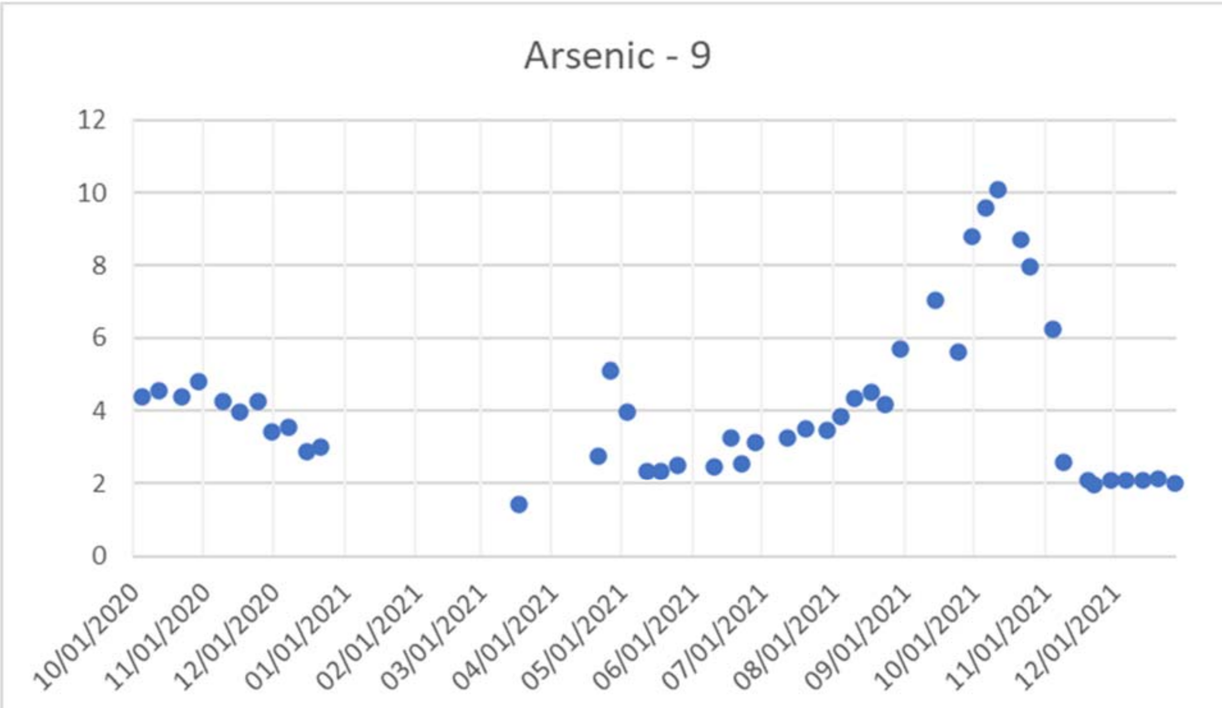


**Figure 6: Arsenic concentration in MW-SAT Screen 9, values are in ug/L**.

### Source

As reported previously arsenic concentrations in SWIFT Water remain < 1 µg/L, eliminating the recharge water as a source. 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.

At the recommendation of DEQ, HRSD examined 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. There was no evidence of this observed in the gamma log (Figure 7). The driller's logs and geologist logs were examined and likewise showed no indication of any arsenic bearing strata.

