DAN RIVER COAL ASH SPILL
NATURAL RESOURCE DAMAGE ASSESSMENT PLAN

For Public Review and Comment

June 2015 DRAFT

Prepared by

Dan River Natural Resource Trustee Council:

United States Fish and Wildlife Service
North Carolina Department of Environment and Natural Resources
North Carolina Wildlife Resources Commission
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CHAPTER 1: INTRODUCTION AND BACKGROUND INFORMATION

The Department of the Interior (DOI) through the U.S. Fish and Wildlife Service (Service), the Commonwealth of Virginia through the Department of Environmental Quality (VADEQ), and the State of North Carolina through the North Carolina Department of Environment and Natural Resources (NCDENR), collectively the Dan River Natural Resource Trustees (Trustees) have initiated the natural resource damage assessment and restoration (NRDAR) process to address natural resource injuries resulting from the release of hazardous substances to the waters of, and to the habitats associated with, the Dan River and associated environs downstream of the Dan River Steam Station in Rockingham County, NC (Figure 1-1). This Natural Resource Damage Assessment Plan (Assessment Plan) will serve as the guiding document for all damage assessment activities.

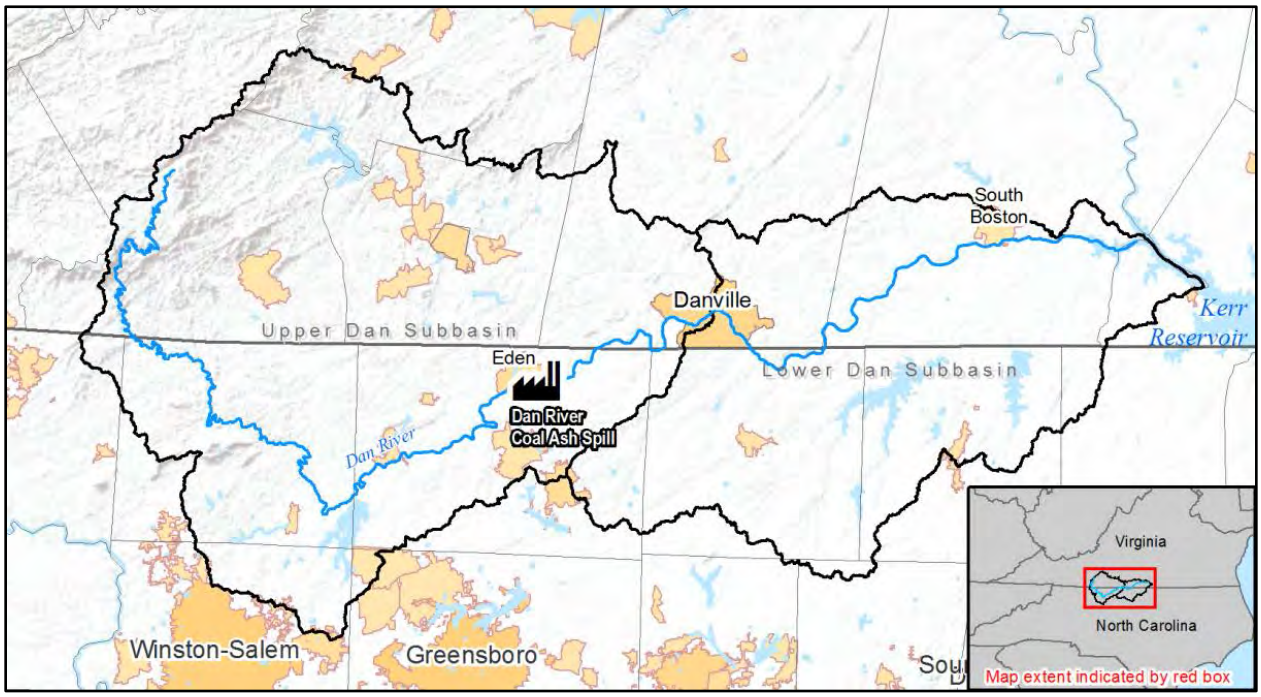

Figure 1-1. Watershed map for the Dan River coal ash spill

Authority to Conduct a NRDAR

Pursuant to the authority of Section 107(f) of the Federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, 42 U.S.C. § 9607(f); Federal Water Pollution Control Act, as amended, 33 U.S.C. 125, et seq. (CWA); Subpart G of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Sections 300.600, 300.605; and other applicable Federal and State laws, designated Federal and State authorities may act on behalf of the public as natural resource Trustees to pursue claims for natural resource damages for injury to, destruction of, or loss of natural resources resulting from the release of hazardous substances to the environment. Claims may be pursued against parties that have been identified as responsible for releasing hazardous substances to the

environment. Under CERCLA, sums recovered by Trustees as damages shall be used to restore, replace, or acquire the equivalent of such natural resources.

The President has designated Federal resource Trustees in the NCP, 40 C.F.R. § 300.600 and through Executive Order 12580, dated January 23, 1987, as amended by Executive Order 13016, dated August 28, 1996. Pursuant to the NCP, the Secretary of the DOI acts as a Trustee for natural resources and their supporting ecosystems, managed or controlled by the DOI. In this matter, the Service is acting on behalf of the Secretary of the DOI as Trustee for natural resources under its jurisdiction, including but not limited to migratory birds and endangered and threatened species.

In accordance with 42 U.S.C. 9607(f)(2)(B) and the NCP, the Virginia Secretary of Natural Resources has been designated the natural resource Trustee by the Governor of Virginia. In this matter, that responsibility has been delegated to the Director of the VADEQ. The State of North Carolina has designated the Secretary of the NCDENR as its Natural Resource Damages Trustee representative. In this matter, that responsibility has been delegated to the Division Director for the Division of Mitigation Services. The State Trustees act on behalf of the public as Trustee for natural resources, including their supporting ecosystems, within the boundaries of their state, or belonging to, managed by, controlled by, or appertaining to North Carolina and Virginia.

The State Trustees have, or share trusteeship, with the Service over the natural resources potentially affected in this matter. This shared trusteeship is reflected in the coordinated wildlife management practices of the Service, North Carolina, and Virginia, and is consistent with the management policies of North Carolina, Virginia, and the Service.

In developing this Assessment Plan, the Trustees have been guided by DOI's regulations for performing damage assessments provided at Title 43, Part 11 of the Code of Federal Regulations. These regulations establish guidelines and procedures for performing NRDARs and define the criteria for determining whether natural resources have been injured. Consistent with DOI regulations, the Trustees' decision to proceed with this assessment is based on the results of a Preassessment Screen Determination (Preassessment Screen), which was completed in March 2014 (DRNRTC 2014a). The Preassessment Screen, concluded that the Trustees have a reasonable probability of making a successful damage claim. Specifically, the Trustees have determined that:

- A release of hazardous substance has occurred;
- Natural resources for which the Trustees may assert trusteeship under CERCLA have been or are likely to have been adversely affected by the release;
- The quantity and concentration of the released hazardous substance is sufficient to potentially cause injury to natural resources;
- Data sufficient to pursue an assessment are readily available or likely to be obtained at a reasonable cost; and
- Response actions, carried out may not sufficiently remedy the injury to natural resources without further action.

Consistent with the DOI regulations, the preassessment screen was based on a review of readily available information.

Purpose

The purpose of this Assessment Plan is to document the Trustees' basis for conducting a damage assessment, and to outline the proposed approach for determining and quantifying natural resource injuries and calculating the damages associated with those injuries. By developing an Assessment Plan, the Trustees can ensure that the NRDAR will be completed at a reasonable cost relative to the magnitude of damages sought. The Trustees also intend for this Plan to communicate proposed assessment methodologies to the responsible party and to the public in an effective manner so that these groups can productively participate in the assessment process.

This Assessment Plan lays out the steps the Trustees will undertake in calculating the two primary components of a damage claim: the cost to restore, rehabilitate, replace, and/or acquire equivalent resources for the injured resources, and "compensable values," or the monetary value of the natural resource services that were lost prior to the restoration of injured resources to their "baseline"[1] condition.

History and Identification of Potentially Responsible Party

The spill occurred on or around February 2, 2014, from the collapse of a stormwater pipe beneath a coal ash slurry impoundment at the Duke Energy Dan River Steam Station (Site). Ash material and ash pond water within the reservoir was released into the Dan River as a result of failure of a 48-inch diameter stormwater pipe comprised of concrete and corrugated metal. According to the U.S. Environmental Protection Agency (EPA), up to 39,000 tons of ash and 27 million gallons of ash pond water were released into the Dan River. Coal ash is a gray, powdery byproduct of burning coal to produce energy. Coal ash is composed of materials remaining after coal is burned, including fine sand (called silica), unburned carbon and various trace metals such as arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc; compounds that have potential to be chemicals of concern associated with the Dan River spill. The Site is less than 10 river miles from Virginia, and Service reconnaissance documented ash or ash-like material co-mingled with native sediment as far as 70 river miles downstream in the days immediately following the spill.

In total, three removal actions have been conducted related to the spill. On February 8, 2014, a coal ash bar about 75 feet long and 15 feet wide which had as much as five feet of ash or ash/sand mix over the natural stream bottom was identified and was subsequently removed (February 11-13, 2014), resulting in the recovery of 15 tons of coal ash and native sediment. On

[1] Baseline is the condition(s) that would have existed in the assessment area had the release of hazardous substances under investigation not occurred

July 7, 2014, Duke Energy announced completion of the removal of a coal ash deposit (258 tons of a coal ash and river sediment mixture) at a location approximately two miles downstream from the Site on a native sandbar delta at the mouth of Town Creek with the Dan River. Removal of 2,500 tons of coal ash comingled with native sediment in a larger deposit upstream of the Schoolfield Dam in Danville, Virginia began on May 6, 2014, and was also completed in early July 2014 (although Abreu Grogan Park, where cleanup equipment was mobilized, was closed to public use to support cleanup activities between April 1 - August 1, 2014). In addition to these removal actions, a total of about 466 cubic yards of solids (ash/sediment mix) was removed from the water treatment plants at Danville and South Boston, Virginia and properly disposed of along with dredged material from the Dan River.

Duke Energy is the sole owner and operator of the Dan River Steam Station at the time of the release and is responsible for historic operational activities at the Site; therefore, Duke Energy is considered a responsible party (RP) for the spill.

Overview of the NRDAR Process

It is the intent of the Trustees to conduct the NRDAR according to the DOI NRDAR Regulations at 43 C.F.R. Part 11. These regulations describe the process by which Trustees may conduct a NRDAR. This process includes the following three phases:

- Preassessment,
- Assessment, and
- Post-Assessment

To date, as noted above, the Trustee council has completed the preassessment phase. The following administrative and preassessment planning documentation is available on the Dan River Coal Ash NRDAR website (U.S. Department of the Interior 2015):

Notice of Intent. The Trustees sent a notice of intent to initiate a NRDAR to Duke Energy on March 4, 2014.

Preassessment Screen Determination. The Trustees finalized a Preassessment Screen on March 19, 2014 (DRNRTC 2014a), which provided the basis for the Trustees' determination that further investigation was warranted based on a review of the readily available information on hazardous substance releases and the potential impacts of those releases on natural resources under the trusteeship of Federal and State authorities.

The Trustee's Memorandum of Understanding. The Trustees executed a Memorandum of Understanding (MOU) on May 5, 2014 creating the Dan River Natural Resource Trustee Council (DRNRTC) comprised of agency representatives to ensure the coordination and cooperation among the Trustees during the NRDAR process.

The Funding and Participation Agreement between the Trustees and Duke Energy. The Trustees entered into an agreement with Duke Energy on June 9, 2014, intended to provide an expedited, focused framework for cooperative NRDAR activities and to facilitate the resolution of claims for natural resource damages arising from the releases of hazardous substances. The agreement outlines procedures for (a) coordinating data collection and assessment activities to determine the extent of natural resource injuries; (b) expediting restoration of injured natural resource and/or the services provided by those resources; and (c) paying assessment and restoration costs incurred and to be incurred by the Trustees.

The Trustee council is now undertaking the assessment phase, which includes the following:

- Assessment planning,
- Pathway determination,
- Injury assessment (determination and quantification),
- Damage determination and restoration

Each of the steps to be followed in assessing injury and damages is discussed in greater detail in the chapters that follow. Although these steps often progress linearly in the NRDAR process, in this case, the restoration planning process is moving forward concurrent with the injury assessment and damage determination phases of the NRDAR based on the RP's stated interest in early restoration opportunities and the Trustee's recognition that early restoration presents benefits to trust resources. Accordingly, the Trustees initiated restoration planning and solicitation of public input.

Scoping Document for Restoration Planning. In October 2014, the Trustees released a restoration scoping document to (a) present restoration project eligibility and evaluation criteria and preliminary restoration project concepts, and (b) solicit on additional restoration activities with potential to meet the Trustee's objective of restoring affected resources and services (DRNRTC 2014b).

Restoration Scoping Response Summary. A summary of the feedback received by the Trustees on the Scoping Document for Restoration Planning was finalized in December 2014 (DRNRTC 2014c).

Use of available data

The Trustees' general approach to the assessment is and has been to review the existing data, analyze gaps, and then undertake additional testing and sampling as needed. This minimizes the cost of the assessment and maximizes the use of existing information.

Intent to Perform a Type B Assessment

As part of the assessment planning process, the Trustees decide whether to conduct a simplified assessment or a comprehensive assessment. In light of the complexities noted above

and other considerations, the Trustees have determined that the simplified procedures of the "type A" assessment provided for in the NRDAR regulations are inappropriate for this NRDAR and that a "type B" assessment should be conducted. The "type A" procedures, which use minimal field observations and computer models to generate a damage claim, are limited by the regulations to the assessment of relatively minor, short duration discharges or releases in coastal or marine environments or in the Great Lakes. Based on the Trustees' determination (1) that the nature of the releases and exposures to hazardous substances associated with coal ash in the assessment area are not short-term and are spatially and temporally complex, (2) that substantial site-specific data already exist to support the assessment, and (3) that additional site-specific data can be collected at reasonable cost, the Trustees have concluded that the use of "type B" procedures is justified.

The NRDAR regulations provide that before including any "type B" methodologies in the Assessment Plan, it must be confirmed that at least one of the natural resources identified as potentially injured in the Preassessment Screen has in fact been exposed to the released hazardous substance. The Preassessment Screen identified sediment, water, and biota and human uses of the Dan River as potentially injured natural resources and services. Confirmation of the exposure of natural resources is provided in Chapter 3. Those natural resources of the Dan River that have been exposed to contamination and for which such confirmation of exposure has been made include surface water resources, including river sediments, and geologic resources, including floodplain soils. Quality assurance procedures associated with the "type B" procedures are available along with standard operating procedures and protocols for assessment techniques as detailed in Appendices A-D.

Coordination with Other Activities

"Response" and "restoration" represent two related, but distinct processes under CERCLA. Response is intended to reduce or eliminate risks to human health and the environment associated with contamination. NRDAR, which is designed to restore injured natural resources that were not fully addressed by cleanup activities, is the process through which the public is compensated for injuries to natural resources caused by the contamination or the response, itself. Restoration includes returning injured resources to baseline and addressing losses that occur from the onset of the injury to the time at which the resources are restored. Response is overseen by EPA while NRDAR is conducted by the Trustees.

The DOI regulations support the coordination of a damage assessment, to the extent possible, with response actions or other investigations being performed pursuant to the National Contingency Plan (i.e., cleanup activities). At a minimum, the Trustees intend to take into consideration the objectives of these activities during the continued planning and implementation of this assessment. Whenever possible, the Trustees have explicitly coordinated damage assessment activities with other investigations to satisfy the Trustees' NRDAR objectives in a cost and resource efficient manner. To facilitate this process, the Trustees are working closely with the EPA Region 4 and 5 offices. The Trustees are coordinating the NRDAR concurrent with an ongoing interagency process focused on removal and long term

monitoring needs. Trustee input to the interagency group facilitated development of data collection and quality assurance plans to meet concurrent response and NRDAR information needs. Specific data collection activities and associated quality assurance protocols developed by the interagency group germane to the NRDAR process are provided in Appendices A-D. Coordinated response and restoration activities are intended to provide sufficient data to assess past, present, and future potential natural resource injuries and lost natural resource uses and services.

Public Participation

The Trustees are interested in receiving feedback on this Assessment Plan. To facilitate this process, the Trustees are asking the public and the party or parties responsible for the contamination to review the Assessment Plan and provide feedback on the proposed approach and studies. Comments should be submitted by July 17, 2015. These comments will help the Trustees plan and conduct an assessment that is scientifically valid, cost effective, and that incorporates a broad array of perspectives. To that end, the Trustees request that you carefully consider this Assessment Plan and provide any comments you may have to:

Sara Ward, U.S. Fish and Wildlife Service
Raleigh Ecological Services Field Office
Phone: 919/856 4520 Ext. 30
Email: Sara_Ward@fws.gov,

or

Susan Lingenfelser, U.S. Fish and Wildlife Service
Virginia Ecological Services Field Office
Phone: 804-824-2415
Email: Susan_Lingenfelser@fws.gov

The Trustees will consider all public comments and input on the Assessment Plan, and will prepare a responsiveness summary to the comments. Based on the public's comments or other information, the Trustees may modify the Assessment Plan at any time. Any substantive modifications will be made available for review by the public, including the party or parties responsible for the contamination.

Assessment Timeline

The Trustee council does not have a fixed timeline for the completion of the NRDAR process. As called for in the DOI regulations for NRDAR under CERCLA, the Trustee council has, and will continue, to coordinate the assessment with the remedial process where possible. The timeline of the assessment will also be adjusted to accommodate public participation and environmental conditions (e.g., any required field studies may be subject to seasonal constraints, assessment of resources may be limited by weather and/or other factors).

CHAPTER 2: DESCRIPTION OF THE ASSESSMENT AREA

Scope of the Assessment

Geographic

The assessment area is defined in the DOI regulations as:

> *The area or areas within which natural resources have been affected directly or indirectly by the discharge of oil or release of a hazardous substance and that serves as the geographic basis for the injury assessment (43 CFR 11.14(c)).*

The assessment area at a minimum includes, but is not limited to the point of discharge from the Facility's storm sewer management pipe in Rockingham County, North Carolina downstream (approximately 77 river miles) up to and including Buggs Island Lake (John H. Kerr Reservoir), located in Virginia and North Carolina. In total, the potentially affected surface water route encompasses waters in Rockingham, Caswell, Person, Granville, Vance, and Warren Counties in North Carolina and Pittsylvania, Halifax, Charlotte, and Mecklenburg Counties in Virginia. The boundaries of the assessment area may be amended as more data become available.

