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

This report documents SWIFT Water Quality results for the second full quarter of recharge operations which includes the period from September 1, 2018 – November 30, 2018. 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 the following tables (Tables 1-4), extracted from Attachment B of the UIC-IIP. Figures 1 and 2 and Table 6 provide the data from the second quarter of operations relative to these SWIFT Water Quality Targets.

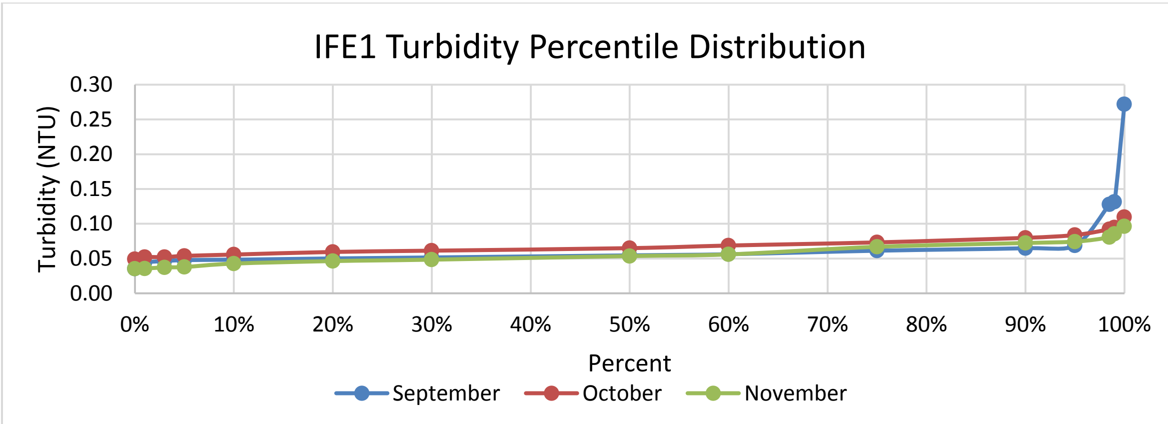
Parameter	Proposed Regulatory Limit	Non-Regulatory Action/Goal
EPA Drinking Water Primary Maximum Contaminant Levels (MCLs)	Meet all primary MCLs	N/A
Total Nitrogen	5 mg/L Monthly Average; 8 mg/L Max Daily	Secondary Effluent Critical Control Point (CCP) Action Limit for Total Inorganic Nitrogen (TIN) = 5 mg/L-N; CCP Action Limit for SWIFT Water Total Nitrogen (TN) = 5 mg/L-N[1]
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 0.10 NTU to initiate backwash or place a filter in standby
Total Organic Carbon (TOC)[2]	4 mg/L Monthly Average 6 mg/L Maximum	Critical Operating Point (COP) Action Limit to Initiate GAC Regeneration; See Table 8 COP for GAC TOC
Total Coliform	<2 CFU/100 mL 95% of time; Not to exceed geometric mean of 3 CFU/100 mL, based on a running calculation of 20 days of daily samples for total coliforms	N/A
E.coli	Non-detect	N/A
TDS[3]	N/A	Monitor PAS Compatibility

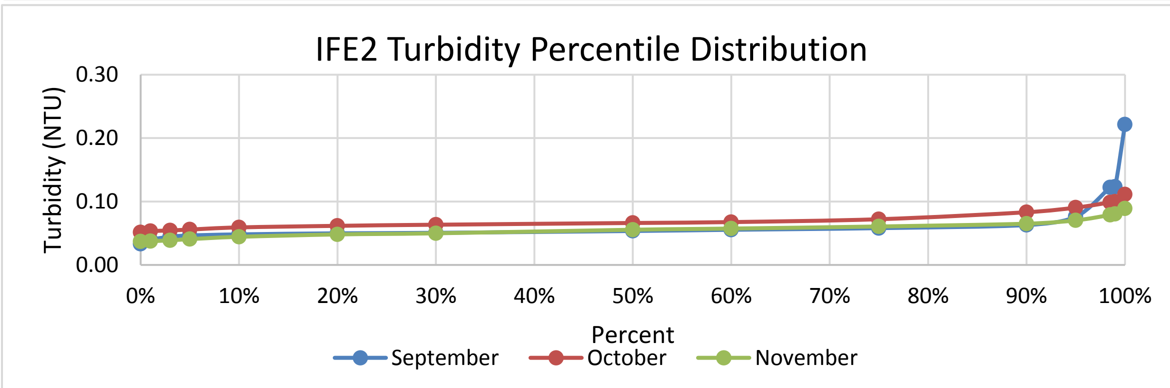
Table 1: SWIFTRC Regulatory and Monitoring Limits for SWIFT Water

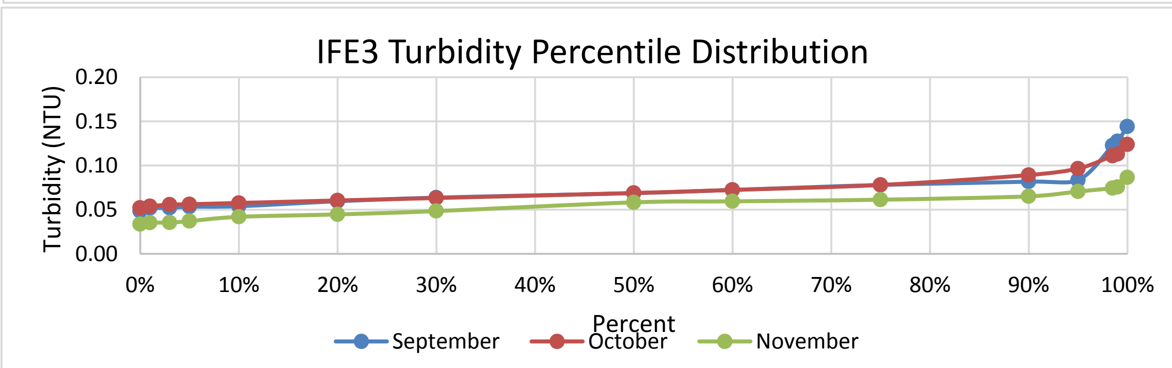
[1] Total Inorganic Nitrogen (TIN) CCP for the secondary effluent was adjusted to 5 mg/L in August 2018 as an additional measure of protection to prevent exceedance of the Total Nitrogen regulatory limit. An additional CCP was also added to the SWIFT Water for TN. When added in August 2018, the SWIFT Water TN CCP was set with an alarm level of 6 mg/L. Rising TN levels in SWIFT Water observed in October (maximum of 5.56 mg/L, average of 4.56 mg/L) prompted a reduction in the alarm level to 5 mg/L as of October 17, 2018.

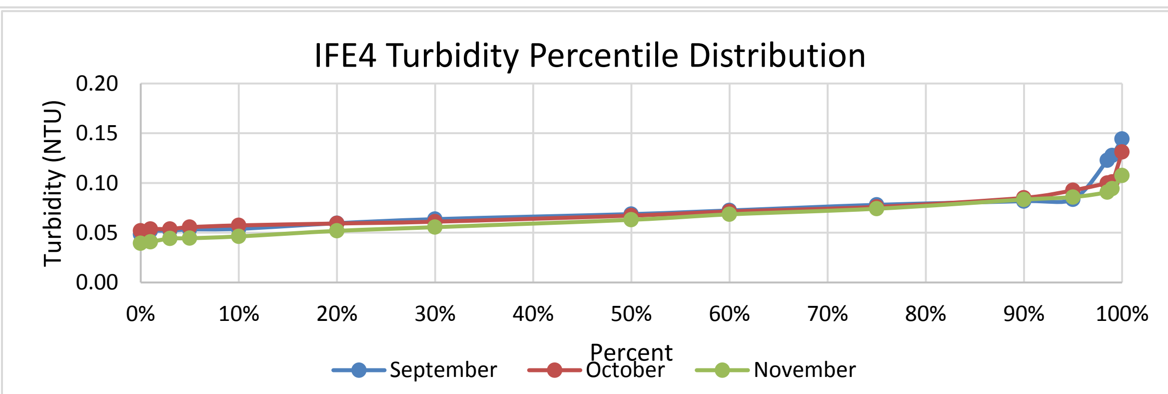
[2] Regulatory limit applies to the TOC laboratory analysis which is collected at a frequency of 3 times per week.