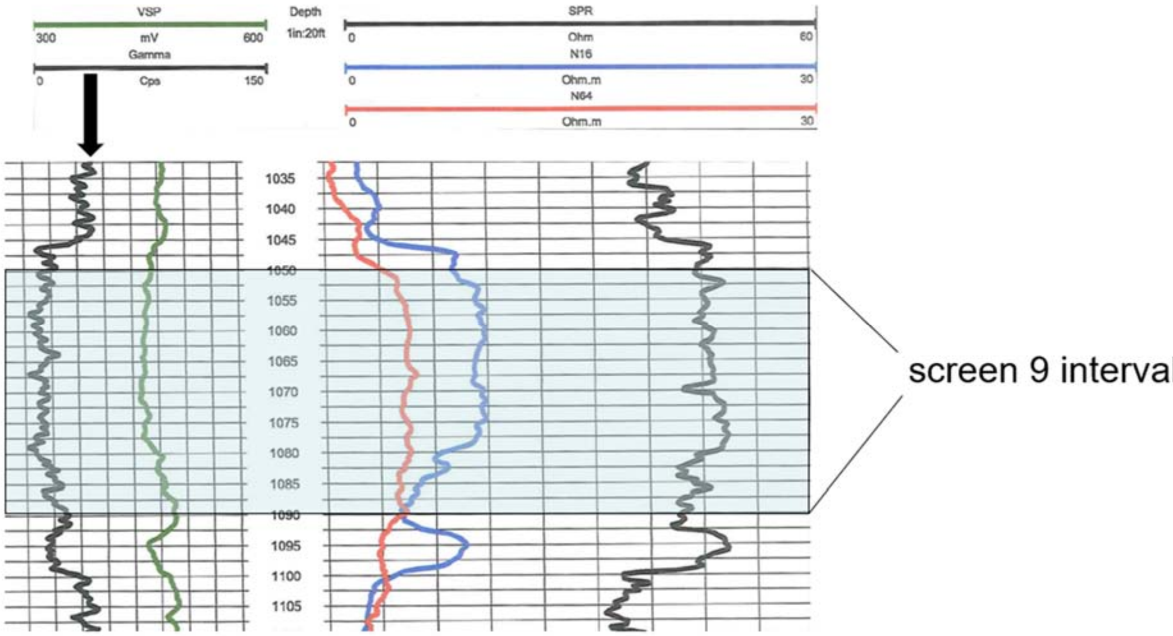


**Figure 7: TW-1 geophysical log, gamma signal on the far left**

### SWIFT arsenic mitigation approach

Although no arsenic bearing minerals were found in the cuttings collected during well installation, the sample set is relatively limited, 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.

### Cause of second increasing Arsenic trend

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 arsenian pyrite can release arsenic, mobilizing arsenic in the migrating recharge water and potentially elevating arsenic above the MCL.

The mechanisms that can result in arsenic mobility in groundwater were reviewed in the previous Quarterly Report. Potential causes of elevated arsenic concentration in Screen 9 are summarized as follows:

- Pyrite oxidation – pyrite oxidation tends to occur at the leading edge of the migrating recharge water. The SWIFT Water plume has long since passed the location of MW-SAT and the signs of pyrite oxidation are not present; 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. Arsenic leaching from competitive desorption likely occurs later during recharge operations.

- 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 (Figure 8). The drop in DO slightly precedes the release of As showing up in the MW-SAT screen 9 samples matching the travel time of SWIFT Water to screen 9. This results in reducing conditions, dissolving HFO surfaces and releasing arsenic. Specifically, geochemical modeling indicates that the SWIFT Water must maintain a DO of at least 3 mg/L to preserve the integrity of the HFO surface. This can be observed in the graph in Figure 8. As the DO in the SWIFT Water rebounds above 3 mg/L a subsequent steady decline in As concentrations is observed at Screen 9. The As concentrations in screen 9 lag the changes in DO due to the travel time in the aquifer; it takes approximately 2 weeks for the SWIFT Water to reach MW-SAT screen 9 at a recharge rate of 500 gpm.