Temporal

Trustees can seek recovery of damages for both primary restoration and compensatory restoration. Compensatory restoration actions are intended to compensate for the "interim loss" in natural resource services from the time of the release through return of the injured resource to its baseline condition. As such, compensatory loss estimation requires selection of a time period over which losses will be estimated. The temporal scope of this assessment will be based on determination of both injuries to natural resources and corresponding reductions in natural resource services. Documented natural resource exposure to hazardous contaminant releases within the study area has occurred since the spill which occurred on February 2, 2014.

In terms of prospective assessment of damages, injuries will be quantified, and damages calculated, through the expected date of resource recovery to baseline. The rate of resource recovery will be determined based on information related to remedial and restoration activities, natural attenuation, and resource recoverability.

Hazardous Substances Released

Coal ash is a gray, powdery byproduct of burning coal to produce energy. Coal ash is composed of materials remaining after coal is burned, including fine sand (called silica), unburned carbon and various metals such as arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc; compounds that are hazardous substances of potential concern associated

with the Dan River release. Preliminary screening of analytical results of surface water, coal ash, and sediment samples collected during the spill response allowed the Trustees to develop a release-specific list of parameters exceeding standards or other effects thresholds in the Preassessment Screen (DRNRTC 2014a) including, but not limited to, arsenic, copper, selenium, iron, turbidity, zinc, and lead. However, the specific hazardous substances of concern on which the injury analysis will focus will be refined by the DRNRTC as part of the assessment process.

Natural Resources and Services in the Assessment Area

The DOI regulations define five categories of natural resources for which natural resource damages may be sought: surface water resources, ground water resources, air resources, geologic resources, and biological resources. Surface water resources include both the water column and associated bed or bank sediments. The following sections briefly describe each of these categories in the context of the assessment area.

Surface water resources. The surface water resources in the assessment area include the water and the bed and bank sediments of the Dan River from the area of the spill downstream to John H. Kerr Reservoir. River sediments are included within the regulatory definition of surface waters for NRDAR purposes. The contamination of these resources has both direct and indirect impacts on the health of biological resources. For example, contaminated sediments can cause injury to benthic invertebrate populations, which in turn can result in injuries to resident fish populations for whom the invertebrates are a source of food. Similarly, injury to invertebrates and/or fish resulting from exposure to contaminated sediments and surface water can lead to injury in local insectivorous (insect eating) or piscivorous (fish eating) bird populations. In addition, contaminated sediments serve as a source of continuing releases of hazardous substances to the water column. Surface water resources provide a suite of ecological and human services. Ecological services include, but are not limited to, habitat for trust species, including food, shelter, breeding areas, and other factors essential to survival. Human services provided by surface water resources include, but are not limited to, recreational uses such as water-contact recreation, boating, canoeing, and other activities.

Ground water resources. Ground water resources include the water in a saturated subsurface zone and the rocks or sediments through which this water flows. Ground water resources serve as a potential pathway for contaminants to migrate from their source to surface water resources. The Trustees do not consider an assessment of the ground water pathway to be a cost-effective use of assessment resources, as ground water discharges of hazardous substances associated with coal ash is assumed to play a relatively minor role in causing the potential injuries that will be the focus of this damage assessment.

Air resources. Air resources are typically assessed in the context of their ability to serve as a pathway for hazardous substances to reach, and potentially injure, other resource categories. The Trustees do not consider an assessment of the air pathway to be a cost-effective use of assessment resources, as deposition of airborne contaminants is assumed to play a relatively minor role in causing the potential injuries that will be the focus of this damage assessment.

Geologic resources. Geologic resources include soils and sediments that are not otherwise accounted for under the definition of surface water or ground water resources. In this case, geologic resources include the soils and sediments located in upland and wetland areas closely associated with the Dan River. Geological resources, including soil and sediments resources in riparian and other wetland areas, provide habitat and other services that regulate ecosystems and water quality while offering human services including hiking and nature observation.

Biological resources. Along with surface water resources, biological resources comprise a key component of this damage assessment. The Trustees will focus on the assessment of injuries to three categories of biological resources: benthic invertebrates, fish, and migratory birds and aquatic dependent wildlife. Biota that inhabit the area provide a wide range of ecological services including nutrient cycling, pollination, and as food sources. Insects, amphibians, reptiles, birds, and small mammals serve as food sources for higher trophic level animals including raptors and predatory mammals. Biological resources also provide a range of human services including fishing, hunting, and wildlife viewing.

CHAPTER 3: INJURY ASSESSMENT

Injury Assessment Overall Approach

The Trustees are conducting a damage assessment to evaluate injuries to natural resources exposed to hazardous substances associated with coal ash in and around the Dan River, following the guidelines and procedures provided in the DOI NRDAR regulations, including defining criteria for determining whether natural resources have been injured.

The injury assessment comprises both injury determination and injury quantification. Determination of injury to natural resources under the DOI's regulations consists of documentation that there is: (1) a pathway for the released hazardous substance from the point of release to a point at which natural resources are exposed to the released substance, and (2) that injury of a natural resource of interest (i.e., air, surface water, sediment, soil, groundwater, biota) has occurred, as defined in 43 C.F.R. § 11.62. Injuries generally fall into two categories. The first category establishes injury based on the exceedance of regulatory criteria. This may include violation of established standards or the existence of state health advisories warning against the consumption of contaminated biota and closures or restricted use of resources. The second category establishes injury based on physical, chemical, or biological changes in the resource resulting from contaminant exposure. Examples of these injuries include changes in an organism's physical development, health, reproductive success, or behavior. Quantification of injuries that have occurred involves defining the scope of lost ecological services and natural resource injuries by establishing the baseline ("but for the spill") conditions and quantifying injuries to natural resources and the services they provide. Loss of services may include impairment of the habitat that a resource provides or diminished human use of a resource. The injury quantification phase evaluates the recoverability of the injured resource and the reduction in services that resulted from the release as a foundation for determining appropriate compensation for those losses, otherwise known as damage determination (Chapter 4).

The Trustees' general approach to the assessment is and has been to review the existing data, analyze gaps, and then identify additional testing and sampling as needed. This minimizes the cost of the assessment and maximizes the use of existing information. The Trustees will, based on that initial review and additional preliminary investigations where necessary, determine the need for any additional sampling or investigations necessary to define the nature and extent of injuries caused by hazardous substances associated with coal ash released into the Dan River. The remaining sections of this chapter summarize the Trustees' approach to injury assessment within each category of natural resource. The proposed injury assessment endpoints presented herein are intended to represent the suite of assessment activities with potential to meet the Trustee's goal of assessing injuries to natural resources and services. The Trustees may rely on some or all of these assessment endpoints at their discretion in order to efficiently and effectively reach estimates of injuries. Chapter 4, Damage Determination and Restoration, focuses on the Trustees' approach to determine the type and magnitude of compensation required to restore injured natural resources to the appropriate baseline condition and to

address the public's loss of natural resource services for the period preceding restoration to baseline (the "interim loss").

Pathway Determination

Pathway is an essential component of the determination of injury to natural resources. Pursuant to 43 CFR 11.14(dd), a pathway is defined as:

> *The route or medium through which…a hazardous substance is or was transported from the source of the discharge or release to the injured resource.*

The primary mechanism for release of coal ash and hazardous substances associated with coal ash was the ruptured storm water management line. Secondary pathways include transport by storm water runoff, erosion, surface water, and wind. Possible pathways resulting in exposure of biota to ash-related hazardous substances include direct contact with suspended or dissolved hazardous substances in the water column, direct contact with sediments contaminated by hazardous substances, direct contact with contaminated sediment interstitial pore water, exposure by re-suspended, pre-contaminated sediments, ingestion of contaminated sediment during foraging or feeding, and/or indirect contact through ingestion of contaminated prey species, including bioaccumulation.

Confirmation of Exposure

Consistent with 43 C.F.R §§ 11.31(c)(1) and 11.37, this Plan will document that natural resources have been exposed to hazardous substances. Consistent with 43 C.F.R § 11.25(d), the Preassessment Screen for the Dan River coal ash spill presented estimates of concentrations of hazardous substances in various environmental media in Section 3 of that document (DRNRTC 2014a). That presentation of measured contaminant concentrations in environmental media, and its reference herein, fulfills the requirement of confirmation of exposure.

Data Sources

There are various pre- and post-spill data sources available to the Trustees for our use to assess baseline conditions inform our understanding of injuries within each category of natural resource. A summary of available data sources is presented here; more specific discussion of how these data will be applied in the injury assessment follows in the subsections related to each natural resource category.

Background information sources to be summarized (HDR 2014) include, but are not limited to, the following:

- Duke Energy historic monitoring reports for Belews Creek and Dan River Stations and the Dan River – 1982 to 2013
- NC DENR monitoring data for the Dan River in North Carolina
- VADEQ monitoring data for the Dan River in Virginia

- Monitoring data collected by the Dan River Basin Association (DRBA)
- Other environmental data available through federal, state and other publicly available databases
- University studies and literature with relevant information about the background condition of the Dan River

Site-specific post-release data sources include, but are not limited to, the following:

- Duke Energy sampling. Routine water quality, fish tissue, fish community, benthic macroinvertebrate surveys, mussel study, sediment sampling and periphyton sampling began immediately following the spill and continues to date (though the scope and frequency have been reduced based on sampling results to date). Specific locations and sampling frequency are described in detail in the Dan River Ash Release Environmental Impact Assessment and Sampling and Analysis Plan in Appendix A (SAP). The sampling approach outlined in the SAP reflects input from the joint interagency team supporting the spill response and long term monitoring.

- EPA sampling. Routine surface water, sediment, drinking water, sediment water interface, soil, and coal ash/ash pond samples were collected at the spill source and several locations upstream and downstream of the Site (U.S. EPA 2015). Samples were collected starting on February 6, 2014 and some sampling continues to date (ash deposition and sediment monitoring), though at a reduced frequency and scale. EPA sampling was conducted by EPA's Superfund Technical Assessment & Response Team (START) Contractor and the EPA Region 4 Science and Ecosystem Support Division (SESD).

- NC DENR sampling. Routine water quality, fish community, fish tissue, and benthic macroinvertebrate surveys began immediately following the spill and continues to date (NCDENR 2014, 2015a, 2015b, 2015c). Appendix B provides additional details regarding the frequency, geographic scope, and methods for NCDENR sampling.

- VADEQ sampling. Routine water quality, fish community, fish tissue, and benthic macroinvertebrate surveys began immediately following the spill and continues to date. Appendix C provides additional details regarding the frequency, geographic scope, and methods for VADEQ sampling.

- Sediment transport model. The National Center for Computational Hydroscience and Engineering at the University of Mississippi (in collaboration with the U.S. Army Corps of Engineers Engineer Research and Development Center) has developed one- (1D) and two-dimensional (2D) models and simulations of the transport and fate of coal ash and some selected contaminants in the Dan River (Altinakar et al. 2015).

Appendix D presents maps illustrating all pre- (baseline) and post-release (emergency response and long term monitoring) sampling stations for which data are available that the Trustees can rely on for use in the NRDAR. The Trustees are aware of additional data collection activities (e.g., drinking water supplier sampling, Dan River Basin Association benthic and water quality survey data, and university studies conducted post-incident) that may also provide useful information to the assessment.

Finally, the Trustees have the option of relying upon existing relevant studies where appropriate. A Reasonably Conservative Injury Evaluation (RCIE) uses existing information and other data sources from similar releases and subsequent assessments at other sites along with information from the scientific literature to evaluate injuries. The Trustees recognize that, in some cases, it may be more practical and cost-effective to make reasonable and conservative estimates of injuries or losses using best professional judgment, information obtained for other purposes, or estimates rather than spend additional time and money on injury assessment studies. Implicit to the RCIE approach is a tradeoff between investment in incident-specific studies to reduce uncertainty regarding the nature and/or scale of injury and the ultimate investment in restoration to compensate the public for injured resources and services. Specific sources of information and literature that the Trustees have identified for application to the Dan River NRDAR are referenced below.

Injury Assessment for Surface Water Resources

The Dan River provides habitat for a wide range of plants and animals. The river provides food and shelter for these organisms, as well as essential habitat for many species that nurture their offspring in the open waters, shoals, and eddies. The Dan River also serves as a source of drinking water for several communities and provides opportunities to boat, swim, fish, and view wildlife. The specific approach that the Trustees will use to determine injuries to Dan River surface water resources are described below.

Water Quality Evaluation

The NRDAR regulations provide that when chemical contamination is present in waterways at levels that exceed the standards set by the State or Federal government, the surface water resource is injured, if the surface water met the standards before the release and is a "committed use" as a habitat for aquatic life, water supply, or recreation. Accordingly, the Trustees will assess injuries to surface water by evaluating 1) surface water with respect to applicable water quality criteria, and 2) history, dates, and geographic ranges of the recreational surface water advisory.

1. Water quality standards have been established by EPA and the State of North Carolina and the Commonwealth of Virginia to protect humans and wildlife from the effects of exposure to hazardous substances. The Trustees will screen post-incident water quality data against North Carolina Water Quality standards for aquatic life, EPA ambient water quality criteria (criterion maximum concentration [CMC] and criterion continuous

concentration [CCC]), and Virginia water quality standards for aquatic life. The extent to which exceedances of screening values for parameters of concern is reflective of the release versus background conditions will be determined by establishing baseline water quality conditions using historic (pre-spill) State and Duke Energy datasets.

2. Regulatory recreational contact advisories[2] and other warnings have occurred as a result of the release of coal ash from the Site and have affected human use of surface water resources. On February 12, the North Carolina Department of Health and Human Services (NCDHHS) issued a recreational contact advisory for the Dan River; the advisory was subsequently lifted on July 22, 2014 (NCDHHS 2014a, 2014b, 2014c). In Virginia, no formal advisories were issued; however, the Virginia Department of Health (VDH) issued the following recommendation to the public: "VDH recommends exercising caution when using the Dan River for primary contact purposes (swimming, boating, kayaking, etc)" (VDH 2014). Trustees will assess the direct reduction in services spatially and temporally that resulted from advisory and warning issuance.

Available/Pending Data

Following the release, surface water grab samples were collected by Duke Energy, EPA (START and SESD), NCDENR, and VADEQ. Sampling locations include the spill source, several downstream locations, and potable water intakes at the Danville and South Boston, Virginia, water treatment plants (WTP). In addition, at a subset of sediment sampling locations (with sufficient water depth), the EPA SESD team collected water column samples (including surface and sediment/water interface grab samples). Drinking water sampling (including raw and finished water) was also conducted by Duke Energy, VDH, and EPA START and SESD teams.

Long term surface water sampling continues is also being conducted by Duke Energy (bi-monthly at 3 sites upstream and 6 sites downstream of the spill), NCDENR (monthly at one site upstream and 3 sites downstream of the spill[3]), and VADEQ (monthly at 6 sites downstream of the spill).

In addition to available post-spill water quality datasets, pre-spill water quality datasets (including Duke Energy, NCDENR, DRBA, and VADEQ results noted above) are available to determine appropriate baseline conditions.

Data Gaps/ Uncertainty

Based on the spatial distribution and temporal frequency of post-spill surface water quality sampling efforts, there is reasonable likelihood that the Trustees can complete the injury assessment without data collection beyond the ongoing state and Duke Energy sampling

[2] Note, other regulatory advisories related to consumption of fish and shellfish in spill affected areas are discussed below (see "Injury Assessment for Biological Resources").

[3] Routine water monitoring sites; water samples also collected in conjunction with sediment and non-routine sampling events (see Appendix B)

efforts. Accordingly, given ample site-specific data and availability of screening values, uncertainty is limited.

Sediment Evaluation

River sediments are included within the regulatory definition of surface waters for NRDAR purposes. The Trustees are evaluating two mechanisms for determining sediment injury: 1) quantification of sediment contamination sufficient to cause toxicological adverse effects to biota, 2) sediment and recreational injury resulting from response / removal activities, and 3) recreational injury resulting from response / sediment removal activities.

1. Sediments are also injured when they contain hazardous substances of sufficient concentration and duration to cause injury to other natural resources biological resources when exposed to surface water, suspended sediments, or bed, bank, or shoreline sediments. The Trustees determined that the concentrations of hazardous substances associated with coal ash in Dan River sediments were sufficient to cause injury to other natural resources, such as biota, that are exposed to those sediments (DRNRTC 2014a). The Trustees plan to expand that assessment to determine the potential for hazardous substances associated with coal ash to cause direct toxicological effects on benthos (in contrast to accumulation of metals in benthos and resultant food web effects, discussed below). These results can be screened using the probable effects concentration (PEC; MacDonald 2000), and guidelines for interpreting biological effects of metals (U.S. Bureau of Reclamation 1998). Initial screening conducted by the Trustees indicates that both selenium and arsenic are at concentrations of concern. The spatial and temporal extent of such exceedances of effects values can be determined.

2. The results of ash deposition surveys and analyses informed an assessment of presence, thickness and condition of ash in the river and supported decision-making regarding ash recovery efforts (Duke Energy 2014, updated for NRDAR April 2015 in Appendix E). Three areas in the Dan River and the intake basins of the water treatment facilities at Danville and South Boston, Virginia were identified for ash removal. Ash and ash/sediment removal actions can result in impacts to native soil, sediment and associated habitats of the Dan River. The Trustees can assess the extent of river habitat affected as well as the diminished value of the dredged habitat during the recovery period to inform the injury assessment.

3. Likewise, removal activities also resulted in the closure of Abreu Grogan Park in Danville to the public where cleanup between April 1 and August 1, 2014. Trustees will assess the direct reduction in services spatially and temporally that resulted from public closure of the park.

