Groundwater Monitoring Plan

GROUNDWATER MONITORING PLAN

BREMO POWER STATION
EAST, WEST, AND NORTH ASH PONDS
1038 BREMO BLUFF ROAD
BREMO BLUFF, VIRGINIA

SOLID WASTE PERMIT NO. 618

Dominion Energy

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1.0 INTRODUCTION

This *Groundwater Monitoring Plan* (GWMP) was prepared for the Bremo Power Station (Station) in Bremo Bluff, Virginia. The location of the Station is shown on Drawing 1. The Station is operated by Dominion Energy Virginia (Dominion Energy). As part of the Station operations, Dominion Energy historically operated three surface impoundments (East Ash Pond, West Ash Pond, and North Ash Pond) that were used to store coal combustion residuals (CCR).

The West Ash Pond was unlined and has been excavated, with the CCR materials transferred to the unlined North Ash Pond. The East Ash Pond is also unlined, and excavation began in 2017, with the CCR materials being transferred to the North Ash Pond. Based on current plans, subject to change, the North Ash Pond is expected to be closed in accordance with the CCR Rule, consistent with state and federal regulations. The former West and East Ash Ponds are considered inactive CCR ponds and are scheduled for a closure-by-removal demonstration, which will include a groundwater demonstration in accordance with applicable federal and state regulations. The groundwater demonstration for the West and East Ash Ponds will include the evaluation of groundwater quality data (modified Assessment Monitoring Program constituents as outlined herein) from the downgradient wells and one well to be constructed near the center of each former impoundment. Placement of this well will depend on the final grading plan of the ponds and future intended uses.

This GMP was prepared for the three ponds at the Station and is designed to meet:

- applicable provisions of the U.S. Environmental Protection Agency's (USEPA's) *Disposal of Coal Combustion Residuals* (CCR) *from Electric Utilities* (CCR Rule; Federal Register Vol. 80, No. 74, 21302-21501) as published on April 17, 2015 (40 CFR 257 *et seq*.);

- applicable provisions of USEPA's CCR Rule amendment (Federal Register Vol. 81, No. 151, 51802-51808) as published on August 5, 2016; and

- the CCR Rule as adopted in the Virginia Solid Waste Management Regulations (VSWMR, 2016) on January 27, 2016 (Title 9 Virginia Administrative Code Agency 20, Chapter 81, Section 800 *et seq*.; 9VAC20-81-800).

Specifically, this GMP outlines the procedures for collecting, analyzing, and managing groundwater samples and data from the uppermost aquifer underlying the three ash ponds. In the event that future amendments to the VSWMR and/or CCR Rule conflict with any provisions of this GMP, the VSWMR and/or CCR Rule will supersede this GMP, with the exception of Department of Environmental Quality (DEQ)-approved variances and Alternate Source Demonstrations (ASDs), and permit-specific conditions.

Revisions to this GMP may be required in the future due to changes in the monitoring network, sampling action, revisions to USEPA or VSWMR regulations, or at the request of the unit owner. Any revisions made to the GMP will be posted to the operating record and will be submitted to DEQ within 60 days of completion.

2.0 SITE LOCATION INFORMATION

The Bremo Power Station, owned and operated by Dominion Energy, is located in Fluvanna County at 1038 Bremo Road, east of Route 15 (James Madison Highway) and north of the James River. A site location map is presented as Drawing 1 and the layout of the Station, including monitoring well locations, is presented on Drawing 2.

2.1 Site Topography and Land Use

As shown on Drawing 1, a portion of the USGS 7½-minute topographic map of Arvonia, Virginia, the general area has moderately steep topography in the upland areas bordering the Station. The local topography is dissected by drainage swales that have developed a mix of dendritic and trellis drainage patterns reflecting an underlying structure control. Both intermittent and perennial streams characterize surface flow in the vicinity of the Station, with broad ridges and hilltops serving as topographical highs [maximum elevations of roughly 450 feet above mean sea level (AMSL) to the north of the Station]. The Station, along with the East and West Ash Ponds, are located within the James River floodplain where topographic elevations range from 230 to 200 feet AMSL. The North Ash Pond is located in the northern section of the Station in an upland area outside of the floodplain.

In general, the Station property consists of wooded, open, and developed land just north of the James River. The Station's northern, eastern, and western boundaries are bordered by primarily undeveloped parcels, and the Station property is bordered to the south by a CSX rail line and the James River. Land use surrounding the Station is classified as "A-1 Agricultural," and consists of undeveloped wooded and agricultural properties within a rural residential setting.

2.2 Climate

Based on available data from the *Soil Survey of Fluvanna County, Virginia* (USDA, 1958; USDA, 2015) and online National Oceanic and Atmospheric Administration (NOAA) data from Weatherspark (https://weatherspark.com/y/20218/Average-Weather-in-Palmyra-Virginia-United-States-Year-Round), the prevailing wind in the vicinity of the Station is from the west and north, and averages about 1.9 miles per hour (mph), with November through May being the months with the highest average wind speed of 2.2 mph. The average annual temperature is 56.3 F, the average daily maximum temperature is 66.6 F, and the average daily minimum is 47.3 F.

Based on statistics presented in the *Soil Survey of Fluvanna County, Virginia* (USDA, 1958), the average annual precipitation amount for the Station area is 41.24 inches. Precipitation is distributed throughout the year and averages 3.44 inches per month, with a low of 2.33 inches in November and a high of 4.53 inches in August. The average annual snowfall is 12.6 inches.

2.3 Site History

Power generation activities at the Station were initiated in the late 1930's. Ash from the power generation activities has historically been stored in the three on-site CCR surface impoundments (North Ash Pond, West Ash Pond, and East Ash Pond). In 2014, the Station converted from a coal-fired power plant to a natural gas-fired power plant. No newly generated CCR has been placed in these impoundments since the conversion to a gas-fired plant. The CCR materials in the West Ash Pond were removed in the 2016 – 2017 timeframe and transferred to the North Ash Pond. The CCR materials in the East Ash Pond are being moved to the North Ash Pond as of the date of this Plan.

Historically, groundwater at the Station has been monitored on a 5-year cycle under Virginia Pollutant Discharge Elimination System (VPDES) Permit (Permit No. VA0004138). Beginning in 2013, following installation of an updated groundwater monitoring network under VPDES Permit No. VA0004138, quarterly background sampling activities were completed between March 2013 and October 2014. After completing the background sampling activities, a *Groundwater Background and Water Quality Report* was submitted to the DEQ on January 14, 2015. The report indicated that several parameters were present in groundwater at concentrations that exceeded background concentrations with arsenic concentrations present in MW-7 and MW-8 at concentrations that exceeded the United States Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL).

Based on the results from the 2015 report, a Corrective Action Plan (CAP) was submitted to the DEQ on April 14, 2015. The CAP included plans completing assessment activities for the East Ash Pond and corrective measures for the East Ash Pond, the West Ash Pond, and the North Ash Pond pursuant to the CCR Rule. The East Ash Pond assessment activities included site characterization activities that involved the installation of three new wells (MW-16, MW-17, and MW-18) and the sampling of site wells and surface water. The results of the investigation, which included an assessment of risk, were submitted to the DEQ in an Assessment Report in July 2015. The risk assessment concluded that the observed groundwater impacts downgradient from the East Ash Pond did not pose risks in excess of regulatory levels to human health or the environment.

In October 2016, following the installation of additional monitoring wells around the perimeter of the active North Ash Pond, background sampling activities under the CCR Rule were initiated. The background sampling activities for the North Pond under the CCR Rule were completed in July 2017. The initial CCR Rule Detection Monitoring Program event for the North Ash Pond was completed on September 6, 2017. Based on the results from the initial CCR Rule Detection Monitoring Program sampling event, a CCR Rule Assessment Monitoring Program was initiated (initial CCR Rule Appendix III and IV sampling event) for the North Ash Pond on January 29, 2018, following placement of the statistically significant increase notification in the operating record on December 13, 2017, consistent with the CCR Rule. The initial semi-annual sampling event for the North Ash Pond was completed on April 30, 2018.

Background sampling activities for the CCR rule for the inactive East Ash Pond and inactive West Ash Pond were initiated in October 2017 following installation of additional monitoring wells for these units. The background sampling activities for these units are expected to be completed by February 2019.

3.0 SITE GEOLOGY AND HYDROGEOLOGY

The following sections present a summary of the geological and hydrogeological conditions for the Station and surrounding areas.

3.1 Site Soils

Based on the information obtained during hydrogeologic and geotechnical investigations (various investigations including URS, 2015; and Golder 2016 and 2017), the Station's soils are classified primarily as clays, silts, and sands. The soils, with the exception of alluvial and colluvial materials, are predominantly derived from the deposition of weathered local parent rock material (saprolite), and include predominantly more clayey soils (slate parent rock) to the west and sandy soils (granite and granodiorite parent rocks) to the east of the West Ash Pond.

In general, saprolitic soil is present over the underlying bedrock in most areas of the Station with the exception of the floodplain area, where the saprolitic soils may be absent locally due to erosion. Additionally, the bedrock is locally exposed with no saprolite or alluvium cover in the escarpment demarcating the eastern section of the floodplain (area between the East Ash Pond and the North Ash Pond). In the upland area of the Station (surrounding the North Ash Pond), the saprolite thickness can exceed 50 feet.

The floodplain sediments are a mix of alluvial materials, with a cobble and/or sand/gravel layer (interpreted high energy channel depositional environment similar to the current river bed) identified immediately above the bedrock in selected borehole locations. Locally, the cobble/gravel bed appears to be absent. Where present, the cobble/gravel bed is overlain by a fine-grained clayey stratum (interpreted infilled channel meander). Where absent, the fine-grained clayey stratum directly overlies bedrock or a thin section of saprolite. The clayey stratum is in turn overlain by a sandy silt to sand that is rich in organic matter locally (interpreted overbank deposit).

The United States Department of Agriculture (USDA, 2015) has mapped a variety of soils at the Station (Drawing 3). The three major soil types within the immediate area, based on area of coverage from greatest to least, are the Louisburg sandy loam, Appling sandy loam, and Congaree silt loam (USDA, 2015). The Louisburg and Appling sandy loam soils are associated with upland areas, and the Congaree silt loam is characterized as a lowland soil sometimes overflowed by the adjacent streams. None of the soils beneath the CCR impoundments exhibit hydric characteristics.

3.2 Geology

As presented on Drawing 4, the Station is located in the central part of the Piedmont Physiographic Province on the Chopawamsic Terrane (Bailey and Owens, 2012; VDMR, 1993). The surrounding area is characterized by undulating terrain incised by a number of dendritically patterned, intermittent and perennial stream channels flowing in a generally southern direction towards the James River. The Piedmont Physiographic Province is characterized by igneous and metamorphic rock formations of Pre-Cambrian (Catoctin Formation) to Ordovician geologic age. The Province consists of a mosaic of accreted terrain and has been folded and faulted near the end of Ordovician time.

Regionally, the Station is located within the Central Virginia Volcanic - Plutonic Belt and southeast limb of the BIue Ridge anticlinorium. The Chopawamsic Terrane is variously described as being comprised of an arc complex series of metamorphosed volcanic, plutonic, and sedimentary rocks. Specifically, basin-origin proto-sedimentary deposits associated with the Arvonia/Quantico slate and the metamorphosed Buffard conglomerate formation unconformably overlie felsic and mafic metavolcanics that have been intruded by granitic rocks of the Columbia and Ellisville plutons (Bailey and Owens, 2012).