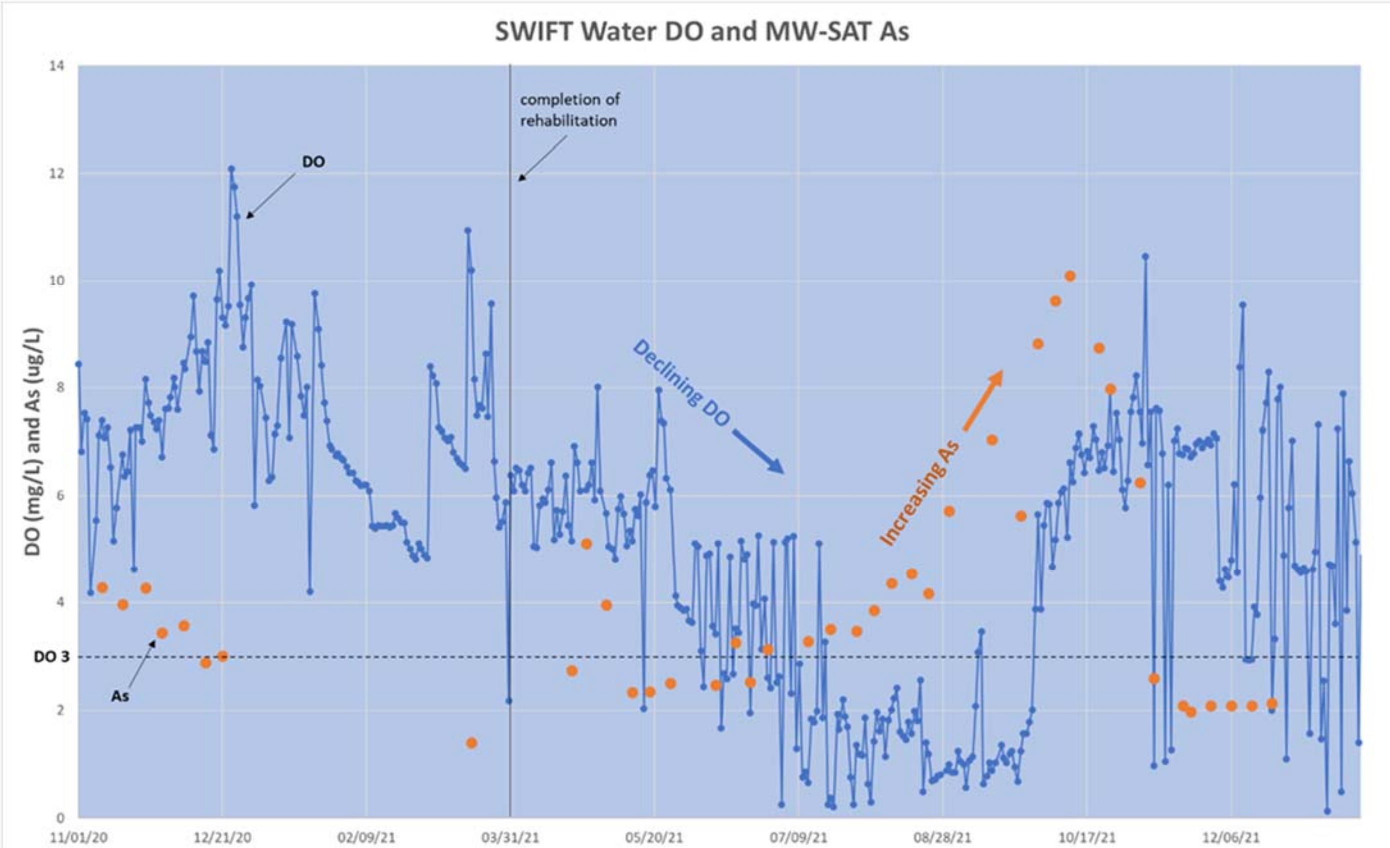


**Figure 8: SWIFT Water Dissolved Oxygen and MW-SAT As concentrations**

Further evidence of reductive dissolution of the HFO surface is shown in the As speciation data. Arsenate (As V) adsorbs more readily to HFO than arsenite (As III), therefore if the increase is composed of As V it is indicative of degradation in the HFO surfaces. Arsenic speciation was performed on several samples collected during the elevated event. As illustrated in Figure 9, As III concentrations remain steady in the samples as Total As increased, indicating the increased As observed was As V. This points to reductive dissolution of HFO time coincident with a drop in recharge DO.