Available/Pending Data

Several sources of sediment data are available for the Trustees to rely on:

Ash Deposition Monitoring. Ash deposition reconnaissance surveys were initiated and conducted in the Dan River within days following the spill, involving multiple float trips and core sampling making observations regarding the presence, extent and thickness of ash deposited in the river from the Site to John H. Kerr Reservoir. By late March, 2014, a formal ash deposition transect study was designed and efforts initiated to collect data at 30 defined transect locations (Duke Energy 2014). Visual observations (including presence and depth of suspected ash layers in sediment cores), percent ash, and sediment chemistry (described below) were recorded from each transect for percent ash, arsenic and selenium during four rounds of monthly surveys (April through July, 2014). Following the three removal actions, the location-specific ash deposition assessment program was reduced in scope to include sediment sampling at five transect locations quarterly.

Sediment chemistry. During response operation , sediment samples were collected from the river by the EPA SESD team at one mile intervals along the Dan River in areas immediately downstream (including through Danville, Virginia) and then at greater spatial intervals throughout the remaining riverine portion of the Dan River system. The purpose of the sampling was to determine qualitatively the extent of ash deposits and collect particle size information. The EPA SESD team metal results were available for a subset of sites for screening purposes. Results of these initial phase efforts were used to inform the design of a formal ash deposition transect study. NCDENR also conducted sediment sampling at two stations downstream of the spill during response operations.

Long term monitoring of sediment chemistry is being conducted in by EPA and Duke Energy in conjunction with ash deposition monitoring as described above. Finally, long term sediment chemistry samples are also being collected NCDENR (Appendix B) by VADEQ (monthly at 6 sites downstream of the spill, Appendix C).

Sediment transport model. A sediment transport modeling effort to predict ash behavior in the river system was initiated by Duke Energy with EPA oversight. 1D and 2D modeling results will inform estimates of sediment deposition in space and time and contaminant transport and fate.

Data Gaps/ Uncertainty

There are gaps in available sediment chemistry both temporally and spatially for which assumptions may be necessary. Based on criteria established by EPA in an Administrative Order on Consent (AOC) with Duke Energy, the need for future ash deposition monitoring surveys as outlined in the *Ash Removal Site Assessment Plan for the Dan River Steam Station Ash Release* (Duke Energy 2014) is being evaluated by EPA. Based on results of prior rounds of quarterly sampling, AOC-required sampling will continue in May 2015; a decision regarding continued monitoring will be determined based on those sampling results. If warranted, continued sampling for the NRDAR at a subset of the original transect locations may be continued to satisfy injury assessment needs outlined above. In addition, ash monitoring sites to date have focused on depositional areas and natural and man-made (e.g., impoundments) pools in the

Dan River system. Riffle areas represent a notable gap in sediment and ash deposition sampling to date that will need to be addressed during the injury assessment given the importance of these areas for biological resources in the Dan River. These ash deposition sampling protocols, updated to address the ongoing NRDAR injury assessment, are presented in Appendix E.

Uncertainties associated with the sediment transport model assumptions are presented in Altinakar et al. 2015, and will be discussed in greater detail in a forthcoming report. Site-specific data or literature on the diminished value of dredged habitat does not exist, so assumptions and reliance on literature from other systems will be needed. An additional source of uncertainty in determining service reductions is the limited pre-spill sediment chemistry dataset (e.g., Duke Energy sampling efforts at a limited number of stations with only one downstream of the Site).

Injury Assessment for Geologic Resources

Geologic resources include soils and sediments located in upland and wetland areas closely associated with the Dan River. Geologic resources (e.g., wetland soils) are injured if they contain concentrations of substances sufficient to cause injury to other resources (e.g., surface water, ground water, biological). The Trustees are evaluating two mechanisms for determining geologic injury: 1) quantification of sediment contamination sufficient to cause toxicological adverse effects to biota in wetland areas and 2) injury to wetland areas from response / removal activities that are not otherwise accounted for under the injury assessment for surface water resources.

Available/Pending Data

The primary sources of data available for the Trustees to rely on include:

Results of EPA sediment chemistry sampling conducted in conjunction with the Town Creek removal action (encompassing wetlands environments at the confluence of Town Creek and the Dan River) are available for screening against appropriate sediment quality guidelines. The spatial scope of removal actions in areas beyond the river bed (which are covered in the surface water resources injury assessment) is available for Trustee review to assess the extent of wetland and/or upland habitats affected by recovery actions.

Data Gaps/ Uncertainty

There is reasonable likelihood that the Trustees can complete the injury assessment without data collection beyond results that are readily available. Uncertainties are limited to assumptions and/or literature estimates to inform the diminished value and recovery period of dredged wetland habitat.

Injury Assessment for Biological Resources

Possible pathways resulting in exposure of aquatic biota to ash-related hazardous substances include direct contact with suspended or dissolved hazardous substances in the water column, direct contact with sediments contaminated by hazardous substances associated with coal ash, direct contact with contaminated sediment interstitial pore water, exposure by re-suspended, pre-contaminated sediments, ingestion of contaminated sediment during foraging or feeding, and/or indirect contact through ingestion of contaminated prey species, including bioaccumulation. The concentrations of hazardous substances in surface water and sediment have been sufficient to cause injury to fish and other aquatic biota, as evidenced by exceedances of freshwater aquatic life criteria and consensus-based probable effects concentrations for freshwater ecosystems. The following sections summarize the Trustees' approach to injury assessment for various aquatic and aquatic-dependent biota and the services provided by them.

Benthic Invertebrates

In general, an injury to a biological resource has occurred if concentrations of hazardous substances are sufficient to cause the invertebrates or their offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations (43 CFR 11.62(f)(1)(i)). The Trustees are evaluating the potential impacts of physical burial of the stream-bottom habitat that particularly important for mussels and other aquatic insects with limited mobility. The ash can coat the bottom, burying animals and their food. There may also be longer-term toxicological impacts to benthic invertebrates due to exposure to elevated concentrations of metals in ash. The Dan River system supports a wide variety of mussel species including the federally listed endangered James spinymussel (*Pleurobema collina*) and the green floater (*Lasmigona subviridis*), a species being evaluated by the Service to determine if protection under the federal Endangered Species Act (ESA) is warranted. Records for both of these species are found either upstream or downstream of the Site. As discussed above (see Injury Assessment for Surface Water Resources), toxic impacts to benthic invertebrates can be determined by comparing metals concentrations in sediment to literature-derived effects data for benthos. The Trustees can also evaluate injuries to benthic invertebrates by 1) assessing the temporal and spatial extent of physical impact of burial of benthic invertebrates by ash and 2) comparing benthic invertebrate health (as measured by community diversity indices) pre-and post-spill.

1. When released, the coal ash is a new source of material to the river that behaves similarly to sediment when the more coarse fractions of the material are deposited. Ash deposits observed shortly after the spill during reconnaissance of depositional areas between the Site and John H. Kerr Lake headwaters include a coal ash bar with up to five feet of ash or ash/sand mix overlying natural stream bottom downgradient of the release point (since removed), ash deposits over five inches thick atop sand bars within two miles of the Site, and deposits two inches thick to the North Carolina/Virginia line

about nine miles downstream. Further downstream as far as South Boston, Virginia, observations included one-eighth to one-half inch of ash on sandbars and other depositional areas, and traces of ash all the way to Kerr Lake. The potential physical impact of ash deposits on biota (e.g., benthic invertebrates) may occur via physical burial or altered physical quality of substrate. These physical affects can be assessed temporally and spatially using existing datasets including field-based ash deposition observations, ash content of sediment, and predicted deposition from the sediment transport model.

2. Benthic macroinvertebrates are an important part of the aquatic community and food web. The health of this biological group is also an indicator of the biotic integrity of the aquatic ecosystem they inhabit. Impacts to this group could lead to overall degradation of the aquatic community. Consequently, generating community diversity indices or metrics will present a relative comparison of expected macroinvertebrate assemblages between reference areas and areas downstream of the release.

Available/Pending Data

To assess the extent of ash smothering of benthic invertebrates, the Trustees will rely on field-based ash deposition observations, ash content of sediment, and predicted deposition from the sediment transport model as described in the sediment evaluation section above. Benthic community diversity indices are available to assess pre- and post-spill conditions (e.g., HDR 2015, post-spill benthic invertebrate monitoring datasets from Duke Energy, NCDENR, and VADEQ monitoring as described in Appendices A through C). The Trustees will also evaluate relevant literature from other coal ash release sites.

Data Gaps/ Uncertainty

Data gaps associated with the ash deposition observations, ash content of sediment, and sediment transport model results are discussed in the sediment evaluation section above. Data gaps related to the benthic community health assessment are related to the temporal and spatial gaps in available data (particularly pre-spill where baseline benthic monitoring is limited).

Fish

Freshwater fish, including sport and non-game fish species, have been affected or potentially affected by the spill. In addition to common game and non-game species, there is one federally listed endangered fish species, the Roanoke logperch (*Percina rex*) in the Dan River system in North Carolina and Virginia. The system also provides habitat for the orangefin madtom (*Noturus gilberti*), a fish species which the USFWS is currently evaluating to determine if protection under the ESA is warranted. The Dan River system supports another freshwater fish species, the orangefin madtom (*Noturus gilberti*), which the Service is currently evaluating to determine if protection under the ESA is warranted. Records for both of these species are

found either upstream or downstream of the Site. The Trustees will evaluate injuries to fish by 1) comparing selenium residues in food items to effect values reported in the literature for fish, 2) history, dates, and geographic ranges of the fish consumption advisory, and 3) comparing fish health (as measured by community diversity indices) pre-and post-spill.

1. Selenium effects related to the spill include potential impacts to egg-laying vertebrates (including fish). Selenium at coal ash sites in general has the potential to bioaccumulate (Rodgers et al. 1978, Cherry et al. 2004). Selenium in coal ash is predominantly selenite (Huggins et al. 2007, Bednar et al. 2010, Liu et al. 2013), which is also highly bioaccumulative (Presser and Luoma 2010, Conley et al. 2009, 2013) and can amplify in higher trophic levels of food chains through ingestion of contaminated prey items. Given that ash and affected sediment exceed ecological risk thresholds (Van Derveer and Canton 1997, Bureau of Reclamation 1998, and others) as summarized above, there is potential for toxicological impacts of selenium to fish that will be evaluated during the injury assessment phase of the NRDAR. Long term monitoring plans include collecting data for selenium in water, sediments, and several trophic levels of biota (including benthic macroinvertebrates, periphyton, and fish) that can be used to estimate injury by comparing food item concentrations of selenium to screening values for effects in fish (Lemly 1993, Bureau of Reclamation 1998, Ohlendorf 2003, Hamilton et al. 2002, 2005). If confirmed, the spatial and temporal extent of such exceedances of effects values can be determined.

2. The NRDAR regulations define the fish consumption advisories issued by the State of North Carolina as an injury. To document this injury, the Trustees can evaluate the history, dates, and geographic ranges of the advisories.

3. Fish communities un-impacted by human activities or other events that alter the aquatic environment typically are characterized by an expected (endemic) species composition and anticipated species abundance ranges within an ecoregion (Abell et al. 2000). Therefore, assessments can be performed over time to evaluate whether fish communities in the Dan River areas potentially affected by the spill meet expectations of an un-impacted fish community for species composition, exhibit good fish health, are not dominated by pollution tolerant species, reproduce and recruit well, and are in balance with respect to predator and prey species.

Available/Pending Data

The primary sources of data available for the Trustees to rely on include: data for selenium in water, sediments, and several trophic levels of biota including benthic macroinvertebrates, periphyton, and fish (e.g., datasets from EPA, Duke Energy, NCDENR, and VADEQ). Fish community health data are also available from Duke Energy and VADEQ (Appendices A and C). The Trustees will also evaluate relevant literature from other coal ash release sites.

Data Gaps/ Uncertainty

Sediment to biota concentration factors are needed to estimate the potential food chain transfer impacts to higher trophic level fish species. While there is reasonable likelihood that the Trustees can estimate biota transfer using data that are readily available (selenium from food items including benthic invertebrates, periphyton, water, and sediment), a laboratory based study to generate a site-specific sediment to biota transfer factor could be performed to reduce uncertainty. Data gaps related to the fish community health assessment are related to the temporal and spatial gaps in available data (particularly pre-spill where baseline fish monitoring is limited).

Migratory birds and aquatic dependent wildlife

Migratory birds protected by the Migratory Bird Treaty Act (16 U.S.C. 703-712), as amended, occur at the Site and in affected downstream areas of the Dan River watershed including songbirds, waterfowl, raptors (including bald eagle nests between the Site and Danville), colonial waterbirds (including rookeries between the Site and Danville) and others. The Trustees will evaluate injuries to birds by comparing selenium residues in food items to effect values reported in the literature for birds. Like fish, birds and other egg-laying vertebrates have the potential for negative affects through ingestion of selenium-contaminated prey items. Selenium residues in water, sediment, and other food items will be compared to the literature on effects levels for birds and other aquatic dependent wildlife to determine injuries (and birds (Lemly 1993, Lemly 1996, Bureau of Reclamation 1998, Ohlendorf 2003, Ohlendorf and Heinz 2011). If confirmed, the spatial and temporal extent of such exceedances of effects values can be determined.

Available/Pending Data

The primary sources of data available for the Trustees to rely on include:

- Results of Duke Energy, NCDENR, and VADEQ sampling to confirm residues of hazardous substances in biota (including periphyton, benthic invertebrates, and fish tissue).
- Water and sediment concentrations of hazardous substances (from EPA, Duke Energy, NCDENR, and VADEQ)

Data Gaps/ Uncertainty

Sediment to biota concentration factors are needed to estimate the potential impacts to higher trophic level avian species. While there is reasonable likelihood that the Trustees can estimate biota transfer using data that are readily available (selenium from food items including benthic invertebrates, periphyton, fish, water, and sediment), there is potential that a laboratory based study to generate a site-specific sediment to biota transfer factor as well. The Trustees will also evaluate relevant literature from other coal ash release sites.

CHAPTER 4: DAMAGE DETERMINATION

In the damage determination phase, the Trustees determine the type and magnitude of compensation required to restore injured natural resources to the appropriate baseline condition and to address the public's loss of natural resource services for the period preceding restoration to baseline (the "interim loss"). To accomplish this objective, the Trustees may use one or both of the following approaches depending on the circumstances of the case: calculate the cost of restoring, replacing, or acquiring the equivalent of the injured resources and the services they provide; and determine the value of the losses due to the resource injuries and apply that amount to resource restoration. The Trustees have an expressed preference for direct selection and scaling of restoration options, over estimation of the monetary value of lost services. Accordingly, once injuries have been quantified, the Trustees anticipate the following steps to determine natural resource damages: 1) determine the type and scale of restoration projects that are needed to fully compensate the public for quantified injuries to natural resources and the services those resources provide, and 2) calculate damages as the cost, in dollars, to perform the restoration projects.

Baseline

Chapter 3 described the Trustees' approach to baseline in the context of quantifying lost services, which is an essential component in the calculation of compensable values. The Trustees must also consider baseline in the context of restoration in order to appropriately evaluate the scale of restoration project needed to offset injuries to natural resources and the services they provide. Specifically, the Trustees must be prepared to describe more completely the conditions (i.e., the baseline) that they seek to restore. As stated in the DOI regulations, baseline, in general, should reflect conditions that would have been expected at the assessment area had the release of hazardous substances not occurred, taking into account both natural processes and those that are the result of human activities (43 CFR11.72(b)(1)). Accordingly, baseline for surface water, sediment and soil in the Dan River assessment area can be described as an environment in which hazardous substances related to the coal ash spill no longer contribute to the impairment of their use as habitat for biological resources. In its baseline condition, the Dan River assessment area also would not be subject to fish consumption advisories upstream of Danville due to the presence of spill related hazardous substances.

Restoration

Restoration is the goal of the Dan River Coal Ash NRDAR process. It is an active component of damage assessment that can be seen and felt for generations. For example, restoration projects may improve or create aquatic habitats, thereby providing fish with clean spawning habitat and anglers with expanded opportunities to catch fish. Similarly, restoration may involve creating conservation areas that are attractive for wildlife habitat and public use. Restoration also may include increasing the viability and abundance of threatened, endangered, special concern, or rare species.

The restoration planning process is initiated and managed by the Trustees. The Trustees previously conducted scoping of potential restoration projects to identify existing restoration opportunities in the Dan River watershed area, develop partnerships with stakeholders (e.g., conservation organizations and river users), engage the public, and identify potential concerns (DRNRTC 2014b). That scoping document describes eligibility and evaluation criteria that were used to identify categories of potential restoration alternatives (along with examples of potential concepts) that may be consistent with each alternative. A summary of these criteria and potential restoration alternatives are presented below.

The Trustees received helpful feedback and project suggestions from the public, which have been summarized (DRNRTC 2014c). The Trustees will consider a number of restoration alternatives, including taking no action and estimating the time required for natural recovery. The Trustees will then select the most appropriate alternative. In the event that early restoration is pursued by Duke Energy, it is the Trustees' intent that any projects implemented satisfy the restoration criteria identified for the Dan River NRDAR; however, the ultimate determination of whether any early restoration projects implemented are sufficient to offset injury is contingent upon completion of the injury assessment.

Criteria

An important component of damage determination Step 1 above is the consideration of general criteria for evaluation of restoration projects indicated in the DOI NRDAR regulations (43 C.F.R. § 11.82(d)), as well as any site-specific criteria or objectives for particular restoration projects (discussed below). Project selection criteria were outlined in the Scoping Document to allow Trustees to assess the potential restoration projects. Briefly, these criteria include, but are not limited to:

- Nexus – Does the project have a significant connection to the restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured natural resources or lost services?
- Relevance – Can the project effectively meet the Trustees' restoration goals and objectives?
- Cost Reasonableness – What is the cost of the proposed restoration effort? Can the benefits be quantified? Is there an opportunity to share costs with other organizations and/or agencies?
- Measurable – Can a project deliver tangible and specific resource restoration results that are identifiable and measurable?
- Efficacy – How likely is it that the restoration project will be successful? What are the future maintenance needs for the project? Is the project vulnerable to natural or human-induced stresses following implementation?
- Legality – Does the restoration project comply with applicable/relevant Federal, State, and local laws and regulations? Does the project ensure protection of human health and safety?

- Ecological leverage – Will the restoration project promote other environmental benefits? Does the project avoid collateral injury to natural resources as a result of implementation? Is the project additional (e.g., not subject to an independent, prior obligation to perform the action)?
- Compatibility – Is the project compatible with the surrounding land use?