[3] Proposing no limit for TDS as the primary driver is aquifer compatibility. Expected range for SWIFT Water at SWIFTRC is 500-850 mg/L.


IFE1 Turbidity Percentile Distribution
Turbidity (NTU)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent
September
October
November


IFE2 Turbidity Percentile Distribution
Turbidity (NTU)
0.30
0.20
0.10
0.00
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent
September
October
November


IFE3 Turbidity Percentile Distribution
Turbidity (NTU)
0.20
0.15
0.10
0.05
0.00
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent
September
October
November


IFE4 Turbidity Percentile Distribution
Turbidity (NTU)
0.20
0.15
0.10
0.05
0.00
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent
September
October
November

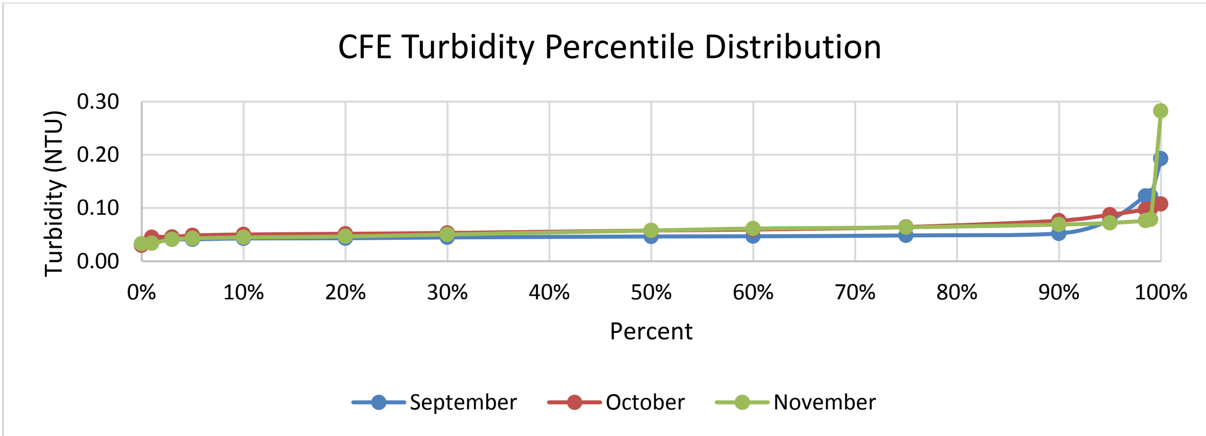


Figure 1: Percentile distribution of 15-minute average Individual Filter Effluent (IFE) Turbidities for Biofilters 1-4 (IFE1-4) and Combined Filter Effluent (CFE). There were no 15-minute periods in this quarter with biofilter effluent turbidity values greater than 0.3 NTU. The 95% measured value for each biofilter IFE and the CFE was less than 0.1 NTU for each month in this quarter.

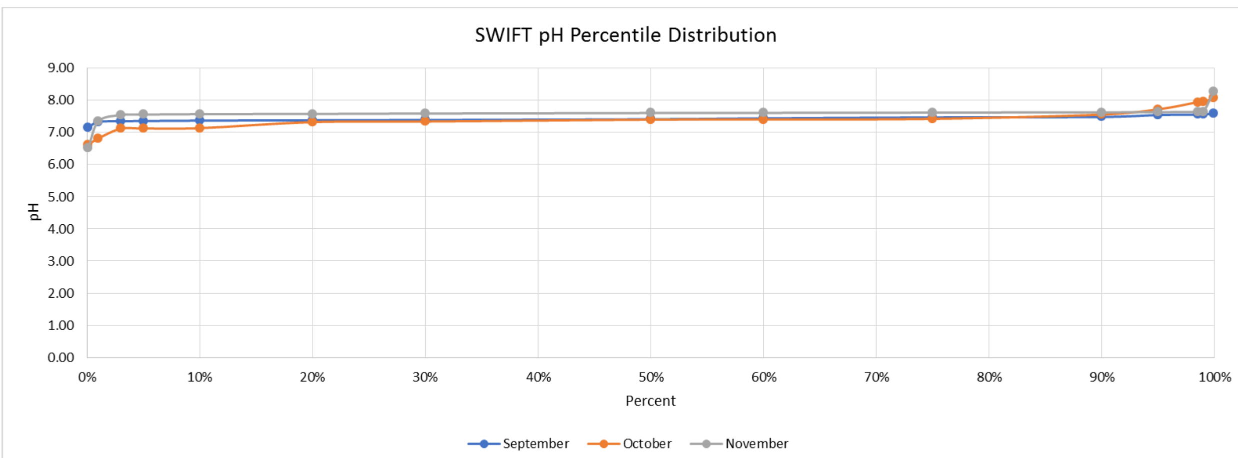


Figure 2: Distribution of Monthly SWIFT Water pH values.

Monitoring at the SWIFTRC also includes monitoring for performance indicators as documented in Table 2, extracted from Attachment B of the UIC-IIP.

Table 5-1. SWIFTRC Non-Regulatory Performance Indicators

Constituent	Category	Value	Unit	Notes
1,4-Dioxane	Public Health	1	µg/L	CCL4; CA Notification Limit
17-β-Estradiol	Public Health	TBD	ng/L range	CCL4
DEET	Public Health	200	µg/L	MN Health Guidance Value
Ethinyl Estradiol	Public Health	TBD	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	µg/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

TBD = to be determined

Table 2: SWIFTRC Non-Regulatory Performance Indicators (Table 5-1 of the UIC-IIP).

Pathogen Log Removal Value (LRV) is not strictly regulated but the SWIFTRC 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: SWIFTRC Pathogen LRV for Potomac Aquifer System (PAS) Recharge.

Table 7-1. Additional Monitoring to Support Ozone and UV LRV [1]
Ozone LRV
Ozone Influent Temperature
Ozone Influent Flow
Liquid Phase Ozone Concentration[2]
Contact Time
CT
UV LRV
UV Intensity, each reactor
UVT, GAC Combined Effluent
Reactor Flow, each
Calculated Dose, each Lamp
Status, each

[1] All continuous measurements. 15 min data will be submitted.
[2] The ozone liquid phase probe will be verified with lab grab samples performed at least once per week.

Table 4: Additional Monitoring to Support Ozone and UV LRV (Table 7-1 of the UIC-IIP).

Critical Control Points

The SWIFTRC 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 SWIFTRC 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 SWIFTRC will continue to operate through the CCP violation, but the SWIFT Water will be diverted back to the Nansemond Plant chlorine contact tank (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 SWIFTRC. Modifications have been made to the CCPs since startup as compared to the original design documents. Those made in the first full quarter of operations were identified and discussed in the first quarterly research report. Additional changes during the second quarter are noted in redline and discussed below.

- A change was made to the GAC Combined Effluent (CE) on-line analyzer TOC, reducing the alarm level from 6.0 mg/L to 5.0 mg/L. The GAC vessels were backwashed at the end of October and following the backwash, only one GAC vessel was placed back into service. With one vessel in service, the TOC of the GAC CE began to increase. In order to provide additional compliance assurance, the alarm level for the GAC CE was reduced to 5.0 mg/L. The maximum reported TOC value in SWIFT Water via laboratory analysis during this period of single vessel GAC operation was 3.83 mg/L on November 5. On November 6, operation was returned to two GAC vessels in service.

- A change was made to the SWIFT Water TN CCP. This was a new CCP implemented in August 2018 with an action level of 6 mg/L to protect the regulatory limits for TN of 8 mg/L maximum and 5 mg/L as a monthly average. Rising TN levels in SWIFT Water observed in October (maximum of 5.56 mg/L, average of 4.56 mg/L) prompted a reduction in the action level to 5 mg/L as of October 17, 2018 to provide additional compliance assurance.