As shown on Drawing 4 and on the Virginia Division of Mineral Resources (VDMR) Geologic Map of the Dillwyn Quadrangle, the eastern half and portions of the western half of the Station are underlain by likely Pre-Cambrian age medium- to coarse-grained gneissic quartz diorite, granodiorite, and granite comprising the undifferentiated felsic metavolcanic rocks of the Chopawamsic Terrane (historically described as the Hatcher Complex; VDMR, 1969). Similarly, Drawing 4 indicates that the western portions of the Station are underlain by migmatitically interlayered hornblende gneiss of Pre-Cambrian age, and schist and slate units of Late Ordovician age of the Arvonia Formation. The Arvonia Formation rests unconformably with a basal conglomerate upon gneissic granodiorite and quartz diorite rocks (undifferentiated felsic metavolcanic rocks of the Chopawamsic Terrane, formerly the Hatcher Complex). These literature observations are confirmed by site observations from outcrops and soil borings advanced at the Station.

The sequence of units was folded into asymmetrical and overturned anticlines and synclines (Arvonia Syncline near the western limits of the Station) near the end of the Paleozoic period. The units were later subjected to the last major period of regional metamorphism near the end of the Mississippian Period. Metamorphic grade generally increases from west (greenschist) to east (amphibolite) across the Chopawamsic Terrane.

Attitudes of the Arvonia Syncline bedding indicate a steep southeasterly dip along the west limb of the fold, and a vertical or nearly vertical dip along the east limb of the fold, indicating that the Arvonia syncline is asymmetrical, with its axial plane dipping steeply to the southeast. Bedrock foliation within the vicinity of the Station is mapped as possessing a dominant northeasterly trend with varying attitudes of dip direction and angle. Northwesterly trending joints are also noted within bedrock underlying the Station (VDMR, 1969).

Site observations and regional mapping as illustrated on Drawing 4 indicate that portions of the Station near the James River are underlain by unconsolidated Quaternary-age alluvial sediments. Locally, a basal stratum is observed to overlie competent bedrock or saprolite, and is generally characterized as a gravel or cobble deposit of variable thickness. The gravel is in turn overlain by fine-grained sediments that appear to be associated with fluvial infill sediments (fine-grained), which in turn are overlain by coarser grained overbank deposits.

To assist with illustration of the relationship between the site geology and hydrogeology, a series of cross sections have been prepared (A-A', B-B', C-C', and D-D') which are presented on Drawing 5. Cross section A-A' is parallel to the James River and illustrates the geology underlying the East and West Ash Ponds. Sections B-B' and C-C' are perpendicular to the River and cross cut the West Ash Pond, and the North and East Ash Ponds. Section D-D' cuts the North Ash Pond to illustrate the historical preconstruction conditions for that pond. As presented, the uppermost aquifer is comprised of bedrock overlain by saprolite with the saprolite in turn over lain by colluvial deposits and where the saprolite is absent, the bedrock is directly overlain by colluvium.

3.3 Hydrogeology

Based on information obtained from soil borings and wells installed at the Station, the Site Conceptual Model developed for the Station is comprised of an upland recharge area and a hydrogeologic boundary associated with the James River. Locally, it is expected that artificial recharge associated with the inactive CCR impoundments may create similar conditions to those expected in the upland recharge area. The uppermost aquifer potentiometric surface transcends geologic boundaries, with the aquifer matrix ranging from saprolite, fractured bedrock (various), to alluvium associated with the James River. These different geological units are expected to impart variability into the uppermost aquifer hydraulic properties as well as geochemical conditions. Details for the monitoring and observation wells installed at the Station are summarized in Table 1 and available soil boring and well construction logs are presented in Appendix A.

As presented on Drawing 6, the groundwater surface in the uppermost aquifer generally mimics site topography, with groundwater movement from topographically high areas to topographically low areas. The uppermost aquifer beneath the Station is unconfined and found in the surficially exposed overburden and bedrock. Locally, the groundwater flow direction in the uppermost aquifer is from the northeast to the southwest across the Station property towards the James River. As presented on Drawing 6, groundwater elevations range from 350 feet AMSL beneath the upland recharge areas to less than 220 feet AMSL along the boundary with the James River. Potentiometric surface level data for nested wells indicate that an upward gradient is present between the lower bedrock and the alluvium beneath the East and West Ash Ponds. Similarly, potentiometric surface data indicate that variable vertical gradients are present between the lower bedrock and upper saprolite in the vicinity of the North Ash Pond, with an upward gradient observed along the northern boundary and a downward gradient observed to the west and south of the North Ash Pond.

Depth-to-water measurements have been obtained since 2012 from several observation and monitoring wells constructed at the Station. The trend and range of fluctuation in the water table surface beneath the study area, with some exceptions, are relatively consistent across the study area, and presumably a function of long-term variations in precipitation and seasonal trends. As expected, the magnitude of the fluctuation is greater in those wells located in the upland areas and wells located at the western portions of the Station, where fine-grained slate bedrock is present, as opposed to those wells located near the East Ash Pond and those closer to the James River hydrogeologic boundary.

Groundwater measurements collected in 2017 from wells screened in the uppermost aquifer beneath the study area indicate that the depth to groundwater in the vicinity of North Ash Pond is between 50 and 100 feet depending on topographic elevation. The measured saturated thickness of the saprolite/bedrock uppermost aquifer beneath the North Ash Pond exceeds 75 feet. The depth to groundwater in the vicinity of the East and West Ash Ponds, both of which are located in the floodplain, ranges from 10 to 25 feet depending on topographic elevation. The measured saturated thickness of the alluvium/bedrock uppermost aquifer beneath the East and West Ash Ponds exceeds 75 feet.

3.3.1 Uppermost Aquifer Hydraulic Conductivity

Analysis of slug testing data obtained from the observation and monitoring wells evaluated in 2012, 2016, and 2017 indicates that the average hydraulic conductivity of the uppermost unconfined aquifer is variable depending on the aquifer matrix. Table 2 summarizes the estimated hydraulic conductivities for the various aquifer matrices present at the Station based on analysis of the slug testing data using the Aqtesolv™ software and appropriate data evaluation procedures (see summary in Table 2). A summary of the geometric average hydraulic conductivity values for the aquifer matrices present at the Station is presented below:

Aquifer Matrix	Estimated Average Hydraulic Conductivity(cm/s)
Saprolite (North Ash Pond)	7.37E-05
Bedrock (East, West, and North Ash Ponds)	2.23E-04
Alluvium (East and West Ash Ponds)	2.01E-04

cm/s = centimeter per second

The effective porosity of the unconfined aquifer along the downgradient side of the Station (*i.e.*, area where the uppermost aquifer is present within alluvial sediments) is estimated at 20% (Saunders, 1998; Fetter, 1988). Similarly, the average effective porosity of the saprolite is estimated at approximately 20% based on expected primary and second porosity (chemical and physical weathering). Along the upgradient, northern area of the Station, the uppermost aquifer is believed to occur within a matrix comprised of partially weathered bedrock (saprolite) ranging to competent fractured bedrock. The effective porosity of this aquifer matrix is expected to range from a whole-rock porosity based primarily on secondary porosity (discontinuities) of approximately 1 to 5% or less on a megascopic to macroscopic scale, to greater than 50% on a microscopic scale along discrete preferential flow pathways within the fractured rock (*i.e.,* open fractures). On average the effective porosity of the saprolite and bedrock is estimated at 2.5% (Fetter, 1988).

Understanding the interaction between the weathered/competent bedrock portion (*i.e.*, preferential pathways within this unit) of the uppermost aquifer and the overlying alluvial sediments comprising the uppermost aquifer in the southern portion of the site provides significant insight into the spatial and vertical distribution of the site's geochemical facies, as well as the overall movement of groundwater within the laterally and vertically continuous variable-matrix aquifer system. Current observations indicate that groundwater within the fractured bedrock/saprolite matrix beneath headlands on the northern side of the Station discharges to the alluvium in the floodplain area on the southern side of the Station. The basal gravel/cobble deposit in the southern floodplain portion of the Station, where present, is expected to provide the main conduit for the transmission of bedrock discharge based on a relatively high expected conductivity relative to the average conductivity of the alluvium. The observed confining conditions of the coarse-grained alluvium deposits indicate a robust connection with the underlying fractured bedrock, with an upward hydraulic gradient from the bedrock into the alluvium. Flow from the uppermost aquifer, including the alluvium and saprolite, is ultimately towards the James River.

3.3.2 Horizontal Component of Flow

Using the groundwater contours presented as an overlay on Drawing 6, the average hydraulic gradient for the uppermost aquifer in the study area was calculated as follows using the algorithm below.

Area	Starting Head (Elevation ft AMSL)	Ending Head (Elevation ft AMSL)	Distance (feet)	Calculated Gradient (unitless)
North Ash Pond	350	200	3,856	0.039
East Ash Pond	350	200	3,856	0.039
West Ash Pond	225	200	1,138	0.022

Note: AMSL = Above Mean Sea Level

$$i_{gw} = \left({h_L}/{L} \right)$$

Where: i_{gw} = gradient
h_L = head loss (elevation difference)
L = length (horizontal distance)

Using the estimated average effective porosity value of 20% for the alluvium and 2.5% for the bedrock/saprolite, the estimated average hydraulic conductivity values for the different matrices, and the calculated gradients, the average rate of groundwater flow (V_{gw}) in the uppermost aquifer beneath the units was calculated as follows using the algorithm below.

Area	Gradient (unitless)	Effective Porosity	Hydraulic Conductivity (cm/s)	Groundwater Velocity (ft/year)
North Ash Pond	0.039	0.025	7.37E-05	119.0
East Ash Pond	0.039	0.20	2.01E-04	40.6
West Ash Pond	0.022	0.20	2.01E-04	22.9
Bedrock	0.039	0.025	2.23E-04	359.9

Notes: cm/s = centimeter per section
ft/year = feet per year

$$V_{gw} = K\, i\, \left({}^{1}/_{n_e}\right)$$

Where: V_{gw} = Groundwater velocity
K = Hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity

3.3.3 Vertical Component of Flow

Using groundwater elevation data from 2017, the vertical component of flow within the aquifer was evaluated using various well pairs as presented below. The vertical gradients for these well pairs were calculated as shown below.

$$i_{gw} = \left({}^{h_L}/_{L}\right)$$

Where: h_L = head loss (elevation difference)
L = length (vertical distance – midpoint of the well screens)

Well Pair	Shallow Groundwater Elevation (ft AMSL)	Deep Groundwater Elevation (ft AMSL)	Distance (feet)	Gradient (unitless)	Effective Porosity	Hydraulic Conductivity (cm/s)	Groundwater Velocity (ft/year)
MW-29S / MW-29D	345.90	346.64	84.5	-8.8E-03	0.025	2.23E-04	-81.2
MW-26S / OW-26D	343.26	343.35	30	-3.0E-03	0.025	2.23E-04	-27.7
OW-32S / OW-32D	217.90	203.83	83.5	1.7E-01	0.20	7.37E-05	64.8
MW-27S / MW-27D	297.97	296.54	110.5	1.3E-02	0.20	7.37E-05	5.0
MW-25S / OW-25D	317.72	318.39	60	-1.1E-02	0.025	2.23E-04	-102
MW-20S / MW-20D	202.65	203.56	43	-2.12E-02	0.025	2.23E-04	-196

Note: Negative velocity indicates upward flow.