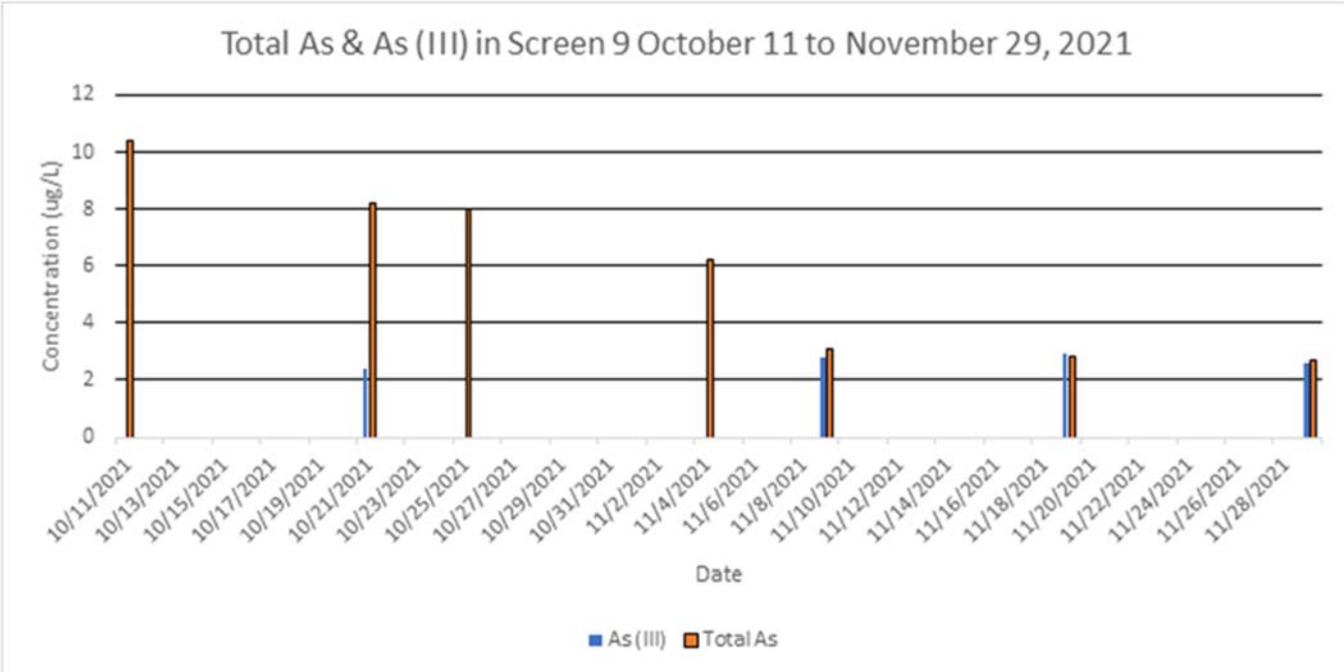


**Figure 9: As (III) vs Total As in samples from MW-SAT Screen 9.**

## Continued Evaluation

The following field and laboratory analytical efforts are still 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, and ORP
2. Organic carbon analyses
3. 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.