Parameter	Alert Value	Alarm Value	Unit	Action
Critical Control Points (CCPs)				
Influent Pump Station Conductivity	1,200	1,500	microSiemens per centimeter	Divert settled water to drain pump station
Influent Pump Station Total Inorganic Nitrogen	4.0	5.0	mg/L	Divert settled water to drain pump station
Influent Pump Station Turbidity	15	20	NTU	Divert settled water to drain pump station
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	<100% LRV Goal	%	Open Biofilter Backwash Waste Valve
Biofilter Individual Effluent Turbidity	0.1	0.15	NTU	Place that filter in filter-to-waste mode
Biofilter Combined Filter Effluent Turbidity	0.1	0.15	NTU	Place all filters in filter-to-waste mode
GAC Combined Effluent TOC, instantaneous online analyzer	4.0	~~6.~~5.0	mg/L	Divert SWIFT Water
UV Reactor Dose	<120% of Dose Setpoint	<105% of Dose Setpoint	%	Divert SWIFT Water
Free Chlorine CT ***(This CCP is not being used since free chlorination of the SWIFT Water is not currently being practiced)***	<120% of CT Target	<105% of CT Target	%	Divert SWIFT Water
GAC Combined Effluent Nitrite	0.25	0.50	mg/L	Divert SWIFT Water
SWIFT Water TN	4.5	~~6~~5.0	mg/L	Divert SWIFT Water
Ozone dose	80	90	lbs/day	Place all filters in filter-to-waste mode

Table 5. Hazard Analysis and Critical Control Point: Critical Control Points

Resolved Investigations from the Previous Quarter

As noted in the previous quarterly report, the following issues were the subject of further investigation and resolution.

- Ozone LRV: On July 23-24 there were approximately 8 hours of low virus and giardia LRV. These were likely caused by a problem with the ozone residual probe. It was unclear at the time why the CCP for virus LRV did not engage and bypass the filters. A follow-up investigation identified that the CCP for virus LRV did not engage because the operator deactivated the CCP action to troubleshoot problems we were experiencing with the ozone residual probe. However during this time the ozone feed system was placed in manual at a dose high enough to ensure LRV values greater than 3. To avoid this is the future, no deactivation of any CCP actions will be permitted for any reason. All operators were provided with in-depth training to prevent a recurrence of this on November 6. It is important to reiterate that during this time a trend of the data showed that the ozone system was running with a relatively high dose of 90 PPD through this entire period. In addition to the daily laboratory verification of the ozone residual probe in triplicate, a "hot standby" ozone residual probe was added, and associated operating procedures were developed.
- Reliability of the Combined Filter Effluent Turbidimeter: The combined filter effluent turbidimeter was periodically reading turbidities in excess of 0.3 NTU when the individual filter effluent turbidimeters of the operational filters were all reading less than 0.1 NTU. This was attributed to sample delivery problems and was resolved by installing a new sample pump.
- IFE3 Turbidity: Turbidity in IFE3 was >0.3 for more than three consecutive readings on August 21. Though recharge was not occurring at the time, the CCP should have triggered a diversion of the filter effluent, and the filters should have gone into standby. This did not appear to happen and a follow-up investigation attributed this to operator error. During this time, the CCP was in fact triggering filter standby but the operator continued to return the filter back to service. All operators were provided with in-depth training to prevent a recurrence of this on November 6.

Table 6: SWIFT Water Quality and LRV Compliance

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	September			October			November		
					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	0.5	Daily[3]	**4.12**	**5.14**	**25**	**4.59**	**5.56**	**28**	**3.98**	**6.11**	**25**
NO_3	mg/L	10	0.01	Daily[3]	**3.37**	**4.33**	**25**	**3.83**	**4.79**	**28**	**3.29**	**5.41**	**25**
NO_2	mg/L	1	0.05	Daily[3]	**0.01**	**0.07**	**25**	**0.02**	**0.24**	**28**	**0.01**	**0.13**	**25**
Turbidity	NTU	NA		Continuous					**Figure 1**				
Total Organic Carbon (TOC)	mg/L	NA	0.1	3x/Wk[3]	**1.68**	**2.07**	**11**	**2.68**	**3.52**	**13**	**2.85**	**3.83**	**11**
pH		NA		Continuous					**Figure 2**				
TDS[4]	mg/L	Potomac Aquifer System Range: 694-8,720	2.5	Monthly		**548**	**1**		**632**	**1**		**617**	**1**
Microorganisms													
Total Coliform[5]	MPN/100 mL	MCLG = 0	1	Daily[3]	**<1**	**<1**	**25**	**0.1**	**3**	**27**	**<1**	**<1**	**20**
E. coli	MPN/100 mL	NA	1	Weekly	**<1**	**<1**	**10**	**<1**	**<1**	**27**	**<1**	**<1**	**20**
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	10	Quarterly					**<10,H3**	**1**			
Disinfection Byproducts													
Bromate	µg/L	10	0.15	Monthly		**3.55**	**1**		**3.38**	**1**		**2.02**	**1**
Chlorite	mg/L	1.0	0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
Trihalomethanes													
Bromodichloromethane	µg/L		1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Bromoform	µg/L		1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Chloroform	µg/L		1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Dibromochloromethane	µg/L		1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Total Trihalomethanes	µg/L	80											
HAAs													
Dichloroacetic acid	µg/L		0.6	Monthly		**<0.6**	**1**		**0.64**	**1**		**1.22**	**1**
Trichloroacetic acid	µg/L		0.2	Monthly		**<0.2**	**1**		**<0.2**	**1**		**<0.2**	**1**
Monochloroacetic acid	µg/L		0.6	Monthly		**<0.6**	**1**		**<0.6**	**1**		**<0.6**	**1**
Bromoacetic acid	µg/L		0.4	Monthly		**<0.4**	**1**		**<0.4**	**1**		**<0.4**	**1**
Dibromoacetic acid	µg/L		0.2	Monthly		**<0.2**	**1**		**<0.2**	**1**		**0.44**	**1**
Total Haloacetic Acids	µg/L	60											
Disinfectants													
Monochloramine (as Cl2)[6,7]	mg/L	4		Continuous	**0.45**	**2.47**		**0.34**	**2.14**		**0.51**	**0.79**	
Chlorine (as Cl2)[8]	mg/L	4		Continuous	**0.46**	**1.59**		**0.38**	**2.12**		**0.48**	**2.06**	

Table 6: SWIFT Water Quality and LRV Compliance

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	September			October			November		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Inorganic Chemical													
Antimony	µg/L	6	1	Monthly		<1	1		<1	1		<0.5	1
Arsenic	µg/L	10	1	Monthly		<1	1		<0.5	1		0.29	1
Asbestos	MFL	7	0.2	Monthly		<0.2,QG	1		<0.2	1		<0.2	1
Barium	mg/L	2	0.005	Monthly		0.009	1		0.010	1		0.006	1
Beryllium	µg/L	4	0.5	Monthly		<0.5	1		<0.2	1		<0.1	1
Cadmium	µg/L	5	0.5	Monthly		<0.5	1		<0.2	1		<0.1	1
Chromium (total)	µg/L	100	5	Monthly		<1	1		<4	1		<5	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		17	1		<10	1
Fluoride	mg/L	4.0	0.05	Monthly	0.882	0.986	25	0.995	1.11	28	0.818	1.01	24
Lead	µg/L	15 (action level)	0.5	Monthly		<0.5	1		<0.2	1		<0.1	1
Mercury	µg/L	2	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Selenium	µg/L	50	25	Monthly		<25	1		<10	1		<5	1
Thallium	µg/L	2	0.5	Monthly		<0.5	1		<0.2	1		<0.1	1
Organic Chemicals													
Acrylamide[8]	µg/L	Treatment Technique, MCLG = 0	0.1	Monthly		<0.1	1		<0.1	1		0.24	1
Alachlor	µg/L	2	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Atrazine	µg/L	3	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Benzo(a)pyrene (PAHs)	µg/L	0.2	0.02	Monthly		<0.02	1		<0.02	1		<0.02	1
Di(2-ethylhexyl) adipate	µg/L	400	0.6	Monthly		<0.6	1		<0.6	1		<0.6	1
Di(2-ethylhexyl) phthalate	µg/L	6	0.6	Monthly		<0.6	1		<0.6	1		<0.6	1
Hexachlorocyclopentadiene	µg/L	50	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Hexachlorobenzene	µg/L	1	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Simazine	µg/L	4	0.05	Monthly		<0.05	1		<0.05	1		<0.05	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											

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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	September			October			November		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
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**
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	0	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Carbon Tetrachloride	µg/L	5	0	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Chlorobenzene	µg/L	100	1	Monthly		**<1**	**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-Dichloroethylene	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**
p/m-Xylene	µg/L		2	Monthly		**<2**	**1**		**<2**	**1**		**<2**	**1**
o-Xylene	µg/L		1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Total Xylene	µg/L	10,000	3	Monthly		**<3**	**1**		**<3**	**1**		**<3**	**1**