The positive gradient for the OW-32S/OW-32D and MW-27S/MW-27D well pairs indicates that the hydraulic gradient is downward in these areas of the Station. The MW-27S/MW-27D well pair is located next to a hydrogeologic boundary (bedrock drainage) channel, and the observed gradient is expected. The OW-32S/OW-32D well pair is located near the interface between the upland recharge area and the floodplain discharge area, and the downward gradient likely reflects the hydraulic interaction that is occurring in this area.

The negative gradient observed at the remaining well pairs indicates that the groundwater flow direction in these areas is upward, reflecting the strong regional gradient in the underlying bedrock aquifer and the groundwater discharge features (receiving waters) associated with the North Ash Pond and the James River.

3.4 Water Supply Wells

There are no known drinking water supply wells located downgradient from the North, West, or East Ash Ponds (*i.e.*, between the units and the groundwater discharge divide associated with the James River). No drinking water wells are located on the Station property. A former low-capacity, non-potable water supply well was located next to the sewage treatment building. Current site information indicates that this former well was decommissioned and is no longer in use or accessible. The approximate location of the former pump house based on historical drawings from 1949 is shown on Drawing 2 and 6.

A second well is still in use at the Station. This well is pumped at a rate of approximately 2 gallons per minute and is used as part of the Station's sanitary wastewater treatment system. No information on well construction is currently available other than visual observations indicating that the well is cased with a 6-inch-diameter polyvinyl chloride (PVC) casing. Based on this observation, it is expected that the well is cased to bedrock with an open borehole in the bedrock. The approximate location of this well is shown on the site plan (Drawing 2). Based on available information, this well is not expected to significantly influence the flow of groundwater at the Station, as the measurable radius of influence is expected to be less than 50 feet.

4.0 DESIGN OF THE GROUNDWATER MONITORING SYSTEM

Three groundwater monitoring systems are proposed to monitor the groundwater quality in the vicinity of the North, West, and East Ash Ponds. The monitoring wells proposed for the closure demonstration monitoring networks and compliance monitoring network are located and constructed with a sufficient number of wells to yield groundwater samples representative of the conditions in the uppermost aquifer beneath the units that:

- Accurately represent the quality of background groundwater that has not been affected by leakage from the waste management units (CCR units), and
- Accurately represent the quality of groundwater passing the waste boundary of the waste management units (CCR units). The downgradient monitoring systems installed at the waste boundary will ensure early detection of groundwater contamination in the uppermost aquifer. Dominion Energy will monitor potential contaminant pathways related to the waste management units (CCR units).

Certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of the CCR Rule (40 CFR 257.91(f)) is required. This certification was placed in the unit's operating record on October 17, 2017 in accordance with the recordkeeping requirements of 40 CFR 257.105. Pursuant to 40 CFR 257.106(h) and 40 CFR 257.107(h), the DEQ was notified on November 15, 2017 that the certification was placed in the operating record and on Dominion Energy's publicly available internet site. Any future modifications to the groundwater monitoring system will require DEQ approval and updates to the operating record and publicly available internet site in accordance with the CCR Rule.

Well placement, construction, development, and decommissioning procedures are discussed in the following sections. Monitoring well construction logs for existing wells are provided in Appendix A. Recommended monitoring well construction, development, and decommissioning procedures are included in Appendix B.

4.1 Special Conditions

Special conditions are site conditions that can affect the design of a groundwater monitoring system. These conditions may include:

- Waste management units, including CCR units, located above a mounded groundwater table;
- Waste management units, including CCR units, located above aquifers with seasonally variable groundwater flow directions;
- Waste management units, including CCR units, located in areas where nearby surface water features or tidally influenced surface water bodies may influence groundwater levels or expected flow directions;

- Waste management units, including CCR units, located near intermittently or continuously used groundwater production wells; and/or
- Waste management units, including CCR units, located in karst (carbonate bedrock) or faulted areas where subsurface geologic features may modify expected groundwater flow paths.

Based on the available hydrogeologic information for the Station, other than the considerations listed below, Dominion Energy is not aware of any special conditions, including those listed above, that would affect the design of a downgradient groundwater monitoring network that can effectively monitor the uppermost aquifer:

- Nearby residential properties may operate water supply wells that are screened in the lower fractured bedrock. The operation of these wells in sidegradient and upgradient locations is not expected to adversely impact Dominion Energy's ability to monitor groundwater beneath the CCR impoundments with a conventional groundwater monitoring network. This determination is based on the distance between the residential structures and the CCR ponds, the steep gradient that is present within the fractured bedrock, and the minimal expected groundwater extraction rate for residential wells (*i.e.*, limited cones of depression).

4.2 Monitoring Well Placement

The monitoring networks described herein are designed to meet the performance standards specified in the VSWMR and the CCR Rule, and will be protective of human health and the environment. Accordingly, the monitoring networks are designed so that adequate monitoring coverage is provided to represent the quality of groundwater upgradient and downgradient of the existing and former CCR units. A summary of survey information for the monitoring wells is provided in Table 1, and available soil boring and well construction logs are presented in Appendix A. Drawing 6 shows the hydraulic locations of the compliance wells relative to the CCR units.

4.2.1 West Ash Pond Compliance Network

As presented in the following sections, the compliance monitoring network for the West Ash Pond includes four background wells and seven downgradient wells including one to be installed within the former impoundment (MW-38) that are screened within the uppermost aquifer beneath the West Ash Pond.

4.2.1.1 West Ash Pond Upgradient CCR Wells

The compliance monitoring network for the West Ash Pond includes four background wells as follows:

MW-1	MW-11
MW-32S	MW-32D

As shown on Drawing 6, monitoring wells MW-1, MW-32S, and MW-32D are located upgradient from the West Ash Pond and MW-11 is located upgradient from the Station. A summary of the well construction information is provided in Table 1 and soil boring-well construction logs are presented in Appendix A.

4.2.1.2 West Ash Pond Downgradient CCR Wells

The compliance monitoring network for the West Ash Pond includes seven downgradient wells, including one well installed within the former impoundment (MW-38) as follows:

MW-12	MW-13	MW-31
MW-37 (proposed)	MW-38 (proposed)	MW-39S (proposed)
MW-39D (proposed)		

As shown on Drawing 6, the downgradient compliance wells are or will be located hydraulically downgradient from the West Ash Pond in close proximity to the downgradient waste unit boundary. A summary of the well construction information for existing and proposed downgradient compliance wells is provided in Table 1.

4.2.2 East Ash Pond Compliance Network

As presented in the following sections, the compliance monitoring network for the East Ash Pond includes three background wells and six downgradient wells that are screened within the uppermost aquifer beneath the East Ash Pond.

4.2.2.1 East Ash Pond Upgradient CCR Wells

The compliance monitoring network for the East Ash Pond includes three upgradient wells as follows:

MW-11	MW-29S	MW-29D

As shown on Drawing 6, monitoring wells MW-29S and MW-29D are located hydraulically upgradient from the East and North Ash Ponds, and MW-11 is located in a sidegradient location to the North Ash Pond and is included as a background well since its groundwater quality assists with understanding the spatial variability of the natural water quality that is present in the water table portion of the uppermost aquifer beneath the East (and North) Ash impoundments as such upper water is expected to discharge across the point of compliance downgradient from the upgradient area. A summary of the well construction information is provided in Table 1.

4.2.2.2 East Ash Pond Downgradient CCR Wells

The compliance monitoring network for the East Ash Pond includes seven downgradient wells, including one well installed within the former impoundment (MW-36) as follows:

MW-19	MW-20S	MW-20D
MW-21	MW-22	MW-23
MW-36 (proposed)		

As shown on Drawing 6, the downgradient compliance wells are located hydraulically downgradient from the East Ash Pond in close proximity to the downgradient waste unit boundary. A summary of the well construction information for the existing and proposed downgradient compliance wells is provided in Table 1.

4.2.3 North Ash Pond Compliance Network

As presented in the following sections, the compliance monitoring network for the North Ash Pond includes three background wells and five downgradient wells that are screened within the uppermost aquifer beneath the North Ash Pond.

4.2.3.1 North Ash Pond Upgradient CCR Wells

The compliance monitoring network for the North Ash Pond includes three upgradient wells as follows:

MW-11	MW-29S	MW-29D

As shown on Drawing 6, monitoring wells MW-29S and MW-29D are located hydraulically upgradient from the North Ash Pond, and MW-11 is located in a sidegradient location to the North Ash Pond and is included as a background well since its groundwater quality assist with understanding the spatial variability of the natural groundwater quality that is present in the water table portion of the uppermost aquifer beneath the North (and East) Ash impoundments as such upper water is expected to discharge across the point of compliance downgradient from the upgradient area. A summary of the well construction information is provided in Table 1.

4.2.3.2 North Ash Pond Downgradient CCR Wells

The CCR compliance monitoring network for the North Ash Pond includes five downgradient wells as follows:

MW-33	MW-34	MW-35
MW-24	MW-27D	

As shown on Drawing 6, the downgradient compliance wells are located hydraulically downgradient from the North Ash Pond in close proximity to the downgradient waste unit boundary. A summary of the well construction information for downgradient compliance wells is provided in Table 1.

4.2.3.3 North Ash Pond VSWMR Sentinel Wells

In addition to the CCR compliance wells, the North Ash Pond will be monitored with six wells once the DEQ issues a solid waste permit, as follows:

MW-25S	MW-25D	MW-26S
MW-26D	MW-27S	MW-28

Details for construction of the VSWMR sentinel wells are presented in Table 1. Background sampling will not be required for the sentinel wells once the permit is issued; rather, these wells will be sampled semi-annually with the compliance wells.

4.2.3.4 North Pond Observation Wells

In addition to the CCR and VSWMR compliance wells, Dominion Energy maintains several observation wells at the Station for periodic water level gauging. Construction details for these wells are presented in Table 1 and the well locations are shown on Drawing 6.

4.2.4 Horizontal Placement

The downgradient wells are placed as close to the CCR impoundment boundaries as is practical and, based on the groundwater contours, at a point where a release would be detected. The background wells are located so that groundwater samples will not be affected by a release from the CCR impoundments.

4.2.5 Vertical Placement

The monitoring wells have been drilled and completed to monitor the uppermost aquifer.

4.2.6 Screen Interval Placement

Monitoring well screen lengths are summarized in Table 1. As presented, the wells were designed and constructed with between 5 and 15 feet of screen to provide representative groundwater samples from the water-bearing portion of the uppermost aquifer underlying the CCR impoundments. In general, the wells are constructed so that the top of the screen is located beneath the seasonal low water table, and where practical, beneath the bottom of the adjoining CCR impoundment.

4.3 Monitoring Well Construction

Boring and well construction logs for the compliance monitoring network wells are presented in Appendix A. Consistent with USEPA guidance (Technical Enforcement Guidance; USEPA, 1986), the monitoring wells are constructed with 0.010-inch factory-slotted 2-inch inside diameter (ID) schedule 40 PVC well screen and 2-inch ID schedule 40 PVC riser casing. The well casing joints are threaded and the bottom of the wells are equipped with PVC end caps. The surface completions for the monitoring wells are completed above grade, with wells that are located within the 100-year floodplain completed with a flood-resistant wellhead that is designed to seal the well in the event of rising floodwaters.

The monitoring wells were drilled using hollow-stem auger, air rotary equipment, and/or sonic drilling technology. It is anticipated that future wells will be constructed using sonic drilling technology or a similar industry-accepted method.