Potential restoration alternatives

Through consideration of the criteria described above and the natural resources and associated services potentially impacted by the spill (habitat, surface water and sediment, aquatic biota, migratory birds, and human uses), the Trustees identified categories of potential restoration alternatives. It is the intent of the Trustees that these categories of potential restoration alternatives provide the universe from which a suite of specific restoration projects will be identified. The estimated costs of these actions can be used to monetize the damages as the dollar amount required to perform the restoration projects. A summary of the categories of potential restoration alternatives follow:

- Avoided Habitat Loss via Land Acquisition/Protection – Acquire environmentally sensitive land vulnerable to conversion for public use or benefit.
- Fish Passage – Create or enhance opportunities for migratory fish to reach priority upstream habitats and restore genetic flow between populations.
- Restoration of In-stream Habitats – Create, restore, or enhance in-stream habitats to address existing water quality impairment and habitat degradation.
- Restoration of Riparian and Wetland Habitats – Create, restore, or enhance wetlands and riparian areas to address existing water quality impairment and habitat degradation.
- Rare and Nongame Species Restoration – Actions to improve integrity of populations and habitat for targeted species of conservation significance.
- Improve quality of fishing experience – Improve or create boating and fishing access.
- Expand river-centered opportunities for public recreation and wildlife viewing – Establish or expand recreational infrastructure at high priority recreational areas.

Compensable Values

The Trustees believe the estimation of compensable values may be appropriate for 1) the interim loss of ecological services and 2) the interim loss of recreational opportunities. These follow directly from the quantification of lost services described in Chapter 3.

Approach to Damage Determination

The Trustee's approach to damage determination for ecological and recreational service losses is described below. A summary of the damage determination approach for each assessment endpoint identified in Chapter 3 is provided in Table 4-1 (Injury Assessment and Damage Determination Summary).

Ecological Damage Determination

The Trustees are assessing exposure of natural resources to coal-ash related hazardous substances and determining whether injuries are occurring to a variety of natural resources, including surface water, sediment, and various biota, as a result of that exposure. As part of the damage assessment, the Trustees may determine the amount of restoration that is necessary to compensate the public for identified injuries to these resources for the period between the onset of injury and the resource's return to baseline. The Trustees anticipate using Habitat Equivalency Analysis (HEA) or Resource Equivalency Analysis (REA) to determine ecological losses and scale restoration. These methods are founded on the principle that the public can be compensated for past and future losses of natural resources by providing additional resources of the same type and quality (NOAA 2000, Unsworth and Bishop 1994). The HEA method provides compensation by establishing equivalency between the quantity of injured resources or services and the quantity of restoration. The Trustees will determine the appropriateness of using this or other methods when the injuries are determined.

The ecological service model will assess the change in ecological services associated with the Dan River ash release and estimate the ecological benefits of alternative restoration projects proposed to offset the estimated damages. The ecological services model will be based on habitat/resource equivalency and will include both baseline and "with release" components. The model will calculate ecological indices (e.g., Discounted Service Acre Years—DSAYS) on the basis of this variation using the measurement endpoints discussed in Chapter 3 (e.g., fish and invertebrate community structure indices, exceedances of affects thresholds and standards for aquatic life, etc). To identify restoration-based offset equivalents, the model will also determine value judgments of the relative worth of service improvements across alternative restoration projects on the Dan River versus habitat improvements of an alternative ecological service outside the Dan River.

The ecological service model will use following parameters:

- List of affected services
- Baseline level of affected services
- Reduction in baseline services resulting from the ash release
- Geography over which the services have been affected
- Timing over which the services are affected

Uncertainty created by assumptions made in the assessment process can be incorporated into the ecological service model for any of the listed parameters where suitable information exists and/or where it is desirable to examine the sensitivity of the damage estimates and restoration benefits based on parameter-specific uncertainty. In addition to incorporating parameter uncertainties into the model, it is anticipated that the model can be used to assess alternative scenarios to evaluate their effect on the damage estimates (e.g., evaluating differences in the timing of when each service is expected to return to its baseline condition).

Recreational Use Damage Determination

The Trustees are assessing the value of the lost use of the recreational services of the Dan River as part of the damage determination. The trustees will rely on existing literature and studies and publicly available data to develop recreation demand models to evaluate changes in the following recreation activities that are expected to have been affected by the spill:

- Fishing (through the issuance of a new fish consumption advisory in the portion of the Dan River flowing through North Carolina downstream of Eden, North Carolina to the Virginia boarder and the implications of the North Carolina consumption and contact advisories may have affected anglers' decisions to fish outside of the advisory areas in NC)
- Boating and outdoor recreation (through potential changes in human behavior that may have occurred because of issuance of contact advisories and closure of Abreu Grogan Park boat launch facilities)
- Park visitation (through the closure of Abreu Grogan Park in Danville for ash recovery activities in the Dan River)

Appropriately constructed models will be used to assess the losses in the human-use services associated with the spill as well as estimate the benefits of potential human-use restoration projects. The models will be based on existing recreation demand models found in the literature that have evaluated how changes in environmental quality affect social welfare associated with recreational activities. The models will account for recreation preferences across site characteristics that occur in both the baseline (but-for release) and "with release" conditions. In recreation demand models, the underlying preference functions identify how recreators make tradeoffs between characteristics of alternative recreation sites that recreators have to choose from. For example, contamination resulting from the release of coal ash has likely changed the way that anglers view the Dan River and its fishery. In particular, the consumption advisory issued by the State of North Carolina may alter angler behavior and reduce the enjoyment that each angler receives from a fishing trip. Common responses that anglers have when faced with chemical contamination and any associated advisories at their preferred fishing location include fishing less frequently or not at all, fishing in less preferred locations, traveling further to fish, converting to catch-and-release angling, or pursuing a different activity altogether.

By combining information on recreation use preferences from the existing literature with publicly available information and data to determine the size of the recreator population and the number of annual trips they take, a representation of recreation demand for each of the three recreation activities listed above can be developed. The following three steps provide a general description of the process that will be followed to evaluate losses and benefits associated with recreational fishing, boating/outdoor recreation, and park visitation:

- Step 1—Assess available recreation data.

- Step 2—Identify relevant recreation preference functions based on existing literature.
- Step 3—Develop recreation demand by combining preference functions and site characteristics under baseline and “with release” conditions

The recreation demand models will be constructed so baseline levels of recreational use (i.e., fishing, boating and outdoor recreation, and park visitation) are consistent with available site-specific data for the Dan River.

Table 4-1. Injury Assessment and Damage Determination Summary

NATURAL RESOURCE INJURY CATEGORY	RESOURCE	INJURY	INJURY ASSESSMENT APPROACH	DAMAGE DETERMINATION APPROACH	STATUS[4]
Surface Water	Water	Exceedance of surface water standards	Water quality and service loss evaluation	Habitat equivalency analysis	In progress
	Water	Contact advisory	Contact advisory	Lost recreation demand model	In progress
	In-stream sediments	Exceedance of sediment quality guidelines	Sediment quality and service loss evaluation	Habitat equivalency analysis	In progress
	In-stream sediments	Response-related sediment removal	Document spatial and temporal extent of impact	Habitat equivalency analysis	In progress
	In-stream sediments	Response-related public park closure	Document spatial and temporal extent of impact	Recreation demand model	In progress
Geologic	Wetland sediments	Response-related sediment removal	Document spatial and temporal extent of impact	Habitat equivalency analysis	In progress
Biological	Benthic Invertebrates	Ash smothering	Ash deposition observations and model	Habitat equivalency analysis	In progress
	Benthic invertebrates	Benthic invertebrate health	Evaluation of community diversity metrics	Habitat equivalency analysis	Potential
	Fish	Exceedance of thresholds for food chain impacts	Evaluate hazardous substance residues in prey items	Habitat equivalency analysis	Potential
	Fish	Fish consumption advisory	Fish consumption advisory	Recreation demand model	In progress
	Fish	Fish health	Evaluation of community diversity metrics	Habitat equivalency analysis	Potential
	Birds and aquatic-dependent wildlife	Exceedance of effects thresholds for food chain impacts	Evaluate hazardous substance residues in prey items	Habitat equivalency analysis	Potential

[4] Data collection is in progress to support all of the injury assessment endpoints listed. Endpoints noted with a status of "potential" can be evaluated should the joint damage assessment team determine they should be included based on interim results of monitoring activities.

CHAPTER 5: QUALITY ASSURANCE

The DOI regulations provide for the Trustees to develop quality assurance procedures. These procedures are intended to ensure the validity of original data collected as part of the NRDAR. For the purposes of this Assessment Plan, the Trustees are relying primarily on individual data collection activities developed separate from the NRDAR, but in coordination with the Trustees, to support the needs of the Dan River interagency group. Quality assurance procedures are tailored to a specific activity; therefore, documentation for specific data collection activities is included in the Appendices to this Assessment Plan (Appendices A through D).

In general, quality assurance procedures must provide sufficient detail to demonstrate that:

- The project technical and quality objectives (i.e., data quality objectives, when used) are identified and agreed upon;
- The intended measurements or data acquisition methods are appropriate for achieving project objectives;
- Assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained; and
- Any limitations on the use of the data can be identified and documented (USEPA 1994).

Data Sharing

Consistent with the cooperative nature of the Dan River NRDAR, all source data that the NRDAR will rely upon will be made available to all parties (including Trustee and RP representatives). Field data records will be shared among all parties including all data sheets (photos or scanned originals), GPS way points and/or track logs, analytical results and official photographs among the collaborators to this Assessment Plan. For laboratory results of field samples, the electronic preliminary data with pre-validated analytical results will undergo quality assurance/quality control (QA/QC) procedures, after which time the validated/QA/QC'd data shall be made available to all collaborators to this Assessment Plan. Should any party show a critical operational need for data prior to validation/QA/QC, any released data will be clearly marked "preliminary/ unvalidated" and will be made available equally.

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APPENDICES

Appendix A – Duke Energy Dan River Ash Release Environmental Impact Assessment and Sampling and Analysis Plan

DAN RIVER ASH RELEASE ENVIRONMENTAL IMPACT ASSESSSMENT
and
SAMPLING AND ANALYSIS PLAN

1.0 PURPOSE

The purpose of this study is to assess the potential long-term environmental impacts of the accidental release of approximately 30,000 to 39,000 tons of coal ash from the decommissioned Dan River Steam Station (DRSS) ash basin to the Dan River after a storm water conveyance pipe underlying the ash pond failed. The overall health of the aquatic community will be characterized to look for evidence of detrimental impacts that could be related to the presence of ash, particularly in depositional areas of the river.

2.0 OBJECTIVES

The objectives of this study are to (1) provide an assessment of the long-term impacts of the subject coal ash release on the water and aquatic organisms in the Dan River from DRSS to the headwaters of Kerr Lake and (2) evaluate whether long-term damage has occurred to the aquatic community as it relates to the Natural Resources Damage Assessment (NRDA). Information gained during this study will also be important to inform potential restoration activities outlined in the NRDA.

3.0 NATURE OF STUDY

The potential impacts of the DRSS coal ash release to the aquatic community will be assessed by sampling and analyzing the Dan River limnology (i.e., water quality and water chemistry), the benthic macroinvertebrate community (including mussels), the fish community, and trace elements accumulation in benthic macroinvertebrates, fish, periphyton, and sediments. The potential impacts will be assessed at locations of possible and confirmed areas of ash deposition in the Dan River and the results will be analyzed using appropriate statistical methods. Additional statistical approaches may be employed if indicated by the results. Key limnological variables will be assessed at locations considered potentially impacted by the coal ash and an upstream location for comparison purposes. Where historical data exists, comparisons will be made to evaluate apparent changes in the aquatic community from pre-release to post-release timeframes.

4.0 LOCATION AND DURATION

The study will be conducted at eight areas in the Dan River and one area in the headwaters of Kerr Lake. Each area will be sampled at multiple stations with multiple replicates (depending on type of sampling)(Figure.1-4 and Table 1). The sampling areas are defined by an upstream beginning transect and a downstream ending transect. For the purposes of this assessment, the sampling areas will be referred to as transects (Transects A-I). Transect A (excluding benthic macroinvertebrates), Transect B, and Transect C (excluding fisheries) will serve as upstream reference sampling areas (un-impacted by the ash release) selected because of the presence of habitat similar to most of the downstream impacted areas, the existence of some historical data (i.e., trace elements), and/or ease of access. The downstream locations (Transects C-I) were selected to be representative of pools and impounded areas (where the greatest ash deposition potentially occurred) and conveyance areas with the presence of shoals, riffles, and runs. Limited historical trace element data exists for Transects A and E (Duke Power 1999, 2000, 2001, 2002, 2003, 2004, and 2005; Duke Energy 2006, 2007, 2008, 2009, 2010, and 2011). Duke Energy plans to perform long-term monitoring of the aquatic community in the Dan River for at least three years. The stakeholder agencies will be asked to review the monitoring results at the end of this period and recommend if any additional monitoring should be considered.

5.0 THE DUKE ENERGY LONG-TERM SAMPLING AND ANALYSIS PLAN

5.1 Benthic Macroinvertebrate Community Assessment

Benthic macroinvertebrates are an important part of the aquatic community and food web. The health of this biological group is also an indicator of the biotic integrity of the aquatic ecosystem they inhabit. Impacts to this group could lead to overall degradation of the aquatic community. An assessment will be undertaken according to the Duke Energy Biology Program Procedures Manual (Procedure NR00077; Appendix A) and the North Carolina Standard Operating Procedures for Collection and Analysis of Benthic Macroinvertebrates (NCDENR 2013) at Transects B, C, E, F, G, and H. Both wadeable and boatable techniques will be employed, as needed, depending on river conditions and location. The field schedule, methods, and statistical analyses to be used by Duke Energy are found in Tables 1, 2, 3, and 4, respectively. Samples will be processed and sorted either in-house by the Duke Energy benthic macroinvertebrate laboratory or by Pennington and Associates, Inc. (PAI; certified in North Carolina and in

possession of a letter of approval from the State of Virginia Department of Environmental Quality). PAI will perform all final sample identifications and the generation of IBI metrics. The intent of generating the IBI-type metrics is not to score the sections of the Dan River but rather to present a relative comparison of expected macroinvertebrate assemblages between reference areas and areas downstream of the DRSS ash release. At minimum, 10% of the samples will be re-identified by a separate taxonomist and individual taxa will be maintained in separate vials if questions arise regarding any identifications. Raw data generated by this sampling and analysis program, and the benthic macroinvertebrate data will be available to stakeholders (i.e., agencies) upon request.

5.2 Native Mussel Population Survey

Due to the potential presence of federally endangered species, the James spinymussel, and federal species of concern, the Atlantic pigtoe and green floater, a special native mussel population survey will be undertaken to assess the overall extent of native mussels in a large area of the Dan River. The extent of suitable habitat for the presence of native mussels in the main stem reach of the Dan River from DRSS to the headwaters of Kerr Lake, and therefore, the potential for impacts of the coal ash release to native mussels is unknown. For this reason, a recognized and accredited expert, Dr. John Alderman of Alderman Environmental Services, Inc. (AES), has been retained by Duke Energy to perform this special native mussel population survey as part of the overall long-term EIA/SAP. The AES survey plan is attached in Appendix B of this document.

5.3 Fish Community Assessment

Fish communities un-impacted by human activities or other events that alter the aquatic environment typically are characterized by an expected (endemic) species composition and have expected species abundance ranges within an ecoregion (Abell et al. 2000). Therefore, assessments will be performed over time to evaluate whether fish communities in the Dan River areas potentially affected by the DRSS coal ash release meet expectations for species composition, exhibit good fish health, are not dominated by pollution tolerant species, reproduce and recruit well, and are in balance with respect to predator and prey species.

Standard fisheries sampling methods, including boat electrofishing (NR00080; Appendix A) or backpack and pram electrofishing (Zale et al. 2012) will be conducted four times (seasonal)

annually at seven locations during daylight hours from the Dan River at Duke Transects A, B, D, E, F, G, and I (Figures 1-4.) The field schedule, methods, and basic statistical analyses to be used are found in Tables 1, 2, 3, and 4, respectively. As stated above, additional analysis methods may be used if needed. When adequate river flow permits, scheduled boat electrofishing will be used to sample juvenile and adult fish during daylight hours. At each transect, two stations with three replicates each consisting of two- to three-hundred meter distances (depending on the size of the sampling area) will be sampled at each station using a Smith-Root equipped, Wisconsin-design electrofishing boat with pulsed DC current. Where necessary, station replicates will be staggered in an alternating fashion from one bank to the other to minimize recapture of released fish. During the mid-summer sampling periods (July or August), additional methods will be employed based on the modified fishery IBI used by Duke Energy (PEC 2012, available from Duke Energy on request). Different sampling gear will necessarily be employed in the pool/impounded locations and the conveyance locations. For example backpack electrofishing and seining will not be employed in pools and impounded areas. Also, smaller d-hoop nets will be used in more confined riverine areas while larger three-winged fyke nets will be deployed in the slower moving or impounded areas. As stated above, the intent of generating the IBI-type metrics is not to score the sections of the Dan River and Kerr Lake but rather to present a relative comparison of expected fish assemblages between reference areas and areas downstream of the DRSS ash release.

Fish will be identified, total length measured to nearest millimeter, weighed to nearest gram, and qualitatively examined for presence of external parasites, disease, and anomalies/deformities. If gross unidentified lesions or anomalies are observed in fish collected in the field, affected specimens will be dissected and tissue preserved in 10% formalin for histopathological evaluation (Auburn University Fisheries and Allied Aquacultures, Histology Laboratory) annually (may be reported for samples collected during the previous year). Adult fish will be checked for spawning condition and qualitatively noted based on whether eggs or milt could be readily stripped from the fish with pressure on the abdominal and urogenital pore region. Consistent data on seasonal spawning condition will be collected for bluegill, redear sunfish, golden redhorse, and largemouth bass. Small fish not readily identifiable in the field will be preserved in 10% formalin and returned to the laboratory for identification. Water quality data (i.e., temperature, dissolved oxygen, pH, and conductivity) will be collected to evaluate environmental conditions during each fishery sampling trip.

