



**BY ELECTRONIC MAIL**

May 11, 2020

Ms. Laura Stuart, P.G.  
Virginia Department of Environmental Quality – Valley Regional Office  
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**RE: Bremo Power Station, Solid Waste Permit No. 618:  
Revised Surface Water Monitoring Plan**

Dear Ms. Stuart:

In accordance with Permit Module XVIII.I.1, Dominion Energy is providing the attached revised Surface Water Monitoring Plan (SWMP) for the Bremo Power Station, Solid Waste Permit No. 618. The following revisions were made to the SWMP:

- Section 3.2, Table 1, Figure 2: Station sample locations have been revised to reflect exact coordinates of each sampling location adjacent to the permanent markers recently installed at the shoreline.
- Section 3.2 and Figure 2: The location of sampling station BR-04 has been adjusted westward to minimize the influence of the nearby outfall.
- Section 4.0: Dissolved cobalt and molybdenum have been added to the sampling constituent list as a result of recent CCR Rule groundwater protection standard exceedances identified during the 2019 second semi-annual sampling event.

If you have any questions regarding this information, please contact Kelly Hicks at (804) 273-4903 or via email at [kelly.a.hicks@dominionenergy.com](mailto:kelly.a.hicks@dominionenergy.com).

Sincerely,

A handwritten signature in blue ink that reads 'Lisa C. Messinger'.

Lisa C. Messinger  
Director, Environmental Services

Attachment



**Surface Water Monitoring Plan**  
**Dominion Energy**  
**Bremo Power Station**  
**Bremo Bluff, Virginia**

Virginia Department of Environmental Quality  
Solid Waste Permit No. 618

*Prepared for*

Dominion Energy Services, Inc.  
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*Prepared by*

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August 2019 (revised May 2020)  
EA Project No. 6346101

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**LIST OF ACRONYMS AND ABBREVIATIONS**

CCR	Coal combustion residual
EPA	U.S. Environmental Protection Agency
GPS	Global Positioning System
Q	Quarter
VDEQ	Virginia Department of Environmental Quality

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## 1. FACILITY DESCRIPTION

The Brema Power Station is located at 1038 Brema Bluff Road, east of Route 15 (James Madison Highway) and north of the James River, in Brema Bluff (Figure 1). The facility includes three privately owned/operated surface impoundments that managed sluiced (or wet) coal combustion residuals (CCRs) from the Brema Bluff Power Station as part of the facility's wastewater treatment system and in accordance with Virginia Pollutant Discharge Elimination System Permit Number VA0004138.

In 2014, the power station converted from a coal-fired power plant to a natural gas power plant. The three CCR surface impoundments consist of East Pond, West Pond, and North Pond. The East Pond was placed into service in the 1930s, is approximately 26.5 acres, and contained 1,800,000 cubic yards of CCRs, which were consolidated into the North Pond. The West Pond is approximately 17 acres in size and contained approximately 327,000 cubic yards of CCRs, which were consolidated into the North Pond. The North Pond was constructed during 1982 and 1983, is approximately 67.5 acres, and contains approximately 8 million cubic yards of CCRs.

All three surface impoundments are subject to U.S. Environmental Protection Agency's (EPA's) final rule Standards for the Disposal of CCR from Electric Utilities (80 Federal Register 21302 [17 April 2015] [as amended]) (EPA CCR Rule). Surface impoundments East Pond and West Pond are inactive CCR surface impoundments under the EPA CCR Rule as they did not receive CCRs after 19 October 2015. They are being closed by removal in accordance with 40 Code of Federal Regulations 257.102(c). North Pond, which began receiving CCRs from surface impoundments East Pond and West Pond again at the end of June 2016, is considered an existing surface impoundment under the EPA CCR Rule because it received CCRs after 19 October 2015.

## 2. PURPOSE AND SCOPE

Solid Waste Facility Permit documents for the Brema Power Station (Permit Number 618) include surface water monitoring requirements in Permit Module XVIII (Appendix A). As stated in Permit Module XVIII, the objective of the surface water monitoring program is to determine if there is an impact to surface water that may be occurring as a result of potential groundwater to surface water exchange downgradient of the surface impoundments. This Surface Water Monitoring Plan describes the quarterly monitoring that will be performed to meet the requirements of Permit Module XVIII.

Revisions to this Surface Water Monitoring Plan may be required in the future due to changes in the required sampling constituents, frequency, location of sampling stations, or at the request of the Virginia Department of Environmental Quality (VDEQ) or the owner. Any technical revisions made to the plan should be provided to VDEQ for review and concurrence prior to implementation.



### 3. SURFACE WATER SAMPLING

The permit requires surface water sampling near-shore of the Bremono Power Station property where groundwater could potentially intersect with surface water. Based on the groundwater contour maps (Appendix B), groundwater is expected to flow to the southwest, in the direction of the James River (Golder Associates, Inc. 2019). Surface water samples will be collected from the James River. Surface water sampling activities will be conducted in accordance with the requirements specified in Permit Module XVIII.

#### 3.1 ACCESS AND LOGISTICS

Due to the steep vegetated banks on this stretch of the James River, it is recommended that surface water sampling locations at the Bremono Power Station be accessed by boat. The James River is shallow, there are exposed rocks, and sampling will require maneuvering along the shoreline to pass the submerged flow control structure that extends across the center of the James River; a 16-foot Jon boat or equivalent is recommended for access.

On-water activities require a crew with a minimum of two people, in compliance with applicable Virginia Department of Game and Inland Fisheries boating regulations; the use of U.S. Coast Guard-approved Type 1 personal flotation devices is also required. Surface water sampling activities will comply with safety procedures as detailed in a project-specific health and safety plan to be completed by the sampling contractor. Sampling personnel will also be required to complete a site-specific safety orientation annually.

Two boat ramps are available to launch boats for sampling. The boat ramp on the shoreline adjacent to the Bremono Power Station (Figure 2) on CSX property may be used to access the James River. However, the boat ramp is steep and overgrown with vegetation; access to the boat ramp also requires driving on unpaved roadways. A public boat launch, the New Canton/Bremont Bluff Boat Launch (Figure 2), is a more accessible alternative.

Surface water sampling should be coordinated with the Bremono Power Station onsite point of contact. Sampling personnel will check in and check out each day with the onsite point of contact. Bremono Power Station site security is onsite daily, and sampling personnel are required to check in and check out if they require site access.

#### 3.2 STUDY DESIGN

Surface water collection will be conducted quarterly during the closure and post-closure care periods, and will include eight sample locations at the Bremono Power Station and two reference samples in the James River upstream of the influence of the Bremono Power Station (Figure 2). The length of the quarterly sampling period will be an interval of 90 days; however, in order to allow for schedule, weather, and staff flexibility, the permit allows monitoring within 15 days (prior to and following) of each 90-day interval. It should be noted that the James River often freezes during the winter months, typically in January and February. Therefore, it is recommended that monitoring occur toward the end of each calendar quarter so that the sampling

events are not scheduled during January and February. Sampling may be delayed or cancelled if unsafe conditions such as flooding, high winds, or thunderstorms are present.

The permit requires a minimum of eight sample locations: four sample location downgradient of surface impoundments North and East Pond and four sample locations downgradient of surface impoundment West Pond. As shown on 2019 groundwater contour maps provided in Appendix B, groundwater flows southwest from the surface impoundments in the direction of the James River. Sample locations BR-01 through BR-04 are located in the James River downgradient of the West Pond, and sample locations BR-05 through BR-08 are located in the James River downgradient of the North Pond and East Pond. Sampling locations which have insufficient yield for two consecutive monitoring periods shall be evaluated for relocation and a new location proposed for approval by the VDEQ.

Reference sampling can be a powerful line of evidence to demonstrate natural or regional conditions. Storm events, common background sources, and seasonal variability are possible sources of elevated metal concentrations in surface water. Therefore, in addition to the eight sample locations required by the permit, two reference samples (JR-01 and JR-02) will be collected upstream of the influence of the Bremono Power Station. Sample coordinates for each sample location from the 2020 Quarter 1 sampling event are presented in Table 1; sample locations are depicted in Figure 2. Exact coordinates will be recorded during each field sampling event as discussed in Section 3.3.

**Table 1 Bremono Power Station Sample Locations**

<b>Sample Location</b>	<b>Latitude</b>	<b>Longitude</b>
BR-01	37.71008	-78.29521
BR-02	37.70967	-78.29369
BR-03	37.70932	-78.29198
BR-04	37.70891	-78.29054
BR-05	37.70620	-78.28488
BR-06	37.70540	-78.28332
BR-07	37.70458	-78.28168
BR-08	37.70390	-78.28063
JR-01	37.71119	-78.30020
JR-02	37.71084	-78.29847

### 3.3 SAMPLING METHODOLOGY

Sampling will be conducted from downstream to upstream to prevent surface water sample cross-contamination from disturbed sediment. Sampling personnel will mobilize to each proposed sampling location using a Global Positioning System (GPS).

The boat will be maneuvered to within 10 feet of the proposed sample location along the shoreline and the water will be sampled as close to the shoreline as permitted by water depth. The proposed sample locations were selected based on aerial imagery, and vegetation may have obstructed the view of the shoreline. Therefore, the proposed sample locations may need to be

adjusted during the first sampling event to avoid debris and to capture the groundwater-surface water interface. The GPS coordinates of the actual sample location will be recorded, and the sample locations will be permanently marked or flagged during the first sampling event (after the sample is collected to prevent water sample contamination) at the nearest on-shore location for future identification. It is anticipated that sampling personnel can access the shoreline via boat to install the permanent marker or flag. The GPS coordinates of the sampled location will be noted for each surface water sample location during each monitoring event.

If the established sample locations are obstructed by debris during sampling events, sampling personnel will attempt to clear debris before sampling and if unsuccessful, will establish a new sample location as close as possible to the original location. A new permanent marker or flag at the new sample location will be required and the sample location naming should be revised to notate the new sample location. For instance, if it is not possible to sample BR-05, BR-05a may be established for continued monitoring.

At each location, the following information will be recorded on datasheets, in a field logbook, or using electronic data forms:

- Weather (including recent storm events) and local conditions
- Sample Location
- Location coordinates and description
- Water depth
- Sample date and time
- Water quality (pH and temperature)
- Sample identification
- Sample collection details and description.

Surface water collection will begin with a depth sounding and the measurement of water quality parameters (pH and temperature) at mid-depth using an electronic water quality meter. The water quality meter will be calibrated daily prior to sampling, and the calibration will be documented in the field logbook.

Sampling methods will be conducted in a manner equivalent to the QA/QC procedures specified in the most current version of the VDEQ Standard Operating Procedures Manual for Water Quality Monitoring, section 4.8 (Appendix C). Per the permit requirements, dissolved metals results will be reported, and the samples will be filtered in the field during collection.

A peristaltic pump connected to Teflon tubing will be used for surface water collection. New (dedicated) tubing will be used for each new field sample. Tubing used for the collection of an equipment blank prior to collecting a field sample may also be used for the field sample. However, tubing will not be reused for additional field samples. Tubing will be lowered to mid-depth of the water column and a filtered water sample will be collected using an in-line 0.45-micron filter. Each filter will be used for only one sample. Sample collection will follow the Collection of Trace Element Samples (Clean Metals) protocol provided in Appendix C including the “clean hands/dirty hands” sampling approach for sample collection. Certified clean sample containers will be used for water sample collection.

Sample locations are named with two-letter site identifiers (“BR” for Brema Power Station and “JR” for reference samples in the James River) and two-digit number location identifiers (01 through 08). Surface water samples will be named with the sample location, quarter, and year. For instance, the sample from BR-05 collected in the fourth quarter of 2019 will be named “BR-05-19-Q4”. It is recommended that waterproof labels printed on a laser printer be used to avoid smudging. Labels will include the project name, sample ID, date, time, analyses, method, container, and sampler.

Quality assurance samples will be collected at a rate of 5 percent for matrix spike/matrix spike duplicates, and at a rate of 10 percent or greater for field duplicates and equipment blanks. The first equipment blank will be collected prior to the first surface water sample. To denote field duplicates, matrix spikes, and matrix spike duplicates, “FD”, “MS”, and “MSD” will be added to the end of the sample name. Equipment blanks will be named “EB” and two-digit number identifiers with the quarter and year of sampling, such as “EB-01-19-Q4”. Sufficient volume will be collected for field duplicates and matrix spike/matrix spike duplicates. Equipment blanks will be collected from deionized water. The rate of collection of quality assurance samples is included on Table 2. Samples will be kept on ice (<4 °C) following sample collection. Chain-of-custody documentation will be completed, and the samples will be shipped to the laboratory for next-day delivery. Shipping and packaging procedures outlined in Appendix C will be followed.

**Table 2 Brema Power Station Quarterly Monitoring Program Sample Numbers**

Type of Sample	Q1	Q2	Q3	Q4	Totals
Brema and Reference Samples	10	10	10	10	40
Field Duplicates	1	1	1	1	4
Matrix Spike/Matrix Spike Duplicates	2	2	2	2	8
Equipment Blanks	1	1	1	1	4
<b>Total</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>56</b>

#### 4. SAMPLE ANALYSIS AND VALIDATION

Samples will be submitted to a Virginia Environmental Laboratory Accreditation Program (VELAP) certified laboratory, for the following analyses:

- Dissolved antimony, arsenic, boron, cadmium, calcium, total chromium, cobalt, copper, lead, lithium, magnesium, molybdenum, nickel, selenium, silver, thallium, and zinc by SW-846 Method 6010 or 6020, provided that the method detection limits in Table 3 can be met
- Dissolved chromium VI by SW-846 Method 7199 or 7196A, provided that the method detection limits in Table 3 can be met
- Dissolved mercury by SW-846 Method 7470 or EPA 245.7, provided that the method detection limits in Table 3 can be met
- Dissolved chromium III calculated by subtracting chromium VI from total chromium concentrations
- Hardness calculated using calcium and magnesium concentrations.

Per the permit requirements, analyses will meet method detection limits for inductively coupled plasma mass spectrometry from the 2017 Standard Operating Procedures Manual for the Department of Environmental Quality Water Quality Monitoring (Table 3), as available. The laboratory will produce Level 3 data packages that include analytical results, data qualifiers, case narrative, preparation logs, run logs, and batch quality control (method blanks, laboratory control spikes, and matrix spike/matrix spike duplicate) results. Data packages will be submitted to the data validator for 90 percent Tier 1 and 10 percent Tier 2 validation on a Level 3 data package. Data validation will include completeness and compliance checks, data assessment, and validation following *National Functional Guidelines for Inorganics Method Data Review* (U.S. Environmental Protection Agency 2017) to assess compliance.

The goal of the Tier 1 review is to quickly provide a brief summary of key analytical issues/deficiencies and indicate whether data quality is consistent with the intended use. A Tier 1 review may include, but is not limited to: review of the data package for completeness; review of chain of custody forms (against laboratory reported information), for signatures, sample condition upon receipt by the laboratory, and sample preservation; review of holding times; review of quality control summaries; review of blank results for possible field or laboratory contamination; random checks of reported results against raw data, and random checks of raw data for interference problems or system control problems (e.g., baseline anomalies, baseline drifts, etc.).

A Tier 2 review may include, but is not limited to, the components of a Tier 1 review plus a random check (percentage determined by the professional judgement of the data evaluator on a project specific basis) of all the various calculations in the data set (e.g., verifying and

recalculating concentrations of standards including checking of expiration dates of standards from standard preparation logs, confirming calibration criteria were met, verifying quality control sample results were as stated, etc.), checking raw data for correct integration, confirming mass ion spectra matches (if applicable), and assessing interference problems or system control problems (e.g., baseline anomalies, baseline drifts, etc.). These checks would be conducted in the context of project data quality objectives. An evaluation of potential high/low bias or false positive/false negative results around project thresholds of concern will be the primary focus.