4.3.1 Drilling Methods

Drilling new monitoring wells and/or observation wells, if necessary, will be performed in general accordance with the specifications presented in Appendix B, and are expected to use sonic drilling technology or a similar industry-accepted method. A qualified groundwater scientist will prepare a boring and well construction log for each new well. Dominion Energy will transmit the boring logs, well construction logs, and appropriate maps for any wells to be included in the permitted network to the DEQ within 14 days of certification (no more than 44 days from the completion of well construction activities, to include a survey by a licensed surveyor) by the qualified groundwater scientist in accordance with the VSWMR. Available boring logs and well construction diagrams for the existing on-site monitoring wells are provided in Appendix A.

4.3.2 Well Screens

Monitoring well screens should, in most circumstances, be 10 feet in length. The design of new monitoring wells should take into consideration the hydrogeologic conditions at the site, the fate and transport considerations of the potential contaminants being monitored, and the procedure(s) being used to sample the monitoring well(s). Ideally, to preserve the geochemical integrity of the water samples, well screens should be designed and placed (vertically) in a manner that prevents a change in the well screen exposure during sampling (relative to the exposure between sampling events) so that conditions during the sampling event do not change from the conditions that are present between sampling events. For CCR facilities, DEQ requires that all monitoring wells be screened solely within the saturated zone of the uppermost aquifer (no portion of the screen should be exposed above the zone of saturation). In addition, wells shall be screened in naturally occurring geologic formations, not in manmade deposits (i.e. fill, mine spoil, etc.).

4.3.3 Wellhead Completions

Wells will be completed with a locking protective standpipe and a concrete apron for surface protection. Construction of new monitoring wells will be performed in general accordance with the specifications presented in Appendix B. Protective bollards for monitoring wells will be installed at the time of well construction as needed for wells located adjacent to high traffic areas or the 100-year floodplain, or at a later date if it is determined that protective bollards are warranted. Bollards will generally be painted with high-visibility paint to assist with wellhead protection.

4.3.4 Well Development

Newly constructed wells will be developed to remove particulates that are present in the well casing, filter pack, and adjacent aquifer matrix due to construction activities. Development of new monitoring wells will be performed at least 24 hours after well construction. Wells may be developed with disposable PVC bailers, a well development pump, or other approved method. Well development procedures are presented in Appendix B.

Samples withdrawn from the monitoring wells should be clay- and silt-free; therefore, wells may require redevelopment from time to time based upon observed turbidity levels during sampling activities, and/or measurements of total depth over time that indicate sediment accumulation. If redevelopment of a monitoring well is required, it will be performed and documented in a manner similar to that used for a new well.

4.3.5 Pump Installations

Wells designated for use in the compliance monitoring networks have dedicated bladder pumps, or similar pumps, installed to facilitate micropurge sampling activities. The pumps and associated tubing are constructed of environment-inert materials suitable for use in compliance monitoring programs. Each pump should be placed within the middle portion of the well screen, and no closer than 2 feet from the bottom of the well.

4.3.6 Documentation

Documentation of future well construction activities will be in accordance with the VSWMR and CCR Rule. New wells will be surveyed by a licensed surveyor to within ±0.05 foot on the horizontal plane and ±0.01 foot vertically in reference to mean sea level. A boring log, well construction log, groundwater monitoring network map, and installation certification will be submitted to the DEQ within 14 days of certification by the qualified groundwater scientist in accordance with the VSWMR. Separately, a copy of the boring log, well construction log, groundwater monitoring network map, and installation certification will be incorporated into the Station's operating record as required under §257.105 of the CCR Rule as adopted in the VSWMR. The certification shall occur within 30 days of well construction (including the licensed well survey).

4.4 Monitoring Well Decommissioning Procedures

If a monitoring well becomes unusable during the life of the monitoring program, Dominion Energy will make reasonable attempts to decommission the monitoring well in accordance with procedures presented in Appendix B.

4.4.1 Documentation

DEQ approval will be obtained prior to decommissioning any monitoring wells that are in the Station's compliance monitoring networks. A report describing the decommissioning procedures will be transmitted to DEQ following completion of the decommissioning activities. Separately, a copy of the report will be included in the Station's operating record in accordance with the recordkeeping requirements of §257.105 as adopted in the VSWMR.

4.5 Monitoring Well Replacement

Any monitoring well that fails to perform as designed shall be replaced prior to the next regularly scheduled groundwater sampling event, or as warranted. Non-performance of permitted groundwater monitoring wells should be reported to DEQ within 30 days of recognition.

If a monitoring well becomes unusable during the life of the monitoring program, Dominion Energy will make reasonable attempts to decommission the monitoring well in accordance with the procedures presented in Appendix B.

4.5.1 Documentation

DEQ approval will be obtained prior to decommissioning any monitoring wells that are in the compliance monitoring networks. A report describing the decommissioning procedures will be transmitted to DEQ following completion of the decommissioning activities. The report will be prepared in accordance with the provisions in Appendix B.

4.6 Well Operations and Maintenance

In accordance with the VSWMR and §257.91(e)(2), the compliance monitoring wells will be operated and maintained so they perform to their design specifications throughout the life of the monitoring program. Maintenance activities for the compliance wells are as follows:

Activity	Schedule
Lock Inspection	Each Monitoring Event
Protective Casing Inspection	Each Monitoring Event
Pump Inspection & Cleaning	Annually
Depth to Well Bottom	Annually
Concrete Pad Inspection	Each Monitoring Event
Surface Water Infiltration Evaluation	Each Monitoring Event
Grass Mowing	As Needed

The results from the well inspections will be recorded on a Well Inspection Log during the routine semi-annual sampling events. A sample of a typical well inspection log is presented in Appendix B.

4.6.1 Floodplain Wells

Monitoring and observation wells that are located in the 100-year floodplain may at Dominion Energy's discretion be retrofitted with a flood-resistant well head as detailed in Figure 1 of Appendix B. This well head is designed to allow the well to breath under normal conditions (atmospheric pressure) and will close to prevent well flooding if the surrounding water level overtakes the vent housing. Additionally, the wells are protected from rafted debris with bollards on the four corners of the surface pad. If these well heads are used by Dominion, the wells will be inspected after every flooding event to ensure that there is no surficial damage from the flood that could impact the integrity of the well or future groundwater samples. If damage is observed, Dominion Energy will affect repairs before the next sampling event and will document the damage and completed repairs for the operating record.

For wells that are not retrofitted with the floodplain well housing, Dominion Energy will coordinate for removal and sealing of the wells with water tight compression caps as feasible. Such measures will prevent surface water from entering the well and impacting the uppermost aquifer. After the highwater has passed, each well will be accessed to determine if surficial damage that could impact the integrity of the well or future groundwater samples has occurred. Provided no damage is observed, the dedicated pumps will be reinstalled in the well after the assessment for use with the next compliance event. If damage is observed, Dominion Energy will affect repairs before the next sampling event and will document the damage and completed repairs for the operating record.

If Dominion Energy is not able to seal one or more wells prior to a flooding event, the well will be assessed after the flood event is over to determine the extent of impacts, if any. If available data indicates that the well head was submerged, the pump will be removed and decontaminated and the well will be re-developed to remove silt and other materials that may have entered the well. The goal of the redevelopment activities will be silt removal and to flush the well and surrounding aquifer with aquifer water. Development activities will be conducted until such time as the pH and specific conductance of the water recovered from the well is measured to be to be similar (within the bound of) to the upper and lower confidence limits for the targeted parameters based on measurements collected during the previous four sampling events. If development activities are not able to restore the water quality, the DEQ will be contacted at that time to discuss alternative solutions.

5.0 GROUNDWATER MONITORING PROGRAM

This GMP is intended to provide a framework for consistent sampling and analysis procedures (as provided in Section 6.0) that are designed to ensure monitoring results provide an accurate representation of groundwater quality at the background and downgradient wells.

Groundwater monitoring activities for North Ash Pond, East Ash Pond, and West Ash Pond have historically been performed in compliance with two regulatory programs:

1. Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0004138 – Groundwater monitoring and reporting activities are currently being conducted in accordance with the conditions in the Bremo Power Station VPDES Permit and the affiliated VPDES GMP.

2. CCR Rule – Groundwater monitoring for the North Ash Pond began in 2016 under the Detection Monitoring Program which included eight background sampling events and the initial Detection Monitoring Program event which was conducted in September 2017. Evaluation of Detection Monitoring Program data identified statistically significant increases (SSIs) over background for several CCR Rule Appendix III constituents. The SSI determination was completed in December 2017. Based on the SSI findings, Dominion Energy initiated the Assessment Monitoring Program with the initial Assessment Monitoring Program sampling event conducted in January 2018.

   CCR Rule - Groundwater monitoring for the East Ash Pond and the West Ash Pond, both of which are inactive CCR impoundments, began in October 2017 with the collection of the initial background samples under the Detection Monitoring Program. Background sampling activities and the initial Detection Monitoring Program compliance event are scheduled to be completed (analyses included) by April 17, 2019.

In order to comply with the requirements of the CCR Rule, as well as the pending VSWMR permit that is expected to be issued for the Facility, Dominion Energy has prepared this GMP which presents a “modified” program modeled on the requirements of the CCR Rule and the VSWMR and as directed by DEQ. This GMP is designed to be implemented in parallel with the VPDES GMP until the groundwater monitoring requirements in the VPDES permit are superseded by the groundwater monitoring requirements in the VSWMR permit (*i.e.*, at the time of solid waste permit issuance). The modified Detection Monitoring Program is designed to meet the requirements of VSWMR’s First Determination Monitoring Program and CCR’s Detection Monitoring Program. The modified Assessment Monitoring Program is designed to meet the requirements of VSWMR’s Phase II Monitoring Program and CCR’s Assessment Monitoring Program. To the extent a conflict exists between the requirements of the CCR

Rule and VSWMR, this GMP utilizes the more stringent of requirements. Current monitoring has transitioned to the CCR Assessment Monitoring Programs; therefore, upon issuance of the amended Solid Waste Permit, groundwater monitoring activities for the West Ash Pond, East Ash Pond, and the North Ash Pond will be conducted in the modified Assessment Monitoring Program.

Records of the background groundwater quality data and subsequent measurements, including concentration data, will be kept in the operating record, provided to DEQ, and placed on the publicly available website in accordance with the recordkeeping and notification requirements of §257.105, §257.106, and §257.107 as adopted in the VSWMR. These records will be maintained throughout the active lives and post-closure care periods for the impoundments.

For each parameter, the laboratory certificates-of-analysis will identify the analytical Limit of Quantitation (LOQ), the analytical Limit of Detection (LOD), the reported concentration, and applicable laboratory quality assurance/quality control (QA/QC) data on surrogate and standards analyses. Statistical evaluations of the analytical data (if completed), GPS comparisons, static water level determinations and evaluations, and use of other measurement, sampling, and analytical devices, will be retained throughout the active lives and post-closure care periods for the impoundments.

Details for the Modified Detection and Assessment Monitoring Programs are presented in the following sections.

5.1 Modified Detection Monitoring Program

Upon issuance of the Solid Waste Permit for the Bremo Power Station, the North Ash Pond will be monitored under the modified Assessment Monitoring Program. Details regarding the modified Detection Monitoring Program are presented herein in the event that one or more impoundments meets the requirements for monitoring under the modified Detection Monitoring Program at a future time.

The modified Detection Monitoring Program is designed to identify the presence and concentration of targeted potential CCR and solid waste constituents in the uppermost aquifer beneath the impoundments. Components of the modified Detection Monitoring Program, including analytical requirements, sampling frequency, and data evaluation, are discussed in the following sections.