| 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 2021 | | | November 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Average[2] | Maximum | Numer of Samples | Average[2] | Maximum | Numer of Samples |
| **Regulatory Parameters** | | | | | | | | | | |
| Total Nitrogen (TN) | mg/L | NA | 0.50 | Daily[3] | **3.44** | **5.00** | **27** | **2.18** | **3.83** | **5** |
| $NO_3$ | mg/L | 10 | 0.01 | Daily[3] | **3.03** | **4.34** | **27** | **2.55** | **3.83** | **4** |
| $NO_2$ | mg/L | 1 | 0.01 | Daily[3] | **<0.01** | **<0.01** | **27** | **<0.01** | **<0.01** | **4** |
| Turbidity | NTU | NA | 0.01 | Continuous | | | | | **Figure 1** | |
| Total Organic Carbon (TOC) | mg/L | NA | 1.00* | 3x/Wk[3] | **2.82** | **3.45** | **19** | **1.53** | **2.91** | **4** |
| pH | | NA | NA | Continuous | | | | | **Figure 2** | |
| TDS[4] | mg/L | Potomac Aquifer System Range: 694-8,720 | 2.5 | Monthly | | **592** | **1** | | **640** | **1** |
| **Microorganisms** | | | | | | | | | | |
| Total Coliform | MPN/100 mL | MCLG = 0 | 1 | Daily[3] | **<1** | **<1** | **27** | **<1** | **<1** | **4** |
| E. coli | MPN/100 mL | NA | 1 | Weekly | **<1** | **<1** | **27** | **<1** | **<1** | **4** |
| Cryptosporidium | oocysts/L | Treatment Technique, MCLG = 0 | 0.093 | Quarterly | | | | | **<0.093** | **1** |
| Giardia lamblia | oocysts/L | Treatment Technique, MCLG = 0 | 0.093 | Quarterly | | | | | **<0.093** | **1** |
| Legionella | MPN/100 mL | Treatment Technique, MCLG = 0 | 1 | Quarterly | | | | | **<1** | **1** |
| **Disinfection Byproducts** | | | | | | | | | | |
| Bromate | µg/L | 10 | 0.15 | Monthly | | **1.80** | **1** | | **1.15** | **1** |
| Chlorite | mg/L | 1.0 | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| **Trihalomethanes** | | | | | | | | | | |
| Bromodichloromethane | µg/L | | 1 | Monthly | | **1.4** | **1** | | **<1** | **1** |
| Bromoform | µg/L | | 1 | Monthly | | **3.6** | **1** | | **<1** | **1** |
| Chloroform | µg/L | | 1 | Monthly | | **1.3** | **1** | | **<1** | **1** |
| Dibromochloromethane | µg/L | | 1 | Monthly | | **4.6** | **1** | | **<1** | **1** |
| Total Trihalomethanes | µg/L | 80 | | | | **11** | | | **<1** | |
| **HAAs** | | | | | | | | | | |
| Dichloroacetic acid | µg/L | | 0.6 | Monthly | | **1.36** | **1** | | **<0.6** | **1** |
| Trichloroacetic acid | µg/L | | 0.2 | Monthly | | **<0.2** | **1** | | **<0.2** | **1** |
| Monochloroacetic acid | µg/L | | 0.6 | Monthly | | **<0.6** | **1** | | **<0.6** | **1** |
| Bromoacetic acid | µg/L | | 0.4 | Monthly | | **0.96** | **1** | | **<0.4** | **1** |
| Dibromoacetic acid | µg/L | | 0.2 | Monthly | | **4.91** | **1** | | **1.25** | **1** |
| Total Haloacetic Acids | µg/L | 60 | | | | **7.2** | | | **1.3** | |
| **Disinfectants[5]** | | | | | | | | | | |
| Monochloramine (as $Cl_2$) | mg/L | 4 | | Continuous | **0.02** | **0.04** | | **0.02** | **0.02** | |
| Chlorine (as $Cl_2$) | mg/L | 4 | | Continuous | **2.92** | **3.51** | | **2.82** | **3.02** | |
| **Inorganic Chemical** | | | | | | | | | | |
| Antimony | µg/L | 6 | 2 | Monthly | | **<2** | **1** | | **<2** | **1** |
| Arsenic | µg/L | 10 | 0.6* | Monthly | | **<0.6** | **1** | | **<0.5** | **1** |
| Asbestos | MFL | 7 | 0.2 | Monthly | | **<0.2** | **1** | | **<0.2** | **1** |
| Barium | mg/L | 2 | 0 | Monthly | | **0.006** | **1** | | **0.028** | **1** |
| Beryllium | µg/L | 4 | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **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 2021 | | | November 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Average[2] | Maximum | Numer of Samples | Average[2] | Maximum | Numer of Samples |
| Cadmium | µg/L | 5 | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| Chromium (total) | µg/L | 100 | 1.0 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Copper | mg/L | 1.3 (action level) | 0.005 | Monthly | | **<0.005** | **1** | | **<0.005** | **1** |
| Cyanide (total) | µg/L | 200 | 10 | Monthly | | **<10** | **1** | | **<10** | **1** |
| Fluoride | mg/L | 4.0 | 0.05 | Monthly | **0.932** | **1.07** | **27** | **0.908** | **0.961** | **5** |
| Lead | µg/L | 15 (action level) | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| Mercury | µg/L | 2 | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| Selenium | µg/L | 50 | 5 | Monthly | | **<5** | **1** | | **<5** | **1** |
| Thallium | µg/L | 2 | 0.2 | Monthly | | **<0.2** | **1** | | **<0.2** | **1** |