**Table 3 Method Detection Limits**

<b>Analytes</b>	<b>Method Detection Limits from Water Quality Monitoring Standard Operating Procedure (micrograms per liter) Inductively Coupled Plasma Mass Spectrometry (µg/L)</b>
Antimony	0.33
Arsenic	0.24
Boron	--
Cadmium	1.72
Calcium	--
Chromium (total)	--
Chromium (III)	--
Chromium (VI)	--
Cobalt	--
Copper	0.87
Lead	0.28
Lithium	--
Magnesium	--
Molybdenum	--
Mercury	0.12
Nickel	0.39
Selenium	0.77
Silver	0.15
Thallium	--
Zinc	2.18
NOTE: Virginia Department of Environmental Quality (VDEQ) 2017.	

## 5. QUARTERLY REPORTING

Following receipt of validated data, the data will be reviewed for quality assurance and electronically transferred into a project-specific database. A surface water monitoring report will be submitted to VDEQ within 60 days from the completion of sampling and analysis unless as allowed under a director-approved extension. Each quarterly report will include:

- signature page certifying the results by a facility representative;
- facility name and permit number;
- statement noting whether all sampling locations were sampled and, if not, the reason a sample was not obtained or reported. If the sampling location did not contain sufficient water column for sampling, a statement noting the number of occurrences of lack of sufficient water column and based upon the number of occurrences, a new proposed sampling location;
- a copy of the full laboratory analytical report including dated signature page from laboratory manager or representative;
- a written summary of field activities;
- tabulated analytical data and field measurements;
- a site figure showing sampling locations;
- copies of field documentation;
- a data validation summary.

Per the permit requirements, final surface water results will be reported as dissolved metals. Sampling results will be compared to the lowest applicable standards established by 9 Virginia Administrative Code 25-260-140 Virginia Water Quality Standards (Appendix D). Samples will meet the qualitative water quality standards described in 9 Virginia Administrative Code 25-260. For any constituent not listed in Permit XVIII, Section D.1 that has an exceedance of a Groundwater Protection Standard under the Modified Assessment Groundwater Monitoring Program, surface water sampling results will be compared to the VDEQ-approved Groundwater Protection Standard. Surface water monitoring records will be maintained at the Bremo Power Station and made available to VDEQ upon request.

Verified laboratory results indicating surface water column results above a water quality standard in 9VAC2-260-140 or a Groundwater Protection Standard will be reported to VDEQ within 30 days of issuance of the final laboratory results. Additional required actions for surface water quality standard exceedances are detailed in XVIII.H of the Solid Waste Permit.

## 6. REFERENCES

- Golder Associates, Inc. 2019. *2018 CCR Annual Groundwater Monitoring and Corrective Action Report, Bremo Power Station, North Ash Pond*. Prepared for Dominion Energy Virginia Electric and Power Company. 31 January.
- U.S. Environmental Protection Agency. 2017. *National Functional Guidelines for Superfund Inorganics Method Data Review*. January.
- Virginia Department of Environmental Quality (VDEQ). 2017. *Standard Operating Procedures Manual for the Department of Environmental Quality Water Quality Monitoring and Assessment Program*. Revision 20. 5 June.



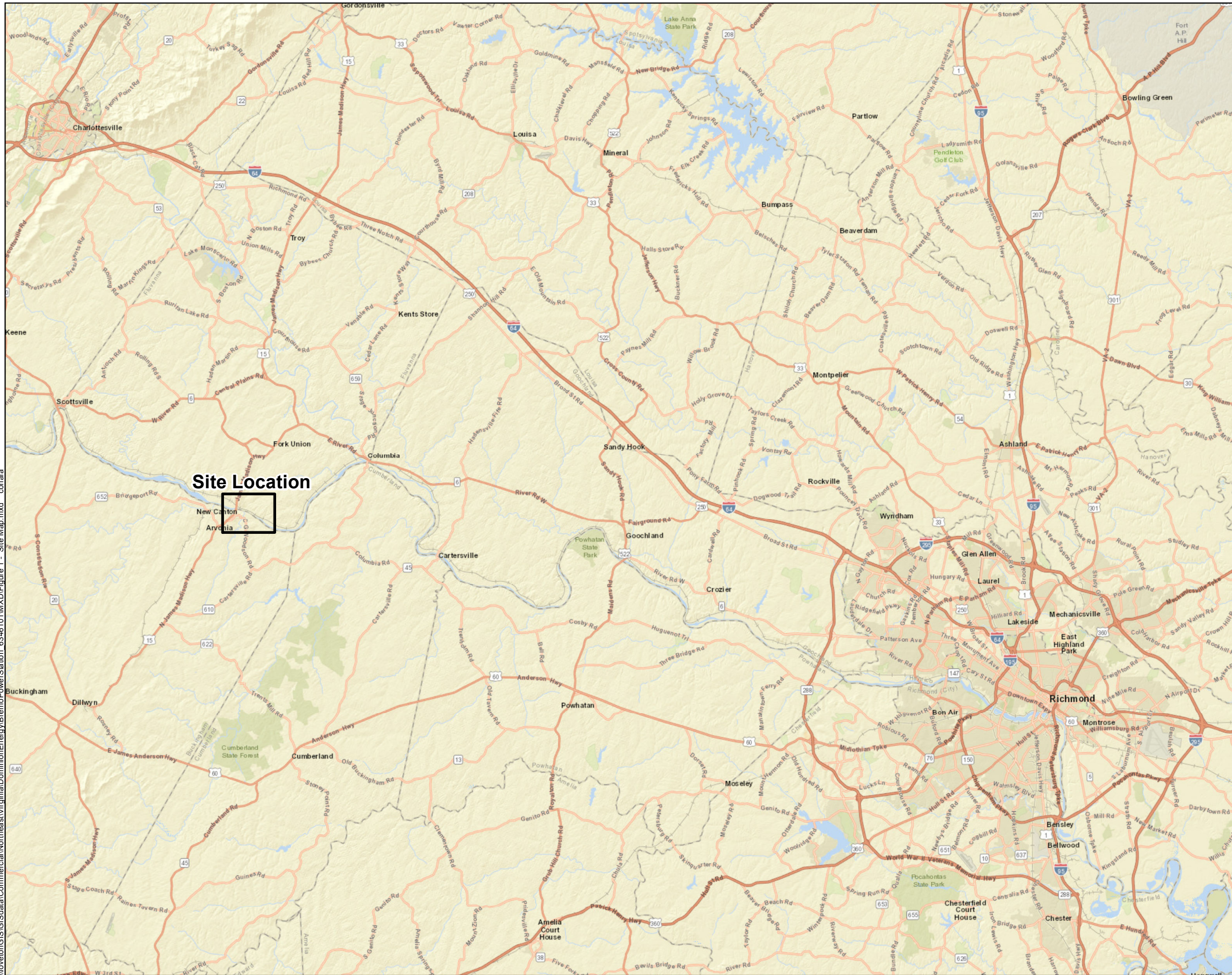
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## Figures

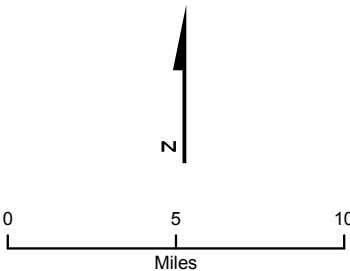
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\\ovetonGIS\GISData\Commercial\Northeast\Virginia\DominionEnergy\BremoPower\Station\_634610\MXD\Figure 1 - Site Map.mxd cohara



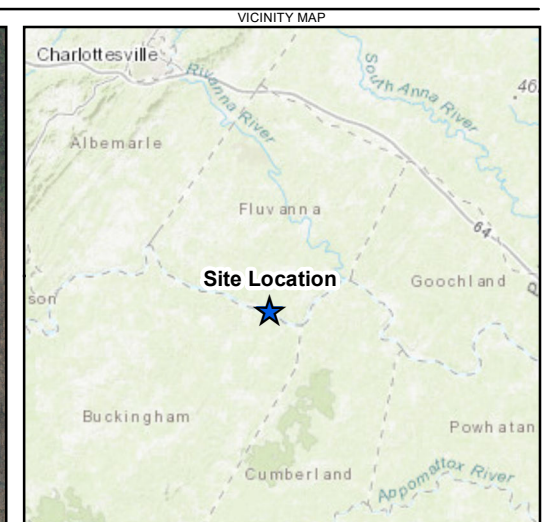
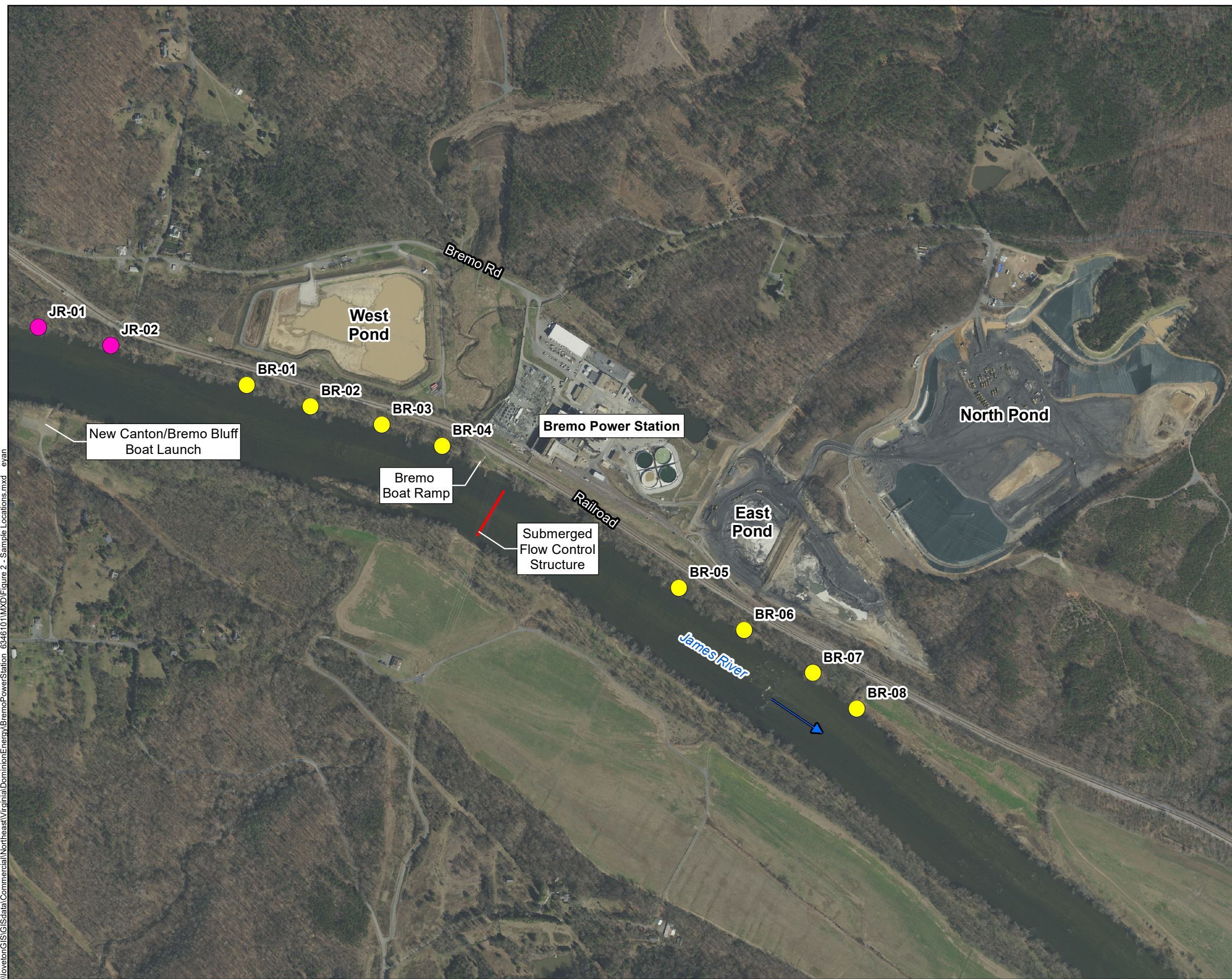
Map Date: 7/11/2019  
Source: ESRI, 2015  
Projection: NAD 1983 Virginia State Plane North



**Figure 1**  
**Site Map**  
Bremo Power Station  
Fork Union, VA



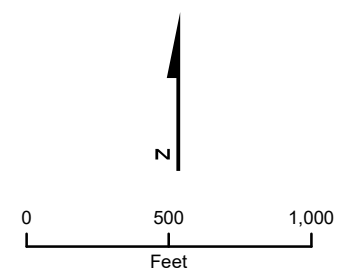
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#### Legend

- Surface Water Sample
- Reference Sample
- Submerged Flow Control Structure

Map Date: 3/28/2020  
Source: VA GIS, 2017  
Projection: NAD 1983 Virginia State Plane North



**Figure 2**  
**Sample Locations**  
Bremo Power Station  
Fork Union, VA



## **Appendix A**

### **Permit No. 618 Module XVIII Surface Water Monitoring Requirements**

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## **PERMIT MODULE XVIII**

### **SURFACE WATER MONITORING REQUIREMENTS**

This monitoring program is designed to determine if there is an impact to surface water that may be occurring as a result of potential groundwater to surface water exchange.

Surface Water Monitoring at this facility will take place under the program described herein and the actions undertaken shall be consistent with VSWMR, WQS, and VPDES regulations as applicable. The Permittee must maintain a surface water monitoring program that meets the requirements of this module and outline that program in the Surface Water Monitoring Plan.

Nothing in this permit module authorizes the Permittee to have an unauthorized discharge in contravention of State Water Control Law or accompanying regulations.

The Surface Water Monitoring Plan shall be developed in accordance with these requirements and submitted to the Department for approval within 60 days of permit issuance and shall be implemented within 30 days of approval by the Department.

#### **XVIII.A. SAMPLING LOCATIONS**

XVIII.A.1. A minimum of eight (8) sample locations shall be identified and approved by the Department. At a minimum, the locations shall be near-shore of the property where groundwater potentially could intersect with surface water and represent results from the CCR units located at the facility. These locations:

XVIII.A.1.a. shall be noted on a site facility map and identified with GPS coordinates;

XVIII.A.1.b. may be augmented by additional sampling locations as needed, based on the results of the surface water sampling program, and to ensure potential impacts from groundwater to surface water are identified;

XVIII.A.1.c. shall be permanently marked or flagged at the nearest shore to allow easy identification; and

XVIII.A.1.d. shall include at least four sampling locations down gradient of Surface Impoundments North and East Pond; and at least four sampling locations down gradient of Surface Impoundment West Pond.

XVIII.A.2. Sampling locations which do not contain a sufficient surface water column within which to sample will not be required to be re-sampled during the compliance period. However, sampling locations which have insufficient



yield for 2 consecutive monitoring periods shall be evaluated for relocation and a new location proposed for approval by the Department.

#### **XVIII.B. SAMPLING ACTIONS**

The Permittee shall:

- XVIII.B.1. Collect samples from the surface water columns at the designated locations identified in XVIII.A. The samples shall be taken at mid-depth of the water column. Tidal samples shall be collected at low tide if feasible.
- XVIII.B.2. Conduct the surface water column sampling actions in a manner equivalent to the QA/QC procedures specified in the most current version of the Department's Standard Operating Procedures Manual, Water Monitoring and Assessment Program, Section 4.8 - Collection of Trace Elemental Samples (Clean Metals), and others as applicable.
- XVIII.B.3. Analyze surface water column samples in accordance with methods approved by the Department and performed by a VELAP accredited laboratory.
- XVIII.B.4. Provide final results of surface water column samples as dissolved metals.