5.1.1 Constituents

The modified Detection Monitoring Program will include sampling and analysis of the inorganic constituents (metals) listed in Table 3.1 Column A of the VSWMR and Appendix III of the CCR Rule. Suggested analytical methods and Practical Quantitation Limits (PQL) are presented in Table 3.

5.1.2 Background Sampling

VSWMR and the CCR Rule differ in the minimum number of independent samples required to establish background; as a result, the more stringent of the regulatory requirements will be followed. Therefore, a minimum of eight independent background samples for monitored constituents and parameters will be collected from each background and downgradient well for the modified Detection Monitoring Program. The background sampling events will be performed on a temporal schedule (if feasible) that accounts for both seasonal and spatial variability in groundwater quality for the constituents listed in Tables 3 and 4. The background sampling activities for the North Ash Pond have been completed and the background sampling activities for the East and West Ash Ponds is ongoing.

5.1.3 Sampling Schedule

After establishing background concentrations for the impoundments, the modified Detection Monitoring Program sampling schedule will be based on a semi-annual schedule (once every 180 days plus or minus 30 days) with the sample analyses completed within the calendar year semi-annual period consistent with the CCR Rule.

5.1.4 Verification Sampling Events

If verification sampling events are undertaken to verify suspect analytical results, the verification sampling activities, including laboratory analyses, must be completed within the combined 30-day determination and 14-day reporting window for reporting statistical exceedances (total of 44 days from the date of receipt of the laboratory certificates of analysis for the sampling event).

5.1.5 Analytical Data Evaluation

VSWMR and the CCR Rule differ in the required evaluation period after the receipt of laboratory analytical results; as a result, the more stringent of the regulatory requirements will be followed. Therefore, within 30 days of receiving the laboratory analytical results, the groundwater data will be evaluated statistically as described in Section 7.0 of this GMP. The results of the statistical analyses will then be evaluated as follows:

- Provided that there are no statistically significant detections over the impoundment background concentrations, the modified Detection Monitoring Program will continue on a semi-annual schedule with the results of the statistical analyses presented in the semi-annual and annual reports prepared for the impoundment.
- If one or more monitored constituents are detected at statistically significant concentrations over the impoundment background concentrations the Dominion Energy shall within 14 days of this finding notify the DEQ of its intention to:
  - Implement the modified Assessment Monitoring Program; or
  - Prepare and submit an ASD to the DEQ and obtain DEQ's approval of said ASD within 90 days unless a longer timeframe is granted by DEQ.

5.1.6 Reporting

Dominion Energy will comply with the requirements of the CCR Rule and VSWMR for data collection, storage, and reporting including:

- Recordkeeping requirements specified in 40 CFR 257.105(h);
- Recordkeeping requirements specified in 9VAC20-81-250.E.1;
- Reporting requirements specified in 9VAC20-81-250.E.2;
- Notification requirements specified in 40 CFR 257.106(h); and
- Publically accessible Internet site requirements specified in 40 CFR 257.107(h).

Reports required under the modified Detection Monitoring Program include statistical exceedance notifications, if required; semi-annual reports; annual reports; and a Facility Background Determination Report. The minimum required information for each report and submittal timeframes for the reports are discussed in the following sections.

5.1.6.1 Statistical Exceedance Notification

In the event that one or more constituents are detected at a statistically significant concentration relative to the impoundment background concentrations, Dominion Energy is required to notify the DEQ within 14 days of this determination. The notification shall identify the impoundment, the constituent exceeding the background concentration, the well identification, and the owner's/operator's intent to either initiate a modified Assessment Monitoring Program for that impoundment or to submit and obtain DEQ approval of an ASD.

5.1.6.2 Semi-Annual Report

For each impoundment, no later than 120 days of completing the first semi-annual event of each year (*i.e.*, after receiving the laboratory analytical results), Dominion Energy will submit a semi-annual report to DEQ. Each semi-annual report will include the following:

- Signature page signed by a professional geologist or qualified groundwater scientist;
- Impoundment name and permit number;
- Statement noting whether or not all monitoring points within the permitted network for the impoundment installed to meet the requirements of the VSWMR were sampled as required during the event;
- Calculated rate of groundwater flow during the sampling period;
- The groundwater flow direction as determined during the sampling period presented as either plain text or graphically as a potentiometric surface map;
- Statement noting whether or not there were SSIs over background during the sampling period, the supporting statistical calculations, and reference to the date the director was notified of the increase pursuant to timeframes in the VSWMR, if applicable;

- Copy of the full Laboratory Analytical Report including dated signature page (laboratory manager or representative) to demonstrate compliance with the VSWMR timeframes. The DEQ will accept the lab report in CD-ROM format; and
- A brief discussion of the sampling and analysis activities.

5.1.6.3 Annual Report

For each impoundment Dominion Energy will prepare an annual report for submission to the DEQ no later than January 31st of each year pursuant to §257.90.e of the CCR Rule or 120 days from the date the second semi-annual sampling and analysis activities are complete pursuant to 9VAC20-81-250.E.2 of the VSWMR, whichever occurs first. The annual report will include the following:

- A signature page;
- A completed QA/QC DEQ Form ARSC-01.
- The impoundment's name, type, permit number, current owner or operator, and location keyed to a United States Geological Survey (USGS) topographic map;
- Summary of the design type, operational history, and size (acres) of the impoundment, including key dates such as beginning, and termination of waste disposal actions and dates different groundwater monitoring phases were entered;
- Description of the surrounding land use noting whether any adjoining land owners utilize private wells as a potable water source;
- A discussion of the topographic, geologic, and hydrologic setting of the impoundment including a discussion on the nature of the uppermost aquifer (*i.e.*, confined versus unconfined) and proximity to surface waters;
- A discussion of the monitoring wells network noting any modifications that were made to the network during the year or any nonperformance issues and a statement noting that the monitoring well network meets (or did not meet) the VSWMR performance requirements;
- A listing of the groundwater sampling events undertaken during the previous calendar year;
- A historical table listing the detected constituents, and their concentrations identified in each well during the sampling period; and
- Evaluations of and appropriate responses to the groundwater elevation data; groundwater flow rate as calculated using the prior year's elevation data; groundwater flow direction (as illustrated on a potentiometric surface map); and sampling and analytical data obtained during the past calendar year.

In addition to the above requirements, Dominion Energy must comply with the CCR Rule recordkeeping requirements specified in §257.105(h)(1), the notification requirements specified in §257.106(h)(1), and the internet requirements specified in §257.107(h)(1).

5.1.6.4 Alternate Source Demonstration

Dominion Energy may demonstrate that a source other than the impoundment caused the contamination, or that a statistically significant detection resulted from an error in sampling procedures, analysis, statistical procedures, or natural variation in groundwater quality. The ASD must be submitted to and approved by the DEQ within 90 days of confirming the statistical exceedance to avoid advancing into the modified Assessment Monitoring Program.

If the ASD is approved by the DEQ, the operator may continue with the modified Detection Monitoring Program. If the ASD is not approved by the DEQ, the operator will initiate the modified Assessment Monitoring Program within 90 days of the statistically significant detection.

5.1.6.5 Well Installation Report

Well installation reports as may be required shall be submitted to the DEQ within 44 days of well completion (including the licensed survey). The well installation reports shall include permit-required information and shall be certified by a qualified groundwater scientist.

5.1.6.6 Well Decommissioning Report

Well decommissioning reports as may be required shall be submitted to the DEQ within 44 days of completing the physical well decommissioning activities. The well decommissioning reports shall include permit-required information and shall be certified by a qualified groundwater scientist.

5.1.6.7 Well Non-performance Notification

Well non-performance reports as may be required shall be submitted to the DEQ within 30 days of recognizing the non-performance issue.

5.2 Modified Assessment Monitoring Program

The modified Assessment Monitoring Program is designed to identify the presence and concentration of targeted potential CCR constituents in the uppermost aquifer beneath the CCR unit, and to determine if those constituents are derived from the CCR unit at concentrations that would require groundwater corrective action.

As the current monitoring program for the North Ash Pond has transitioned to the CCR Assessment Monitoring Program, upon issuance of the Solid Waste Permit, groundwater monitoring for the North Ash Pond will be conducted in the modified Assessment Monitoring Program. Monitoring of the East and West Ash Ponds will also commence under the modified Assessment Monitoring Program upon issuance of the Solid Waste Permit.

In accordance with the CCR Rule as adopted in the VSWMR, a notification must be prepared and placed in the Station's operating record and on the publicly available website stating that a modified Assessment

Monitoring Program has been established. Pursuant to §257.106 as adopted in the VSWMR, the DEQ must be notified when the notice has been placed.

As requested by the DEQ, Dominion Energy will establish a background concentration for the constituents in the modified Assessment Monitoring Program. The background concentrations will be submitted to the DEQ as a Facility Background Report.

Components of the modified Assessment Monitoring Program, including analytical requirements, sampling frequency, and data evaluation, are discussed in the following sections.

5.2.1 Constituents

The modified Assessment Monitoring Program will consist of the following constituents:

- CCR Rule Appendix III constituents;
- CCR Rule Appendix IV constituents (annual event with semi-annual events for detected constituents);
- VSWMR Table 3.1 Column B metals not included in the CCR Rule;
- VPDES Parameters alkalinity, iron, manganese, hardness, sodium, and total organic carbon
- Cyanide and Sulfide; and
- Speciation of chromium (hexavalent).

The suggested analytical methods and PQL for the proposed modified Assessment Monitoring Program constituents are presented in Table 4.

5.2.2 Sampling Schedule

Sampling under the modified Assessment Monitoring Program will occur semi-annually (180 days plus or minus 30 days) with the sample analyses completed within the calendar year semi-annual period consistent with the CCR Rule.

5.2.3 Verification Sampling Events

If verification sampling events are undertaken to verify suspect analytical results, the verification sampling activities, including laboratory analyses, must be completed within the combined 30-day determination and 14-day reporting window for GPS exceedances (total of 44 days from the date of receipt of the laboratory certificates of analysis for the sampling event).

5.2.4 Establishing Groundwater Protection Standards

Impoundment-specific GPS will be calculated using recent data for CCR Appendix IV constituents and VSWMR Table 3.1 Column B constituents. GPS will be established in accordance with §257.95(h) as adopted in the VSWMR. The proposed GPS will be developed based on the following requirements unless the requirements for establishing GPS are revised by the USEPA with future revisions to the CCR Rule, in which case the CCR Rule provisions will supersede these provisions:

- For constituents for which a USEPA Maximum Contaminant Level (MCL) has been established, the MCL for that constituent will be used as GPS;
- For constituents for which MCLs have not been established, the impoundment-specific background concentration established from the background wells will be used as GPS; or
- For constituents for which the impoundment-specific background level is higher than the MCL, the background concentration established from the background wells will be used as GPS, as approved by the DEQ.

The established GPS will be included in the annual monitoring report required by §257.90(e) as adopted by the VSWMR and the corrective action report (if required). The MCL-based GPS will be updated upon USEPA's promulgation of new or revised MCLs. Following approval, the background-based GPS will be updated as needed.

Following initiation of the modified Assessment Monitoring Program and the establishment of background concentrations for the Table 4 constituents to be presented to the DEQ in a Facility Background Report, proposed GPS for the applicable constituents (CCR Rule Appendix IV constituents and VSWMR Table 3.1 Column B constituents) will be submitted to the DEQ consistent with the VSWMR and the CCR Rule. The GPS based on MCLs will become effective immediately upon proposal. The GPS based on background concentrations will become effective upon written DEQ approval.

The GPS will be submitted to the operating record after completing the initial modified Assessment Monitoring Program event and no later than 30 days after establishing background concentrations for required monitoring constituents.