| **Organic Chemicals** | | | | | | | | | | |
| Acrylamide | µg/L | Treatment Technique, MCLG = 0 | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| Alachlor | µg/L | 2 | 0.05 | Monthly | | **<0.05** | **1** | | **<0.05** | **1** |
| Atrazine | µg/L | 3 | 0.05 | Monthly | | **<0.05** | **1** | | **<0.05** | **1** |
| Benzo(a)pyrene (PAHs) | µg/L | 0.2 | 0.02 | Monthly | | **<0.02** | **1** | | **<0.02** | **1** |
| Di(2-ethylhexyl) adipate | µg/L | 400 | 0.6 | Monthly | | **<0.6 (R7)** | **1** | | **<0.6** | **1** |
| Di(2-ethylhexyl) phthalate | µg/L | 6 | 0.6 | Monthly | | **<0.6** | **1** | | **<0.6** | **1** |
| Hexachlorocyclopentadiene | µg/L | 50 | 0.05 | Monthly | | **<0.05** | **1** | | **<0.05** | **1** |
| Hexachlorobenzene | µg/L | 1 | 0.05 | Monthly | | **<0.05** | **1** | | **<0.05** | **1** |
| Simazine | µg/L | 4 | 0.05 | Monthly | | **<0.05** | **1** | | **<0.05** | **1** |
| Carbofuran | µg/L | 40 | 0.5 | Monthly | | **<0.5** | **1** | | **<0.5** | **1** |
| Oxamyl (Vydate) | µg/L | 200 | 0.5 | Monthly | | **<0.5** | **1** | | **<0.5** | **1** |
| Chlordane | µg/L | 2 | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| Endrin | µg/L | 2 | 0.01 | Monthly | | **<0.01** | **1** | | **<0.01** | **1** |
| Heptachlor | µg/L | 0.4 | 0.01 | Monthly | | **<0.01** | **1** | | **<0.01** | **1** |
| Heptachlor Epoxide | µg/L | 0.2 | 0.01 | Monthly | | **<0.01** | **1** | | **<0.01** | **1** |
| Lindane | µg/L | 0.2 | 0.01 | Monthly | | **<0.01** | **1** | | **<0.01** | **1** |
| Methoxychlor | µg/L | 40 | 0.05 | Monthly | | **<0.05** | **1** | | **<0.05** | **1** |
| Toxaphene | µg/L | 3 | 0.5 | Monthly | | **<0.5** | **1** | | **<0.5** | **1** |
| PCB Arochlor1016 | µg/L | | 0.08 | Monthly | | **<0.08** | **1** | | **<0.08** | **1** |
| PCB Arochlor1221 | µg/L | | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| PCB Arochlor1232 | µg/L | | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| PCB Arochlor1242 | µg/L | | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| PCB Arochlor1248 | µg/L | | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| PCB Arochlor1254 | µg/L | | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| PCB Arochlor1260 | µg/L | | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| Total Polychlorinated Biphenyls (PCBs) | µg/L | 0.5 | | | | **<0.1** | | | **<0.1** | |
| 2,4-D | µg/L | 70 | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| Dalapon | µg/L | 200 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Picloram | µg/L | 500 | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| 2,4,5-TP (Silvex) | µg/L | 50 | 0.2 | Monthly | | **<0.2** | **1** | | **<0.2** | **1** |
| Dinoseb | µg/L | 7 | 0.2 | Monthly | | **<0.2** | **1** | | **<0.2** | **1** |
| Pentachlorophenol | µg/L | 1 | 0.04 | Monthly | | **<0.04** | **1** | | **<0.04** | **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 2021 | | | November 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Average[2] | Maximum | Numer of Samples | Average[2] | Maximum | Numer of Samples |
| Dioxin (2,3,7,8-TCDD) | pg/L | 30 | 5 | Monthly | | **<5** | **1** | | **<5** | **1** |
| Diquat | µg/L | 20 | 0.4 | Monthly | | **<0.4** | **1** | | **<0.4** | **1** |
| Endothall | µg/L | 100 | 5 | Monthly | | **<5** | **1** | | **<5** | **1** |
| Epichlorohydrin | µg/L | Treatment Technique, MCLG = 0 | 0.4 | Monthly | | **<0.4** | **1** | | **<0.4** | **1** |
| Glycophosphate | µg/L | 700 | 6 | Monthly | | **<6** | **1** | | **<6** | **1** |
| Benzene | µg/L | 5 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Carbon Tetrachloride | µg/L | 5 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Chlorobenzene | µg/L | 100 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| 2-dibromo-3-chloropropane (DBCP) | µg/L | 0.2 | 0.02 | Monthly | | **<0.02** | **1** | | **<0.02** | **1** |
| o-Dichlororbenzene | µg/L | 600 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| p-Dichlorobenzene | µg/L | 75 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| 1,2-Dichloroethane | µg/L | 5 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| 1,1-Dichlororethylene | µg/L | 7 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| cis-1,2-Dichloroethylene | µg/L | 70 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| trans-1,2-Dichloroethylene | µg/L | 100 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Dichloromethane | µg/L | 5 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| 1,2-Dichloropropane | µg/L | 5 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Ethylbenzene | µg/L | 700 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Ethylene Dibromide (EDB) | µg/L | 0.05 | 0.02 | Monthly | | **<0.02** | **1** | | **<0.02** | **1** |