Table 6: SWIFT Water Quality and LRV Compliance

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	September			October			November		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Radionuclides													
Alpha particles	pCi/L	15	3	Monthly		**<3**	**1**		**4.1**	**1**		**6.8**	**1**
Beta particles and photon emitters	pCi/L	4 mrem/yr[9]	3	Monthly		**13**	**1**		**16**	**1**		**18**	**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	0.5	Monthly		**<0.5**	**1**		**<0.2**	**1**		**<0.1**	**1**
Strontium-90	pCi/L	NA	0.647	Monthly		**<0.637**	**1**		**<0.647**	**1**		**<0.597**	**1**
Tritium	pCi/L	NA	340	Monthly		**<265**	**1**		**<337**	**1**		**<340**	**1**
Non-regulatory Performance Indicators													
Public Health Indicators		**Trigger Limits**											
1,4-dioxane	µg/L	1	0.06	Quarterly	**0.40**	**0.43**	**3**	**0.43**	**0.49**	**5**	**0.40**	**0.45**	**4**
17-β-estradiol	ng/L	TBD	0.0004	Quarterly					**<0.0004**	**1**			
DEET	ng/L	200,000	10	Quarterly					**<10**	**1**			
Ethinyl estradiol	ng/L	TBD	5	Quarterly					**<5**	**1**			
Tris(2-carboxyethyl)phosphine (TCEP)	ng/L	5,000	10	Quarterly					**<10**	**1**			
NDMA	ng/L	10	2	Quarterly	**<2**	**<2**	**4**	**0.570**	**2.85**	**5**	**0.510**	**2.04**	**4**
Perchlorate	µg/L	6	0.5	Quarterly					**0.84**	**1**			
Perfluorooctanoic Acid (PFOA)	µg/L	0.070 (PFOA+PFOS)	0.02	Quarterly					**<0.02**	**1**			
Perfluorooctanesulfonic Acid (PFOS)	µg/L	0.070 (PFOA+PFOS)	0.04	Quarterly					**<0.04**	**1**			
Treatment Efficacy Indicators		**Trigger Limits**											
Cotinine	ng/L	1,000	10	Quarterly					**<10**	**1**			
Primidone	ng/L	10,000	25	Quarterly					**<25**	**1**			
Phenytoin (Dilantin)	ng/L	2,000	20	Quarterly					**<20**	**1**			
Meprobamate	ng/L	200,000	5	Quarterly					**<5**	**1**			
Atenolol	ng/L	4,000	5	Quarterly					**<5**	**1**			
Carbemazepine	ng/L	10,000	5	Quarterly					**<5**	**1**			
Estrone	ng/L	320,000	5	Quarterly					**<5**	**1**			
Sucralose	ng/L	150,000,000	100	Quarterly					**<100**	**1**			
Triclosan	ng/L	210,000	100	Quarterly					**<100**	**1**			

Table 6: SWIFT Water Quality and LRV Compliance

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	September			October			November		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Additional Monitoring (Ozone & UV LRV)					**Average**	**Minimum**		**Average**	**Minimum**		**Average**	**Minimum**	
Ozone Virus LRV[10]				Continuous	**4.17**	**3.29**		**3.98**	**0.13**		**3.55**	**2.61**	
Ozone Giardia LRV				Continuous	**1.94**	**1.40**		**1.87**	**0.06**		**1.79**	**1.26**	
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. In September, there was no recharge on three days and very limited recharge on one additional day (less than 25%) which impacted the collection and sample frequency for Total coliform (TC), Total Nitrogen (TN), Nitrate (NO3), Nitrite (NO2) and TOC. A fifth sample date for TC, TN, NO3 and NO2 was impacted by improper preservation which invalidated the data. In October, there was no recharge on two days and very limited recharge on one additional day (< 25%) which impacted the collection and sample frequency for TC, TN, NO3, NO2, and TOC. For TC, an additional daily sample was missed on October 25 when recharge did not occur during the hours of 6 am - 6 pm. In November, there was no or limited recharge (<25%) on five days which impacted sample frequency for TC, TN, NO3, NO2 and TOC. Sample collection for TC did not occur on four additional days in which recharge did not occur or was limited during the hours of 6 am - 6 pm. TC was also not collected on November 13 due to operator error and was addressed through retraining. Though recharge ceased on November 22, the advanced treatment system (AWT) continued to operate and produce SWIFT Water which allowed for additional sample collection to characterize AWT performance.

[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] A positive TC result was documented on October 29 with a result of 3 CFU/100 mL. The duplicate sample was <1 CFU/100 mL. The Quality Control measures for the method were met and the result is considered valid. E coli was absent.

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

[7] Monochloramine: Between 10:00 and 15:15 on September 18, the SWIFT Water online monochloramine analyzer read a constant value of 8.17 mg/L, which is in violation of the EPA MCL. During this time the total chlorine analyzer continuously read values less than 1.5 mg/L indicating that the monochloramine analyzer was likely in error. The monochloramine analyzer was checked, calibrated, and placed back into service.

[8] Acrylamide: Note the data for the November 6 sampling event was available from the contract lab for HRSD review on December 10 when the AWT was no longer in operation. This represents the first quantifiable result for acrylamide. The MCL for acrylamide is a treatment technique designed to reduce the level of the contaminant in water. HRSD will evaluate the use of polymers within the wastewater system to determine if there are opportunities to limit the addition of acrylamide.

[9] 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 conversation tables, currently available in the referenced document.

[10] Ozone: There were over 150 instances where the 15-minute average was less than the 3.0 LRV set point during this quarter.

(1) All CCPs are currently set up in HRSD's DCS to trigger only if the measured value has continuously violated the limit for a specified duration. For example, the ozone CCP would trigger only when the measured ozone residual is below the residual CCP value for every second during a 10-minute continuous period. Because this method requires continuous violation to trigger a CCP, there are times when the 15-minute average can be below the limit without the CCP recording a violation. This occurred 56 times in October and 110 times in November. During this period the minimum value in October was 2.49 and the average of the 59 violations was 2.85. In November, the minimum value was 2.61 and the average of the violations was 2.88. Ozone is specifically prone to this because there is a normal variation of about 0.1 mg/L in the measured ozone residual. As a result, the ozone residual can be consistently below the CCP limit for the majority of a 15-minute period and the CCP won't trigger as long as a few points are measured above the limit. To address this, HRSD will make an adjustment to its DCS programming for ozone, turbidity, and UV so that the CCP engages based on a running average measurement as opposed to the current method that requires continues detection of a violation over a specified duration.

(2) HRSD is currently using ozone virus LRV as one of three CCPs targeted at the ozonation process, and in DCS the virus and giardia LRVs are calculated based on the ozone residual, residence time, and temperature, using equations from the Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual. Current setpoints for this control include the ozone residual setpoint and the probe location, which determines the contact time. As temperature drops, the ozone residual required to achieve the LRV target increases. As shown in FIGURE 3, the temperature began dropping in October and the measured LRV got closer to the limit of 3. Once operational staff realized this, the ozone residual setpoint was increased, also shown on FIGURE 3. The setpoint increase brought the calculated LRV back above the limit. To prevent this from happening in the future, HRSD is changing the DCS control strategy to be based on a virus LRV setpoint instead of an ozone residual setpoint. This prevents an ozone residual setpoint from being set that inadvertently results in a virus LRV that is close to or less than 3 and will provide a more consistent buffer between the achieved LRV and the required value.

(3) On October 10/11, between 2:00 and 2:45 SWT (Floc/Sed effluent) diverted due to a high TIN value on the influent pump station which shut off the ozone system and the biofilters. However the operator forced the BAFs to go back in service at 2:15 causing them to drain slowly for about 45min. The ozone system was not in operation at this time and there was no flow moving through the ozone contactor. During this time, there were 3 consecutive 15-min periods at 0.13 LRV, in violation of the 3 LRV setpoint. All water that moved through the filters was water that was already in the filter box. The SWIFT operational team has discussed this issue and in-depth training of all operators to prevent recurrence was conducted November 6.

Contract Laboratory Flags

(H3) - Sample was received and/or analysis requested past holding time.

(QG) - Sample was not filtered within 48 hours of collection. As per the method, sample was ozonated before filtration and analysis. Data is acceptable for compliance.