A variety of standard fishery data metrics including total number, total biomass, catch per unit effort, Relative Weight (WR), percent by species, percent pollution-tolerant species, percent intolerant species, trophic status, and others will be tabulated and reported to relate to potential impacts from the DRSS ash release. All raw fisheries data will be available to stakeholders upon request.

Since there exists potential for collection of the endangered Roanoke logperch during fishery sampling in the Dan River, care will be taken to closely follow the reporting requirements of the respective states if specimens of the Roanoke logperch are collected during sampling.

5.4 Trace Element Monitoring in Sediments and Tissues

The primary potential environmental impacts from the DRSS coal ash release would result from the accumulation of trace elements in the various compartments of the aquatic ecosystem. Trace element accumulation in tissues and solid matrices (hereafter referred to as trace element samples) including sediments, periphyton, benthic macroinvertebrates, and fish tissues will be evaluated using EPA Method 6020 and 7471. The field schedule, methods, and statistical analyses to be used by Duke Energy are found in Tables 1, 2, 3, and 4, respectively. Trace element samples for biological tissues (including fish) will be collected and analyzed by an experienced external laboratory with full Virginia Environmental Laboratory Accreditation Program (VELAP) accreditation. Annual trace element samples may be collected for the specified matrices during multiple trips depending on availability of some target species and river conditions (Figures 1-4).

The field methods for collection of sediments and tissues are found in Appendix A. Sediments, benthic macroinvertebrate, and periphyton trace element samples will be co-located at each designated sampling location (Table 1) to evaluate the relationship of coal ash deposition with potential trace elements bioaccumulation in the aquatic community. Coring devices and/or petite ponar grabs will be used to collect surficial (upper 2.5 centimeters) sediment and benthic macroinvertebrate samples. Since relatively large quantities of tissues will be needed for trace element analysis, the aim of the field methods employed for biota will be to maximize sample mass collection rather than more refined methods associated with population survey. At least 100 grams of sediments will be collected while at least 30 grams of benthic macroinvertebrates

and periphyton will be collected for analysis while attempting to minimize water in the samples. Based on reconnaissance sampling, the target groups for composite benthic macroinvertebrate samples will include *Hexagenia* sp., odonates, and Asiatic clams *Corbicula fluminea*. However, if some or all of the primary three target groups are unavailable, other groups including craneflies, hellgrammites, stoneflies may be substituted. Sample collection for benthic macroinvertebrates will be primarily in May and June each year (based on emergence). Periphyton sample collection methods will include either scraping material from hard structures such as submerged rocks, wood, and gravel (Duke Procedure P-3220.0) and/or by use of Hester-Dendy type samplers (Duke Procedure P-3022) deployed as outlined in Appendix A.

The target species of fish for trace elements sampling will be sunfish (redbreast/bluegill), black bass (largemouth bass), and redhorse suckers (golden redhorse). Redbreast sunfish are the most available sunfish species in the river locations and bluegill are more available in the reservoir locations. Other closely-related species such as smallmouth bass, redear sunfish, and v-lip redhorse may be substituted when target species are limited or unavailable. Ten individuals from each target group will be the target number for collection, however, if the full complement is not obtained after reasonable effort (multiple sampling attempts) is made, then the other closely-related species may be substituted. Only live fish that show little or no signs of deterioration will be retained for analysis. Fish tissue to be analyzed will be left axial muscle (filets). As recommended by the U.S. Environmental Protection Agency (EPA), an attempt will be made to limit the smallest fish to approximately 75% of the largest fish in total length by species, also depending on availability (U.S. EPA 1995). The target total fish length for tissue trace elements samples will be 140-190 millimeters for sunfish, 250-350 millimeters for black bass, and 250-350 redhorse sucker. Fish carcasses will be retained for two years following collection and processing such that, if necessary, they could be re-analyzed. Ancillary fisheries data including species, number, total length (mm), and total weight (g) will also be recorded.

Fish collected for trace element analysis will be placed in a labeled (date, station, etc.) plastic bag and placed on ice until frozen. Each day following collection, the fish will be transferred to a portable freezer taken with the field crew during sampling trip. Water quality data consisting of temperature, pH, dissolved oxygen, and specific conductance will be recorded daily at the surface at each sampling location. Other noteworthy environmental conditions including river flow and weather conditions will be noted on a Duke Energy fisheries investigation form.

5.5 Limnology

Almost all components of the DRSS coal ash release long-term assessment program will have limnological monitoring (water chemistry and water quality) of key variables associated with the activity related to the coal ash release. Water quality generally includes temperature, dissolved oxygen, pH, conductivity, and turbidity and will be measured in the field using a multi-parameter meter with a submersible sonde according to Duke Energy procedure NR00097 (Appendix A). Water chemistry samples will be collected from the water column near the sediment-water interface via a submersible sampler (peristaltic pump and hose), transferred to pre-prepared non-metal bottles, field filtered (for dissolved metals), quickly sealed, and returned to the laboratory on ice for analyses (NR00096 in Appendix A; VADEQ 2014, and in-the-field training/demonstration received from VADEQ). Water chemistry parameters will include nutrients, total organic carbon, total alkalinity and hardness, ions, and trace elements. Two important trace elements for tracking the presence of ash, arsenic and selenium, will be monitored in water as both dissolved (filtered) and total (unfiltered) fractions. All analyses will be run by a laboratory (Pace Analytical) certified in North Carolina and Virginia (VLAP) and the protocols include EPA 200.7, 200.8, 245.1, 300.0, 350.1, 351.2, 353.2, 1631E, SM 2320B, 2540-C, 4500-Cl, and 5310B. The analytical quality assurance and control measures taken by the external contract laboratory will be consistent with their certifications/accreditations and approved SOPs. In addition, one duplicate per sample set (10% duplicate/blank ratio) will be included. The limnological parameter list for the bimonthly Dan River sampling program is appended in Appendix C. The charge balance for analyzed sample sets will be checked by summation of the major anions and cations including $Ca2^{+}$, $Mg2^{+}$, Na^{+}, K^{+}, Cl^{-}, and $SO_4(2^{-})$, expressed as milli-equivalents per liter (Murray and Wade 1996). The calculated anions OH-, HCO^{3}-, and $CO_3(2^{-})$ are also used in the summation. Analysis of water chemistry samples will be performed by laboratories accredited/certified by both the State of North Carolina and the State of Virginia.

6.0 DATA MANAGEMENT

All data generated by Duke Energy including benthic macroinvertebrates, fisheries, trace elements, water chemistry and water quality data will be recorded electronically and uploaded to a mainframe computer for storage in the Duke Energy long-term SAS database. All data will undergo internal QA/QC protocols to ensure accuracy of the stored data. When used, GPS data

will be presented as decimal degree coordinates. Geographical Information System (GIS) will be utilized when appropriate along with compatible programs for two-dimensional graphic display for presentation or reporting purposes.

7.0 REPORTING

Written reports from the study will be provided to stakeholder groups and agencies on an annual basis within the year following data collection. Interim results may be presented to the stakeholders as needed. Processed data (post QA/QC validation) will be available in tabulated format to stakeholders on the stakeholder collaboration website.

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Approved by: _____

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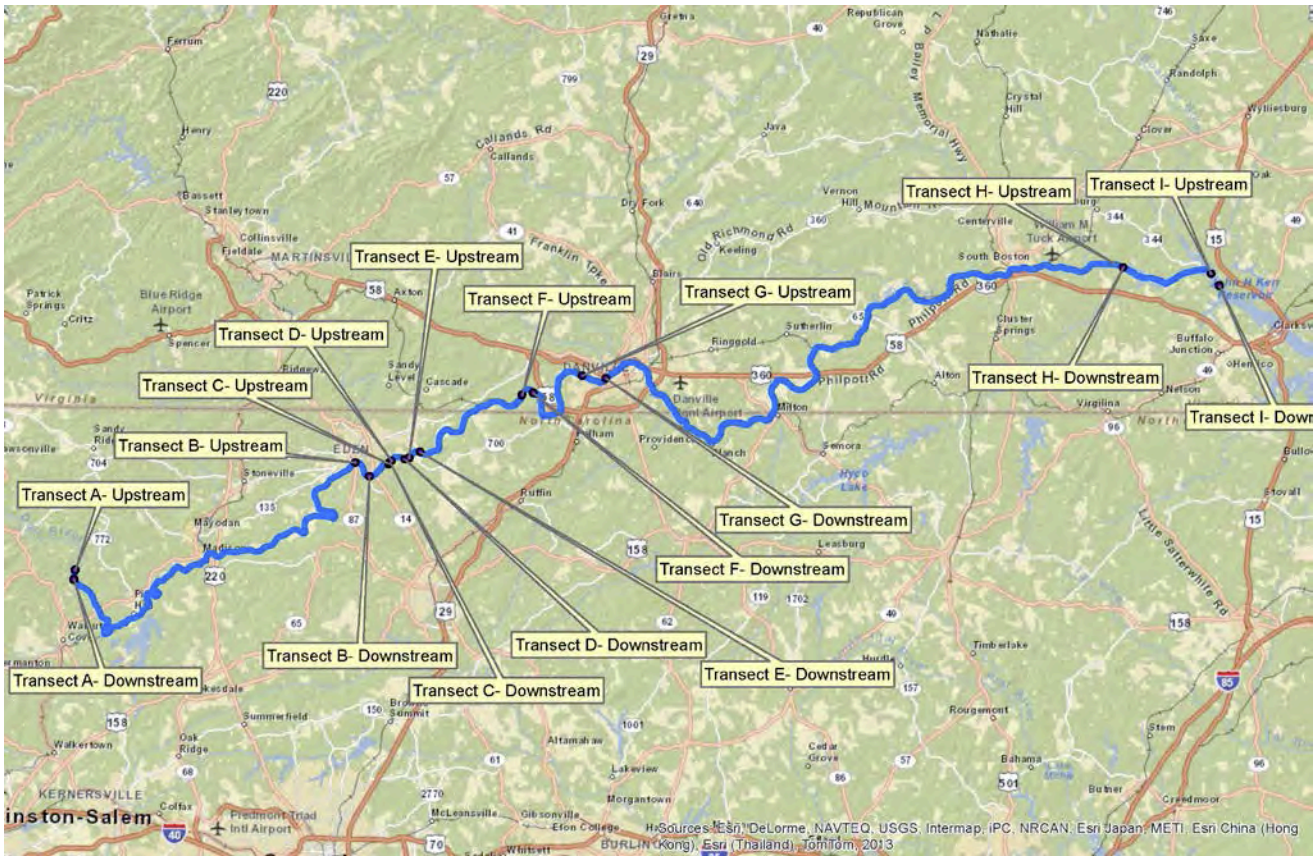

Figure 1. Dan River long-term environmental monitoring program sampling locations.

Figure 2. Transects A-C with GPS coordinates (decimal degrees).

Figure 3. Transects D-F with GPS coordinates (decimal degrees).

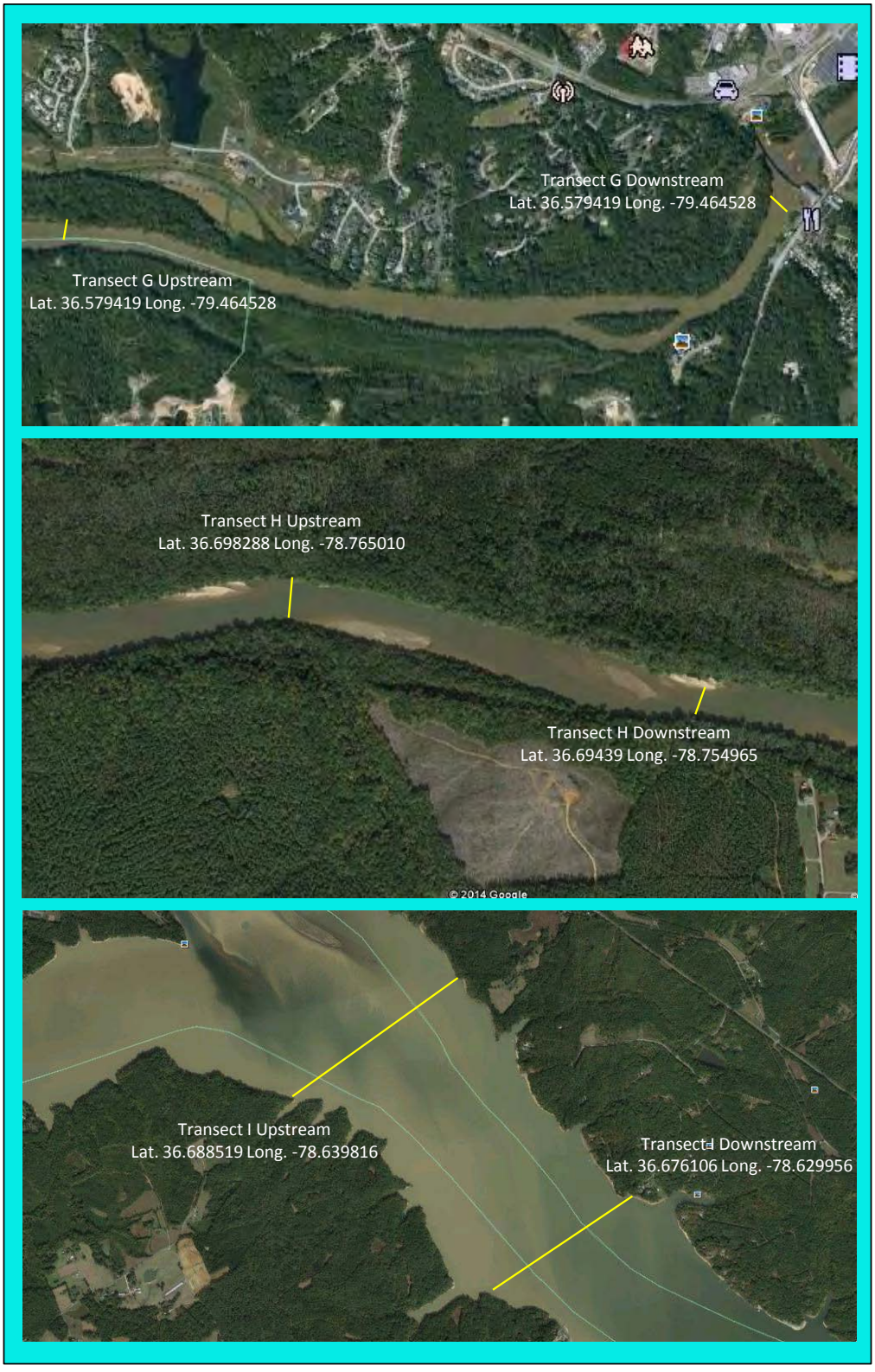

Figure 4. Transects G-I with GPS coordinates (decimal degrees).

Table 1. Dan River long-term environmental monitoring program sample location designations and descriptions.

Transect	Program	Description	Approximate River Kilometer (Mile)	Decimal Degree Coordinates Upstream (Downstream)
A	Limnology, Fisheries, Trace elements	Dan River upstream of Belews Creek Steam Station	209 (130)	Lat. 36.366043 Long. -80.127539 (Lat. 36.365198 Long. -80.128397)
B	Limnology, Benthic Macroinvertebrates, Fisheries, Trace elements	Dan River near the Smith River confluence	150 (93)	Lat. 36.486000 Long. -79.761440 (Lat. 36.471399 Long. -79.743094)
C	Limnology, Benthic Macroinvertebrates, Trace elements	Dan River upstream of the ash release at the DRSS	145 (90)	Lat. 36.48500 Long. -79.719780 (Lat. 36.486530 Long. -79.715900)
D	Limnology, Fisheries/Trace elements	Dan River at and immediately downstream of the ash release location	143 (89)	Lat. 36.488240 Long. -79.713928 (Lat. 36.489789 Long. -79.696543)
E	Limnology, Fisheries, Benthic Macroinvertebrates, Trace elements	Near the Highway 700 bridge	142 (88)	Lat.36. 491311 Long. -79.691482 (Lat. 36.497534 Long. -79.676712)
F	Limnology, Fisheries, Benthic Macroinvertebrates, Trace elements	Wares Shoals	124 (77)	Lat 36.558697 Long. -79.543403 (Lat. 36.561094 Long. -79.529209)
G	Limnology, Fisheries, Benthic Macroinvertebrates, Trace elements	Upstream of School Dam	111 (69)	Lat. 36.579419 Long. -79.464528 (Lat. 36.579419 Long. -79.464528)
H	Limnology, Benthic Macroinvertebrates, Trace elements	Dan River near the Kerr Lake headwaters	22 (14)	Lat. 36.698288 Long. -78.765010 (Lat. 36.69439 Long. -78.754965)
I	Limnology, Fisheries, Trace elements	Kerr Lake headwaters	11 (7)	Lat. 36.688519 Long. -78.639816 (Lat. 36.676106 Long. -78.629956)

Table 2. Dan River long-term environmental monitoring program.

Program	Frequency	Location
Water quality (Temperature, pH, dissolved oxygen, specific conductance, turbidity)	Alternate calendar months (January, March, May, July, September, November)	Transects A-H (surface only); Transect I (surface to bottom at 1-m intervals)
Water chemistry (see Appendix C)	Alternate calendar months (January, March, May, July, September, November)	All Transects (sediment water interface)
Benthic macroinvertebrates (non-mussels)	Once per calendar year (fall season based on prevailing ambient conditions)	Transects B, C, E, F, G, and H
Native mussel population survey	See Appendix B	TBD based on habitat mapping
Fisheries	Once per calendar quarter	Transects A, B, D, E, F, G, and I
Trace elements (benthic macroinvertebrates, periphyton, fish & sediment)	Once per calendar year (based on availability of target species)	All Transects depending on program

Table 3. Field sampling and laboratory methods for the Dan River long-term environmental monitoring program.