5.2.5 Analytical Data Evaluation

Groundwater data will be evaluated statistically as described in Section 7.0 of this GMP. The results of the statistical analyses will then be evaluated as follows:

- If no constituents have been detected for two consecutive sampling events at statistically significant concentrations above the impoundment's background concentrations, Dominion Energy may notify the DEQ of this finding and revert to a modified Detection Monitoring Program with DEQ's concurrence.
- If the concentration of any monitored constituent is present in the groundwater at a concentration that is above the impoundment-specific background concentration, but below the current GPS, Dominion Energy shall continue the modified Assessment Monitoring Program.

- If any monitored constituent is present at a concentration that exceeds the impoundment-specific background concentration and/or the most current established GPS, Dominion Energy may:
  - Submit an ASD certified by a qualified professional engineer within 90 days of determining the exceedance of GPS; or
  - Begin the initial steps toward groundwater Corrective Action. The Corrective Action Program will be consistent with both VSWMR 9VAC20-81-260 and §257.96, §257.97, and §257.98 of the CCR Rule.

5.2.6 Data Validation

In accordance with 9VAC20-81-250.A.4.j, voluntary third-party data validation of laboratory data may be completed during the 30-day statistical determination period.

5.2.7 Reporting

Reports required under the modified Assessment Monitoring Program include a GPS exceedance notification (if required), a semi-annual report, and an annual report. Consistent with the CCR Rule reporting requirements, required reports will be provided to the DEQ Regional Office upon posting in the impoundment's operating record and publicly-accessible web site.

The minimum required information for each report and submittal timeframes for the reports are discussed in the following sections.

5.2.7.1 Facility Background Report

A Facility Background Report will be prepared for the impoundment following the initiation of the modified Assessment Monitoring Program. The Facility Background Report will present the impoundment's established background concentrations for the constituents listed in Table 4. The Facility Background Determination Report will be placed in the operating record within 90 days of initiating the modified Assessment Monitoring Program.

5.2.7.2 Groundwater Protection Standard Exceedance Notifications

Consistent with §257.93(h)(2) of the CCR Rule and 9VAC20-81-250.C.3.e(3)(a) of the VSWMR, Dominion Energy will submit a GPS exceedance notification for Table 4 constituents that have established GPS to the DEQ within 14 days of identifying a statistical exceedance of a GPS (44 days of issuance of the laboratory report).

The notification shall identify the constituent exceeding the GPS, the impoundment, the well identification, and the owner's/operator's intent to either initiate a Corrective Action Program and proceed with a Nature and Extent Study and Assessment of Corrective Measures within 90 days of noting the GPS exceedance, or to submit and obtain DEQ approval of an ASD.

5.2.7.3 Semi-Annual Report

No later than 120 days of completing the first semi-annual event of each year (*i.e.*, after receiving the laboratory analytical results), Dominion Energy will submit a semi-annual report to DEQ. Each semi-annual report will include the following:

- Signature page signed by a professional geologist or qualified groundwater scientist;
- Impoundment name and permit number;
- Statement noting whether or not all monitoring points within the permitted network installed to meet the requirements of the VSWMR were sampled as required during the event;
- Calculated rate of groundwater flow during the sampling period;
- The groundwater flow direction as determined during the sampling period presented as either plain text or graphically as a potentiometric surface map;
- Statement noting whether or not there were SSIs over background during the sampling period, the supporting statistical calculations, and reference to the date the director was notified of the increase pursuant to timeframes in the VSWMR, if applicable;
- Copy of the full Laboratory Analytical Report including dated signature page (laboratory manager or representative) to demonstrate compliance with the VSWMR timeframes. The DEQ will accept the lab report in CD-ROM format; and
- A brief discussion of the sampling and analysis activities.

5.2.7.4 Annual Report

An annual report will be prepared and submitted to DEQ no later than 120 days after completing the second semi-annual event of each year (*i.e*., after receiving the laboratory analytical results) or no later than January 31st of the following calendar year. The annual report will include the following:

- A signature page;
- A completed QA/QC DEQ Form ARSC-01.
- The impoundment’s name, type, permit number, current owner or operator, and location keyed to a United States Geological Survey (USGS) topographic map;
- Summary of the design type, operational history (*i.e.*, trench fill versus area fill), and size (acres) of the impoundment including key dates such as beginning, and termination of waste disposal actions and dates different groundwater monitoring phases were entered;
- Description of the surrounding land use noting whether any adjoining land owners utilize private wells as a potable water source;
- A discussion of the topographic, geologic, and hydrologic setting of the impoundment including a discussion on the nature of the uppermost aquifer (*i.e.*, confined versus unconfined) and proximity to surface waters;
- A discussion of the monitoring wells network noting any modifications that were made to the network during the year or any nonperformance issues and a statement noting that the monitoring well network meets (or did not meet) the VSWMR performance requirements;

- A listing of the groundwater sampling events undertaken during the previous calendar year;
- A historical table listing the detected constituents, and their concentrations identified in each well during the sampling period; and
- Evaluations of and appropriate responses to the groundwater elevation data; groundwater flow rate as calculated using the prior year's elevation data; groundwater flow direction (as illustrated on a potentiometric surface map); and sampling and analytical data obtained during the past calendar year.

In addition to the above requirements, Dominion Energy must comply with the CCR Rule recordkeeping requirements specified in §257.105(h)(1), the notification requirements specified in §257.106(h)(1), and the internet requirements specified in §257.107(h)(1).

5.2.7.5 Alternate Source Demonstration

Dominion Energy may demonstrate that a source other than the impoundment caused a statistically significant detection of one or more monitored constituents or statistical exceedances of a GPS, or that the statistical increase resulted from an error in sampling procedures, analysis, statistical procedures, or natural variation in groundwater quality. The ASD must be submitted to the DEQ within 90 days of the sampling event from which the exceedance originated.

If an ASD associated with a GPS exceedance is approved by the DEQ, Dominion Energy may continue with the modified Assessment Monitoring Program. If such an ASD is not approved by the DEQ, Dominion Energy must initiate an Assessment of Corrective Measures and a Corrective Action Program.

5.2.7.6 Well Installation Report

Well installation reports (for new wells) as may be required shall be submitted to the DEQ within 44 days of well completion (including the licensed survey). The well installation reports shall include permit-required information and shall be certified by a qualified groundwater scientist.

5.2.7.7 Well Decommissioning Report

Well decommissioning reports as may be required shall be submitted to the DEQ within 44 days of completing the physical well decommissioning activities. The well decommissioning reports shall include permit-required information and shall be certified by a qualified groundwater scientist.

5.2.7.8 Well Non-performance Notification

Well non-performance reports as may be required shall be submitted to the DEQ within 30 days of recognizing the non-performance issue.

5.2.7.9 Modified Detection Monitoring Program Reversion Notification

Consistent with §257.95(e) as adopted in the VSWMR, if there are no SSIs over background concentrations for two consecutive monitoring events, Dominion Energy may revert the groundwater monitoring program to the modified Detection Monitoring Program with DEQ's concurrence. This reversion shall be documented in a notification submitted to the DEQ before the next compliance monitoring event.

5.2.7.10 Groundwater Protection Standard Update Notifications

Notifications for GPS updates due to changes in USEPA MCLs and/or impoundment-specific background concentrations shall be submitted to the DEQ within 30 days of the update.

5.2.7.11 Off-site Plume Notification

In the event that a groundwater plume (concentrations above GPS) is determined to extend off site onto adjacent downgradient property based on corrective action characterization activities, Dominion Energy will notify the DEQ and the affected landowner within 30 days of the determination consistent with the VSWMR and §257.95(g)(2), §257.105(h)(8), and §257.106(h)(6) as adopted in the VSWMR.

6.0 SAMPLE AND ANALYSIS PROGRAM

Proper sampling procedures are an important and fundamental aspect in an effective monitoring program. The following sections, which are consistent with USEPA guidance and the requirements of the CCR Rule, outline the proposed sample collection procedures.

6.1 Sampling Order

The existing compliance wells are equipped with dedicated purging and sampling equipment; therefore, the likelihood of cross-contamination during sampling is minimized. Accordingly, the anticipated sampling order will follow a sequence based on consideration of field conditions at the time of sampling.

6.2 Water Level Gauging

Prior to purging each monitoring well, the static water level will be gauged using an electronic water level indicator accurate to 0.01 foot. The measurement will be obtained from the surveyed measuring point on each well.

Prior to initial use and between wells, the portion of the water level indicator that comes in contact with the groundwater in the well will be decontaminated to avoid cross-contamination between monitoring wells. In addition to decontaminating the downhole equipment, sampling personnel will don new gloves between wells, and more frequently as needed, to avoid cross-contamination between monitoring wells.

6.3 Purging Procedure

The monitoring wells in the monitoring networks will be purged and sampled using a micropurge technique. Micropurge sampling can greatly reduce the volume of water that must be purged from a well before representative samples can be collected, and typically provides for the collection of more representative samples than do other purge methods, resulting in more consistency in analytical results. Micropurging is accomplished through the use of dedicated low-flow sampling devices. Bailers and portable pumps are not recommended because they cause mixing of the standing water column within the well (Robin and Gilham, 1987). This mixing action requires the removal of the traditional large purge volumes before sampling. Introducing any device into the well prior to sampling causes a surging effect that may increase turbidity and interfere with the normal flow of water through the well screen. This disturbance may remain in effect for as long as 24 to 48 hours (Kearl *et al.*, 1992).

For monitoring wells with dedicated bladder pumps equipped with check values that hold stagnant water in the discharge tubing between sampling events, the discharge tubing shall be purged prior to commencing micropurge activities to ensure that fresh formation water is sampled following the completion of micropurging. The discharge tube purge volume will be determined using the following equation:

$$\text{Discharge Tube Volume (milliliters)} = DTP * V_F$$

Where: DTP = Depth to the top of the pump to the nearest 0.1 foot
V_F = Volume Factor as follows:
10 = 1/4-inch diameter tubing
22 = 3/8-inch diameter tubing
39 = 1/2-inch diameter tubing

If discharge tube purging is required, the purge should be conducted at a rate equal to the well yield to avoid drawing stagnant well column water into the pump (*i.e.*, between 100 and 500 milliliters per minute). During the discharge tubing purge, the flow rate and the depth to groundwater should be monitored on regular intervals (every 3 to 5 minutes) to verify that the purge activities are not removing stagnant water from the water column in the monitoring well.

After completing the discharge tubing purge, if required, water quality parameters (pH, temperature, conductivity, and/or dissolved oxygen) along with the depth to water will be monitored during the micropurge consistent with USEPA guidance on micropurging. The stabilization of these parameters (generally +/- 10% for three consecutive readings) indicates when the discharge water is representative of formation water and samples can be collected for analysis. Measurements of turbidity may also be collected for the purpose of evaluating the purging technique. Water quality measurements will be collected on approximate 3- to 5-minute intervals and will be recorded on a Field Log or in the Field Book to document purge stabilization.

In addition to the water quality parameters, the flow rate may be monitored at regular intervals during the micropurge to verify that the micropurge activities are not removing stagnant water from the water column in the monitoring wells. In general, purge rates when using micropurge sampling procedures should not exceed 500 milliliters per minute, and the purge rate should be adjusted downward as needed to prevent the groundwater elevation from dropping more than 1 foot. Any measurements taken should be recorded on a Field Log or in the Field Book to document steady-state flow conditions during the purge. Sampling personnel will containerize and dispose of purge water generated during sampling activities in accordance with regulatory requirements.