#### **XVIII.C. SAMPLING FREQUENCY**

- XVIII.C.1. The Permittee shall, during the closure and post-closure care periods, sample surface water following a calendar quarterly schedule.
- XVIII.C.2. The length of the quarterly sampling period shall be an interval corresponding to approximately 90 days. For the purposes of scheduling monitoring activities, sampling within 15 days of each 90-day interval will be considered 'quarterly'.
- XVIII.C.3. The Permittee shall sample more frequently when requested by the Department.

#### **XVIII.D. SAMPLING CONSTITUENTS**

- XVIII.D.1. The Permittee shall sample for the following constituents: Antimony, Arsenic, Boron, Cadmium, Chromium (total, III, and VI), Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc.
- XVIII.D.2. Additional indicator and field collection data shall be provided including hardness, pH, and temperature.

XVIII.D.3. Any constituent not listed in XVIII.D.1. that has an exceedance of a Groundwater Protection Standard established in Permit Module XI shall be included.

XVIII.D.4. Any additional constituents or parameters when notified in writing by the Department shall be included.

XVIII.E. DETERMINATION OF APPLICABLE STANDARDS FOR COMPARISON

Sampling results from surface water column testing of the constituents identified in XVIII.D.1. shall be compared to the lowest of the applicable standards established by 9 VAC 25-260-140. For any constituent not listed in XVIII.D.1. that has an exceedance of a Groundwater Protection Standard established in Permit Module XI, the constituent shall be compared to the Groundwater Protection Standard.

XVIII.F. REPORTING REQUIREMENTS

XVIII.F.1. After each quarterly sampling event, the permittee shall submit a surface water monitoring report under separate cover to the Department no later than 60 days from the completion of sampling and analysis unless as allowed under a director-approved extension. The surface water monitoring report shall include:

XVIII.F.1.a. signature page certifying the results by a facility representative;

XVIII.F.1.b. facility name and permit number;

XVIII.F.1.c. statement noting whether or not all sampling locations were sampled and if so, the reason a sample was not obtained or reported. If the sampling location did not contain sufficient water column for sampling, a statement noting the number of occurrences of lack of sufficient water column and, based upon the number of occurrences, a new proposed sampling location; and

XVIII.F.1.d. copy of the full Laboratory Analytical Report including dated signature page from laboratory manager or representative.

XVIII.F.2. The Permittee shall retain all surface water monitoring records throughout the closure and post-closure care period. The records shall be retained at the facility, or alternate location approved by the Director, within the facility's operating record and made available to the Department upon request.

#### XVIII.G. NOTIFICATION REQUIREMENTS

Verified laboratory results indicating surface water column results above a standard identified in XVIII.E shall be submitted to the Director within 30 days of issuance of the laboratory report results.

#### XVIII.H. REQUIRED ACTIONS

XVIII.H.1. Within 60 days of submitting a notification in XVIII.G., the permittee shall submit a Surface Water Investigation Report. The following information shall be assessed in the investigation and discussed in the report:

XVIII.H.1.a. Any error in the collection of the sample that may be identified;

XVIII.H.1.b. Additional conditions and information regarding the surface water at the time of collection;

XVIII.H.1.c. Whether the constituent(s) were detected in groundwater monitoring sampling results;

XVIII.H.1.d. The identified or potential source(s) of the observed impacts, including any potential facility activities;

XVIII.H.1.e. Additional sampling, if any, undertaken by the permittee; and

XVIII.H.1.f. Mitigation action or other actions, if any, undertaken by the permittee.

XVIII.H.2. The permittee, depending on the results of this investigation and as directed by the Department, may be required to conduct additional monitoring, additional source investigation, sampling including interstitial sampling or sediment sampling as feasible, or assessment measures including fish tissue sampling.

XVIII.H.3. The permittee shall submit an action plan for Department review and approval or take other action in accordance with Permit Module XI when required by the Department in response to the Surface Water Investigation Report.

#### XVIII.I. PERMIT DOCUMENTS

The Department-approved Surface Water Monitoring Plan shall be placed in the facility's operating record. This Surface Water Monitoring Plan shall include at minimum the measures required for the facility to accomplish the monitoring required by this module.

- XVIII.I.1 It shall be the responsibility of the Permittee to update this monitoring plan as needed, which may include actions otherwise defined if changes to the monitoring program have taken place since original Plan development.
- XVIII.I.2. Should information contained in a Permittee authored Surface Water Monitoring Plan conflict with any requirement or condition of this Module, the Module condition shall prevail over the language in the Permittee supplied document.
- XVIII.I.3 The Permittee shall review and modify the surface water monitoring plan within 30 days of notification of the agency of required/requested modifications.
- XVIII.I.4. When the Permittee recognizes a failure to submit any relevant facts or has submitted incorrect information in any surface water monitoring report to the Director, he shall, within 7 days, submit such omitted facts or the correct information with a full explanation.

XVIII.J. LIMITATIONS/AUTHORITIES

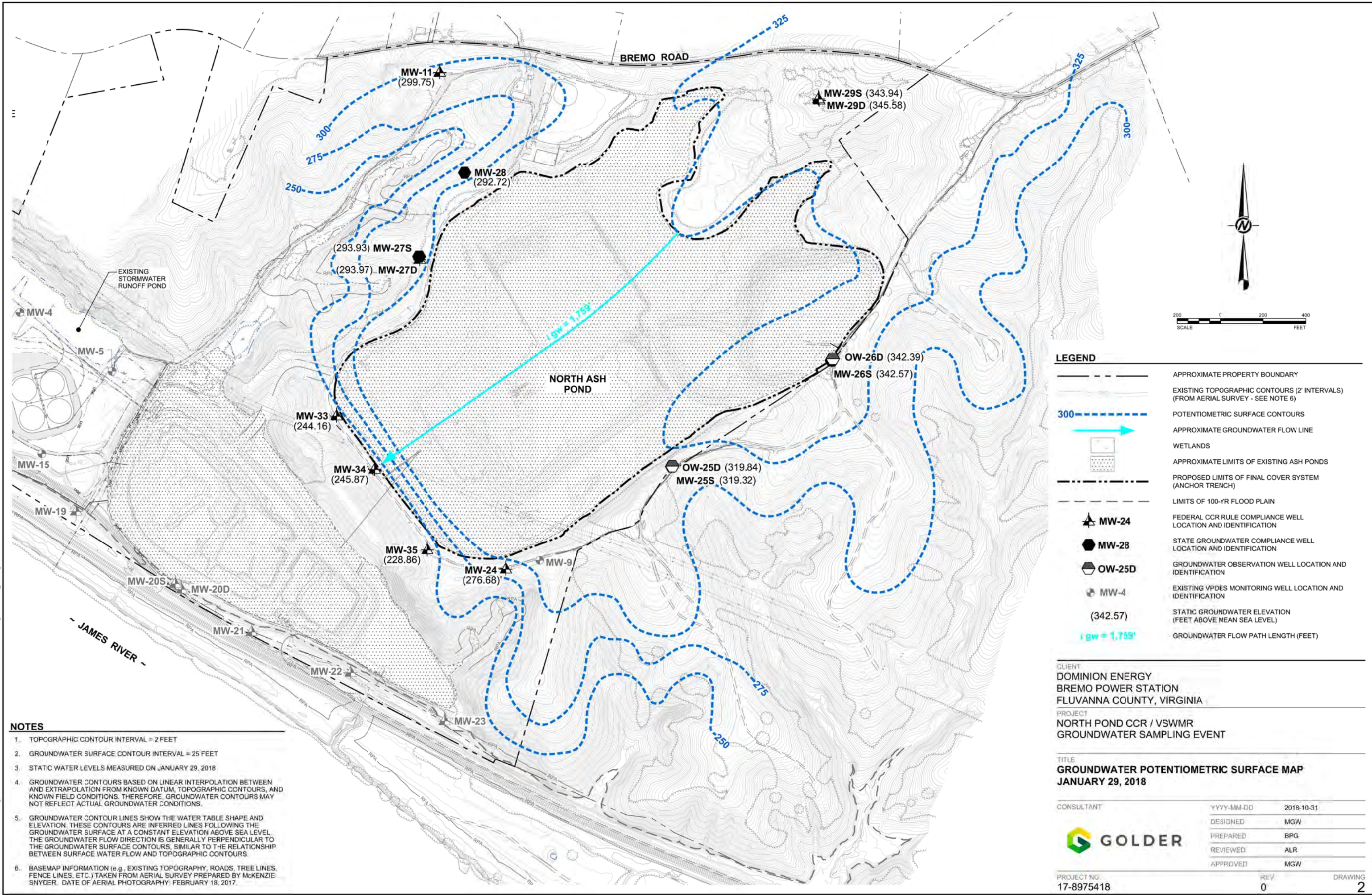
The surface water monitoring and reporting requirements set forth herein are minimum requirements. The Director may require, by amending the Permit, any owner or operator to maintain a surface monitoring system and program that contains requirements more stringent than those of the Regulations and in this current permit module whenever it is determined that such requirements are necessary. Nothing in this permit module limits the Director or the Department from requiring additional actions consistent with applicable laws and regulations.

## **Appendix B**

### **Groundwater Surface Contour Maps (Golder Associates, Inc. 2019)**

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- NOTES**
1. TOPOGRAPHIC CONTOUR INTERVAL = 2 FEET
  2. GROUNDWATER SURFACE CONTOUR INTERVAL = 25 FEET
  3. STATIC WATER LEVELS MEASURED ON JANUARY 29, 2018
  4. GROUNDWATER CONTOURS BASED ON LINEAR INTERPOLATION BETWEEN AND EXTRAPOLATION FROM KNOWN DATUM, TOPOGRAPHIC CONTOURS, AND KNOWN FIELD CONDITIONS. THEREFORE, GROUNDWATER CONTOURS MAY NOT REFLECT ACTUAL GROUNDWATER CONDITIONS.
  5. GROUNDWATER CONTOUR LINES SHOW THE WATER TABLE SHAPE AND ELEVATION. THESE CONTOURS ARE INFERRED LINES FOLLOWING THE GROUNDWATER SURFACE AT A CONSTANT ELEVATION ABOVE SEA LEVEL. THE GROUNDWATER FLOW DIRECTION IS GENERALLY PERPENDICULAR TO THE GROUNDWATER SURFACE CONTOURS, SIMILAR TO THE RELATIONSHIP BETWEEN SURFACE WATER FLOW AND TOPOGRAPHIC CONTOURS.
  6. BASEMAP INFORMATION (e.g., EXISTING TOPOGRAPHY, ROADS, TREE LINES, FENCE LINES, ETC.) TAKEN FROM AERIAL SURVEY PREPARED BY MCKENZIE SNYDER. DATE OF AERIAL PHOTOGRAPHY: FEBRUARY 18, 2017.

**LEGEND**

- APPROXIMATE PROPERTY BOUNDARY
- EXISTING TOPOGRAPHIC CONTOURS (2' INTERVALS) (FROM AERIAL SURVEY - SEE NOTE 6)
- POTENTIOMETRIC SURFACE CONTOURS
- APPROXIMATE GROUNDWATER FLOW LINE
- WETLANDS
- APPROXIMATE LIMITS OF EXISTING ASH PONDS
- PROPOSED LIMITS OF FINAL COVER SYSTEM (ANCHOR TRENCH)
- LIMITS OF 100-YR FLOOD PLAIN
- FEDERAL CCR RULE COMPLIANCE WELL LOCATION AND IDENTIFICATION
- STATE GROUNDWATER COMPLIANCE WELL LOCATION AND IDENTIFICATION
- GROUNDWATER OBSERVATION WELL LOCATION AND IDENTIFICATION
- EXISTING VPDES MONITORING WELL LOCATION AND IDENTIFICATION
- STATIC GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- GROUNDWATER FLOW PATH LENGTH (FEET)

CLIENT  
DOMINION ENERGY  
BREMO POWER STATION  
FLUVANNA COUNTY, VIRGINIA

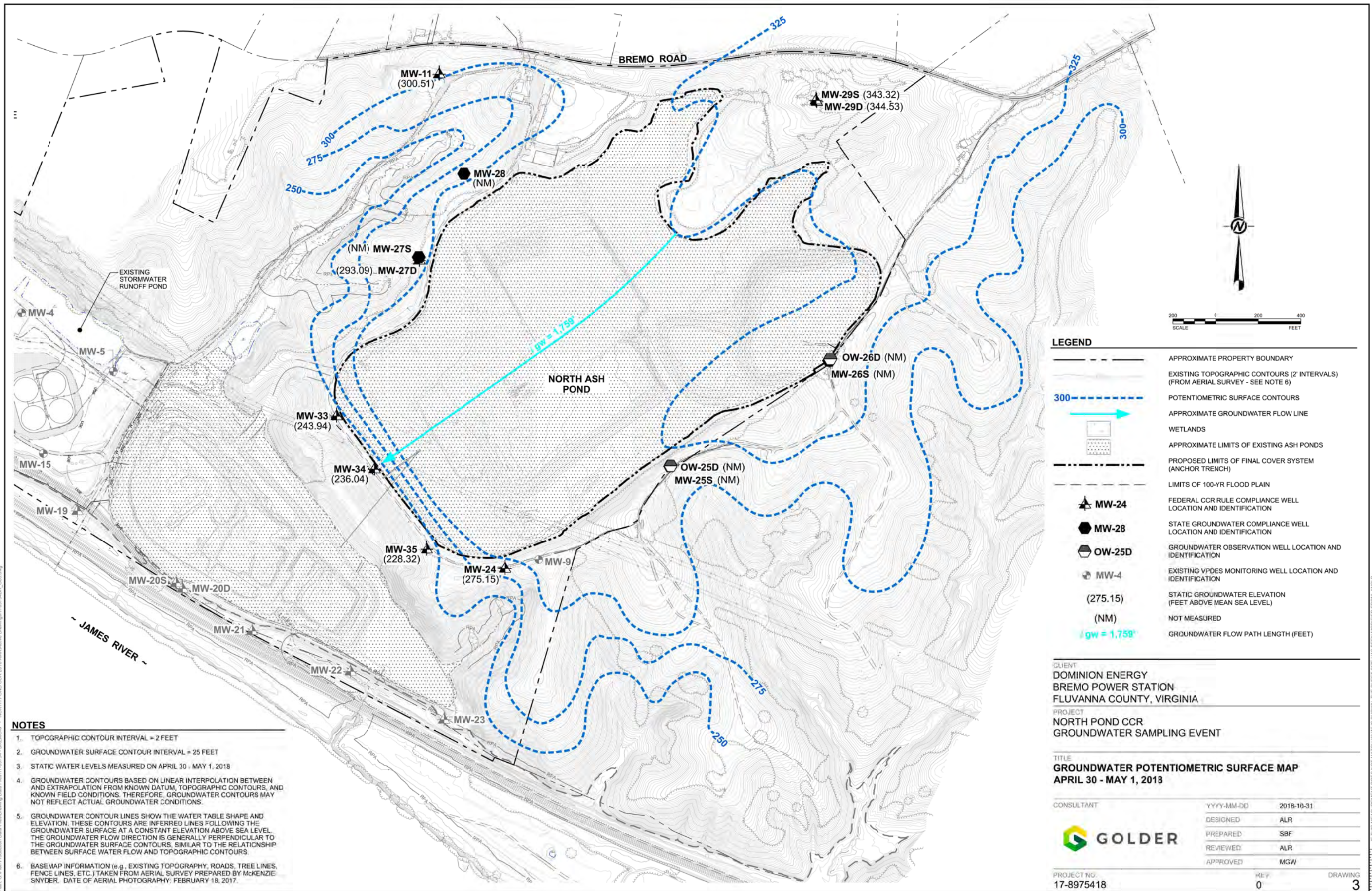
PROJECT  
NORTH POND CCR / VSWMR  
GROUNDWATER SAMPLING EVENT

TITLE  
**GROUNDWATER POTENTIOMETRIC SURFACE MAP**  
JANUARY 29, 2018

CONSULTANT	YYYY-MM-DD	2018-10-31
DESIGNED	MGW	
PREPARED	BPG	
REVIEWED	ALR	
APPROVED	MGW	













## **Appendix C**

**Section 4.8 Collection of Trace Element Samples  
(Clean Metals) of the Standard Operating Procedures  
Manual for the Department of Environmental  
Quality Water Quality Monitoring and  
Assessment Program  
(Virginia Department of Environmental Quality 2017)**

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## **4.8. Collection of Trace Element Samples (Clean Metals)**

Clean metals samples are designed to measure trace levels (parts per billion) of metals in water for specific programs like TMDL or PROBMON. To eliminate sampling contamination, a “clean hands/dirty hands” approach to sampling is required.