| Styrene | µg/L | 100 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Tetrachloroethylene | µg/L | 5 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Toluene | µg/L | 1,000 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| 1,2,4-Trichlorobenzene | µg/L | 70 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| 1,1,1-Trichloroethane | µg/L | 200 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| 1,1,2-Trichloroethane | µg/L | 5 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Trichloroethylene | µg/L | 5 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Vinyl Chloride | µg/L | 2 | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Total Xylene | µg/L | 10,000 | 3 | Monthly | | **<3** | **1** | | **<3** | **1** |
| **Radionuclides** | | | | | | | | | | |
| Alpha particles | pCi/L | 15 | 3 | Monthly | | **<3** | **1** | | **<3** | **1** |
| Beta particles and photon emitters | pCi/L | 4 mrem/yr[6] | 3 | Monthly | | **16** | **1** | | **16** | **1** |
| Radium 226 | pCi/L | 5 (226+228) | 1 | Monthly | | **<1** | **1** | | **<1** | **1** |
| Radium 228 | pCi/L | 5 (226+228) | 1 | Monthly | | **<1 (L1)** | **1** | | **<1** | **1** |
| Uranium | µg/L | 30 | 0.1 | Monthly | | **<0.1** | **1** | | **<0.1** | **1** |
| Strontium-90 | pCi/L | NA | 0.591* | Monthly | | **<0.528** | **1** | | **<0.591** | **1** |
| Tritium | pCi/L | NA | 1000 | Monthly | | **<1000 (U)** | **1** | | **<1000 (U)** | **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 2021 | | | November 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 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 | **0.32** | **0.36** | **4** | **0.16** | **0.31** | **2** |
| 17-β-estradiol | ng/L | 0.9 | 0.4 | Quarterly | | | | | **<0.4** | **1** |
| DEET | ng/L | 200,000 | 5.1 | Quarterly | | | | | **<5.1** | **1** |
| Ethinyl estradiol | ng/L | 280 | 0.9 | Quarterly | | | | | **<0.9** | **1** |
| s(2-carboxyethyl)phosphine (TCEP) | ng/L | 5,000 | 10 | Quarterly | | | | | **<10** | **1** |
| NDMA | ng/L | 10 | 2 | Quarterly | **<2** | **<2** | **3** | **<2** | **<2** | **2** |
| Perchlorate | µg/L | 6 | 0.5 | Quarterly | | | | | **<0.5** | **1** |
| Perfluorooctanoic Acid (PFOA) | ng/L | 70 (PFOA+PFOS) | 2 | Quarterly | | | | | **<2** | **1** |
| erfluorooctanesulfonic Acid (PFOS) | ng/L | 70 (PFOA+PFOS) | 2 | Quarterly | | | | | **<2** | **1** |
| **Treatment Efficacy Indicators** | | **Trigger Limits** | | | | | | | | |
| Cotinine | ng/L | 1,000 | 10 | Quarterly | | | | | **<10** | **1** |
| Primidone | ng/L | 10,000 | 5 | Quarterly | | | | | **<5** | **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 | Quarterly | | | | | **<2** | **1** |
| Sucralose | ng/L | 150,000,000 | 100 | Quarterly | | **2200** | **1** | | **450** | **1** |
| Triclosan | ng/L | 210,000 | 25 | Quarterly | | **<25** | **1** | | **<25** | **1** |
| **Additional Monitoring (Ozone & UV LRV)** | | | | | | **Minimum** | | | **Minimum** | |
| Ozone Virus LRV | | | | Continuous | **4.50** | **4.15** | | **4.65** | **3.42** | |
| Ozone Giardia LRV | | | | Continuous | **2.12** | **1.94** | | **2.34** | **1.71** | |
| UV Dose Reactor 1 | $mJ/cm^2$ | | | Continuous | **>186** | **>186** | | **>186** | **>186** | |
| UV Virus LRV Reactor 1 | | | | Continuous | **>4** | **>4** | | **>4** | **>4** | |
| UV Dose Reactor 2 | $mJ/cm^2$ | | | Continuous | **>186** | **>186** | | **>186** | **>186** | |
| UV Virus LRV Reactor 2 | | | | Continuous | **>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 recharge impacted four days of sampling. In November, limited recharge impacted 25 days of sampling. Recharge did not resume until January 2022 (recharge was halted to accommodate installation of the new recharge well, NP-MAR-01, as described elsewhere in this report).

[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.

Contract Laboratory Flags
R7 - LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.
(L1) - The associated blank spike recovery was above laboratory acceptance limits.
(U) - Results less than the sample detection limit.