On rare occasions, the yield of a monitoring well will be insufficient to keep up with the micropurge. In cases where the yield of the monitoring well is less than 50 milliliters per minute as documented by the recorded flow rate and continually decreasing head level as the well is purged, the required samples may be collected prior to stabilization of the water column provided the water quality parameters have stabilized within the required 10% range.

In the event that dedicated pumping equipment malfunctions during a sampling event, non-dedicated equipment may be used to micropurge the affected well(s) provided the pump can be decontaminated prior to use in each well. The pump and associated discharge hoses must be decontaminated using a non-phosphate-based detergent and water mixture followed by a deionized water rinse to avoid cross-contamination between monitoring wells.

6.4 Sample Collection

Once the water quality data indicate that the micropurge activities have been completed, required samples should be collected directly from the discharge hose on the pump into laboratory-provided, pre-preserved sample containers selected for the required parameters or compatible parameters. Samples collected for the compliance program will not be filtered in the field or at the laboratory. Sample collection should be performed at the same rate (or lower) that was used during the micropurge. Following collection, samples will be placed in a cooler on ice under chain-of-custody control. Samples will be kept at no more than 6°C from collection to laboratory delivery.

Anticipated sample container, minimum volume, chemical preservative, and holding times for each analysis type are provided in Table 5. These standards may change depending on laboratory requirements. Sample preservation methods will be used to retard biological action, retard hydrolysis, and reduce sorption effects. These methods include chemical addition, refrigeration, and protection from light.

6.5 Sample Documentation

Chain-of-custody control is critical for documenting the integrity of the samples following collection, during transport to the laboratory, and at the laboratory. Consequently, the label for each sample container shall be completed to document the sample collection activities. An example sample container label is presented in Appendix C.

The chain-of-custody form should be signed by the sampling personnel and the receiving agent, with the date and time of transfer noted. In the event that the samples are being shipped to a laboratory, the signature of the receiving agent is not required; however, it is recommended that the tracking number for the shipping label be recorded on the chain-of-custody form. After completing the chain-of-custody form, it should be maintained with the samples. An example chain-of-custody form is presented in Appendix C.

6.6 Sample Seals

It is recommended that the shipping container be sealed to ensure that the samples have not been disturbed during transport to the laboratory. If sample seals are used, the tape should be labeled with instructions to notify the shipper if the seal is broken prior to receipt at the laboratory. An example chain-of-custody seal is presented in Appendix C.

6.7 Sample Event Documentation

The sampling event field notes should document the field activities such that they, along with the chain-of-custody form(s), are sufficient to allow for reconstruction of the sampling event by a third party.

6.8 Field Quality Assurance/Quality Control Procedures

Trip blanks, equipment blanks, field blanks, and field duplicates provide QA/QC measures for the monitoring program. The QA/QC measures are discussed in the following sections.

6.8.1 Trip Blanks

Trip blanks are a required part of the field sampling QA/QC program only when analytical parameters include volatile organic compounds (VOCs). Trip blanks are not required for this groundwater monitoring program.

6.8.2 Field Blanks

Field blanks may also be collected as part of the field sampling QA/QC program. The purpose of the field blank is to detect any contamination that might be introduced into the groundwater samples through the air or through sampling activities. At least one field blank is recommended to be collected and analyzed for the same parameters as those for which groundwater samples are analyzed.

Field blanks must be prepared in the field (at the sampling site) using laboratory-supplied bottles and deionized or laboratory reagent-quality water. Each field blank is prepared by pouring the deionized water into the sample bottles at the location of one of the wells in the sampling program. Preservatives are added to specific sample bottles as required. The well at which the field blank is prepared must be identified on the Field Log along with any observations that may help explain anomalous results (*e.g.*, prevailing wind direction, up-wind potential sources of contamination). Once a field blank is collected, it is handled and shipped in the same manner as the rest of the samples.

6.8.3 Equipment Blanks

For wells that must be sampled with non-dedicated equipment, decontamination procedures consist of rinsing the equipment once with deionized or laboratory reagent-quality water, brushing the equipment using laboratory-quality soap, and triple rinsing the equipment with deionized or laboratory reagent-quality water. One equipment blank may be collected during each sampling event and analyzed for the same parameters as those for which groundwater samples are analyzed. Equipment blanks are collected by pouring deionized or laboratory reagent-quality water into or over the sampling device (*e.g.*, the water level indicator), and then filling a set of sample bottles.

If the analytes for the equipment blank would normally be filtered, this water should be placed into a pre-filtration bottle and subsequently filtered. Whether or not it is filtered, this water is placed into the equipment blank bottles, and the proper preservative added (as required).

6.8.4 Field Duplicates

Duplicate samples are generally collected to demonstrate the reproducibility of the sampling technique. Duplicate samples may be collected on a 5% (1 in 20) frequency. This is a separate duplicate from the duplicates a laboratory must run, and cannot be replaced by a laboratory-generated duplicate. Duplicates are representative of field sampling precision, whereas laboratory duplicates are a measure of analytical precision. Both pieces of information are essential to determining the quality of data generated for a project.

6.9 Laboratory Quality Control Procedures

The quality assurance program for the selected Virginia Environmental Laboratory Accreditation Program (VELAP)-accredited analytical laboratory will be documented in their Quality Assurance Program Plan (QAPP). This document describes mechanisms employed by the VELAP-accredited laboratory to ensure that reported data meet or exceed applicable USEPA and Virginia requirements. The QAPP describes the laboratory's experience, its organizational structure, and procedures in place to ensure quality of the analytical data. The QAPP outlines the sampling, analysis, and reporting procedures used by the laboratory. The laboratory is responsible for the implementation of and adherence to the QA/QC requirements outlined in the QAPP. A copy of the laboratory's QAPP will be available to the DEQ or Station personnel upon request.

Audits are an important component of the quality assurance program at the laboratory. Audits are conducted by the laboratory. Internal system and performance audits are conducted periodically to ensure adherence by all laboratory departments to the QAPP. External audits are conducted by accrediting agencies or states. These reports are transmitted to department managers for review and response. Corrective measures must be taken for any finding or deficiency found in an audit.

Data Quality Reviews (DQRs), or equivalent, are requests submitted to the laboratory to formally review results that differ from historical results, or that exceed certain permit requirements or quality control criteria. The laboratory prepares a formal written response to DQRs explaining discrepancies. The DQR is the first line of investigation following any anomalous result.

6.9.1 Laboratory Documentation

Upon receipt of the samples at the laboratory, the following activities are recommended:

- The date, time of sample collection, and analysis to be performed will be provided to the VELAP-accredited laboratory.
- The samples will be examined upon receipt to ensure collection in USEPA-approved containers for the requested analysis. The sample collection data and time will also be reviewed to ensure the USEPA-required sample holding time has not expired or will not expire before the analysis can be performed.
- The information concerning transportation mode and manner will be reported on the form. Samples must be transported on ice or under refrigeration, and the inside temperature of the cooler recorded upon opening.
- The pH of each sample as well as the sample appearance will be recorded if required by the analytical method. Also, preservative adjustments, filtration, and sample splitting must also occur as required prior to distribution. Sample adjustments will be fully documented.

During analysis of the samples, it is recommended that the laboratory agent maintain the integrity of the samples as follows:

- During the sample analysis period, the samples will remain refrigerated.
- If at any point during the analysis process, the results are considered technically inaccurate, the analysis must be performed again if holding times have not been exceeded.

Documentation activities should be completed with permanent ink in a legible manner with mistakes crossed out with a single line.

6.9.2 Laboratory Analyses

Analytical procedures for constituents listed in Table 3.1 of the VSWMR and Appendix IV of the CCR Rule will be performed in accordance with USEPA *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846,* as updated. Analytical methods for the remaining constituents and parameters required for the monitoring programs will be performed pursuant to procedures in USEPA *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846,* as updated or other USEPA-approved methods (*e.g.*, published drinking water methods, clean water act method, Standard Methods). The modified Detection Monitoring Program and modified Assessment Monitoring Program constituents, along with recommended test methods and PQLs, are listed in Tables 3 and 4. Laboratory analytical results for groundwater compliance samples will be reported on a total sample basis.

Alternate methods may be used if they have the same or lower PQL. Methods with higher PQLs will be considered if the concentration of the parameter is such that an alternate test method with a higher PQL will provide the same result.

6.9.3 Limits of Quantitation (LOQs)

Laboratory-specific LOQs will be used as the reporting limits for quantified detections of required monitoring constituents. Laboratory LOQs should be reported with the sample results.

6.9.4 Limits of Detection (LODs)

Laboratory-specific LODs will be used as the reporting limits for estimated detections of required monitoring constituents. Constituents detected at concentrations above the LOD but below the LOQ will be reported as estimated with a qualifying "J" flag on the laboratory certificates of analysis. It is noted that estimated detections are not considered statistically significant and cannot trigger the Corrective Action Program. Laboratory LODs should be reported with the sample results.

6.9.5 Method Blanks

Laboratory method blanks are used during the analytical process to detect any laboratory-introduced contamination that may occur during analysis. A minimum of one method blank should be analyzed by the laboratory per sample batch.

6.9.6 Matrix Spike and Matrix Spike Duplicate Samples

A matrix spike/matrix spike duplicate sample will be run with every sample batch. The relative percent difference between the spike and the spike duplicate sample should be less than 20 percent. Higher values may indicate matrix interference.

6.10 Data Validation

The laboratory is responsible for verifying that the reported analytical results are correct. The QA/QC data provided by the laboratory will be reviewed to ensure that the analytical results meet the project's data quality objectives. The review process should be performed in general accordance with the procedures outlined in the following USEPA guidance documents:

- *National Functional Guidelines for Inorganic Superfund Methods Data Review*, January 2017 (USEPA, 2017); and
- *Multi-Agency Radiological Laboratory Analytical Protocols Manual*. (USEPA, 2004).

7.0 DATA EVALUATION

Statistical analysis of the data will be completed as discussed in the following subsections. These criteria represent a conservative approach to groundwater analysis and incorporate appropriate statistical and other evaluation methodologies.

7.1 Groundwater Data Evaluation

This section outlines the inter-well statistical evaluation methodologies that may be used to detect a release from the CCR units by comparing downgradient well results to unit-specific statistically calculated background concentrations.

During background sample collection, it will be necessary to examine the data for outliers, anomalies, and trends that might be an indication of a sampling or analytical error. Outliers and anomalies are inconsistently large or small values that can occur due to sampling, laboratory, transportation, or transcription errors, or even by chance alone. Significant trends indicate a source of systematic error, or an actual contamination occurrence, that must be evaluated and corrected before valid inter-well statistical evaluations can be implemented. The inclusion of such values in the historical database used for temporal water quality evaluations or in the unit's background database for inter-well statistical evaluations could cause misinterpretation of the data set, and result in high false positive (*i.e.*, an indication of a release when none exists) and/or false negative (*i.e.*, falsely concluding there is no release in the presence of an actual release) conclusions.

To prevent the inclusion of anomalous data in the inter-well database, background monitoring results will be evaluated during background development for any new wells constructed, once those well(s) have at least four measurements for a given constituent using time vs. concentration graphs. Parameter concentrations that appear anomalous (*e.g.*, that are 5 times or greater than the previous results) may be verified during the next sample collection event or after a reasonable period of time to ensure sample independence (*e.g.*, 3 months). If the anomalous result is not verified, the outlier may be removed from the database to maintain the accuracy of the evaluation method. Any detected systematic trends or verified outliers in the background database will be evaluated and reported to the DEQ in a timely manner.