### **4.8.1. Scope and Applicability**

This procedure outlined below is intended to be used to collect dissolved and or total trace metals in freshwater, groundwater, saltwater, and wastewater for laboratory analysis with results typically in the 200 ppb or less range.

The below procedures are appropriate for any surface, ground, or waste effluent waters with a conductivity below 1000 uS/cm. Saltwater, brackish water, and highly turbid wastewater such as landfill leachates, use the same sampling procedure but require special laboratory preparation and analysis.

If metals concentrations are expected to be above 200 ppb, notify the lab in advance as different analysis is required.

**Table 4.1** lists the Method Detection Limits (MDL) established for each parameter using the protocols specified in this guidance following procedures specified in 40 CFR 136, Appendix B.

### **4.8.2. Summary**

Ambient samples are collected midstream by submerging a precleaned 4 liter plastic bottle referred as a Bridge Bottle (see **Figure 4.1 Bridge Bottle**). Such containers are provided by DCLS. Using a piece of flexible tubing connected to the bridge bottle and in lined with a capsule filter, the sample is transferred by peristaltic pump from the bridge bottle into a plastic sample container, see **Figure 4.2 Loop Sample Container** and **Figure 4.3 Sample Container Schematics**. A sample wand configuration may be used if sampling while wading or from the boat, see **Figure 4.4 Ambient Sampling Apparatus**.

Effluent samples are collected directly into a sample container by submerging a Teflon tube at the sample site. Using a peristaltic pump, sample water is transferred through a piece of flexible tubing in-lined with Teflon tubing through a capsule filter and into the sample bottle. See **Figure 4.5 Effluent Sampling Apparatus**.

It is recommended that two field technicians work with collecting trace metals.

### **4.8.3. Equipment Preparation and Ordering Sample Kits**

#### **4.8.3.1. Regional Field Equipment Preparation**

Store all trace metals sampling equipment in a plastic container to prevent dust contamination. Ideally, use a clean plastic bag to store equipment needed to sample one station to allow ease of transport to the field and prevent contamination.

Prior to sampling, charge peristaltic pump batteries using the charger adaptor provided with the pump. Do not use other battery chargers to avoid damaging the pump. A charged battery will work continuously for about 7 hours.

Run through the checklist to ensure there are adequate supplies to collect the scheduled samples. Gloves are the main item needed in excess as many changes will be required. At least one additional site worth of clean metals sampling equipment should be included.

#### **4.8.3.2. Ordering Kits**

Regions can maintain a small supply of clean metals sampling kits and containers but kits and bottles over six months old must be discarded. Avoid ordering too many kits as they are expensive. Use a FIFO (First In, First Out) inventory system to ensure containers do not exceed this storage time.

**Note:** All quality control blanks are handled as separate samples and one blank should be ordered for each sample site and event.

Ambient sampling sites should be established in CEDS prior to sample collection and then processed using the CEDS system.

Prior to sample collection, the sample containers must be ordered directly from the laboratory and must be scheduled through CEDS.

ORDER SAMPLE CONTAINERS from DCLS by e-mailing Norma Roadcap ([Norma.Roadcap@dgs.virginia.gov](mailto:Norma.Roadcap@dgs.virginia.gov)) and Cindy Johnson ([Cynthia.Johnson@deq.virginia.gov](mailto:Cynthia.Johnson@deq.virginia.gov)) with the number and type (by group codes) of samples you wish to collect, when they will be collected, and your region. ALLOW 6 WEEKS FOR DELIVERY.

Please refer to Table 4.2 Parameter Group Codes for the parameter codes to request for containers based on the sample matrix type.

#### **Freshwater sample kit includes the following supplies:**

1. One bridge bottle,
2. One tubing kit,
3. Two loop sample containers, and
4. Two 100ml Mercury bottles.

#### **Saltwater and effluent sample kit includes the following supplies:**

1. One tubing kit,
2. Two loop sample containers, and
3. Two 100ml Mercury bottles.

#### **4.8.3.3. Monthly Run Schedule**

The vast majority of routine metals sampling collected are for dissolved metals. Total metals along with clean metals are usually collected for very specific special studies. Only when a special study requires it, should regions total metals in addition to dissolved metals.

1. Schedule samples with DCLS through CEDS using the group codes found in **Table 4.2**.
2. Refer to **Figure 4.6 WQM Run Parameters**. Refer to the Run ID that corresponds to your type of sample whether it is an effluent (EFF), freshwater (FRESH), or saltwater (SALT). Field equipment blanks (EB) use group code CMETB. Be sure to note the Equipment Blank in the **Blank/Dup** field. One CMETB should be run at each sample site tested to confirm equipment is clean between sites.

**Note:** Due to the time involved at each site, usually only four or five sites can be tested in a day.

#### **4.8.4. Equipment and Supplies**

##### **4.8.4.1. Items Which Should Be Stored in Equipment Box**

**Table 4.3** lists the supplies required for sampling clean metals. Supplies for each site and sample run should be stored in a plastic bag and in a plastic container to prevent contamination.

##### **4.8.4.2. Ancillary Items**

Other items which may be needed include those listed in Table 4.4 Ancillary Supplies.

Batteries need to be charged overnight. Prior to each sampling run, check to make sure there are enough supplies and the battery is charged and functioning. The leads and fuse system on the batteries are prone to breaks and shortages. Every six months, completely discharge batteries and recharge to extend battery life.

##### **4.8.4.3. Sampling Apparatus, Bottles and Containers**

DCLS will supply all the necessary sample containers, bridge bottles, and tubing kits based on the number and types of samples ordered.

- When placing orders for samples, try to group four to five sites that field teams can sample on the same day. DCLS will send out coolers with kits and bottles batched for the number of samples scheduled. The same cooler can be used to return the samples for analysis.
- Dispose or recycle tubing kits, filters, bridge bottles, and mercury bottles. Never use the same equipment at another site.

#### **4.8.5. Bridge Bottle Protocol for Freshwater and Saltwater**

##### **4.8.5.1. Equipment Setup**

1. Identify an area where sample processing will occur. The area must be on a flat, smooth surface protected from the wind that is free of falling debris and swirling dust. The tailgate of an enclosed truck bed or SUV is often a good location.
2. Place the equipment box and coolers containing the sample containers and kits as close as possible to the sample processing area.

3. Cover the work area with a large piece of plastic sheeting (>2 mil thickness). Set out the pump and connect the battery. Switch the pump on and dial the pump speed to 5. Turn off the pump until needed.
4. Remove a tubing kit and necessary sampling containers from the plastic bag in the cooler and place on the plastic near the pump.
5. Remove a pack of powder free gloves from the storage container and place on the plastic.
6. Remove the plastic sample caddy from the storage box and place it on the sample processing area near the pump. Secure the sample bottles in the caddy.

#### **4.8.5.2. Bridge Bottle Filling**

1. If sampling from a bridge or similar location, locate the sample weights to connect to the bridge bottle. Avoid using exposed metal weights. Rubber or plastic encased metal weights may be used. No weights are necessary if filling directly in a stream.

**Note:** If collecting field data (pH, DO, etc.), place the sonde downstream or away from the sampling location to avoid contamination. In addition, other samples such as nutrients should be collected after the clean metals sample is collected.

2. Locate the polypropylene sampling rope spool, cut a sufficient length of rope to allow for deployment.
3. Don one or two pairs of vinyl gloves using clean procedures. Specifically by touching only the cuff or backside of the glove with a bare hand.
4. Tie one end of the sampling rope to the five pound plastic coated weight leaving approximately one foot free rope at the end to connect to the bridge bottle.
5. Untie or tear open the top of the outer plastic bag containing the bridge bottle.
6. Reach into the outer bag and untie the inner bag near the handle connection. Check the configuration of the tubing to ensure that proper filling will occur. Inspect the smaller vent tubing and adjust if it appears crimped. While the bottle is still in the inner bag, it is acceptable to remove the cap fitting to check the inner sipper tube. Adjust all fittings appropriately.
7. When the fittings have been properly secured and adjusted, remove the bridge bottle from the inner bag and lay on the plastic film. Tie the weighted end of the rope onto the handle of the bottle leaving about six inches of line between the bottle and the weight.
8. Proceed to the sampling location with the bridge bottle apparatus. Carry several extra pairs of gloves to the site to ensure clean handling of the bridge bottle.

9. When deploying from bridges with moderate to low stream velocities collect the sample upstream of the bridge by lowering the assembly into the water. Ensure that the assembly does not touch any structures or other objects as it is lowered into the water.
  - a. The weight will partially submerge the bridge bottle and begin to fill.
  - b. Check to insure the air vent is above the water level and not blocked. When the bottle is first submerged, it should push a small slug of water from the air vent tube. The bottle will fill within a few minutes if properly adjusted.
  - c. The bridge bottle is allowed to sink completely below the surface as long as the inlet tube does not contact the bottom.
  - d. When full, carefully retrieve the bridge bottle so as to not contact any structures or other objects.

**Note:** Deploying bridge bottles in high flow waters can be difficult. Sampling bridges on the downstream side is acceptable to avoid losing the bottle assembly due to the current. When stream velocities are high, adding additional weight may help. If adding additional weight, extend the bridge bottle vent tube past the bottom of the bottle to avoid an air lock.

- e. If the inlet tube becomes clogged during filling, it is often due to
  - i. The vent tube contains a slug of water or other obstruction
  - ii. The vent tube is below the surface of the water,
  - iii. The weight is not positioned close enough to the bottle, or
  - iv. The vent tube or inlet tube has become disconnected from the bottle.

**Note:** Most blockages are cleared by flipping the bridge bottle right side up (bottle opening pointing up). If the blockage does not clear by this method, a new bridge bottle may be necessary to collect a representative sample.

11. When deploying a bridge bottle while wading or from a small boat, the bridge bottle can be submerged by hand without using weights.
12. For shallow water where the bridge bottle cannot be submerged, use the effluent sample configuration seen in Figure 4.4 where the stream sample is pumped directly into the loop sample container. However, this will require bringing a pump to the sample site. This is best accomplished by attaching the pump assembly to a backpack.
13. When the bridge bottle is approximately 2/3 full retrieve the bottle to return to the sample processing area. Reconnect the inlet and vent tubing to keep the sample from spilling out or contaminants entering the bottle.

**Note:** If hiking back to the processing area, place the bridge bottle back in the plastic bags it arrived in to help protect the sample.

14. Once back at the processing area, set it next to the pump and remove the weight if it is attached. With the inlet and vent tubing closed together, the bridge bottle is protected from atmospheric contamination.



#### 4.8.5.3. Dissolved Grab Sample Blank Procedure

Refer to Figure 4.4 Ambient Sampling Apparatus for the schematic of the field sampling equipment used to process blanks and samples.

Determine which field specialist will be **clean hands** and which will be **dirty hands**.

1. **Dirty hands** and **clean hands** don one or two pairs of Nitrile or vinyl gloves. Only touch the areas of gloves with bare hands which will not contact sampling equipment.
2. **Dirty hands** ensure the plastic sheeting is fixed on the work area and pump is ready to run and the outer bags for the two (or three) loop and mercury bottles are opened. **Clean hands** open the inner bag for the loop and mercury bottles and places the bottles on the plastic sheet.
3. **Dirty hands** open the outer bag containing the bridge bottle  
**Clean hands** open the inner plastic bag containing the bridge bottle.
4. **Dirty hands** open the tubing kit outer plastic bag.  
**Clean hands** open the inner plastic bag and remove the tubing assembly.
5. **Clean hands** disconnect one side of the sample loop on the first sample container and connect the end of the tubing kit opposite the filter to the opened sample container. The sample container is full of clean water from the lab.
6. **Dirty hands** connect the peristaltic tubing at approximately the mid-point of the length to the field pump.  
**Clean hands** invert the sample container and point the outflow nozzle of the sample filter cartage upwards (flow arrow points up). This will insure proper wetting of the filter and remove air bubbles.  
**Dirty hands** switches on the pump.
7. Process the entire contents, 1000ml, of the sample container through the tubing and filter apparatus at a flow rate of 500ml/min (pump setting of 5). **Dirty hands** switches off the pump when the last continuous stream of water enters the filter. The filter must not be allowed to go dry or excessive back pressure will blow the tubing off the filter.
8. **Clean hands** disconnects the pump tubing from the now empty loop bottle and reconnects this same end to the second loop bottle containing ultrapure water provided by the lab for the sample blank and inverts the container.  
**Dirty hands** switches on the pump. Process the blank water from the loop bottle until approximately 125 ml have flowed from the filter. **Dirty hands** switches off the pump.
9. **Clean hands** open the first mercury container and discard the water. Then holds the outlet of the capsule filter just above the open mouth of the mercury bottle.  
**Dirty hands** turns on the pump

10. **Clean hands** fill the mercury bottle to overflowing  
**Dirty hands** shut off the pump.
11. **Clean hands** lays the nozzle down on the plastic sheeting or inside the clean bag holding the sample loop bottles so the tip does not come into contact with any surface and caps the mercury bottle tightly shut. The mercury bottle should have no air bubbles larger than a pea
12. **Clean hands** then connects the capsule filter outlet to the empty loop container via the sample loop tubing and process the remaining contents (~875 ml) of the remaining ultrapure water through the tubing and filter apparatus into the first sample container.  
**Dirty hands** switches off the pump before the filter is completely dry.
13. **Clean hands** disconnect the outlet tubing from the blank sample container and immediately reconnect the loop tubing on the top of the blank bottle.
14. **Dirty hands** fill out the sample tag for the blank bottle and partially stick the label on the mercury and metals equipment blank (EB) bottle without touching the bottles.  
**Clean hands** secure the label and place the blank container in the inner Ziploc bag with similar processed samples from the site. Remove excess air from the bag and seal.
15. **Dirty hands** hold the outer bag open for **clean hands** to place the bagged sample into.  
**Dirty hands** seals the outer bag and removes as much air as possible and places the bagged sample in a cooler separate from other samples to prevent contamination from the wire tags.

The field blanks collected in this manner is comprehensive blanks because they are collected in the same equipment as the sample and processed like the sample through all steps of the protocol. This is the most important check of contamination in the protocol.