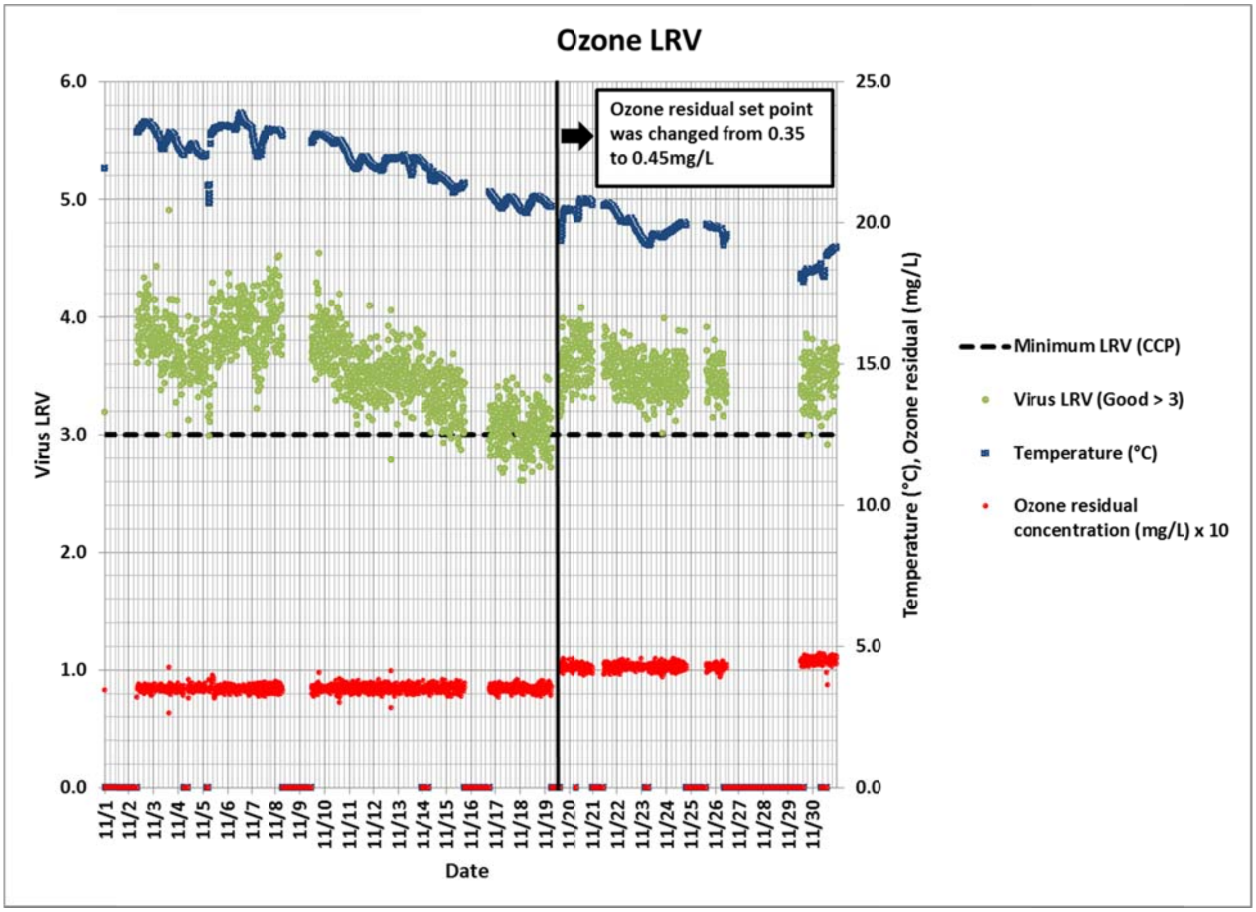


Figure 3: HRSD is currently using ozone virus LRV as one of three CCPs targeted at the ozonation process, and in DCS the virus and giardia LRVs are calculated based on the ozone residual, residence time, and temperature, using equations from the Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual. Current setpoints for this control include the ozone residual setpoint and the probe location, which determines the contact time. As temperature drops, the ozone residual required to achieve the LRV target increases. As shown in FIGURE 3, the temperature began dropping in October and the measured LRV got closer to the limit of 3. Once operational staff realized this, the ozone residual setpoint was increased, also shown on FIGURE 3. The setpoint increase brought the calculated LRV back above the limit. To prevent this from happening in the future, HRSD is changing the DCS control strategy to be based on a virus LRV setpoint instead of an ozone residual setpoint. This prevents an ozone residual setpoint from being set that inadvertently results in a virus LRV that is close to or less than 3 and will provide a more consistent buffer between the achieved LRV and the required value.

Recharge Statistics

The total volume recharged during this operational period was 52.35 million gallons. 1.19 million gallons was backflushed for a net recharge of 51.16 million gallons (Table 7). Brief backflushing periods occur as part of routine well maintenance, generally three times per week.

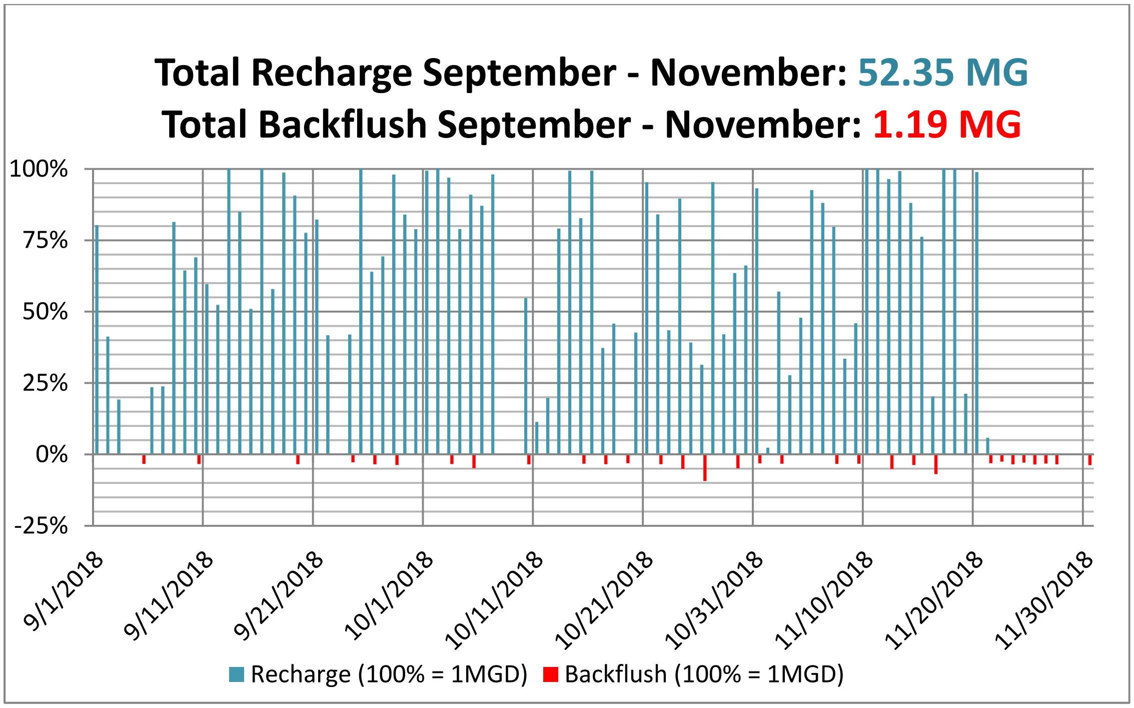


Table 7: Recharge and Backflush Volumes, September 1 – November 30, 2018.

Corrosion in Biofilters

In late October we noted an increase in water level within the recharge well during recharge cycles, signifying a potential reduction in recharge capacity within the well. This prompted an increase in membrane filtration index (MFI) testing and tracking of specific injectivity (SI) and specific capacity (SC) values to evaluate clogging potential of the SWIFT Water and resulting impact to well capacity. The five MFI tests since October 31 had a high degree of variability but in general showed unfavorable results with unacceptably elevated indices, compared to indices originating from tests conducted between June and late September (Table 8). Rising recharge levels, coinciding with falling injectivities, and intermittently elevated MFI indices suggested that the SWIFT Water contained a clogging agent, and possibly had changed in composition, even though turbidity readings were excellent, and backflushing events briefly restored injectivities (Figure 4).