7.1.1 Correcting for Linear Trends

If a data series exhibits a linear trend, the sample will exhibit temporal dependence when tested via the sample autocorrelation function (see Section 14.2.3 of the Unified Guidance; EPA, 2009), the rank von Neumann ratio (see Section 14.2.4 of the Unified Guidance; EPA, 2009), or similar procedure. These data can be de-trended, much like the data in the previous example were de-seasonalized. Typically, the easiest way to de-trend observations with a linear trend is to compute a linear regression on the data (see

Section 17.3.1 of the Unified Guidance; EPA, 2009) and then use the regression *residuals* instead of the original measurements in subsequent statistical analysis.

7.2 Statistical Methodology

In accordance with the CCR Rule §257.93(f)(6) as adopted in the VSWMR, Dominion Energy must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. The certification will include a narrative description of the statistical method selected to evaluate the groundwater monitoring data. As adopted in the VSWMR, this certification is subject to the recordkeeping requirements specified in §257.105(h), the notification requirements specified in §257.106(h), and the internet requirements specified in §257.107(h).

The statistical test used to evaluate the groundwater monitoring data will be selected based on the size of the dataset, the data distribution, and statistical level of significance requirements as allowed by the VSWMR and the CCR Rule and associated state and Federal guidance documents. Dominion Energy will ensure that an adequate number of independent samples for the chosen statistical method are collected within the compliance period such that the level of significance for individual well comparison will be no less than 0.01 and no less than 0.05 for multiple comparisons for any statistical test. Possible statistical test methods are:

- A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method will include estimating and testing the contrasts between each compliance well's mean and the background mean levels for each constituent;
- An analysis of variance (ANOVA) based on ranks followed by multiple comparisons procedures to identify significant evidence of contamination. The method will include estimating and testing the contrasts between each compliance well's median and the background median levels for each constituent;
- A tolerance or prediction interval procedure in which an interval for each constituent is established from the distribution of the background data, and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit;
- A control chart approach that gives control limits for each constituent; or
- Another statistical test method that meets the performance standards specified by the DEQ. A justification for the alternate test method will be submitted for approval by the DEQ.

The statistical analysis chosen to evaluate the groundwater data will meet the following performance standards and will be consistent with the EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009):

- The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of monitoring parameters or constituents. If the distribution is shown by Dominion Energy to be inappropriate for a normal theory test, then the data should be transformed or a distribution-free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.
- If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a GPS, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparisons procedure is used, the Type I experiment-wise error rate for each testing period shall be no less than 0.05; however, the Type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, predictions intervals, or control charts.
- If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be protective of human health and the environment. The parameters shall be determined after considering the number of samples in the background database, the data distribution, and the range of the concentration for each constituent of concern.
- If a tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be protective of human health and the environment. These parameters shall be determined after considering the number of samples in the background database, the data distribution, and the range of the concentrations for each constituent of concern.
- The statistical method shall account for data below the LOD with one or more statistical procedures that shall be at least as effective as any other approach in this section for evaluating groundwater data. Any PQL that is used in the statistical method shall be the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the Station.
- If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

7.2.1 Reporting of Low and Zero Values

Chemical constituents that are not present above the detection limit of the analytical procedure are reported as NOT DETECTED (ND), or less than the LOD, rather than as zero or not present, and the laboratory's LOD is provided on the analytical report. There are a several methods for dealing with data that include values below detection, and the selected method should be consistent with the USEPA's Unified Guidance (USEPA, 2009).

7.2.2 Normality Testing

The original data must be tested for normality using an appropriate method consistent with USEPA's Unified Guidance (USEPA, 2009). The following generalized guidelines should be considered for decisions in normality testing:

- If the original data show that the data are not normally distributed, then the data must be natural log-transformed and tested for normality using the above methods.

- If the original or the natural log-transformed data confirm that the data are normally distributed, then a normal distribution test must be applied.
- If neither the original nor the natural log-transformed data fit a normal distribution, then a distribution-free test must be applied.

7.2.3 Missing Data Values

Missing data values may result in an incomplete measure of environmental variability and an increased likelihood of falsely detecting contamination. If data are missing, there is a danger that the full extent of contamination may not be characterized. Therefore, resampling will occur within 30 days to replace the missing data unless an alternative schedule is otherwise approved by DEQ.

7.2.4 Outliers

An outlier is a value that is much different from most other values in a data set for a given groundwater chemical constituent. The reasons for outliers may include:

- Sampling errors or field contamination;
- Analytical errors or laboratory contamination;
- Recording or transcription errors;
- Faulty sample preparation or preservation, or shelf-life exceedance; or
- Extreme, but accurately detected environmental conditions (*e.g.*, spills, migration from the unit).

Formal testing for outliers should be done only if an observation seems particularly high (by orders of magnitude) compared to the rest of the data set. If a sample value is suspect, the value should be evaluated using the appropriate outlier test described in USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance* (USEPA, 2009). Background observations, which are considered to be outliers, will not be included in the statistical analysis to preserve the power of the test to detect a release from the impoundments.

7.3 Verification Procedure

Once groundwater analysis results have been collected, checked for QA/QC consistency, and determined to be above the appropriate statistical level, the results must be verified in accordance with the objectives of the VSWMR for groundwater monitoring. Verification re-sampling is an integral part of the statistical methodology described by USEPA's Unified Guidance (USEPA, 2009). Without verification re-sampling, much larger statistical limits would be required to achieve site-wide false positive rates of 5% or less. Furthermore, the resulting false negative rate would be greatly increased. Verification sampling should generally be performed for each constituent when it is initially determined to be present above its statistical limit. Consistent with the VSWMR, verification samples, if collected, must be obtained within the 30-day SSI determination period defined in 9VAC20-81-250.A.4.h.(2).

7.4 Comparison to Groundwater Protection Standards

Following the establishment of GPS under the modified Assessment Monitoring Program, detected constituents will be statistically compared to the approved GPS using one of the methods discussed below.

If the GPS for a constituent is derived from the unit's background concentration, then the groundwater monitoring data must be compared directly to the GPS using a value-to-value comparison. If the established GPS is derived from a MCL (or other reference standard concentration), then the groundwater monitoring data may be compared to the GPS statistically and/or using a value-to-value procedure. For constituents that derived GPS from background and are not detected (100% non-detects) in upgradient monitoring wells, the double quantification rule will be used to determine downgradient exceedances. Whereas, if the constituent concentration in a compliance well exceeds the highest historical laboratory reporting limit for two consecutive events, an exceedance of GPS will be confirmed.

Based on the above criteria, groundwater monitoring data will initially be compared to established GPS via a value-to-value comparison. If a GPS is exceeded during the value-to-value comparison for any parameter, a verification sample may be collected. The results from the verification sample will be compared to the GPS via a value-to-value comparison. If the comparison indicates a GPS exceedance, the source of the GPS will be determined. If the GPS is derived from a MCL, two additional groundwater samples for the suspect constituent(s) may be collected to facilitate a statistical comparison to the GPS. It is noted that verification sampling and/or additional sampling required to perform a statistical evaluation must occur within the same compliance monitoring period during which the original samples were collected. The compliance monitoring period begins on the day of sampling and expires 6 months later, or the date of the next compliance sampling event, whichever occurs first.

To perform a statistical comparison, a minimum of four samples must be collected within the compliance monitoring period. Once data have been received for the four samples, then the lower confidence interval can be calculated and compared to the GPS. The lower limit should be calculated initially by using a 95% confidence level. If the lower limit exceeds the GPS, the DEQ may be contacted regarding the use of a confidence level greater than 95%.

8.0 HYDROGEOLOGIC ASSESSMENT

After each sampling event, groundwater surface elevations will be evaluated to determine whether the requirements for locating the monitoring wells continue to be satisfied and the rate and direction of groundwater flow will be determined. Groundwater elevations in monitoring wells must be measured within a period of time short enough (typically within 24 hours) to avoid temporal variations in groundwater flow that could preclude accurate determination of groundwater flow rate and direction.

The rate and direction of groundwater flow will be determined each time groundwater is sampled by comparing the groundwater surface elevations among the monitoring wells, and at least annually, constructing a groundwater surface contour map. The groundwater flow rate shall be determined using the following equation:

$$V_{gw} = K\,i\,\left({}^{1}/_{n_e}\right)$$

Where:

V_{gw} = Groundwater velocity
K = Hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity

If the evaluation shows that the groundwater monitoring system does not satisfy the requirements of the VSWMR, the monitoring system will be modified to comply with those regulations after obtaining approval from the DEQ. Dominion Energy will request the appropriate permit amendment action related to any revisions of the monitoring well network(s) deemed necessary due to a change in groundwater flow pattern or functionality of any monitoring well. Proposed revisions will be submitted to the DEQ within 30 days of determining that the system does not satisfy the requirements of the VSWMR; the modifications may include a change in the number, location, or depth of the monitoring wells.

9.0 REFERENCES

Bailey, C.M. and B.E. Owens. 2012. Traversing suspect terranes in the central Virginia Piedmont: From Proterozoic anorthosites to modern earthquakes, *in* Eppes, M.C., and Bartholomew, M.J., eds. *From the Blue Ridge to the Coastal Plain: Field Excursions in the Southeastern United States: Geological Society of America Field Guide No. 29*. pp 327-344.

Fetter, C.W. 1988. *Applied Hydrology*. Merrill Publishing Company. 592 pp.

Kearl, P.M., Korte, N.E., and Cronk, T.A. 1992. Suggested modifications to groundwater sampling procedures based on observations from the colloidal borescope: *Groundwater Monitoring Review*, v.12, No. 2, pp. 155-161.

Robin, M.L. and Gillham, R.W. 1987. Field evaluation of well purging procedures: *Groundwater Monitoring Review*, v.7, No. 4, pp.85-93.

Saunders, Laura L. 1998. *A Manual of Field Hydrogeology*, 1st Ed., Prentice Hall, 1998. p. 196.

URS. 2015. Groundwater Background and Water Quality Report, Bremo Power Station, Bremo Bluff, Virginia, VPDES Permit VA0004138. January 6.

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service. 2015. Soil Survey Geographic (SSURGO) Database for Fluvanna County, Virginia. USDA, Fort Worth, Texas Online Linkage: URL:http://SoilDataMart.nrcs.usda.gov/

USDA, Soil Conservation Service. 1958. Soil Survey Fluvanna County, Virginia. March. p. 194.

USEPA. 1986. RCRA Ground-Water Monitoring Technical Enforcement Guidance Document. Office of Solid Waste and Emergency Response (OSWER). OSWER-9950.1. September.

USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. Office of Resource Conservation and Recovery – Program Implementation and Information Division. March.

USEPA. 2015. Federal Register. Volume 80. No. 74. Friday April 17, 2015. Part II. Environmental Protection Agency. *40 CFR Parts 257and 261. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule.* [EPA-HQ-RCRA–2009–0640; FRL–9919–44–OSWER]. RIN–2050–AE81. April.

Virginia Division of Mineral Resources (VDMR). 1969. Geology of the Dillwyn Quadrangle Virginia. Report of Investigations 10. Commonwealth of Virginia Department of Conservation and Economic Development Division of Mineral Resources. By William Randall Brown. Charlottesville, Virginia. 1969.

Virginia Division of Mineral Resources (VDMR). 1993. *Geologic Map of Virginia*. Virginia Division of Mineral Resources, scale 1:500,000.

Virginia Waste Management Board (VWMB). 2016. Virginia Solid Waste Management Regulations – (9VAC20-81 *et seq*.). January.

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