#### 4.8.5.4. Dissolved Grab Sample Procedure

1. **Clean hands** immediately (immediately means less than one minute) disconnects the vent tubing from the bridge bottle containing sample water and then connects the inlet side of the pump tubing in place of the vent tubing.
2. **Dirty hands** switches on the pump and process the sample water from the bridge bottle until approximately 125ml have flowed from the filter. **Dirty hands** switches off the pump.
3. **Clean hands** open the first mercury container and discard the water. Then holds the outlet of the capsule filter just above the open mouth of the mercury bottle. **Dirty hands** turns on the pump.
4. **Clean hands** fill the mercury bottle to overflowing  
**Dirty hands** shut off the pump.
5. **Clean hands** lays the nozzle down on the plastic sheeting so the tip does not come into contact with any surface and caps the mercury bottle tightly shut. The mercury bottle should have no air bubbles larger than a pea
6. **Clean hands** unscrew the cap of the second loop sample container and discard the small amount of water remaining in the container.  
**Clean hands** returns the top to the container and then connects the capsule filter outlet to the second empty loop container via the sample loop tubing. If total recoverable metals are to be processed from the bridge bottle, **dirty hands** rocks the bridge bottle using the handle to agitate the water while filtering the sample to prevent settling. It is acceptable to fill the sample container to overflowing, however avoid filtering more than 1000 ml through the filter.
7. **Dirty hands** switches off the pump.  
**Clean hands** disconnect the outlet tubing from the sample container and immediately reconnect the loop tubing back in place to seal the sample bottle.
8. **Dirty hands** fill out the sample tag for the blank bottle and partially stick the label on the mercury and metals equipment blank bottle without touching the bottles.  
**Clean hands** secures the label and places the blank container in the inner Ziploc bag and seals closed removing as much air as possible.
9. **Dirty hands** hold the outer Ziploc bag open for **clean hands** to insert the bagged sample.
10. **Dirty hands** seals the outer Ziploc bag and removes as much air as possible and places the bagged sample in the cooler separate from other samples to prevent contamination from any wire tags used on routine samples.
11. Rinse the rope and weights with water to remove any visible dirt and place inside a plastic bag and storage container. Rope may be reused several times if rinsed frequently.

#### 4.8.5.5. Total Recoverable Grab Sample Procedure

If collecting total recoverable metals along with dissolved samples, the bridge bottle must be shaken regularly during sample processing to ensure proper mixing of suspended solids. Additionally the bridge bottle must be shaken regularly during total recoverable metals processing.

**Note:** Process total recoverable after dissolved samples to avoid having to change the tubing.

1. **Clean hands** remove the capsule filter from the tubing and open the third mercury container and the third total recoverable loop bottle and discard the water. Replace the loop bottle cap immediately after discarding the water.
2. **Dirty hands** switches on the pump  
**Clean hands** hold the outlet of the capsule filter just above the open mouth of the mercury bottle. Fill the mercury bottle to overflowing and loosely cap followed by tightly capping while slightly tilting and squeezing the bottle. Make sure any air bubbles are smaller than a pea.
3. **Clean hands** connects the tubing to the total recoverable loop container and fills the container until full. **Clean hands** immediately reconnect the loop tubing to seal the container.
4. **Clean hands** hold the total recoverable loop container to allow **dirty hands** to place a filled out WQM label directly on the midsection of the bottle. The mercury container also has a WQM label placed on the midsection in the same manner as above.
5. **Clean hands** places the mercury total recoverable container into the inner bag with the total recoverable loop container and seals the inner bag.  
**Dirty hands** proceeds to seal the outer bag.
6. Immediately place blanks and samples on ice in a separate dedicated sample cooler containing only clean metal containers. This prevents contamination from other samples or wire tags.

#### 4.8.5.6. Other Parameters

1. The clean protocol is complete at this step and any field parameters or other samples can now be taken from the remaining water in the bridge bottle.
2. Rinse the rope and weights with lab grade water to remove any visible dirt, place inside a plastic bag, and store in the storage container. Rope may be reused several times if rinsed frequently.

## 4.8.6. Effluent Sample Collection Protocol

### 4.8.6.1. Equipment Setup

1. Locate an area near the effluent sampling location where sample processing will occur. The area must be on a flat, smooth surface protected from the wind that is free of falling debris and swirling dust. The tailgate of an enclosed truck bed or SUV is often a good location.
2. Locate the equipment box and coolers containing the sample containers as close as possible to the sample processing area.
3. Cover the work area with plastic sheeting (>2 mil thickness). Set out the pump and connect the battery. Switch the pump on and dial the speed to 5. Turn off pump.
4. Remove a tubing kit and sample containers from the cooler and place on the plastic near the pump.
5. Remove a pack of powder free vinyl gloves from the storage container and place on the plastic. Remove the plastic sample caddy from the storage box and place it on the sample processing area near the pump.
6. Locate the sample wand used for positioning the Teflon sample tubing in the effluent.
7. Refer to **Figure 4.5**, for the final layout for effluent sampling.

### 4.8.6.2. Dissolved and/or Total Recoverable Grab Blanks and Samples

1. Refer to **Figure 4.5 Effluent Sampling Apparatus** for the schematic of the field sampling equipment used to process blanks and samples.
2. The effluent grab blanks and samples are collected in exactly the same manner as the ambient grab blanks and samples.
3. Instead of collecting from a bridge bottle, use a PVC sample wand equipped with a special notch to hold the Teflon tubing.
4. **Clean hands** presents a section of the Teflon tubing just past the inlet to **dirty hands** who then attaches the tubing to the sample wand.
5. The entire assembly: sample caddy containing the empty sample container, sample tubing, pump/battery, and sample wand are transported to the effluent sampling location.
6. **Dirty hands** place the sample wand into the collection zone and avoiding touching the sample tube tip on any structures, sediment or debris.
7. At this point, refer to section 4.10.7.4 on how to process samples. The procedure is complete once reaching step 9.

#### **4.8.7. Clean Metals Sample Labeling**

After scheduling a run, print the labels from CEDS. Make sure the labels use good quality glue on it (i.e. Avery) and printed on a laser printer to avoid smudging. Unless specified otherwise, fill out labels with date and time and attach to the bottles before getting them wet. Never place a label on the outside of the plastic bag, as this will result in an unlabeled sample bottle.

#### **4.8.8. Shipping Clean Metals Samples**

##### **4.8.8.1. Supplies and Materials**

1. An insulated shipping cooler such as a 28 quart cooler is usually sufficient to hold sample bottles, wet ice packs, and protective material.
2. Liner Bags which are 30 gallon plastic trash bags with a dimension of 30"x36"x1 mil.
3. Non-DCLS laboratories may request wrapping the 1 L sample bottles with plastic bubble wrap. If so, ideal packing material is bubble wrap 1/2" bubbles in 12"x16" sheets. 1' wide roll of the bubble wrap is suitable for the loop containers.
4. Size 33 or similar rubber bands are large enough to secure the bubble wrap around 1 liter containers packed in two Ziploc bags.
5. Wet ice cubes. Unless directed otherwise, do not use blue ice packs. The gel does not ensure proper transport temperature.
6. Strapping tape, 1" filament type.
7. Duct tape, 2" utility type.
8. 3" clear acrylic adhesive tape to seal ice bags and labels to bottles and coolers.
9. Packing list envelopes, clear plastic self-adhesive type.
10. Address Labels, specific to the carrier.

##### **4.8.8.2. Sample Packaging**

1. Immediately following sample collection, place sample bottles in storage cooler with wet ice for transport back to the regional office for packing into shipping coolers.
2. Insert two trash bags into the cooler to provide a double lining.
3. Fill the cooler with ice to the shoulder of the sample bottles.
4. Place the chilled sample containers upright into the lined cooler and surround with ice. The sample containers and ice should be tightly packed. When the cooler is properly packed there will be no extra space left in the cooler.

5. Seal each liner bag by twisting the top of the bag and tying in a knot.
6. If appropriate, attach a 1 gallon Ziploc bag that will hold the packing list envelope to the underside of the shipping cooler lid. Insert the appropriate sample documentation (e.g. chain of custody form, field data sheets, or special lab instructions) and seal the envelope. Place the sealed envelope in the Ziploc bag and seal bag for protection.
7. Close the lid, seal horizontal joints with duct tape, and secure with strapping tape.
8. Attach address label to side of cooler and protect with clear sealing tape.

#### **4.8.8.3. Sample Transportation**

For those samples shipped via standard DCLS courier service, no special precautions beyond normal shipping procedures are required. Sample packaging and transportation items listed below are provided for those samples that are to be shipped long distances (generally interstate) and are intended for worst case shipping conditions.

1. Samples shipped by common carrier must comply with applicable Department of Transportation Hazardous Materials Regulations, [40 CFR Part 172](#). The person offering such material for transportation is responsible for ensuring such compliance. See [40 CFR Part 136 Table II](#) for guidance on applicability of preserved environmental samples.
2. Ship samples on the day of collection and use a reliable courier service for priority or next day delivery.
3. A large amount of effort is required to prepare and sample four to five sites on a typical run. Four samples represents over \$1000.00 in equipment and laboratory costs so coordinate sample shipment closely with DCLS until delivery is confirmed and condition of samples upon receipt is verified.

#### **4.8.9. Clean Metals Quality Control**

1. The protocols in this SOP are designed to include all the necessary Quality Control steps needed to produce reliable accurate data.
2. Table 4.5 Quality Control Recommendations for Trace Metals Sample Collection lists the critical control points of the sampling protocol. These control points are the minimum steps required for the collection of samples. When field contamination is detected additional blanks and other quality control samples are necessary to identify and correct the problem.
3. Field equipment blanks (identified with group code CMETB and container ID EB with a depth of 0.0) should be collected with every sample including the mercury blank. If total recoverable samples are also collected, the dissolved equipment blank will be representative of the total recoverable sample. If only total recoverable samples are collected, then collecting field equipment blank is required.

4. For effluent sites, blank samples must be collected prior to each sample and all trace metal samples.
5. If ambient site conditions indicate potential problems then it would be wise to collect additional samples. Some site conditions which would warrant blanks prior to sample collection are:
  - a. Road construction producing visible dust,
  - b. Any operation causing visible dust emissions,
  - c. High total suspended solids conditions instream,
  - d. Recent deicing of bridges,
  - e. High traffic volume on bridge and,
  - f. Heavy rain events during sampling.

At a frequency of greater than 10%, collect field duplicates. Field duplicates for ambient sample collection involve processing an additional blank and sample from the bridge bottle.

Field duplicates for effluent sample collection involve processing an additional blank and sample in series from the effluent. This may produce variable results due to temporal variability.

#### **4.8.10. Clean Metals Quick Reference Guide**

##### **Ambient Sample Collection Quick Reference**

1. Tie the 5 pound weight to the bridge bottle.
2. Collect the sample using the bridge bottle.
3. Untie the 5 pound weight.
4. Connect the tube to the first loop container.
5. Rinse the filter with the contents of the container.
6. Remove the tube from the empty bottle and place on the second loop container.
7. Pump 125mls of water to waste through the filter to purge previous sample.
8. Fill the mercury blank and seal.
9. Connect the filter to the empty first loop container.
10. Pump out of the second loop container into the first without letting the filter go dry.
11. Seal the blank loop container.
12. Remove the tube from the now empty second loop container and reconnect the tube to the bridge bottle vent tube.
13. Pump 125mls of water to waste through the filter to purge previous sample.
14. Collect the mercury sample.
15. Unscrew the lid of the second loop container and discard the water and replace the lid.
16. Connect the filter to the second loop container and fill.
17. Seal the sample containers.
18. Remove the filter and collect the total recoverable sample.
19. Collect field parameters.
20. Pack in ice and transport.



### **Effluent Sample Collection Quick Reference**

1. Connect the tube to the first loop container.
2. Rinse the filter with the contents of the container.
3. Remove the tube from the empty bottle and place on the second loop container.
4. Pump 125mls of water to waste through the filter to purge previous sample.
5. Fill the mercury blank and seal.
6. Connect the filter to the empty first loop container.
7. Pump out of the second loop container into the first without letting the filter go dry.
8. Seal the blank loop container.
9. Remove the tube from the now empty second loop container and connect the tube to the sample wand.
10. Pump 125mls of water to waste through the filter to purge previous sample.
11. Collect the mercury sample.
12. Unscrew the lid of the second loop container and discard the water and replace the lid.
13. Connect the filter to the second loop container and fill.
14. Seal the sample containers.
15. Remove the filter and collect the total recoverable sample.
16. Collect field parameters.
17. Pack in ice and transport.

### **Ambient Sample Collection without the Bridge Bottle Quick Reference**

1. Connect the tube to the first loop container.
2. Rinse the filter with the contents of the container.
3. Remove the tube from the empty bottle and place on the second loop container.
4. Pump 125mls of water to waste through the filter to purge previous sample.
5. Fill the mercury blank and seal.
6. Connect the filter to the empty first loop container.
7. Pump out of the second loop container into the first without letting the filter go dry.
8. Seal the blank loop container.
9. Remove the tube from the now empty second loop container and connect the tube to the sample wand.
10. Pump 125mls of water to waste through the filter to purge previous sample.
11. Collect the mercury sample.
12. Unscrew the lid of the second loop container and discard the water and replace the lid.
13. Connect the filter to the second loop container and fill.
14. Seal the sample containers.
15. Remove the filter and collect the total recoverable sample.
16. Collect field parameters.
17. Pack in ice and transport.

## 4.8.11. Referenced Documents

The methods and research articles used to develop the field sampling equipment are:

1. Benolt, Gaboury, Clean Technique Measurement of Pb, Ag, and Cd in Freshwater: A Redefinition of Metal Pollution, Environ. Sci. Technol., Vol. 28, No. 11, 1994.
2. Horowitz, A.J. et. al., The Effect of Membrane Filtration Artifacts on dissolved Trace Element Concentrations, Wat. Res. Vol. 26, No. 6, pp. 753-763, 1992.
3. Horowitz, Arthur J., et.al., On the Problems Associated with Using Filtration to Define Trace Element Concentrations in Natural Water Samples, U.S. Geological Survey.
4. Martin, Gary R., et.al., ), A Comparison of Surface-grab and Cross Sectionally Integrated Stream-water-quality Sampling Methods, Water Environment Research, Volume 64, 866 (1992).
5. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels, EPA 821-R-95-034, April 1995.
6. Geological Survey Protocol for the Collection and Processing of Surface-Water Samples for the Subsequent Determination of Inorganic Constituents in Filtered Water. United States Geological Survey, Open-File Report 94-539.

**Table 4.1: Target Analytes**

Parameter	CAS Number	Method Detection Limits, ug/L					
		ICPMS USN Freshwater	ICPMS USN Saltwater	ICPMS USN TR Freshwater	ICPMS USN TR Saltwater	ICPMS	ICP AES USN
Aluminum	7429-90-5			0.04		0.37	
Antimony	7440-36-0	0.05		0.03		0.33	
Arsenic	7440-38-2	0.07		0.03		0.24	5.37
Barium	7440-39-3						
Beryllium	7440-41-7						
Cadmium	7440-43-9	0.05		0.04		1.72	2.37
Calcium	7440-70-2						0.08
Chromium	7440-47-3	0.02		0.04			2.27
Copper	7440-50-8	0.02		0.06		0.87	4.98
Iron	7439-89-6						2.30
Lead	7439-92-1	0.17		0.03		0.28	
Magnesium	7439-95-4						0.00
Manganese	7439-96-5	0.02		0.03		1.32	0.58
Mercury	7439-97-6					0.12	
Nickel	7440-02-0	0.04		0.02		0.39	1.71
Selenium	7782-49-2			0.06		0.77	
Silver	7440-22-4	0.19		0.03		0.15	
Thallium	7440-28-0						
Zinc	7440-66-6	0.26		0.03		2.18	1.95
ICPMS USN- Inductively Coupled Plasma Mass Spectrometry sample introduced by Ultrasonic Nebulization							
ICPMS USN TR- Inductively Coupled Plasma Mass Spectrometry sample introduced by Ultrasonic Nebulization Total Recoverable							
ICPMS- Inductively Coupled Plasma Mass Spectrometry							
ICP AES USN- Inductively Coupled Plasma Atomic Emission Spectrometry sample introduction by Ultrasonic Nebulization							

**Table 4.2: Parameter Group Codes**

SALTWATER	
DCMETS1	Dissolved clean metals in saltwater
TCMETS1	Total clean metals in saltwater
FRESHWATER	
DCMET1	Dissolved clean metals in freshwater
TCMET1	Total clean metals in freshwater
QUALITY ASSURANCE	
CMETB	Clean Metals Equipment Blanks

MERCURY ONLY	
DCHG	Dissolved mercury in freshwater
TCHG	Total mercury in freshwater
EFFLUENT	
CMETSB	Dissolved clean metals in effluents
DEQMET	Total clean metals in effluents

The group codes include mercury and the method blank container. For mercury only, use code DCHG or TCHG.