Program	Method
Water quality	Temperature, dissolved oxygen, pH, specific conductance, and turbidity will be measured with a calibrated multiparameter instrument, dissolved oxygen meter, and specific conductance meter. Measurements will be taken from surface to bottom at 1-m intervals at the lake station and from the surface only at the river station. Water clarity will be measured with a Secchi disk.
Water chemistry	Samples will be taken with a nonmetallic sampler, transported to the laboratory on ice, and then analyzed according to EPA methods (USEPA 1979) and or Standard Methods (SM)(APHA 1995). Parameters include alkalinity (SM 2320B), chloride (SM 4500-Cl or EPA 300.0), sulfate (EPA 300.0), total dissolved solids (SM 2540C), calcium, magnesium, and sodium (EPA 200.7), total organic carbon (SM 5310B), ammonia (EPA 350.1), nitrate+nitrite nitrogen (EPA 353.2), total kjeldhal nitrogen (EPA 351.2), total nitrogen (calculated), mercury (EPA 245.1 and 1631E), arsenic, copper, , and selenium (EPA 200.8).
Benthic macroinvertebrates	Field sampling will be based on the Duke Energy Benthic Invertebrate Rapid Bioassessment Sampling procedure (NR00077, Appendix A). Samples collected in the field will be preserved in 95% ethanol and returned to the laboratory for processing and identification.
Fisheries	From two to six hundred meters of shoreline (depending on available habitat by transect) will be sampled using a Smith-Root equipped Wisconsin-design electrofishing boat with pulsed DC current. Where backpack or pram electrofisher units are utilized, measured distances of river section will be sampled similar to fish IBI methodology. Fish will be identified, measured to the nearest mm for total length, weighed to the nearest gram, and released. Small fish not identified in the field will be returned to the laboratory for identification.
Trace elements	Water, sediments, benthic macroinvertebrates, periphyton, and fish tissues will be analyzed in the laboratory for arsenic, cadmium, copper, chromium, cobalt, iron, mercury, manganese, nickel, lead, selenium and zinc. All media, except water, will processed according to EPA Method 3050B EPA and analyzed by - Method 6020 and 7471 (mercury only). Quality control will be achieved by analytical standards, replicate and spiked samples, and certified reference materials.

Table 4. Basic statistical analyses to be performed on data collected during the Dan River long-term environmental monitoring program.

Program	Variable	Transformation	Statistical test/model[+]	Main effect(s)
Water quality	Temperature, dissolved oxygen, pH, specific conductance	None	ANOVA	Month, Station
Water chemistry	Select monitoring variables	None	ANOVA	Station, Month, Year
Trace elements	Water	None	ANOVA	Transect, year
	Sediment and tissues	None	ANOVA	Transect, year
Fisheries	No. fish per hour	$\ln(x + 1)$	ANOVA	Transect, year
				Transect, year interaction

[+]Basic statistical testing will be conducted using analysis of variance (ANOVA) one-way and two-way models. A significance level of 5% ($P \leq 0.05$) was used to judge the significance of all tests. For the ANOVA models, Fisher's protected least significant difference (LSD) test was applied to determine where differences in means occurred.

Appendix A

Document title

Benthic Invertebrate Rapid Bioassessment Sampling

Document number

NR-00077

Applies to: Progress Energy Carolinas, Inc. – Environmental Services

Keywords: environmental; biology program procedures manual

1.0 Purpose

Benthic Invertebrate Rapid Bioassessment sampling will be conducted to assess the relative biological health of the Pigeon River as related to water quality improvements and for identified special studies. A bioclassification rating of "Good" or better will be used as a part of the criteria in determining whether instream flow releases from the Walters Hydroelectric Project are appropriate.

2.0 Forms referenced in this procedure:

Benthic Laboratory Sample Log-in Sheet (FRM-00874).

3.0 Scope and Frequency

3.1 Sampling will be conducted in the calendar year (1995) after issuance of the operating license for the Walters Hydroelectric Plant and thereafter every third year of the license period or until all criteria for the instream flow requirements are met. Sampling will be conducted during August for the Walters Hydroelectric Plant. Scope and frequency for special studies will be as outlined in section 4.0 of that study.

3.2 Refer to the Environmental Services Biology Program Study Plans for the current year for the sampling locations.

4.0 Summary of Methods

Sampling methods and rating of the benthic invertebrate will follow the methods described in Lenat (1988; 1993), NCDEM (1991; 1995), CP&L (1995), NCDENR (2012), and in Appendix A (FERC 1994) of the Walters Project license.

5.0 Equipment or Apparatus

5.1 Kick net, dip net, and wash bucket (500-1000 μm mesh).

5.2 U.S. Standard Sieve No. 35 (500 μm mesh).

5.3. Assorted size sample jars, vials, and white enamel pan.

5.4 Forceps and labels.

5.5 Field notebook, pencils, and pens.

5.6 Waders with appropriate wading boots.

5.7 Temperature, dissolved oxygen, specific conductance, and pH meter(s).

5.8 Camera.

6.0 Reagent List

6.1 95% denatured ethanol.

7.0 Safety: Limitations, Precautions, and Interferences

7.1 No element of this procedure may supersede the Company's safety standards and policies. Appropriate safety precautions should be used when handling chemicals. Refer to Material Safety Data Sheets for specific descriptions of the physical and chemical properties, physical and health hazards, and precautions for safe handling and use. Refer to the Progress Energy Corporate Safety Guideline for Laboratory Safety, SAF-SUBS-00017, Section 8 for guidelines to the proper use of Extremely Hazardous Chemicals.

7.2 The rough terrain and hazardous stream conditions (strong currents with uneven stream bottom) dictate the appropriate wading attire. Workers should use caution and good judgment about the safety of the sampling conditions. High river flow may preclude sampling and require rescheduling the sampling trip.

8.0 Procedure

8.1 Ten qualitative samples are collected from each sampling location according to the North Carolina Division of Water Quality (formerly Division of Environmental Management) rapid bioassessment methods (Lenat 1988 and NCDENR 2012):

Habitat	Microhabitat	Sampler	No. Samples	Type
		Coarse-mesh (500-1000 μm)		
High current with structure	Riffles	Kick net	2	Single, disturbance
Low current with structure	Banks	Dip net	3	Composite, disturbance
Leaves	Leaf packs	Wash bucket	1	Composite, wash
		Fine-mesh (300 μm)		
Aufwuchs	Rock and logs	U.S. Standard Sieve Size No. 35	2	Composite, wash
Sand	Sand	300 micron mesh bag	1	Composite (3), disturbance
		Visual Collections		
	Rocks & logs		1	Composite

8.2 All organisms are preserved in 95% denatured-ethanol in properly labeled vials and jars and returned to the laboratory. Fragile specimens, large specimens of hellgrammites *Corydalus cornutus*, and crayfish, are preserved and stored in individually labeled vials. Samples will be analyzed by Company personnel or sent to a vendor for identification to the lowest practical level and enumeration.

8.3 At each sample site, water quality data (temperature, dissolved oxygen, pH, and conductivity) are collected and recorded in the field notebook in addition to field notes, photographs (slides), and a general description of the sample site.

8.4 Upon return to the benthic laboratory, sample(s) are logged in on a Benthic Laboratory Sample Log-in Sheet (FRM-00874) and samples are placed in their designated area.

9.0 Calculations

Refer to the metric criteria and scoring procedures described in Lenat (1988; 1993), NCDEM (1991; 1995), CP&L (1995), NCDENR (2006), and in Appendix A (FERC 1994) of the issued license.

10.0 Results

Data are placed on computer and will be analyzed and summarized in reports issued to the N.C. Division of Water Quality and the U.S. Federal Energy Regulatory Commission.

11.0 Definitions

N/A

12.0 References

12.1 FERC. 1994. United States of America 69 FERC Chapter 61,168. Federal Energy Regulatory Commission. Carolina Power & Light Company, Project Nos. 432-004 and -008, North Carolina Electric Membership Corporation, Project No. 2748-000. Order issuing new license. Appendix A. Criteria for instream flow releases into the bypassed reach of the Pigeon River at the Walters Hydroelectric Project. November 4, 1994.

12.2 CP&L. 1995. Walters Hydroelectric Plant. 1993-1994 research and development project. Development and application of biotic indicies to evaluate water quality in the Pigeon River at the Walters hydroelectric Project. Carolina Power & Light Company, Raleigh, NC.

12.3 Lenat, D. R. 1988. Water quality assessment of streams using a qualitative collection method for benthic macroinvertebrates. J. N. Am. Benthol. Soc. 7:222-233.

12.4 Lenat, D. R. 1993. A biotic index for the southeastern United States: derivation and list of tolerance values, with criteria for assigning water-quality ratings. J. N. Am. Benthol. Soc. 12:279-290.

12.5 NCDEM. 1991. Biological assessment of water quality in North Carolina streams: benthic macroinvertebrate data base and long term changes in water quality, 1983-1990. North Carolina Department of Environment, Health, and Natural Resources, Division of Environmental Management, Water Quality Section. Raleigh, NC.

12.6 NCDENR. 2012. Standard operating procedures for benthic macroinvertebrates. October 2012. North Carolina Department of Environment, and Natural Resources, Division of Water Quality, Water Quality Section. Raleigh, NC.

13.0 Quality Control

13.1 Lead scientist will instruct persons assisting in the collection of the samples in the proper sampling techniques and station locations.

13.2 A reference and voucher collection is maintained for each sample site for each sample date (year) to ensure that identifications are correct and consistent.

Benthic Lab Sample Log-In Sheet Form

COLLECTION DATE/TIME	LOG IN DATE/TIME/ RECEIVED BY	DATE PROCESSED	SAMPLE NUMBER	COLLECTORS	SITE/HUC+	STATION	SAMPLE DESCRIPTION

+HUC is the US Geological Survey's designation for a water bodies Hydrologic Unit Code. The Pigeon River's HUC is 03040104. The Pee Dee River's HUC is 06010106.
All benthic macroinvertebrate samples taken by Progress Energy fall under NPDES General Permit number NCG500000.

COLLECTION OF PERIPHYTON FROM SELECTED SUBMERGED NATURAL SUBSTRATES

PROCEDURE NO: 3220.0
REVISION EFFECTIVE: 02/20/2008

APPROVED: Larry Olmsted
DATE: 21 July 1982

I. INTRODUCTION

A. Purpose: This procedure details methods for collecting periphyton from submerged wood, rocks, and gravel.
B. Source: APHA (1975), Weber (1973)
C. Outline of Method: Periphyton is collected from submerged wood, rocks, and gravel by scraping the material off the substrate with a sharp instrument or removing a portion of the substrate and placing the collected material in a labeled sample jar.

II. MATERIALS

A. Equipment
   1. Sharp instrument for scraping
   2. 60-70 ml, wide-mouth sample jars
   3. Polyethylene squeeze bottle
B. Reagents
   1. Distilled water

III. METHOD

A. Field Method
   1. Remove the substrate from the water and scrape the material off the substrate into a labeled (Note l) sample jar. Rinse the scraping instrument into the sample jar with distilled water from the squeeze bottle. If a piece of substrate is small enough, it may be placed whole into the sample jar.

   2. Add distilled water and preservative (Procedure P-3232) to the collected material
   3. Note pertinent information on field data sheet (Enclosure A).
B. Laboratory Method N/A
C. Calculations N/A
D. Quality Control N/A

IV. NOTES

1. Label shall include the following information:
   (a) location
   (b) date
   (c) depth
   (d) substrate type
   (e) collector

V. ENCLOSURES

Enclosure A - Sample field data sheet

VI. REFERENCES

American Public Health Association, American Water Works Association and Water Pollution Control Federation. 1975. Standard methods for the examination of water and wastewater, 14th Ed. American Public Health Association. Washington, D. C. 1193 pp.

Weber, C. I. l973. Biological and field laboratory methods for measuring the quality of surface waters and effluents. National Environmental Res. Center, Office of Res. and Devel., USEPA, Cincinati, Ohio.

Prepared by J. Derwort
Reviewed by D. Buetow
Subunit Leader J. Knight

HESTER-DENDY MULTIPLE-PLATE ARTIFICIAL SUBSTRATE SAMPLERS

PROCEDURE NO: P-3022
APPROVED: Larry Olmsted
DATE: 22 June 1982

I. INTRODUCTION

The purpose of this procedure is to describe the proper use of Hester-Dendy multiple-plate artificial substrate samplers as a method of assessing benthic macroinvertebrate community composition and/or colonization rates.

II. MATERIALS

1. Hester-Dendy multiplate samplers
2. Rope
3. Plastic bags
4. Plastic pans
5. Soft-bristle brush
6. Sieve
7. Sample jars

III. METHOD

1. Tie one end of rope to the eyelet of sampler and secure the other end to a buoy or any secure, stationary object. Suspend the sampler at the desired depth in the water (Notes l and 2).
2. To remove sampler, retrieve from water slowly so as not to dislodge organisms. As sampler is brought to surface, either a) place it in a labelled plastic bag for temporary storage, to be processed later in the lab, or b) place it in plastic pan for immediate processing.
3. To clean sampler, in lab or field, disassemble it in a plastic pan and lightly brush and wash all surfaces; pour contents of pan through an appropriate sieve and place in a sample jar (P-30l2 and l5).

IV. NOTES

1. The recommended exposure period for adequate colonization is from 4 to 6 weeks; this may vary in accordance with the design and objectives of the study.

2. The size and number of plates, their spacing, and depth of suspension may be varied depending on the objectives of the study and/or the exposure area desired. See Rosenberg and Resh (1982) for more information.

V. ENCLOSURES

1. Picture of Hester-Dendy sampler

VI. REFERENCES

1. Rosenberg, D. M. and V. H. Resh. 1982. The use of artificial substrates in the study of freshwater benthic macroinvertebrates. pp. 175-235. Artificial Substrates. J. Cairns, Jr. Editor. Ann Arbor Science Inc., Ann Arbor, MI.

Prepared by T. Bowen Date 28 May 1982
Reviewed by T. FolsomDate 30 Oct. 1981
Sub-Unit Leader D. Braatz Date 28 May 1982

Document title

Boat Electrofisher Field Procedure

Document number

NR-00080

Applies to: Progress Energy Carolinas, Inc. – Environmental Services

Keywords: environmental; biology program procedures manual

1.0 Purpose

To provide fisheries data as required by regulatory agencies. Also of interest to the Company to detect changes in fish populations or distributions.

2.0 Forms referenced in this procedure:

Fisheries Investigation (FRM-00848) Fisheries Laboratory Sample Log-in Sheet (FRM-00827).

3.0 Scope and Frequency

Refer to the Environmental Program Summary for current year.

4.0 Summary of Methods

Controls are set such that adequate amperage of current is registered on the ammeter. Fishes are collected as they are immobilized and placed in a tub of water until the end of the collection period. Numbers, lengths, and weights of fishes are recorded on Fisheries Investigation Form (FRM-00848). If study plan for project requires trace element samples, they are collected at required stations. If sample(s) are returned to the fisheries laboratory for identification or other processing they are logged in on a Fisheries Laboratory Sample Log-in Sheet (FRM-00827).

5.0 Equipment or Apparatus

5.1 Electrofishing boat (Wisconsin DC configuration).

5.2 Generator and gasoline.

5.3 Smith-Root control box and appropriate amperage fuses.

5.4 Electrodes and associated wires.

5.5 Safety pad and switch.

5.6 Dip nets.

5.7 Tub and bucket.

5.8 Rubber gloves and rubber-soled footwear.

5.9 Pound or kilogram and gram scales.

5.10 Measuring board.

5.11 Syringe.

5.12 Sample container(s), labels, and permanent marking pen.

5.13 Temperature-measuring and conductivity measuring devices.

5.14 Fisheries Investigation Form (FRM-00848) or computer-generated form or data logger, labels, and pencil/pen.

5.15 First aid kit.

5.16 Personal Flotation Device (PFD).

5.17 Toolbox.

5.18 Lights (for night electrofishing).

6.0 Reagent List

6.1 ~ 10% Formalin (buffered).

7.0 Safety: Limitations, Precautions, and Interferences

7.1 No element of this procedure may supersede the Company's safety standards and policies. Appropriate safety precautions should be used when handling chemicals. Refer to Material Safety Data Sheets for specific descriptions of the physical and chemical properties, physical and health hazards, and precautions for safe handling and use. Formalin is listed as an irritant and potential human carcinogen by the NC Occupational Safety and Health Standards for General Industry. Refer to the Progress Energy Corporate Safety Guideline for Laboratory Safety, SAF-SUBS-00017, and Section 8 for guidelines to the proper use of Extremely Hazardous Chemicals.

7.2 Use caution in working around the electrical currents associated with electrofishing. Ground generator by securing ground clamp to engine mounting bolt or other suitable ground. Use rubber gloves, rubber soled-footwear, and PFD (NR-00053) at all times. Take precautions to remain dry. Avoid working in the area of boaters or spectators. New employees and inexperienced users are required to read the Smith-Root Instruction Manual before using electrofishing equipment. Avoid placing electrode wires on the main support pole of the anode rings during operation (i.e., avoid shorting out the circuit and preventing power surge in the electrofisher box).

7.3 Allow generator to cool sufficiently before refueling.

8.0 Procedure

8.1 Attach electrodes to boat and connect wires from generator to control box and from control box to electrodes.

8.2 Put on rubber gloves, rubber-soled footwear, and PFD.

8.3 Start generator and turn on control box. Personnel on bow of boat stands on safety switch pad. Conductivity of water will determine size of field. Set controls such that sufficient amperage of current registers on ammeter (usually 2-4 amperes). Ensure timer is on.

8.4 The boat electrofisher is operated in a manner (stationary or moving) that achieves the desired results of the sampling program or study plan.

8.5 Dip immobilized fish and place in a container of water.

8.6 At the end of the specified electrofishing period, turn off controls and generator. The electrofishing period may be varied according to the sampling objectives or by the trip leader conducting the sampling when appropriate due to immediate weather, equipment, or catch conditions. Actual electrofishing time is recorded on the data sheet, and any variation from usual duration will be reported to the lead personnel.

8.7 Record all pertinent information on the data sheets or data-logger (location, transect, station, date, period, depth, gear type, duration, and sample quality).

8.8 Identify, enumerate, measure, and weigh the appropriate number of fish as required by study plan.

8.9 Collect samples for ancillary studies as required.

8.10 Fish not processed in the field may be returned to the laboratory for processing. Inject unknown species with formalin and place in labeled sample containers. Small specimens (< 100 mm) do not require injection. Place in labeled container and adequately cover with water. Add formalin (10 percent of volume) to preserve. Fish may also be kept on ice if identification is to be done before deterioration occurs. Return specimens to laboratory for identification. Upon return to the fisheries laboratory, login sample(s) on a Fisheries Laboratory Sample Log-in Sheet (FRM-00827) and place samples in the designated area.