A brick-reddish discoloration of both the Bypass Filter Index (BFI – a passive cartridge filter) and the more recent MFI tests suggested that iron was the potential contaminant and confirmation was obtained through mineral analysis of the filters. We also noted that SWIFT Water iron concentrations had gradually increased over time with laboratory-generated data maximum of 0.1 mg/L (Table 6, Secondary MCL – 0.3 mg/L). From an operational perspective, elevated iron can impede recharge operations by obstructing the recharge well screens and filling the pore spaces within the recharge well gravel filter pack.

Because of the concerns about potential well impacts, we ceased recharge on November 22 in order to determine the source of the iron. Investigation within the SWIFTRC revealed significant corrosion as a result of coatings failure in the biofilters. HRSD is currently pursuing warranty repairs with the contractor. In the interim, recharge operations are halted. The current anticipated timeline for repairs is January and February. Beginning the week of December 17, well step drawdown testing will be conducted to better understand impacts on the recharge well and assess the need for any invasive well rehabilitation to restore lost recharge capacity. Email communication regarding the need for shut-down for warranty repairs was provided to EPA Region III, the Virginia Department of Health, and the Department of Environmental Quality. A copy of the email is provided in Attachment 1 for additional information.

Test Number	Date	MFI Filter Number	MFI (sec/L^2)	Normalized MFI (sec/L^2)
1	6/6/2018	1	11.54	7.98
2	6/6/2018	2	10.05	7.14
3	7/31/2018	3	0.19	0.18
4	9/26/2018	4	0.59	0.71
5	9/26/2018	8	0.59	0.64
6	10/31/2018	9	50.74	53.11
7	10/31/2018	10	207.87	217.56
8	11/2/2018	1T	217.17	227.29
9	11/13/2018	11132018_2	0.13	0.15
10	11/13/2018	11132018_3	33.33	37.37
11	11/15/2018	11152018_1	6.06	6.80
12	11/16/2018	11152018_2	355.23	398.34
13	11/17/2018	11152018_3	46.03	34.41

Table 8: Membrane Filter Indices at the SWIFTRC from start-up through mid-November. Rising MFI values indicate the presence of a potential clogging agent.

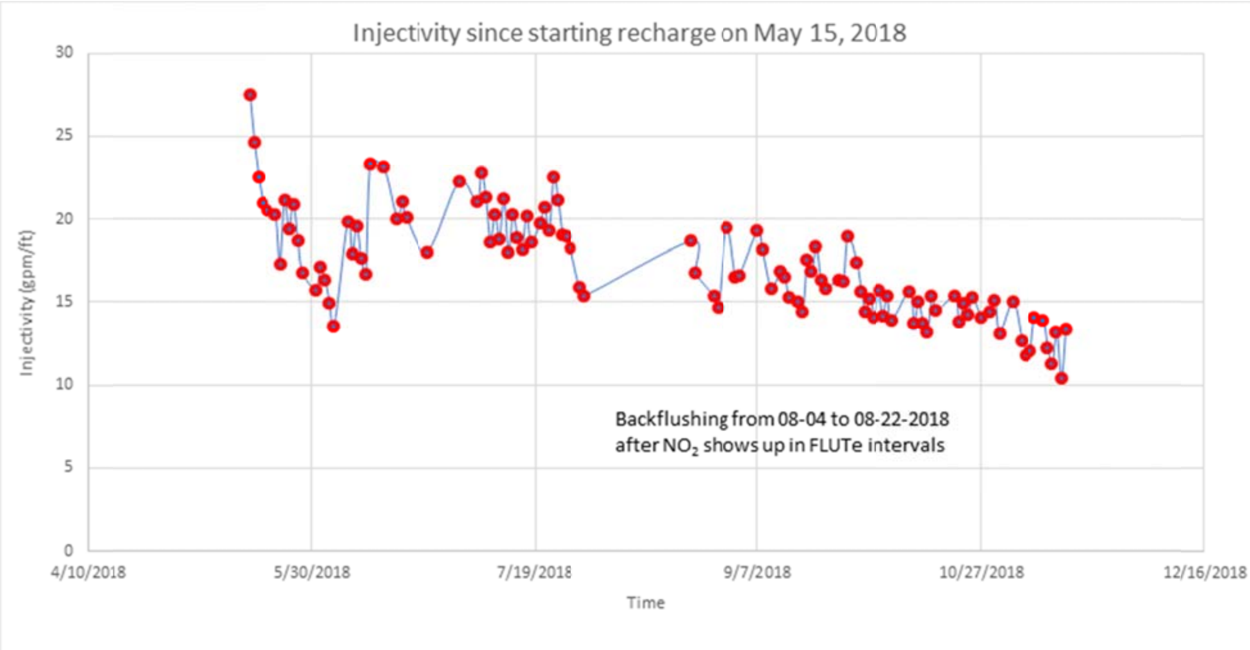


Figure 4: Injectivity of the SWIFTRC recharge well (TW-1). Since late October, injectivities have fallen despite operator's adherence to the backflushing schedule (thrice weekly). Temporally, the decreasing injectivities correspond with the climbing MFI indices.

Nitrite in MW-SAT Update

A finalized report on nitrite in SWIFT Water and in the 50-ft. monitoring well, MW-SAT, was submitted to EPA Region III September 4, 2018 (with copies to the Virginia Department of Health (VDH) and the Virginia Department of Environmental Quality (DEQ)). To recap, HRSD backflushed the recharge well to remove any nitrite that may have been directly introduced via recharge of the SWIFT Water. The total volume backflushed as part of this corrective action was 26.57 million gallons.

Recharge resumed August 22, 2018. Within a week, nitrite levels in two of the eleven monitored MW-SAT intervals again exceeded the nitrite MCL. As described in the report submitted to EPA Region III September 7, 2018 (with copies to VDH and DEQ), this is believed to be the result of the partial denitrification of recharge water nitrate to nitrite in the aquifer. Nitrite remained elevated periodically above the MCL in screens 1 and 2. October 1 was the last recorded MCL exceedance for screen 2 and November 7 was the last recorded value at or above the nitrite MCL in screen 1. Recharge ceased on November 22 as a result of operational concerns regarding high levels of iron in SWIFT Water as discussed above.

Though it is clear that nitrite can be formed in excess of the MCL at MW-SAT while reducing conditions remain, based on the instability of this compound and its removal in the soil columns (refer to the August Nitrite Report), it is anticipated that nitrite in excess of the MCL will not migrate far from the recharge well. The conventional monitoring wells located 400 – 500 feet away from the recharge well will continue to be monitored daily for the presence of nitrite (and nitrate) to evaluate the areal extent of migration, even during this period in which recharge operations are suspended. Figure 7 demonstrates that these conventional wells have shown no indication to date of nitrate or nitrite influence from the SWIFT Water.

While the SWIFTRC is not currently recharging due to the high levels of iron, nitrate and nitrite monitoring within MW-SAT will continue at a reduced frequency of every two weeks. Once recharge operations resume, we will return to daily monitoring of nitrate and nitrite in MW-SAT for a one month period. If the nitrite and nitrate trends in Screens 4 – 11 are consistent with what is seen in Figure 4, we will reduce monitoring in those screens to once every two weeks while continuing daily monitoring in Screens 1 – 3. The variability seen in Screens 1 – 3 along with their historical proximity to or exceedance of the MCL requires closer monitoring at this time until we can demonstrate that these intervals consistently remain less than ½ the MCL. We will continue to provide updates on nitrite and nitrate in the groundwater in these quarterly reports. Figures 5 – 7 document the nitrate and nitrite monitoring at these sample points during the quarter.