**Table 4.3: Essential Equipment List**

	Item	Supplier	Catalog Number
1	Peristaltic pump unit	Cole-Parmer	H-07533-40
2	Quick release pump head	Cole-Parmer	H-07518-60
3	Cigarette lighter adapter cable	Cole-Parmer	H-07573-02
4	Portable battery pack	Cole-Parmer	H-03276-50
5	Powder free vinyl gloves	Fisher Scientific	11-387-3
6	Clear polyethylene drop cloth	Hardware store	4 to 6 mil
7	Preprinted laser jet waterproof labels	Avery	5163
8	Indelible markers	Office supply store	Sharpie
9	Bridge bottle	DCLS	N/A
10	Bridge bottle tubing kit	DCLS	N/A
11	Teflon tubing kit	DCLS	N/A
12	Sample bottles	DCLS	N/A
13	One gallon Ziploc bags	Grocery store	N/A
14	Two gallon Ziploc bags	Grocery store	N/A
15	Bridge bottle weights	Sporting goods store	N/A
16	White polypropylene line	Hardware Store	N/A

**Table 4.4: Ancillary Supplies**

	Item	Supplier	Catalog Number
1	Plastic bubble wrap	Consolidated Plastics	87600LG
2	Rubber bands	Office supply store	Large
3	Ice	RO ice machine	N/A
4	Duct tape	Hardware store	N/A
5	Knife or cutters	Hardware store	N/A
6	Fuses for pump and battery	Hardware store	N/A

**Table 4.5: Quality Control Recommendations for Trace Metals Sample Collection**

Sampling Requirements	Criteria	Frequency
Type of Method	Performance based by demonstration of no detectable contamination of target analytes or interferences in samples or blanks. Method 1669 and the sampling apparatus and techniques used by the DEQ are recommended for sample collection.	Demonstration of contamination free samples and blanks every time a variation is made to the method.
Media Type	Freshwater and treated final effluent wastewater for dissolved and total recoverable metals	N/A
Training	Sample collection by only thoroughly trained personnel. Personnel must demonstrate proficiency in collecting contaminant free blanks and samples	Train a minimum of one time prior to any sample collection. Stop and provide additional training if field QC demonstrates problems until the criteria is achieved
Filtration	0.45 um capsule filter with nominal surface area of 60.0 cm <sup>2</sup> Maximum sample volume 1000 ml through single use filter	Onsite at time of collection or within one hour for composite samples after the sample sequence is complete.
Sample Containers	No detectable target analytes above MDL	Minimum of 1% of containers checked by the laboratory per batch after initial demonstration of acceptable blank QC
Sampling Equipment	No detectable target analytes above MDL	Minimum of 1% of equipment checked by the laboratory per batch after initial demonstration of acceptable blank QC
Comprehensive Grab Field Blank	Blanks must be <10% sample concentration or if sample is < MDL, field blank contamination is OK.	Process one with every sample collected. When duplicate samples are collected, only one blank is necessary.
Comprehensive Composite Field Blank	Blanks must be <10% sample concentration or if sample is <MDL, field blank contamination is OK	Process one per site for every ten samples. When 10% frequency rule is applied, blanks are to be collected with the first sample. Process field blanks every time equipment is field cleaned to be reused between sites or sample events.
Field Duplicate	Statistically equivalent to the RPD of the matrix spike and matrix spike duplicates for quantifiable concentrations	Process one per site for every ten samples.
Preservation	Samples must be iced in the field. Composite samples must be iced during collection. Adjust pH <2 SU within 72 hours of collection and samples must remain in original containers for a minimum of 18 hours prior to digestion or analysis.	All samples must be acid preserved in the field or by the laboratory using ultra-pure HNO <sub>3</sub> to pH <2 SU. Samples should be iced in field immediately after collecting.
Documentation	Sampling activities must be documented on paper or by computerized sample tracking.	Documentation must be done per sample, per site.

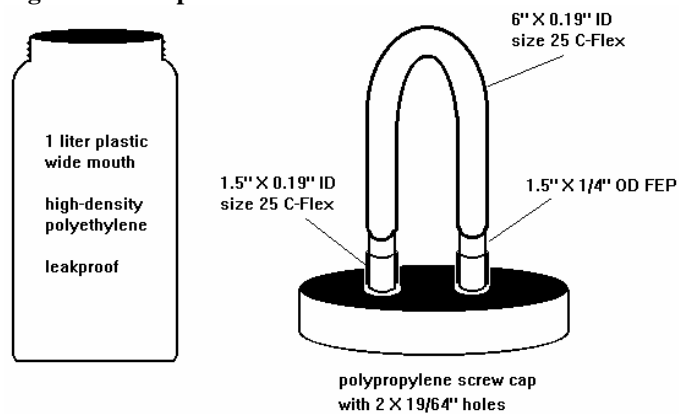
**Figure 4.1: Bridge Bottle**



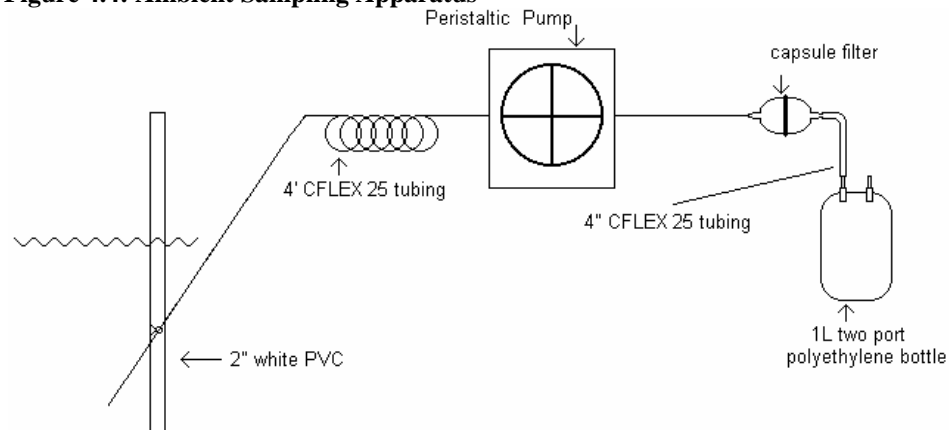
**Figure 4.2 Loop and Mercury Sample Bottles**



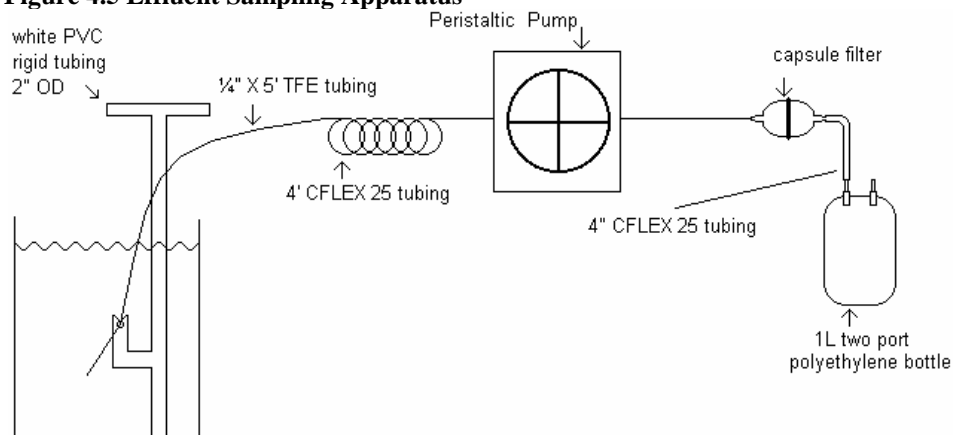
**Figure 4.3 Sample Container Schematics**



**Figure 4.4: Ambient Sampling Apparatus**



**Figure 4.5 Effluent Sampling Apparatus**



**Figure 4.6 WQM Monthly Run Schedule Parameters**

**Run Schedule : TNCLINCH**

General Run Schedule Run

+ Add New Station to Run Schedule Copy New Run Schedule Change Year

Station: **6BCLN177.47** Edit Items

Year: 2016 Visits Per Year: 6 Station Order: 1 %FRB: 50 %

Survey Program	Depth Desc.	Depth	Blanks/Dups	Container Id	Lab Proc Code	Special Study	Parameter Group Cd	Collection Equipment
CL	S	0.3	R	1		15019	DCMET1	Water Sampler (Other)
CL	S	0.3	R	2		15019	PROB4-2	Water Sampler (Other)
CL	S	0.3	R	3		15019	SSC-C2	Water Sampler (Other)
CL	S	0.3	R	4		15019	TCMET1	Water Sampler (Other)
CL	S	0.3	R	5		15019	TNUTL	Water Sampler (Other)
CL	S	0.3	R	6		15019	TOC	Water Sampler (Other)

## **Appendix D**

### **9 Virginia Administrative Code 25-260-140 Virginia Water Quality Standards**

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## 9VAC25-260-140. Criteria for Surface Water.

A. Instream water quality conditions shall not be acutely<sup>1</sup> or chronically<sup>2</sup> toxic except as allowed in 9VAC25-260-20 B (mixing zones). The following are definitions of acute and chronic toxicity conditions:

"Acute toxicity" means an adverse effect that usually occurs shortly after exposure to a pollutant. Lethality to an organism is the usual measure of acute toxicity. Where death is not easily detected, immobilization is considered equivalent to death.

"Chronic toxicity" means an adverse effect that is irreversible or progressive or occurs because the rate of injury is greater than the rate of repair during prolonged exposure to a pollutant. This includes low level, long-term effects such as reduction in growth or reproduction.

B. The following table is a list of numerical water quality criteria for specific parameters.

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Acenaphthene (µg/l) 83329					70	90
Acrolein (µg/l) 107028	3.0	3.0			3	400
Acrylonitrile (µg/l) 107131  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-6</sup>					0.61	70

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
5.						
Aldrin (µg/l) 309002  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .	3.0		1.3		0.0000077	0.0000077
Ammonia (µg/l) 766417  Chronic criterion is a 30-day average concentration not to be exceeded more than once every three years on the average.(see 9VAC25-260-155)						
Anthracene (µg/l) 120127					300	400
Antimony (µg/l) 7440360					5.6	640
Arsenic (µg/l) <sup>5</sup> 7440382	340	150	69	36	10	

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Bacteria (see 9VAC25- 260-160 and 9VAC25- 260-170)						
Barium (µg/l) 7440393					2,000	
Benzene (µg/l) 71432  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup>					5.8	160
Benzidine (µg/l) 92875  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup>					0.0014	0.11
Benzo (a) anthracene (µg/l) 56553  Known or suspected carcinogen;					0.012	0.013

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
human health criteria at risk level 10 <sup>-5</sup>						
Benzo (b) fluoranthene (µg/l) 205992  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup>					0.012	0.013
Benzo (k) fluoranthene (µg/l) 207089  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup>					0.12	0.13
Benzo (a) pyrene (µg/l) 50328  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup>					0.0012	0.0013

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
5						
Bis2-Chloroethyl Ether (µg/l) 111444  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup>					0.30	22
Bis (chloromethyl) Ether 542881  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup>					0.0015	0.17
Bis2-Chloroisopropyl Ether (Bis (2-Chloro-1-methylethyl) Ether) (µg/l) 108601					200	4,000
Bis2-Ethylhexyl Phthalate (µg/l) 117817					3.2	3.7

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> . Synonym = Di-2-Ethylhexyl Phthalate.						
Bromoform (µg/l) 75252  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					70	1,200
Butyl benzyl phthalate (µg/l) 85687					1.0	1.0
Cadmium (µg/l) <sup>5</sup> 7440439  Freshwater values are a function of total hardness as calcium carbonate (CaCO <sub>3</sub> ) mg/l and the WER. The	1.8 CaCO <sub>3</sub> = 100	0.72 CaCO <sub>3</sub> = 100	33 X WER	7.9 X WER	5	



Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
<p>minimum hardness allowed for use in the equation below shall be 25 and the maximum hardness shall be 400 even when the actual ambient hardness is less than 25 or greater than 400.</p> <p>Freshwater acute criterion (µg/l)  <math>WER_e = (0.9789[\ln(\text{hardness})] - 3.866)</math>  <math>(CF_a)</math></p> <p>Freshwater chronic criterion (µg/l)  <math>WER_c = (0.7977[\ln(\text{hardness})] - 3.909)</math>  <math>(CF_c)</math></p> <p>WER =  Water Effect Ratio = 1  unless determined otherwise under</p>						

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
9VAC25-260-140 F  e = natural antilogarithm  ln = natural logarithm  CF = conversion factor a (acute) or c (chronic)  $CF_a = 1.136672 - [(\ln \text{ hardness})(0.041838)]$  $CF_c = 1.101672 - [(\ln \text{ hardness})(0.041838)]$						
Carbon tetrachloride (µg/l) 56235  Known or suspected carcinogen; human health criteria at risk level $10^{-5}$ .					4.0	50
Carbaryl (µg/l) 63252	2.1	2.1	1.6			

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Chlordane (µg/l) 57749  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .	2.4	0.0043	0.09	0.0040	0.0031	0.0032
Chloride (µg/l) 16887006  Human health criterion to maintain acceptable taste and aesthetic quality and applies at the drinking water intake.  Chloride criteria do not apply in Class II transition zones (see subsection C of this section).	860,000	230,000			250,000	
Chlorine, Total Residual (µg/l) 7782505	19 See 9VAC25- 260-110	11 See 9VAC25- 260-110				

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
In DGIF class i and ii trout waters (9VAC25-260-390 through 9VAC25-260-540) or waters with threatened or endangered species are subject to the halogen ban (9VAC25-260-110).						
Chlorine Produced Oxidant (µg/l) 7782505			13	7.5		
Chlorobenzene (µg/l) 108907					100	800
Chlorodibromomethane (µg/l) 124481  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					8.0	210
Chloroform					60	2,000



Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
(µg/l) 67663						
2-Chloronaphthalene (µg/l) 91587					800	1,000
2-Chlorophenol (µg/l) 95578					30	800
Chlorpyrifos (µg/l) 2921882	0.083	0.041	0.011	0.0056		
Chromium III (µg/l) <sup>5</sup> 16065831  Freshwater values are a function of total hardness as calcium carbonate CaCO <sub>3</sub> mg/l and the WER. The minimum hardness allowed for use in the equation below shall be 25 and the maximum hardness shall be 400 even when the actual	570 (CaCO <sub>3</sub> = 100)	74 (CaCO <sub>3</sub> = 100)			100 (total Cr)	

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
ambient hardness is less than 25 or greater than 400.  Freshwater acute criterion $\mu\text{g/l}$ $\text{WER} = e^{\{0.8190[\ln(\text{hardness})] + 3.7256\}}$ $CF_a$  Freshwater chronic criterion $\mu\text{g/l}$ $\text{WER} = e^{\{0.8190[\ln(\text{hardness})] + 0.6848\}}$ $CF_c$  WER = Water Effect Ratio = 1 unless determined otherwise under 9VAC25-260-140.F  e = natural antilogarithm  ln = natural logarithm  CF = conversion factor a						