8.11 Proceed to next station.

9.0 Calculations

N/A

10.0 Results

Data may be recorded on a data-logging device in lieu of the Fishery Investigation Form. Data are placed on computer master file or in non-main frame computer files as required by the study plan.

11.0 Definitions

N/A

12.0 References

12.1 Smith-Root Instruction Manual.

12.2 Murphy, B. R., and D. W. Willis, editors, 1996. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

13.0 Quality Control

13.1 Qualified personnel are responsible for briefing person(s) collecting sample(s) of the study objectives and station locations.

13.2 Any fish not readily identified in the field is returned to the laboratory for identification.

13.3 A fish reference collection is maintained to ensure that identifications are correct and consistent.

PEC

Environmental, Health, and Safety Services

Application:
FISHERIES INVESTIGATION

Revision Date: 11/16/2007

REMARKS:

COLLECTORS:

FORM **5** 1 | VERSION **C** 2 | LOCATION 3 | YEAR 5 | SAMPLE NO. 9 | TRANSECT 13 | STATION 15 | MONTH 17 | DAY 19 | PERIOD 21 | FREQ. 22 | TIME 23 | DEPTH 27

REP 29 | WATER TEMP. 30 | D.O. 33 | CONDUCTIVITY 36 | GEAR TYPE 39 | DURATION 42 | VELOCITY 46 | EXP/AREA/VOL 48 | TIDE 53 | QUALITY 54

SPECIES	SPECIES CODE 55	NUMBER 59	LENGTH 63	WEIGHT 67	SEX 73	MATURITY 74	STATUS 75	TAG NO. 76	RECAP/GRP 81	DMC 82

Fisheries Lab Sample Log-In Sheet Form

COLLECTION DATE	LOG IN DATE	DATE PROCESSED	SAMPLE NUMBER	COLLECTORS	SITE	STATION	SAMPLE DESCRIPTION

Document title

Trace Element Field Procedure

Document number

NR-00095

Applies to: Progress Energy Carolinas, Inc. – Environmental Services

Keywords: environmental; biology program procedures manual

1.0 Purpose

To describe the methods used to obtain and log in samples of fish, sediment, zooplankton, and benthos for trace element analyses.

2.0 Forms referenced in this procedure:

Trace Elements Chain of Custody Record (FRM-00875)
Trace Elements Fish Form Log (FRM-00876)
Trace Elements Sediment Form Log (FRM-00877)
Trace Elements Benthos Form Log (FRM-00878)
Trace Elements Zooplankton Form Log (FRM-00879)

3.0 Scope and Frequency

Refer to the ESS Biology Program Study Plans for current year.

4.0 Summary of Methods

Fish and plankton are collected by standard equipment and returned to the laboratory. Live benthos are returned in a plastic vial on ice if sieved in the field; otherwise, bottom sediments containing benthos are returned to the laboratory in plastic buckets. Sediment samples are obtained with a Petite ponar sampler from which sediments not immediately contact with the sampler surface are retained. These are placed on ice and returned to the laboratory for processing (FRM-00875). All samples are logged in upon return to the laboratory (FRM-00876, FRM-00877, FRM-00878, and FRM-00879).

5.0 Equipment or Apparatus

5.1 Plastic bags and glass vials.

5.2 Cooler and ice.

5.3 Assorted nonmetallic buckets.

5.4 Labels, pencils, marking pens.

5.5 Standard biological collecting equipment used at specific sites.

5.6 Freezer or Dry Ice.

6.0 Reagent List

N/A

7.0 Safety: Limitations, Precautions, and Interferences

7.1 No element of this procedure may supersede the Company's safety standards and policies.

7.2 Handling of samples and contact between sample and metallic materials should be kept to a minimum to lessen the possibility of contamination.

7.3 The inability to obtain the number or size of organisms (as outlined in the study plans) could result in the loss of samples or postponement of sampling. Generally, a second attempt to obtain samples will be considered sufficient effort extended if all required samples are not obtained on the first sampling trip.

7.4 Equipment failure may result in the loss of samples or postponement of sampling.

7.5 Samples should be adequately covered with ice to prevent spoilage and loss.

7.6 Fish samples should be placed on ice or dry ice immediately after collection. If fish samples cannot be returned to the laboratory and processed within 24 hours of collection, samples must be frozen (via. dry ice or freezer).

8.0 Procedure

8.1 Samples are collected according to the schedule in Section 3.0. Standard collecting equipment is generally used, but samples are placed in nonmetallic containers for transport.

8.2 Samples are not preserved chemically but are placed on ice for return to the laboratory.

8.3 Project location code, sample location (transect/station), and date collected are recorded on all sample containers or on labels. Other pertinent information (e.g., means of collection) may be recorded if appropriate.

8.4 All samples are logged in by trace element personnel upon delivery of samples to the laboratory (FRM-00875). A separate log (FRM-00876, FRM-00877, FRM-00878, and FRM-00879) is maintained for each LOCCODE (location code designates site and project).

9.0 Calculations

N/A

10.0 Results

Samples are processed in the laboratory Procedure (NR-00107) and the data are then placed on computer master file. Log sheets are maintained by the lead trace element personnel (FRM-00876, FRM-00877, FRM-00878, and FRM-00879).

11.0 Definitions

N/A

12.0 References

N/A

13.0 Quality Control

13.1 Lead scientist or technician should instruct personnel taking samples in the proper methods, station locations, and type of sample needed.

13.2 Sampling crew will immediately notify trace element lead scientist when samples are returned to the laboratory (FRM-00875). If lead scientist is not present, other trace element personnel should be notified.

13.3 All samples should be carefully logged in by trace element personnel.

TRACE ELEMENTS CHAIN OF CUSTODY RECORD

FACILITY: _____ **PROGRAM:** _____

COLLECTION SITE: _____

COLLECTION PERSONEL: _____

Section 1:

Sample Type*	Number of Samples	Collection Date	Transect/Station	Preservative

***If the Sample Type is Fish, indicate species on separate rows.**

Section 2:

Relinquished By:	Date:	Time:	Total Number of Samples:	Received By:
Relinquished By:	Date:	Time:	Total Number of Samples:	Received By:
Relinquished to Laboratory By:	Date:	Time:	Total Number of Samples:	Received at Laboratory By:
Remarks:				
PE Contact (Name and Telephone No.):				

Harris Energy and Environmental Center
3932 New Hill Holleman Rd.
New Hill, N.C. 27562

PRIORITY:
1. IMMEDIATE: BEFORE ANY OTHER SAMPLES; REQUIRES PROJECT SCIENTIST SIGNATURE
2. HIGH: WILL BE PROCESSED WITHIN FIVE WORKING DAYS FROM RECEIPT; REQUIRED PROJECT OR LEAD SCIENTIST APPROVAL
3. ROUTINE: PROCESS IN CHRONOLOGICAL ORDER OF RECEIPT OF SAMPLES
4. NO PRIORITY: NOT PART OF APPROVED PROGRAM; HOLD UNTIL FURTHER INSTRUCTIONS FROM LEAD SCIENTIST.

*LAB IDENTIFIED BY SAMPLE NUMBER
(1) NA – XXXX @ VENDOR
(2) 85 – XXXX, 86 – XXXX, ECT. = ACL

I = ITEM NUMBER
S = SAMPLE NUMBER

NATURAL RESOURCES TRACE ELEMENT LOG
FISH

I = INITIALS
D =DATE

FRM-00876

PAGE _____ of _______

LOCATION OF STUDY: _________________

SAMPLE TYPE AND DESCRIPTION	TRANS. STA.	NO. SAMPLES FROM STUDY PLAN	ACTUAL NUMBER TAKEN	DATE SAMPLED	DATE ARRIVED	FREQ.	PRIORITY 1, 2, 3, 4,	LOG-IN NUMBER	TAG NUMBER	FINAL LAB DISPOSITION					TRACE ELEMENTS PROCESSES									
										MUSCLE		LIVER	GONAD	LAB*	SAMPLE EXTRACTION		WEIGH	HOMOGENIZE	FREEZE SAMPLE	LYOPHILIZE	WEIGH	POUND	PELLET	ANALYSIS
										I					I									
										S					D									
										I					I									
										S					D									
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PRIORITY:
1. IMMEDIATE: BEFORE ANY OTHER SAMPLES; REQUIRES PROJECT SCIENTIST SIGNATURE
2. HIGH: WILL BE PROCESSED WITHIN FIVE WORKING DAYS FROM RECEIPT; REQUIRED PROJECT OR LEAD SCIENTIST APPROVAL
3. ROUTINE: PROCESS IN CHRONOLOGICAL ORDER OF RECEIPT OF SAMPLES
4. NO PRIORITY: NOT PART OF APPROVED PROGRAM; HOLD UNTIL FURTHER INSTRUCTIONS FROM LEAD SCIENTIST.

*LAB IDENTIFIED BY SAMPLE NUMBER
(1) NA – XXXX @ VENDOR
(2) 85 – XXXX, 86 – XXXX, ECT. = ACL

I = ITEM NUMBER
S = SAMPLE NUMBER

NATURAL RESOURCES TRACE ELEMENT LOG
SEDIMENTS

I = INITIALS
D =DATE

FRM-00877

PAGE _____ of _______

LOCATION OF STUDY: _________________

										FINAL LAB DISPOSITION			TRACE ELEMENTS PROCESSES							
SAMPLE TYPE AND DESCRIPTION	TRANS. STA.	NO. SAMPLES FROM STUDY PLAN	ACTUAL NO. SAMPLES TAKEN	DATE SAMPLED	DATE ARRIVED	FREQ.	PRIORITY 1, 2, 3, 4,	LOG-IN NUMBER	TAG NUMBER	SEDIMENTS		LAB*	WEIGH		FREEZE SAMPLE	LYOPHILIZE	WEIGH	GROUND AND SIEVE	PELLET	ANALYSIS
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							

PRIORITY:
1. IMMEDIATE: BEFORE ANY OTHER SAMPLES; REQUIRES PROJECT SCIENTIST SIGNATURE
2. HIGH: WILL BE PROCESSED WITHIN FIVE WORKING DAYS FROM RECEIPT; REQUIRED PROJECT OR LEAD SCIENTIST APPROVAL
3. ROUTINE: PROCESS IN CHRONOLOGICAL ORDER OF RECEIPT OF SAMPLES
4. NO PRIORITY: NOT PART OF APPROVED PROGRAM; HOLD UNTIL FURTHER INSTRUCTIONS FROM LEAD SCIENTIST.

*LAB IDENTIFIED BY SAMPLE NUMBER
(1) NA – XXXX @ VENDOR
(2) 85 – XXXX, 86 – XXXX, ECT. = ACL

I = ITEM NUMBER
S = SAMPLE NUMBER

NATURAL RESOURCES TRACE ELEMENT LOG
BENTHOS

I = INITIALS
D =DATE

FRM-00878

PAGE _____ of _______

LOCATION OF STUDY: _________________

SAMPLE TYPE AND DESCRIPTION	TRANS. STA.	NO. SAMPLES FROM STUDY PLAN	ACTUAL NO. SAMPLES TAKEN	DATE SAMPLED	DATE ARRIVED	FREQ.	PRIORITY 1, 2, 3, 4,	LOG-IN NUMBER	TAG NUMBER	FINAL LAB DISPOSITION			TRACE ELEMENTS PROCESSES							
										BENTHOS		LAB*	SAMPLE DRIED AND FILTERED		WEIGH	FREEZE SAMPLE	LYOPHILIZE	WEIGH	DESSICATE	SHIP
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
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										I			I							
										S			D							
										I			I							
										S			D							
										I			I							
										S			D							

Document title

Collection of Field Water Chemistry Samples

Document number

NR-00096

Applies to: Progress Energy Carolinas, Inc. – Environmental Services

Keywords: environmental; biology program procedures manual

1.0 Purpose

To provide water chemistry data as required by regulatory agencies and to provide support data for biological programs.

2.0 Forms referenced in this procedure:

Sample chain of custody (provided by Vendor)
Sample chain of custody (FRM-00872)

3.0 Scope and Frequency

Refer to Environmental Program Summary for current year.

4.0 Summary of Methods

Water samples are collected with a standard nonmetallic water sampler. Samples are placed in labeled containers, placed on ice, and sent to a laboratory. When required, a sample chain of custody is maintained.

5.0 Equipment or Apparatus

5.1 Cooler and ice.

5.2 Sample containers or equivalent nonmetallic container.

5.3 Nonmetallic, subsurface water bottle sampler.

5.4 Waterproof marker pen.

5.5 Sample bottles containing appropriate preservatives as required for analysis, e.g. trace metals bottles containing nitric acid, TOC bottles containing sulfuric acid, ammonia-nitrogen and nitrate-nitrite bottles containing sulfuric acid, etc.

6.0 Reagent List

N/A

7.0 Safety: Limitations, Precautions, and Interferences

7.1 No element of this procedure may supersede the Company's safety standards and policies. Appropriate safety precautions should be used when handling chemicals. Refer to Material Safety Data Sheets for specific descriptions of the physical and chemical properties, physical and health hazards, and precautions for safe handling and use. Refer to the Progress Energy Corporate Safety Guideline for Laboratory Safety, SAF-SUBS-00017, Section 8 for guidelines to the proper use of Extremely Hazardous Chemicals.

7.2 Store all water chemistry samples on ice and relinquished to the laboratory as soon as possible to avoid missing sample holding times.

7.3 Surface samples are collected just below the surface to avoid collecting surface scum.

7.4 If a preserved sample is spilled or the bottle is overfilled, the sample must be discarded and recollected to ensure that samples are adequately preserved.

7.5 No element of this procedure may supersede the Company's safety standards and policies. Appropriate safety precautions should be used when handling chemicals. Refer to Material Safety Data Sheets for specific descriptions of the physical and chemical properties, physical and health hazards, and precautions for safe handling and use. Refer to the Progress Energy Corporate Safety Guideline for Laboratory Safety, SAF-SUBS-00017, Section 8 for guidelines to the proper use of Extremely Hazardous Chemicals.

7.6 All sample chain of custody sheet are maintained (FRM-00872), and all pertinent information will be filled out accurately and completely.

8.0 Procedure

8.1 Label sample container with the sample number, location code, station code, date, and depth using waterproof marking pen.

8.2 Sample containers will be rinsed a minimum of two times with the sample water prior to sample container filling. The water sample is transferred from the sampler into the sample containers, filled until overflowing, and capped securely. The samples should be sealed as soon as possible with the minimal amount of entrained air to prevent oxidative changes. Phosphorus sample bottles should be filled so that the water level reaches just below the shoulder of the bottle to prevent rupturing the bottles when the samples are frozen.

8.3 Bottles containing preservatives must not be rinsed prior to filling. Care must be taken not to overfill the bottle as preservative may be lost or diluted.

8.4 When sampling for analysis of volatile organic compounds, special precautions must be taken not to overfill the bottle and also to ensure there are no air bubbles trapped in the bottle.

8.5 Water chemistry surface samples are collected ~ 0.2 m below the surface.

8.6 Bottom samples are collected with a nonmetallic subsurface sampler ~ 0.5 m from bottom. The sample is transferred to labeled container as described in 7.2 through 7.4. If silt or sediment appears in sample or if sampling gear does not properly seal, sample must be discarded and recollected.

8.7 Place samples immediately on ice for transport to the analytical laboratory.

8.8 When samples are sent to a laboratory for specific analyses, a chain of custody sheet for those samples will be maintained during sample transfer, all pertinent information will be filled out accurately and completely, and the chain of custody will be sent to the QA file.

9.0 Calculations

N/A

10.0 Results

Samples brought in from the field are sent to an analytical chemistry laboratory for analysis. Results are placed on computer master file to be utilized in annual reports and/or as information requested by regulatory agencies.

11.0 Definitions

N/A

12.0 References

American Public Health Association, Standard Methods for the Examination of Water and Waste water, 19th Edition 1995, 1015 Fifteenth St., NW, Washington, DC 20005.

13.0 Quality Control

13.1 Lead scientist or technician should instruct personnel taking samples in the proper methods and station locations.

13.2 A sample analysis request form/chain of custody form and sample seals will be completed as required by the selected analytical chemistry laboratory.

CHAIN OF CUSTODY RECORD

PE FACILITY: _____ PROJECT: _____

COLLECTION SITE: _____

COLLECTION BY
FIELD PERSONNEL: _____

SAMPLE NUMBER	DATE	TIME	TRANSECT/ STATION	PARAMETERS TO BE ANALYZED	PRESERVATIVE

Relinquished By:	Date:	Time:	No Samples:	Received By:
Relinquished By:	Date:	Time:	No Samples:	Received By:
Relinquished to Laboratory By:	Date:	Time:	No Samples:	Received at Laboratory By:
Remarks:				
PE Contact (Name and Telephone No,):				

Harris Energy & Environmental Center
Environmental Health and Safety Services Section
Route 1, Box 327
New Hill, N.C. 27562

Document title

Water Quality Field Procedure

Document number

NR-00097

Applies to: Progress Energy Carolinas, Inc. – Environmental Services

Keywords: environmental; biology program procedures manual

1.0 Purpose

To provide data on water temperature, dissolved oxygen (DO), hydrogen ion activity (pH), conductivity, Secchi disk, salinity, turbidity, and photosynthetically active radiation (PAR) as required by regulatory agencies and as needed to determine environmental conditions.

2.0 Forms referenced in this procedure:

Water Quality Data Sheet (FRM-00852)
Photosynthetically Act. Rad. Field Data Sheet (FRM-00864)
Field Collection Verification and QA Records Transmittal (FRM-00803)
Calibration Data Sheet (FRM-00853)
Water Quality Instrument Field Usage (FRM-00884)
Water Quality Instrumentation Control (NR-00058)

3.0 Scope and Frequency

Refer to Environmental Program Summary for current year.

4.0 Responsibilities

Ensure all operation checks and calibrations have been performed prior to leaving the laboratory (NR-00058, FRM-00853, and FRM-00884).

4.0 Summary of Methods

Calibrate the Dissolved Oxygen prior to leaving the laboratory (FRM-00884).