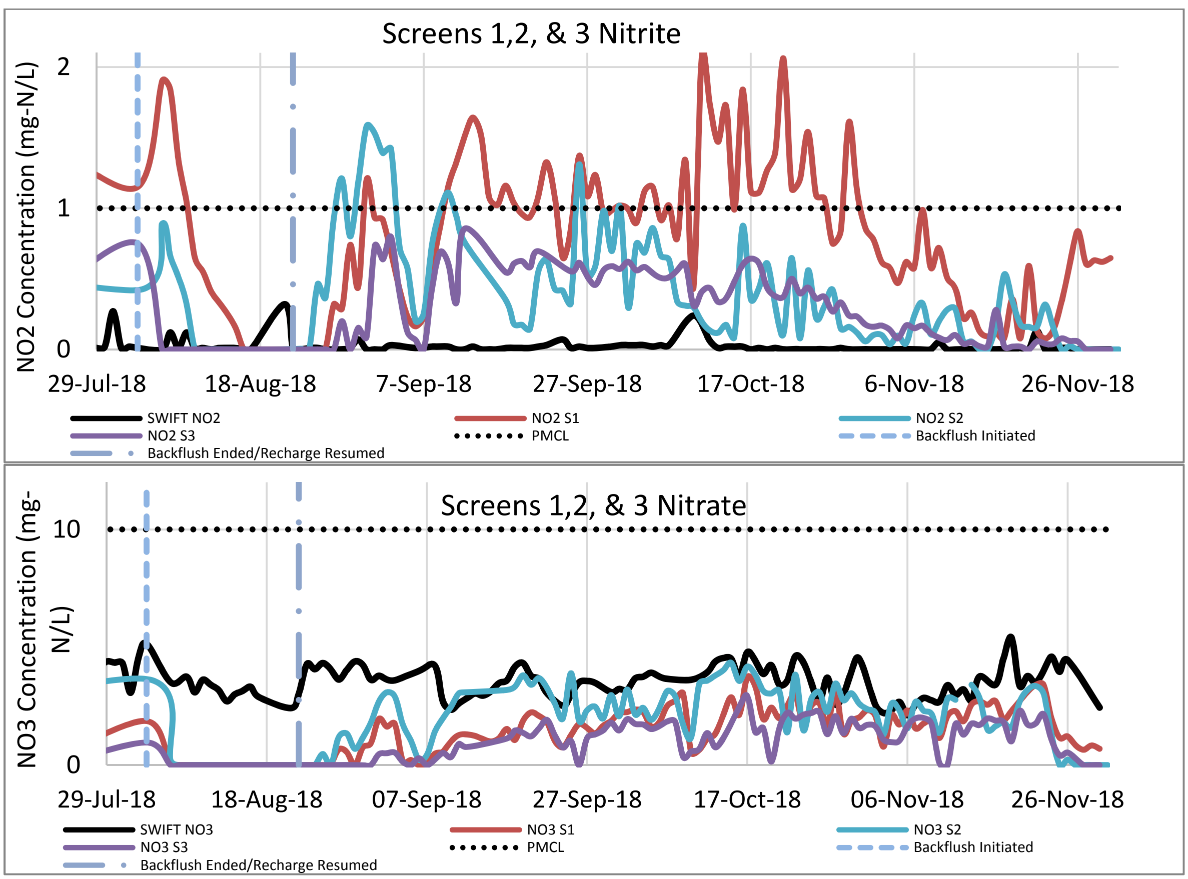
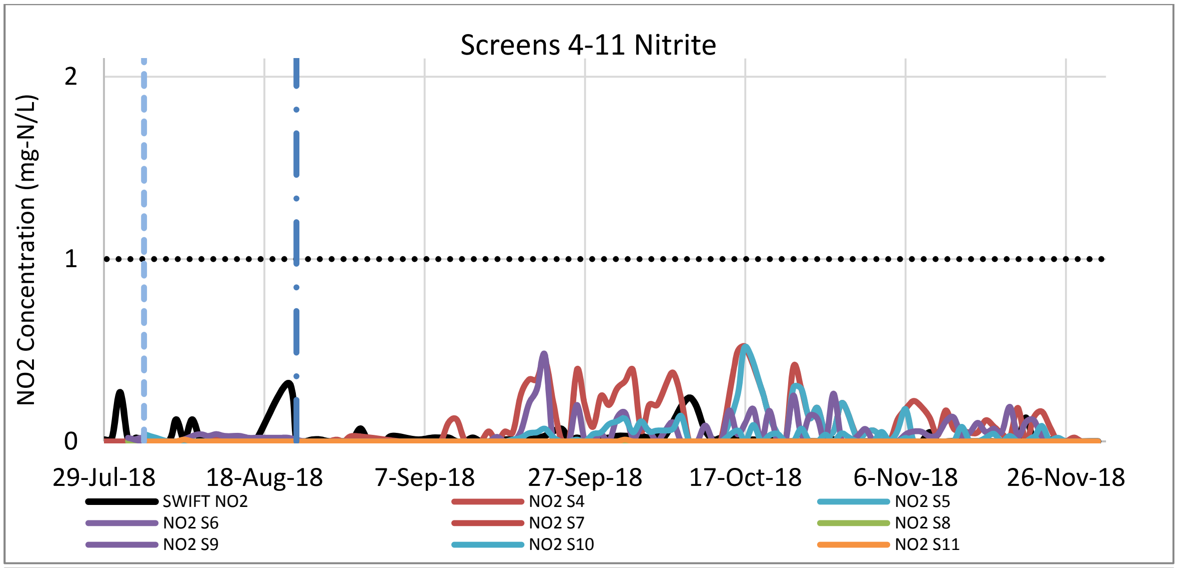


Figure 5: Average Daily Nitrite and Nitrate Concentrations in MW-SAT Screen Intervals 1 (S1), 2 (S2) and 3 (S3) relative to the nitrite PMCL and SWIFT Water concentrations (SWIFT).



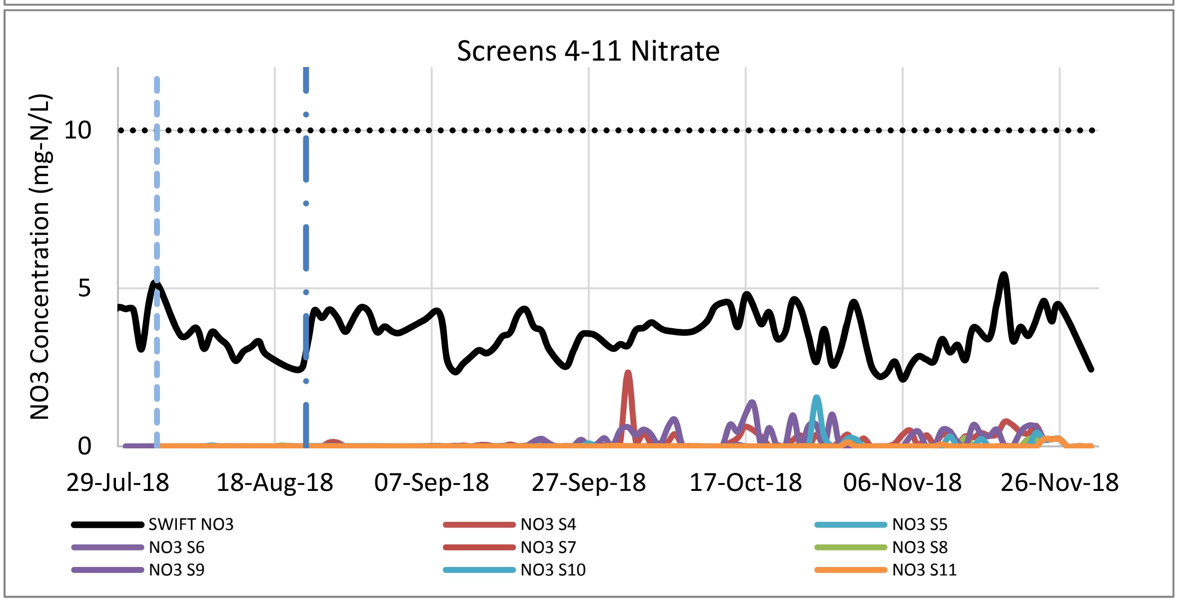
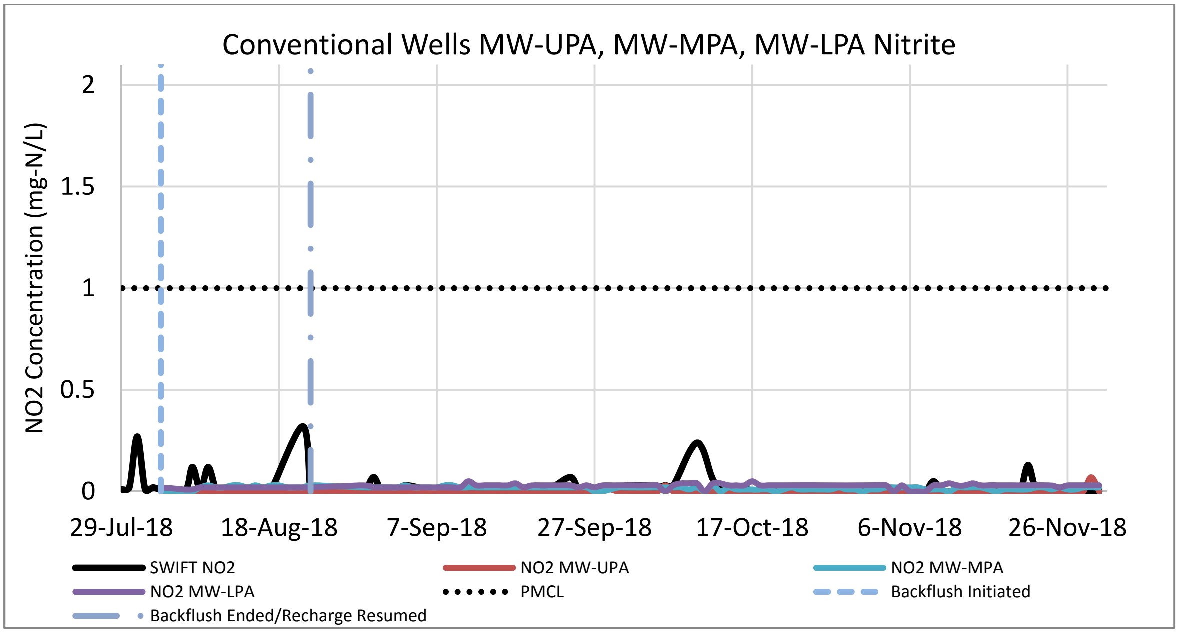