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
(acute) or c (chronic) $CF_a = 0.316$ $CF_c = 0.860$						
Chromium VI ( $\mu\text{g/l}$ ) <sup>5</sup> 18540299	16	11	1,100	50		
Chrysene ( $\mu\text{g/l}$ ) 218019  Known or suspected carcinogen; human health criteria at risk level $10^{-5}$ .					1.2	1.3
Copper ( $\mu\text{g/l}$ ) <sup>5</sup> 7440508  Freshwater values are a function of total hardness as calcium carbonate $\text{CaCO}_3$ mg/l and the WER. The minimum hardness allowed for use in the equation below shall	13 $\text{CaCO}_3 = 100$	9.0 $\text{CaCO}_3 = 100$	9.3 X WER	6.0 X WER	1,300	

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
<p>be 25 and the maximum hardness shall be 400 even when the actual ambient hardness is less than 25 or greater than 400.</p> <p>Freshwater acute criterion (µg/l)</p> $WER [e^{0.9422[\ln(hardness) - 1.700]}]$ <p>(CF<sub>a</sub>)</p> <p>Freshwater chronic criterion (µg/l)</p> $WER [e^{0.8545[\ln(hardness) - 1.702]}]$ <p>(CF<sub>c</sub>)</p> <p>WER = Water Effect Ratio = 1 unless determined otherwise under 9VAC25-260-140 F.</p> <p>e = natural antilogarithm</p>						

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
<p>ln = natural logarithm</p> <p>CF = conversion factor a (acute) or c (chronic)</p> <p>CF<sub>a</sub> = 0.960</p> <p>CF<sub>c</sub> = 0.960</p> <p>Alternate copper criteria in freshwater: the freshwater criteria for copper can also be calculated using the EPA 2007 Biotic Ligand Model (See 9VAC25-260-140 G).</p> <p>Acute saltwater criterion is a 24-hour average not to be exceeded more than once every three years on the average.</p>						
Cyanide,	22	5.2	1.0	1.0	4	

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Free (µg/l) 57125						400
DDD (µg/l) 72548  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.0012	0.0012
DDE (µg/l) 72559  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.00018	0.00018
DDT (µg/l) 50293  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .  Total concentratio n of DDT and metabolites shall not	1.1	0.0010	0.13	0.0010	0.00030	0.00030



Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
exceed aquatic life criteria.						
Demeton (µg/l) 8065483		0.1		0.1		
Diazinon (µg/l) 333415	0.17	0.17	0.82	0.82		
Dibenz (a, h) anthracene (µg/l) 53703  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.0012	0.0013
1,2- Dichloroben zene (µg/l) 95501					1,000	3,000
1,3- Dichloroben zene (µg/l) 541731					7	10
1,4 Dichloroben zene (µg/l) 106467					300	900
3,3 Dichloroben					0.49	1.5

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
zidine (µg/l) 91941  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .						
Dichlorobromomethane (µg/l) 75274  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					9.5	270
1,2 Dichloroethane (µg/l) 107062  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					99	6,500
1,1 Dichloroethylene (µg/l) 75354					300	20,000

Table of Parameters <sup>6, 7</sup>						
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	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
1,2-trans-dichloroethylene (µg/l) 156605					100	4,000
2,4 Dichlorophenol (µg/l) 120832					10	60
2,4 Dichlorophenoxy acetic acid (Chlorophenoxy Herbicide) (2,4-D) (µg/l) 94757					1,300	12,000
1,2-Dichloropropane (µg/l) 78875  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					9.0	310
1,3-Dichloropropene (µg/l) 542756  Known or suspected carcinogen; human					2.7	120

Table of Parameters <sup>6, 7</sup>						
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	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
health criteria at risk level 10 <sup>-5</sup> .						
Dieldrin (µg/l) 60571  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .	0.24	0.056	0.71	0.0019	0.000012	0.000012
Diethyl Phthalate (µg/l) 84662					600	600
2,4 Dimethylphe nol (µg/l) 105679					100	3,000
Dimethyl Phthalate (µg/l) 131113					2,000	2,000
Di-n-Butyl Phthalate (µg/l) 84742					20	30
2,4 Dinitrophen ol (µg/l) 51285					10	300
Dinitrophen					10	1,000

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
ols (µg/l) 25550587						
2-Methyl- 4,6- Dinitrophen ol (µg/l) 534521					2	30
2,4 Dinitrotolue ne (µg/l) 121142  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.49	17
Dioxin 2, 3, 7, 8- tetrachlorod ibenzo-p- dioxin (µg/l) 1746016					5.0 E-8	5.1 E-8
1,2- Diphenylhyd razine (µg/l) 122667  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.3	2.0

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Dissolved Oxygen (µg/l) (See 9VAC25- 260-50)						
Alpha- Endosulfan (µg/l) 959988  Total concentratio n alpha and beta- endosulfan shall not exceed aquatic life criteria.	0.22	0.056	0.034	0.0087	20	30
Beta- Endosulfan (µg/l) 33213659  Total concentratio n alpha and beta- endosulfan shall not exceed aquatic life criteria.	0.22	0.056	0.034	0.0087	20	40
Endosulfan Sulfate (µg/l) 1031078					20	40
Endrin (µg/l) 72208	0.086	0.036	0.037	0.0023	0.03	0.03



Table of Parameters <sup>6, 7</sup>						
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	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Endrin Aldehyde (µg/l) 7421934					1	1
Ethylbenzene (µg/l) 100414					68	130
Fecal Coliform (see 9VAC25- 260-160)						
Fluoranthene (µg/l) 206440					20	20
Fluorene (µg/l) 86737					50	70
Foaming Agents (µg/l)  Criterion measured as methylene blue active substances. Criterion to maintain acceptable taste, odor, or aesthetic quality of drinking water and applies at the drinking water intake.					500	
Guthion		0.01		0.01		

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
(µg/l) 86500						
Heptachlor (µg/l) 76448  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .	0.52	0.0038	0.053	0.0036	0.000059	0.000059
Heptachlor Epoxide (µg/l) 1024573  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .	0.52	0.0038	0.053	0.0036	0.00032	0.00032
Hexachlorob enzene (µg/l) 118741  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.00079	0.00079

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Hexachlorobutadiene (µg/l) 87683  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.1	0.1
Hexachlorocyclohexane Alpha-BHC (µg/l) 319846  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.0036	0.0039
Hexachlorocyclohexane Beta-BHC (µg/l) 319857  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.080	0.14

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Hexachlorocyclohexane (µg/l) (Lindane) Gamma-BHC 58899	0.95		0.16		4.2	4.4
Hexachlorocyclohexane (HCH)- Technical (µg/l) 608731 Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.066	0.1
Hexachlorocyclopentadiene (µg/l) 77474					4	4
Hexachloroethane (µg/l) 67721 Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					1	1
Hydrogen		2.0		2.0		

Table of Parameters <sup>6, 7</sup>						
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	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
sulfide (µg/l) 7783064						
Indeno (1,2,3,-cd) pyrene (µg/l) 193395  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.012	0.013
Iron (µg/l) 7439896  Criterion to maintain acceptable taste, odor, or aesthetic quality of drinking water and applies at the drinking water intake.					300	
Isophorone (µg/l) 78591  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					340	18,000

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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Kepone (µg/l) 143500		zero		zero		
Lead (µg/l) <sup>5</sup> 7439921  Freshwater values are a function of total hardness as calcium carbonate CaCO <sub>3</sub> mg/l and the water effect ratio. The minimum hardness allowed for use in the equation below shall be 25 and the maximum hardness shall be 400 even when the actual ambient hardness is less than 25 or greater than 400.  Freshwater acute criterion (µg/l) WER [e {1.273ln(hardn ess)}]-	94 CaCO <sub>3</sub> = 100	11 CaCO <sub>3</sub> = 100	230 X WER	8.8 X WER	15	



Table of Parameters <sup>6, 7</sup>						
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	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
$1.084 \left[ \frac{1}{\text{WER}} \right] (\text{CF}_a)$ Freshwater chronic criterion ( $\mu\text{g/l}$ ) $\text{WER} = \left[ \frac{1.273}{\ln(\text{hardness})} - 3.259 \right]$ $(\text{CF}_c)$ WER = Water Effect Ratio = 1 unless determined otherwise under 9VAC25-260-140 F e = natural antilogarithm ln = natural logarithm CF = conversion factor a (acute) or c (chronic) $\text{CF}_a = 1.46203 - [(\ln \text{hardness})(0.145712)]$ $\text{CF}_c = 1.46203 - [(\ln \text{hardness})(0.145712)]$						
Malathion		0.1		0.1		

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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
(µg/l) 121755						
Mercury (µg/l) 5 7439976	1.4	0.77	1.8	0.94		
Methyl Bromide (µg/l) 74839					100	10,000
3-Methyl-4- Chloropheno l 59507					500	2,000
Methyl Mercury (Fish Tissue Criterion mg/kg) 8 22967926					0.30	0.30
Methylene Chloride (µg/l) 75092  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> . Synonym = Dichloromet hane					20	1,000
Methoxychlor (µg/l) 72435		0.03		0.03	0.02	0.02

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
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	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Mirex (µg/l) 2385855		zero		zero		
Nickel (µg/l) <sup>5</sup> 744002	180 CaCO <sub>3</sub> = 100	20 CaCO <sub>3</sub> = 100	74 X WER	8.2 X WER	610	4,600
Freshwater values are a function of total hardness as calcium carbonate CaCO <sub>3</sub> mg/l and the WER. The minimum hardness allowed for use in the equation below shall be 25 and the maximum hardness shall be 400 even when the actual ambient hardness is less than 25 or greater than 400.						
Freshwater acute criterion (µg/l) WER [e {0.8460[ln(hard ness)] + 1.312}] (CF <sub>3</sub> )						

Table of Parameters <sup>6, 7</sup>						
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	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Freshwater chronic criterion (µg/l) $WER \left[ e^{0.8460 \left[ \ln(\text{hardness}) - 0.8840 \right]} \right]$ (CF <sub>c</sub> )  WER = Water Effect Ratio = 1 unless determined otherwise under 9VAC25- 260-140 F  e = natural antilogarithm  ln = natural logarithm  CF = conversion factor a (acute) or c (chronic)  CF <sub>a</sub> = 0.998 CF <sub>c</sub> = 0.997						
Nitrate as N (µg/l) 14797558					10,000	
Nitrobenzene (µg/l) 98953					10	600
N-					0.0069	30

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	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Nitrosodimethylamine (µg/l) 62759  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .						
N-Nitrosodiphenylamine (µg/l) 86306  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					33	60
N-Nitrosodipropylamine (µg/l) 621647  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.050	5.1

Table of Parameters <sup>6, 7</sup>						
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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Nonylphenol (µg/l) 84852153	28	6.6	7.0	1.7		
Parathion (µg/l) 56382	0.065	0.013				
PCB Total (µg/l) 1336363  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .		0.014		0.030	0.00064	0.00064
Pentachloro benzene (µg/l) 608935					0.1	0.1
Pentachloro phenol (µg/l) 87865  Known or suspected carcinogen; human health criteria risk level at 10 <sup>-5</sup> .  Freshwater acute criterion (µg/l) e <sup>(1.005(pH)- 4.869)</sup>	8.7 pH = 7.0	6.7 pH = 7.0	13	7.9	0.3	0.4



Table of Parameters <sup>6, 7</sup>						
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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Freshwater chronic criterion (µg/l) <sub>(1.005(pH)-5.134)</sub>						
pH  See 9VAC25-260-50						
Phenol (µg/l) 108952					4,000	300,000
Phosphorus Elemental (µg/l) 7723140				0.10		
Pyrene (µg/l) 129000					20	4,000 30
Radionuclides  Gross Alpha Particle Activity (pCi/L)  Beta Particle & Photon Activity (mrem/yr) (formerly man-made radionuclides)  Combined Radium 226 and 228 (pCi/L)					15    4   5	

Table of Parameters <sup>6, 7</sup>						
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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Uranium (µg/L)					30	
Selenium (µg/l) <sup>5</sup> 7782492  WER shall not be used for freshwater acute and chronic criteria. Freshwater criteria expressed as total recoverable.	20	5.0	290 X WER	71 X WER	170	4,200
Silver (µg/l) <sup>5</sup> 7440224  Freshwater values are a function of total hardness as calcium carbonate (CaCO <sub>3</sub> ) mg/l and the WER. The minimum hardness allowed for use in the equation below shall be 25 and the maximum hardness	3.4; CaCO <sub>3</sub> = 100		1.9 X WER			

Table of Parameters <sup>6, 7</sup>						
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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
shall be 400 even when the actual ambient hardness is less than 25 or greater than 400.  Freshwater acute criterion (µg/l) $WER = \{1.72[\ln(\text{hardness}) - 6.52]\}$ (CF <sub>a</sub> )  WER = Water Effect Ratio = 1 unless determined otherwise under 9VAC25-260-140 F  e = natural antilogarithm  ln = natural logarithm  CF = conversion factor a (acute) or c (chronic)  CF <sub>a</sub> = 0.85						
Sulfate (µg/l)					250,000	

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PARAMETER CAS Number	USE DESIGNATION					
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	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Criterion to maintain acceptable taste, odor, or aesthetic quality of drinking water and applies at the drinking water intake.						
Temperature See 9VAC25-260-50						
1,2,4,5-Tetrachlorobenzene 95943					0.03	0.03
1,1,2,2-Tetrachloroethane (µg/l) 79345  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					2.0	30
Tetrachloroethylene (µg/l) 127184  Known or suspected carcinogen;					100	290

Table of Parameters <sup>6, 7</sup>						
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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
human health criteria at risk level 10 <sup>-5</sup> .						
Thallium (µg/l) 7440280					0.24	0.47
Toluene (µg/l) 108883					57	6,000 520
Total Dissolved Solids (µg/l) Criterion to maintain acceptable taste, odor or aesthetic quality of drinking water and applies at the drinking water intake.					500,000	
Toxaphene (µg/l) 8001352  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .	0.73	0.0002	0.21	0.0002	0.0070	0.0071
Tributyltin (µg/l)	0.46	0.072	0.42	0.0074		

Table of Parameters <sup>6, 7</sup>						
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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
60105						
1, 2, 4 Trichlorobenzene (µg/l) 120821  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.71	0.76
1,1,1- Trichloroethane 71556					10,000	200,000
1,1,2- Trichloroethane (µg/l) 79005  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					5.5	89
Trichloroethylene (µg/l) 79016  Known or suspected carcinogen; human health					6.0	70

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	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
criteria at risk level 10 <sup>-5</sup> .						
2, 4, 5- Trichlorophenol 95954					300	600
2, 4, 6- Trichlorophenol (µg/l) 88062  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					15	28
2-(2, 4, 5- Trichlorophenoxy) propionic acid (Silvex) (µg/l) 93721					100	400
Vinyl Chloride (µg/l) 75014  Known or suspected carcinogen; human health criteria at risk level 10 <sup>-5</sup> .					0.22	16



Table of Parameters <sup>6, 7</sup>						
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	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
Zinc (µg/l) <sup>5</sup> 7440666  Freshwater values are a function of total hardness as calcium carbonate (CaCO <sub>3</sub> ) mg/l and the WER. The minimum hardness allowed for use in the equation below shall be 25 and the maximum, hardness shall be 400 even when the actual ambient hardness is less than 25 or greater than 400.  Freshwater acute criterion (µg/l) $WER_{Fe} = \{0.8473[\ln(hardness)] + 0.884\} (CF_a)$ Freshwater chronic criterion	120 CaCO <sub>3</sub> = 100	120 CaCO <sub>3</sub> = 100	90 X WER	81 X WER	7,400	26,000

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
(µg/l) WER $[e^{\{0.8473[\ln(\text{hardness})]+0.884\}}]$ (CF <sub>c</sub> ) WER = Water Effect Ratio = 1 unless determined otherwise under 9VAC25- 260-140 F e = natural antilogarithm ln = natural logarithm CF = conversion factor a (acute) or c (chronic) CF <sub>a</sub> = 0.978 CF <sub>c</sub> = 0.986						

<sup>1</sup>One hour average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.

<sup>2</sup>Four-day average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.

<sup>3</sup>Criteria have been calculated to protect human health from toxic effects through drinking water and fish consumption, unless otherwise noted and apply in segments designated as PWS in 9VAC25-260-390 through 9VAC25-260-540.

<sup>4</sup>Criteria have been calculated to protect human health from toxic effects through fish consumption, unless otherwise noted and apply in all other surface waters not designated as PWS in 9VAC25-260-390 through 9VAC25-260-540.

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
<sup>5</sup> Acute and chronic saltwater and freshwater aquatic life criteria apply to the biologically available form of the metal and apply as a function of the pollutant's water effect ratio (WER) as defined in 9VAC25-260-140 F (WER X criterion). Metals measured as dissolved shall be considered to be biologically available, or, because local receiving water characteristics may otherwise affect the biological availability of the metal, the biologically available equivalent measurement of the metal can be further defined by determining a water effect ratio (WER) and multiplying the numerical value shown in 9VAC25-260-140 B by the WER. Refer to 9VAC25-260-140 F. Values displayed above in the table are examples and correspond to a WER of 1.0. Metals criteria have been adjusted to convert the total recoverable fraction to dissolved fraction using a conversion factor. Criteria that change with hardness have the conversion factor listed in the table above.						
<sup>6</sup> The flows listed below are default design flows for calculating steady state wasteload allocations unless statistically valid methods are employed which demonstrate compliance with the duration and return frequency of the water quality criteria.						
Aquatic Life:						
Acute criteria		1Q10				
Chronic criteria		7Q10				
Chronic criteria (ammonia)		30Q10				
Human Health:						
Noncarcinogens		30Q5				
Carcinogens		Harmonic mean				
The following are defined for this section:						
"1Q10" means the lowest flow averaged over a period of 1 day which on a statistical basis can be expected to occur once every 10 climatic years.						
"7Q10" means the lowest flow averaged over a period of 7 consecutive days that can be statistically expected to occur once every 10 climatic years.						
"30Q5" means the lowest flow averaged over a period of 30 consecutive days that can be statistically expected to occur once every 5 climatic years.						
"30Q10" means the lowest flow averaged over a period of 30 consecutive days that can be statistically expected to occur once every 10 climatic years.						
"Averaged" means an arithmetic mean.						
"Climatic year" means a year beginning on April 1 and ending on March 31.						

Table of Parameters <sup>6, 7</sup>						
PARAMETER CAS Number	USE DESIGNATION					
	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		Public Water Supply <sup>3</sup>	All Other Surface Waters <sup>4</sup>
	Acute <sup>1</sup>	Chronic <sup>2</sup>	Acute <sup>1</sup>	Chronic <sup>2</sup>		
<sup>7</sup> The criteria listed in this table are two significant digits. For other criteria that are referenced to other sections of this regulation in this table, all numbers listed as criteria values are significant.						
<sup>8</sup> The fish tissue criterion for methylmercury applies to a concentration of 0.30 mg/kg as wet weight in edible tissue for species of fish and shellfish resident in a waterbody that are commonly eaten in the area and have commercial, recreational, or subsistence value.						

C. Application of freshwater and saltwater numerical criteria. The numerical water quality criteria listed in subsection B of this section (excluding dissolved oxygen, pH, temperature) shall be applied according to the following classes of waters (see 9VAC25-260-50) and boundary designations:

CLASS OF WATERS	NUMERICAL CRITERIA
I and II (Estuarine Waters)	Saltwater criteria apply
II (Transition Zone)	More stringent of either the freshwater or saltwater criteria apply
II (Tidal Freshwater), III, IV, V, VI and VII	Freshwater criteria apply

The following describes the boundary designations for Class II, (estuarine, transition zone and tidal freshwater waters) by river basin:

1. Rappahannock Basin. Tidal freshwater is from the fall line of the Rappahannock River to the upstream boundary of the transition zone including all tidal tributaries that enter the tidal freshwater Rappahannock River.

Transition zone upstream boundary – N38° 4' 56.59"/W76° 58' 47.93" (430 feet east of Hutchinson Swamp) to N38° 5' 23.33"/W76° 58' 24.39" (0.7 miles upstream of Peedee Creek).

Transition zone downstream boundary – N37° 58' 45.80"/W76° 55' 28.75" (1,000 feet downstream of Jenkins Landing) to N37° 59' 20.07/W76° 53' 45.09" (0.33 miles upstream of Mulberry Point). All tidal waters that enter the transition zone are themselves transition zone waters.

Estuarine waters are from the downstream boundary of the transition zone to the mouth of the Rappahannock River (Buoy 6), including all tidal tributaries that enter the estuarine waters of the Rappahannock River.

2. York Basin. Tidal freshwater is from the fall line of the Mattaponi River at N37° 47' 20.03"/W77° 6' 15.16" (800 feet upstream of the Route 360 bridge in Aylett) to the upstream boundary of the Mattaponi River transition zone, and from the fall line of the Pamunkey River at N37° 41' 22.64"/W77° 12' 50.83" (2,000 feet upstream of Totopotomoy Creek) to the upstream boundary of the Pamunkey River transition zone, including all tidal tributaries that enter the tidal freshwaters of the Mattaponi and Pamunkey Rivers.

Mattaponi River transition zone upstream boundary – N37° 39' 29.65"/W76° 52' 53.29" (1,000 feet upstream of Mitchell Hill Creek) to N37° 39' 24.20"/W76° 52' 55.87" (across from Courthouse Landing).

Mattaponi River transition zone downstream boundary – N37° 32' 19.76"/W76° 47' 29.41" (old Lord Delaware Bridge, west side) to N37° 32' 13.25"/W76° 47' 10.30" (old Lord Delaware Bridge, east side).

Pamunkey River transition zone upstream boundary – N37° 32' 36.63"/W76° 58' 29.88" (Cohoke Marsh, 0.9 miles upstream of Turkey Creek) to N37° 32' 36.51"/W76° 58' 36.48" (0.75 miles upstream of creek at Cook Landing).

Pamunkey River transition zone downstream boundary – N37° 31' 57.90"/W76° 48' 38.22" (old Eltham Bridge, west side) to N37° 32' 6.25"/W76° 48' 18.82" (old Eltham Bridge, east side).

All tidal tributaries that enter the transition zones of the Mattaponi and Pamunkey Rivers are themselves in the transition zone.

Estuarine waters are from the downstream boundary of the transition zones of the Mattaponi and Pamunkey Rivers to the mouth of the York River (Tue Marsh Light) including all tidal tributaries that enter the estuarine waters of the York River.

3. James Basin. Tidal freshwater is from the fall line of the James River in the City of Richmond upstream of Mayo Bridge to the upstream boundary of the transition zone, including all tidal tributaries that enter the tidal freshwater James River.

James River transition zone upstream boundary – N37° 14' 28.25"/W76° 56' 44.47" (at Tettington) to N37° 13' 38.56"/W76° 56' 47.13" (0.3 miles downstream of Sloop Point).

Chickahominy River transition zone upstream boundary – N37° 25' 44.79"/W77° 1' 41.76" (Holly Landing).

Transition zone downstream boundary – N37° 12' 7.23"/W76° 37' 34.70" (near Carters Grove Home, 1.25 miles downstream of Grove Creek) to N37° 9' 17.23"/W76° 40' 13.45" (0.7 miles upstream of Hunnicutt Creek). All tidal waters that enter the transition zone are themselves transition zone waters.

Estuarine waters are from the downstream transition zone boundary to the mouth of the James River (Buoy 25) including all tidal tributaries that enter the estuarine waters of the James River.

4. Potomac Basin. Tidal freshwater includes all tidal tributaries that enter the Potomac

River from its fall line at the Chain Bridge (N38° 55' 46.28"/W77° 6' 59.23") to the upstream transition zone boundary near Quantico, Virginia.

Transition zone includes all tidal tributaries that enter the Potomac River from N38° 31' 27.05"/W77° 17' 7.06" (midway between Shipping Point and Quantico Pier) to N38° 23' 22.78"/W77° 1' 45.50" (one mile southeast of Mathias Point).

Estuarine waters includes all tidal tributaries that enter the Potomac River from the downstream transition zone boundary to the mouth of the Potomac River (Buoy 44B).

5. Chesapeake Bay, Atlantic Ocean, and small coastal basins. Estuarine waters include the Atlantic Ocean tidal tributaries, and the Chesapeake Bay and its small coastal basins from the Virginia state line to the mouth of the bay (a line from Cape Henry drawn through Buoys 3 and 8 to Fishermans Island), and its tidal tributaries, excluding the Potomac tributaries and those tributaries listed in subdivisions 1 through 4 of this subsection.

6. Chowan River Basin. Tidal freshwater includes the Northwest River and its tidal tributaries from the Virginia-North Carolina state line to the free flowing portion, the Blackwater River and its tidal tributaries from the Virginia-North Carolina state line to the end of tidal waters at approximately state route 611 at river mile 20.90, the Nottoway River and its tidal tributaries from the Virginia-North Carolina state line to the end of tidal waters at approximately Route 674, and the North Landing River and its tidal tributaries from the Virginia-North Carolina state line to the Great Bridge Lock.

Transition zone includes Back Bay and its tributaries in the City of Virginia Beach to the Virginia-North Carolina state line.

#### D. Site-specific modifications to numerical water quality criteria.

1. The board may consider site-specific modifications to numerical water quality criteria in subsection B of this section where the applicant or permittee demonstrates that the alternate numerical water quality criteria are sufficient to protect all designated uses (see 9VAC25-260-10) of that particular surface water segment or body.

2. Any demonstration for site-specific human health criteria shall be restricted to a reevaluation of the bioconcentration or bioaccumulation properties of the pollutant. The exceptions to this restriction are for site-specific criteria for taste, odor, and aesthetic compounds noted by double asterisks in subsection B of this section and nitrates.

3. Procedures for promulgation and review of site-specific modifications to numerical water quality criteria resulting from subdivisions 1 and 2 of this subsection.

a. Proposals describing the details of the site-specific study shall be submitted to the board's staff for approval prior to commencing the study.

b. Any site-specific modification shall be promulgated as a regulation in accordance with the Administrative Process Act (§ 2.2-4000 et seq. of the Code of Virginia). All site-specific modifications shall be listed in 9VAC25-260-310 (Special standards and requirements).

E. Variances to water quality standards.

1. A variance from numeric criteria may be granted to a discharger if it can be demonstrated that one or more of the conditions in 9VAC25-260-10 H limit the attainment of one or more specific designated uses.

a. Variances shall apply only to the discharger to whom they are granted and shall be reevaluated and either continued, modified, or revoked at the time of permit issuance. At that time the permittee shall make a showing that the conditions for granting the variance still apply.

b. Variances shall be described in the public notice published for the permit. The decision to approve a variance shall be subject to the public participation requirements of the Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation, 9VAC25-31.

c. Variances shall not prevent the maintenance and protection of existing uses or exempt the discharger or regulated activity from compliance with other appropriate technology or water quality-based limits or best management practices.

d. Variances granted under this section shall not apply to new discharges.

e. Variances shall be submitted by the department's Division of Scientific Research or its successors to the U.S. Environmental Protection Agency for review and approval or disapproval.

f. A list of variances granted shall be maintained by the department's Division of Scientific Research or its successors.

2. None of the variances in this subsection shall apply to the halogen ban section (9VAC25-260-110) or temperature criteria in 9VAC25-260-50 if superseded by § 316(a) of the Clean Water Act requirements. No variances in this subsection shall apply to the criteria that are designed to protect human health from carcinogenic and noncarcinogenic toxic effects (subsection B of this section) with the exception of the metals, and the taste, odor, and aesthetic compounds noted by double asterisks and nitrates, listed in subsection B of this section.

F. Water effect ratio.

1. A water effects ratio (WER) shall be determined by measuring the effect of receiving water (as it is or will be affected by any discharges) on the bioavailability or toxicity of a metal by using standard test organisms and a metal to conduct toxicity tests simultaneously in receiving water and laboratory water. The ratio of toxicities of the metals in the two waters is the WER (toxicity in receiving water divided by toxicity in laboratory water equals WER). Once an acceptable WER for a metal is established, the numerical value for the metal in subsection B of this section is multiplied by the WER to produce an instream concentration that will protect designated uses. This instream concentration shall be utilized in permitting decisions.



2. The WER shall be assigned a value of 1.0 unless the applicant or permittee demonstrates to the department's satisfaction in a permit proceeding that another value is appropriate, or unless available data allow the department to compute a WER for the receiving waters. The applicant or permittee is responsible for proposing and conducting the study to develop a WER. The study may require multiple testing over several seasons. The applicant or permittee shall obtain the department's Division of Scientific Research or its successor approval of the study protocol and the final WER.
3. 9VAC25-31-230 C requires that permit limits for metals be expressed as total recoverable measurements. To that end, the study used to establish the WER may be based on total recoverable measurements of the metals.
4. The WER is established in a permit proceeding, shall be described in the public notice associated with the permit proceeding, and applies only to the applicant or permittee in that proceeding. The department's action to approve or disapprove a WER is a case decision, not an amendment to the present regulation.

The decision to approve or disapprove a WER shall be subject to the public participation requirements of Virginia Pollutant Discharge Elimination System (VPDES) Regulation, Part IV (9VAC25-31-260 et seq.). A list of final WERs will be maintained by the department's Division of Scientific Research or its successor.

5. A WER shall not be used for the freshwater and saltwater chronic mercury criteria or the freshwater acute and chronic selenium criteria.

G. Biotic Ligand Model for copper. On a case-by-case basis, EPA's 2007 copper criteria (EPA-822-F-07-001) biotic ligand model (BLM) for copper may be used to determine alternate copper criteria for freshwater sites. The BLM is a bioavailability model that uses receiving water characteristics to develop site-specific criteria. Site-specific data for 10 parameters are needed to use the BLM. These parameters are temperature, pH, dissolved organic carbon, calcium, magnesium, sodium, potassium, sulfate, chloride, and alkalinity. If sufficient data for these parameters are available, the BLM can be used to calculate alternate criteria values for the copper criteria. The BLM would be used instead of the hardness-based criteria and takes the place of the hardness adjustment and the WER. A WER will not be applicable with the BLM.

#### **Statutory Authority**

§ 62.1-44.15 of the Code of Virginia; Clean Water Act (33 USC § 1251 et seq.); 40 CFR Part 131.

#### **Historical Notes**

Derived from VR680-21-01.14B, eff. May 20, 1992; amended, Virginia Register Volume 14, Issue 4, eff. December 10, 1997; Errata, 14:12 VA.R. 1937 March 2, 1998; amended, Virginia Register Volume 19, Issue 23, eff. August 27, 2003; Volume 20, Issue 9, eff. February 12, 2004; amended, Virginia Register Volume 26, Issue 12, eff. February 1, 2010; Errata, 26:12 VA.R. 2065 February 15, 2010; Volume 32, Issue 26, eff. July 27, 2017; amended Virginia Register Volume 35, Issue 22, eff. xx, 20xx.