Figure 6: Average Daily Nitrite Concentrations in MW-SAT Screen Intervals 4 - 11 (S4-S11) relative to the nitrite PMCL and SWIFT Water concentrations (SWIFT). The highest recorded nitrite value during the period was in Screens 4 and 5 with a concentration of 0.52 mg/L. The highest recorded nitrate value in these intervals during the quarter was 0.16 mg/L in Screen Interval 4.



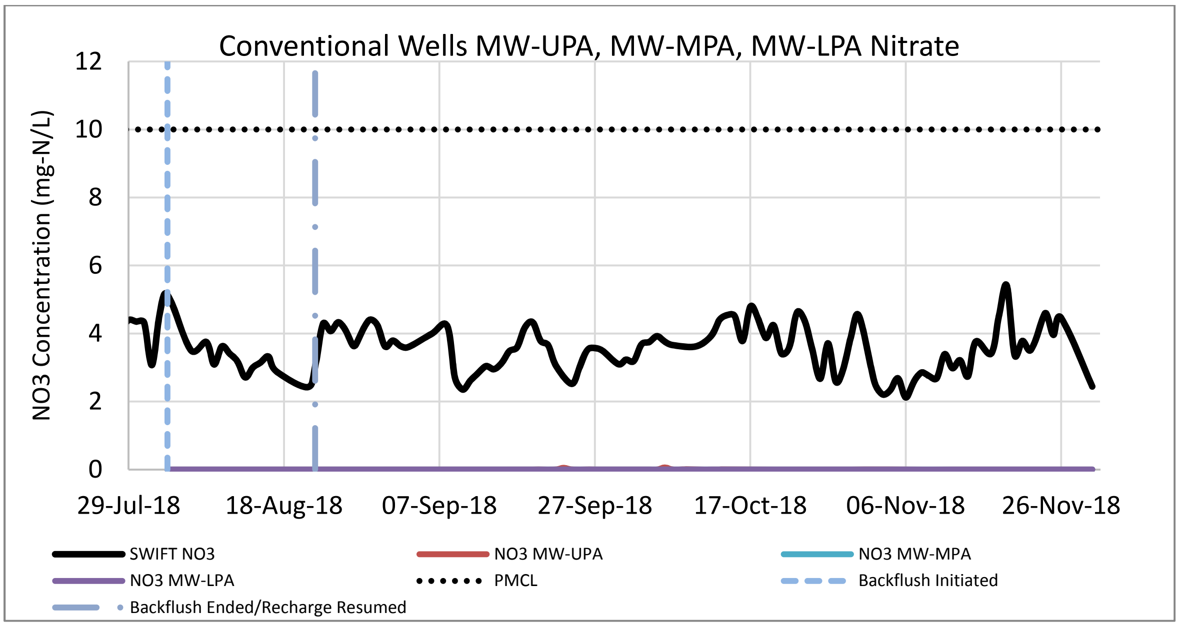


Figure 7: Average Daily Nitrite Concentrations in the conventional monitoring wells (MW-UPA, MW-MPA, MW-LPA).

Attachment 1

HRSD SWIFT Research Center Operations Suspended
Monday, December 17, 2018
12:51 PM

Subject	**HRSD SWIFT Research Center Operations Suspended**
From	Mitchell, Jamie
To	Nelson, Mark (Nelson.Mark@epa.gov); Branby, Jill (Branby.Jill@epa.gov); Roadcap Dwayne ulk16713; 'Degen, Marcia'; Gregory, Lance (VDH (lance.gregory@vdh.virginia.gov); 'Mark Perry'; 'Kudlas, Scott'; Andrew.Hammond@deq.virginia.gov; 'Nicol, Craig'
Cc	Schafran, Gary; Mark Widdowson (mwiddows@vt.edu); Henifin, Ted; Bott, Charles; 'Leila Rice' (leilarice@gmail.com); Pletl, Jim
Sent	Tuesday, December 11, 2018 11:41 AM

All,

I wanted to update you on a necessary and temporary suspension of operations at the SWIFT Research Center to allow our contractor to make some warranty repairs to the process equipment. It is anticipated the SWIFT RC will be down through January for this work. As a result, we are also suspending tours of the SWIFT RC during this time to avoid conflicts with the contractor's operations. Prior to suspending operations at SWIFT RC, we had successfully recharged the Potomac Aquifer with over 90 million gallons of SWIFT Water (treated to meet drinking water standards). The data gathered to date has been valuable and will inform the planning and design of the full-scale SWIFT facilities. The data set will continue to expand once SWIFT RC is back up and running this spring and continue throughout the SWIFT build-out. The SWIFT RC data has already validated the results of our York River "room scale" pilot at a scale nearly 100 times larger. At this point we do not anticipate any deviation from the overall full-scale SWIFT implementation schedule with the permitting process for Williamsburg beginning in 2019 and construction at Williamsburg commencing in late 2020.

The warranty repairs are related to some unexpected issues related to what we believe to be construction deficiencies with the SWIFT Research Center. We backwashed the granular activated carbon contactors near the end of November for the first time since they were put into operation in May. Shortly after, we discovered that the SWIFT Water had unexplained high iron content. Iron is a secondary contaminant (aesthetic issue related to color, sediment, taste and staining) and not included as one of our water quality targets; however, high iron can impact our operations, particularly the efficiency of the recharge well. As a result we suspended recharge operations as we looked for the source of the iron.

Our initial evaluation found several areas of steel corrosion that are potential contributors to the high iron content and appear to be related to construction deficiencies in the SWIFT Research Center. The locations of the worst observed corrosion required draining tanks and opening access hatches that had not been accessible since startup. We continue to pursue resolution with the design-build team but believe corrective action could take at least 6 weeks to complete. Operations at SWIFT RC will be suspended through January and potentially longer. We're in the process of evaluating the need for a well inspection and potential screen maintenance. If it's warranted, we'll take the opportunity to complete this work during the temporary shutdown.

Needless to say this is a painful set back. Some early takeaways – as would be expected for large treatment facilities, full-scale SWIFT will be constructed from reinforced concrete, will not be using steel tanks, and should not experience similar issues; use of design-build actually makes addressing this apparent warranty issue much easier as the designer and contractor are one entity and any finger pointing between them is not our problem – it is their jointly owned issue; a restart in early 2019 will allow us to use the experience we have gained over the past 6-months to build a better set of monitoring data and implement an optimized startup routine.

At this point we are posting a press release explaining the temporary suspension of SWIFT Research Center operations, notifying our own employees with internal email communication and reaching out to the regulators. Our quarterly report is due early next week and we will provide an update on the repair plan and anticipated timeline. If you have any questions in the meantime, please let me know.

Respectfully,
Jamie

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