Water quality measurements (water temperature, DO, pH, conductivity, Secchi disk transparency depth, salinity, and photosynthetically active radiation) are recorded at the specified depths and stations indicated in the current ES Biology Program Study Plans Manual.

5.0 Equipment of Apparatus

5.1 Field temperature, DO, pH, conductivity, turbidity, and salinity meter(s) and probe(s).

5.2 Data sheets and pencils or data logging device.

5.3 Secchi disk.

5.4 LI-COR® underwater spherical quantum sensor, lowering frame, and quantum/radiometer/photometer.

6.0 Regent List

N/A

7.0 Safety: Limitations, Precautions, and Interferences

7.1 No element of this procedure may supersede the Company's safety standards and policies. Appropriate safety precautions should be used when handling chemicals. Refer to Material Safety Data Sheets for specific descriptions of the physical and chemical properties, physical and health hazards, and precautions for safe handling and use. Refer to the Progress Energy Corporate Safety Guideline for Laboratory Safety, SAF-SUBS-00017, Section 8 for guidelines to the proper use of Extremely Hazardous Chemicals.

7.2 Ensure that equipment is working properly and has been calibrated and checked (NR-00058) according to schedule. The LI-COR® underwater spherical quantum sensor and calconnector are calibrated by the manufacturer.

8.0 Procedure

8.1.1 Calibration of Dissolved Oxygen

8.1.2 Document the barometric pressure on FRM-00884.

8.1.2 Check the Calibration of the dissolved oxygen probe by documenting (FRM-00884) the % saturation after placing a small amount of water or a wet sponge in the bottom of the calibration cup.

8.1.3 Ensure the dissolved oxygen probe is dry and place the probe in the calibration cup.

8.1.4 Allow the instrument to run for approximately 5 minutes or until the dissolved oxygen % saturation is stable.

8.1.5 If the % saturation is between 98.0 % and 102.0% no calibration is needed.

8.1.6 If the % saturation is outside of 98.0 % and 102.0%, follow the calibration procedure in the YSI manual and documents the post-calibration % saturation and calibration constants on FRM-00884.

8.2 Header information (location code, date, samplers' initials, and station) are recorded on the data sheet (FRM-00852/FRM-00864), or entered into a data logging device which has an electronic form suitable for entering and uploading water quality data.

Observe and record weather conditions (e.g., cloud conditions, approximate wind speed and direction, precipitation) and the instrument number. Military time is recorded beginning with the first and concluding with the last depth sampled.

8.3 Lower the temperature, DO, pH, conductivity, turbidity, and salinity probe(s) just below water surface to measure surface data. Allow time for the instrument to equilibrate. The spherical quantum sensor and lowering frame are held just above the surface of the water on the sun-lit side of the boat or stream for a measurement of the amount of incident (I_o) light that is reaching the water surface.

8.4 Record required data in the appropriate column(s) on the Water Quality Data Sheet (FRM-00852/FRM-00864), or enter the data on a data logging device. Photosynthetically active radiation is measured at 0.2 m, and then every 0.5 m from 0.5 m to 3.0 m, and then every 1.0 m meter from 3.0 m to 8.0 m or until readings reach "0" on the quantum/radiometer/photometer. Data are recorded on the Photosynthetically Active Radiation Field Data Sheet (FRM-00864).

8.5 Equilibration time is allowed at each depth. Temperature is recorded to the nearest 0.1°C, dissolved oxygen to the nearest 0.1 mg/liter, pH to the nearest 0.1 standard unit, conductivity to the nearest 1 unit (μS/cm), turbidity in two significant digits (one decimal point offset), salinity to the nearest 0.1 ppt, and photosynthetically active radiation to the nearest 0.01 microeinstein per second per square meter (μE/sec/m^2).

8.6 The bottom sample depth is recorded by rounding to the nearest meter.

8.7 Secchi disk depth is read at each reservoir station or as required by the current monitoring program. Record Secchi disk depth to the nearest 0.1 m. Measurements should be an average of two readings--first when the disk disappears and the second when the disk reappears as it is being raised. In addition, measurements should be recorded on the shaded (and if possible, leeward) side of the boat.

8.8 Procedure discrepancies occurring in the field should be noted on the data sheet (FRM-00852/FRM-00864), or in the comments section of data logging device.

9.0 Calculations

N/A

10.0 Results

Data are placed on computer master file (if appropriate) and utilized in annual reports, or as required to determine environmental conditions.

11.0 Definitions

Operation Check – Ensuring the instrument has power and that measured values are stable without comparing it to known standards. This process is completed and documented prior to all sampling trips per procedure NR-00058.

Calibration – is the scheduled (quarterly) comparison between a measured value and a known traceable standard. If the measured value is outside of approved tolerances, an adjustment/calibration is required to bring the instrumentation into the approved tolerances. This process is documented in accordance with Quality Assurance/Quality Control protocols.

12.0 References

12.1 LI-COR® instruction manual LI-250 quantum/radiometer/photometer. LI-COR Incorporated, 4421 Superior St., P. O. Box 4425, Lincoln, NE 68504.

12.2 Lind, O. T. 1974. Handbook of common methods in limnology. C. V. Mosby Co., St. Louis, MO.

12.3 American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 19th Edition 1995, 1015 Fifteenth St., NW, Washington, DC 20005.

13.0 Quality Control

13.1 Lead scientist or technician should instruct personnel taking samples in the proper methods and station locations.

13.2 All stations are sampled on the same day (if possible) in as little time as possible.

13.3 Field verification sheets (FRM-00803) should be completed by field personnel upon return from sampling to indicate any procedural discrepancies.

13.4 Lead scientist/technician should check data upon receipt to determine accuracy. If data are suspect, samples should be retaken.

QA File Name

FIELD COLLECTION VERIFICATION AND QA RECORDS TRANSMITTAL FORM

Sampling Date(s) **Program**

Sampling was conducted as described in the Biology Program Study Plans Manual and followed approved procedures in the Biology Program Procedures Manual.

Procedure Number	Type	Sample Number(s) (if applicable)	Locations	Verified

Equipment Number(s) (If applicable) _____

Deficiencies? Yes ___ No ___ (If yes, explanation required below. See Procedure NR-00125

Comments: _____

Signed: _____(trip leader) _____(coworker)

_____(coworkers)

Reviewed by:_____ _____(Date)

Received by:_____ _____(Date)

CP&L

ENVIRONMENTAL SERVICES

Application:
WATER QUALITY DATA SHEET

FORM CODE: W Q C (1–3) | LOC. CODE (4–7) | DATE: M M D D Y Y Y Y (8–15) | SAMPLERS (17–20 — 21–24)

WEATHER CONDITIONS _____ INSTRUMENT NO. _____

DMC 24	STATION 25	TIME 30	DEPTH 35	WATER TEMP. 40	D.O. 45	CONDUCT. 50	pH 55	SECCHI 60	% D.O. SATURATION 65	SALINITY (ppt) 70	OTHER 75

COMMENTS:

Photosynthetically Active Radiation Field Data Sheet

Location _____
Date _____
Personnel _____
Weather conditions _____

_____

Instrument _____

Station	Time	Secchi Depth (m)	Incident Light (Io)	PAR	
			Water Depth (m)		

Comments _____

Appendix B

Alderman Environmental Services,

Inc. 20 June 2014

Duke Energy Dan River Mussel Conservation Project Plan

The Dan River Subbasin provides habitat for 12 freshwater mussel species (Table 1). One is federally listed as endangered, James Spinymussel, and 2 are federal species of concern, Atlantic Pigtoe and Green Floater. The James Spinymussel and Green Floater are state listed endangered in both Virginia and North Carolina. The Atlantic Pigtoe is state listed endangered in North Carolina and state listed threatened in Virginia. Several of the species are state listed in North Carolina: Triangle Floater, Creeper, and Notched Rainbow.

Conservation Priorities

1. Dan River Mapping and Habitat Assessments

In general, mussel habitat quality declines from near Snow Creek down to Kerr Lake. A baseline is needed to facilitate assessments of habitat quality conditions currently and during future years, and this mapping should help identify potential priority areas for current mussel surveys. Along both banks using a Humminbird 698ci Hd Si Combo attached to a Zodiac Zoom 350S, substrate habitat will be mapped from near Snow Creek in Stokes County to Kerr Lake (Figure 1). Reason: The images produced by the Humminbird create a clear picture of underwater structure and relative depths and can be saved on SD cards. Further analysis and georeferencing of produced side scan images will be completed using the program Sonartrx-SI by Leraand Engineering, Inc. Summary maps associated with the various habitat types and potential preferred mussel survey areas will be provided through ArcGIS. Priority potential surveys will occur in the following habitat types:

- Areas with diverse substrates (fines through coarser substrates) with significant patches of clean sands and gravel

- Thalweg and other deep channel areas with diverse substrates with significant patches of clean sands and gravel; may have old logs present providing structure/protected habitat for mussel individuals
- Areas upstream, adjacent, and downstream from islands with diverse substrates, including areas with relatively clean, lower energy microhabitats

AES staff requirements: 2 staff

Time: 15 ten hour days plus preparation time

2. Dan River Mussel Surveys

Based upon mapping data and biologists' assessments of habitats while collecting substrate habitat data, timed mussel surveys will be completed throughout the Dan River from near Snow Creek down to Kerr Lake. A goal will be to complete at least 1 timed survey at one site within each 3 mile river reach. Minimum time within a surveyed site will be 4.0 person-hours. Each survey should emphasize habitats along both shorelines and across the river where quality habitat exists. Catch-Per-Unit-Effort (CPUE), survey techniques (depending upon habitats, may include use of SCUBA, bathyscopes, snorkeling, unaided visual searches, and tactile searches), specimen identifications, individual length measurements, habitat descriptions, and survey site locations and delineations (precise mapping of site using sub-meter GPS) will be recorded for each survey site. Survey result summary maps will be provided through the use of ArcGIS.

Size of each survey site: In many ways, the survey of the Dan River downstream from Eden is a reconnaissance survey. We do not know if mussels exist within this reach, and if they do exist there, we presently do not understand anything about diversity or abundances. In general, as the density of mussels increases within a site, the area surveyed decreases (assuming approximately equal survey time at each site). In general, the opposite is true for a very low density mussel community (<1 individual/100 m^2): Survey area within the site increases significantly given the same amount of survey time. Thus, in some areas of the Salkehatchie River in South Carolina with an estimated mussel community density of >1,000 mussels/m^2, the site may only be a few square meters in size. However, in some reaches of the Wateree River in South Carolina, even with SCUBA and surveying hundreds of meters of river reach, no mussels may be documented. For the lower Dan River, given unknown mussel densities, it is not possible to provide exact estimates of survey site sizes. The area surveyed will depend upon mussel densities, time available for surveys, and the complexity of habitats available.

Reason: Just as with habitat quality declines, it appears (based upon limited surveys) that mussel communities decline upriver from Eden down to Kerr Lake. Such documentation should help identify future mussel conservation priorities and identify sites where quantitative surveys (density estimates) would be appropriate.

AES staff requirements: 4 staff, including SCUBA divers; NOTE: AES staff possess federal and state permits (i.e., USFWS, VDGIF, NCWRC) to compete these surveys in North Carolina and Virginia.

Time: 22 ten hour days plus preparation time

Potential follow-up quantitative surveys:

A follow-up meeting with various agencies needs to occur following our initial surveys. For some of the surveyed sites, it may be necessary to complete additional quantitative surveys to allow for better comparisons of data collected during future years. If quantitative surveys are necessary, then a stratified (based upon known occupied habitats for each site) systematic sampling design with 3 random starts per site should be completed at those specific sites.

Table 1. Dan River Subbasin freshwater mussel species

Species	Federal Status	North Carolina Listing Status	Virginia Listing Status	TNC G/S Rank NC	TNC G/S Rank VA	No.Live/Shells documented in NC's Dan River Subbasin since 1986 (NCWRC 4/4/14 database)
Triangle Floater (*Alasmidonta undulata*)		T		G4/?	G4/?	15/25
Carolina Lance (*Elliptio angustata*)				G4/?	G4/?	380/1
Eastern Elliptio (*E. complanata*)				G5/S4S5	G5/S5	10624/103
Variable Spike (*E. icterina*)				G5Q/S4	G5Q/?	2/0
Northern Lance (*E. fisheriana*)				G4/S3	G4/S4	73/2
Atlantic Pigtoe (*Fusconaia masoni*)	FSC	E	T	G2/S1	G2/S2	Several/?
Green Floater (*Lasmigona subviridis*)	FSC	E	E	G3/S1	G3/S2	84/5
James Spinymussel (*Pleurobema collina*)	E	E	E	G1/S1	G1/S1	521/40
Eastern Floater (*Pyganodon cataracta*)				G5/S5	G5/S5	73/47
Creeper (*Strophitus undulatus*)		T		G5/S2	G5/S3S4	61/88
Paper Pondshell (*Utterbackia imbecillis*)				G5/S5	G5/S3S5	36/6
Notched Rainbow (*Villosa constricta*)		SC		G3/S3	G3/S3	844/25

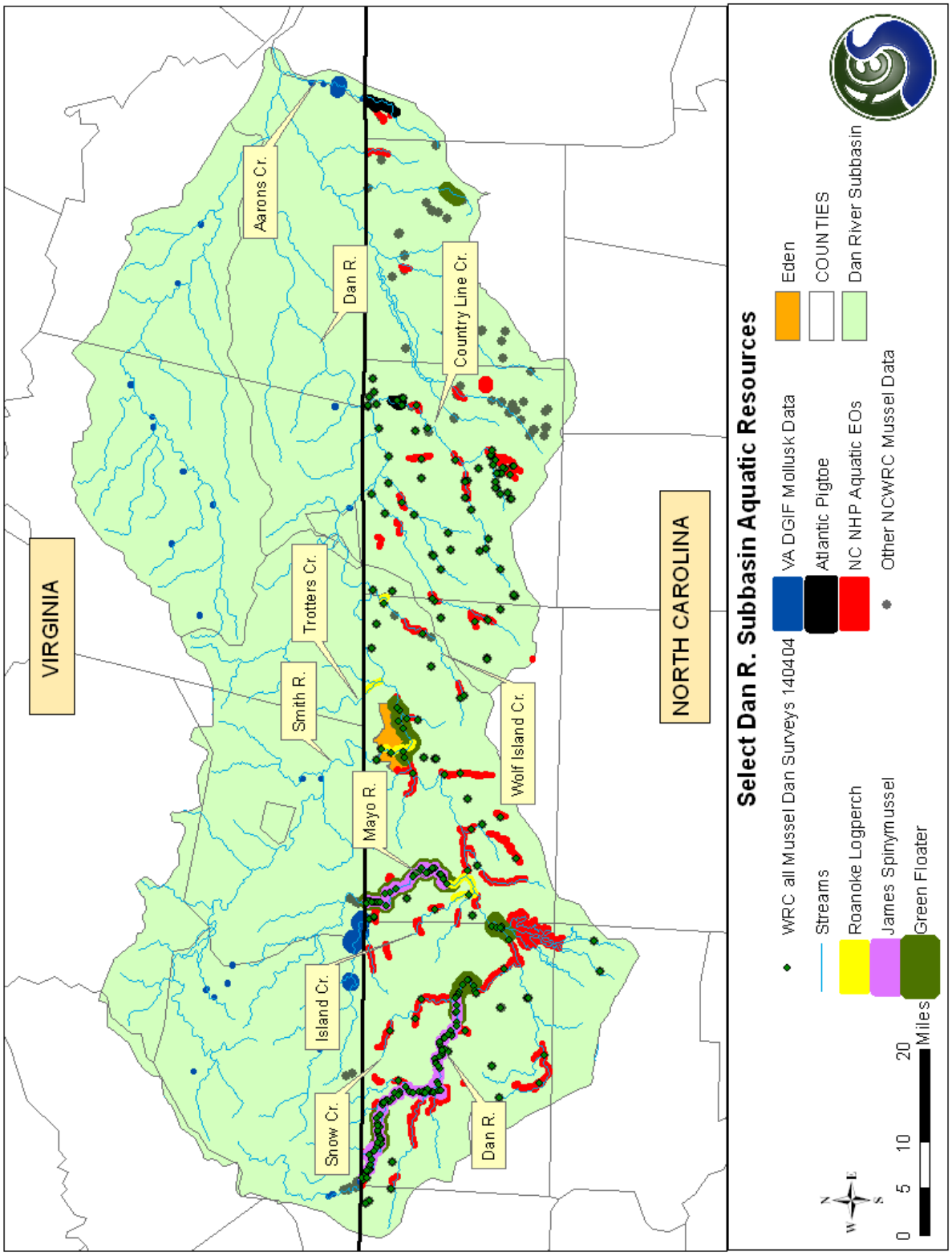


Figure 1. Freshwater mussel surveys and available rare aquatic taxa records

Appendix C

Water Chemistry Parameter List
and Screening Values

ANALYTE (MDL)	SCREENING VALUES-Aquatic Life/Human Health
ALKALINITY (mg/L)	NA/NA
Aluminum (Al) (µg/L)	87/8000
Antimony (Sb) (µg/L)	NA/640
Arsenic (As) (µg/L)	50/10
Barium (Ba) (µg/L)	NA/200
Beryllium (Be) (µg/L)	6.5/NA
Boron (B) (µg/L)	NA/NA
Cadmium (Cd) (µg/L)	2/NA
Calcium (Ca) (mg/L)	NA/NA
Chloride (Cl) (mg/L)	230/NA
Chromium (Cr) (µg/L)	50/NA
Cobalt (Co) (µg/L)	NA/4
Copper (Cu) (µg/L)	7/NA
Hardness Calculation, Total (mg/L)	NA/NA
Iron (Fe) (µg/L)	1.0/NA
Lead (Pb)(µg/L)	25/NA
Magnesium (Mg) (mg/L)	NA/NA
Manganese (Mn) (µg/L)	NA/NA
Mercury (Hg) (µg/L)	0.012/NA
Nickel (Ni) (µg/L)	88/NA
Nitrogen, Ammonia (mg/L)	NA/NA
Nitrogen, Total Kjeldahl Nitrogen (mg/L)	NA/NA
Nitrogen, Nitrate + Nitrite (mg/L)	NA/NA
Phosphorus (P) (µg/L)	NA/NA
Potassium (K) (µg/L)	NA/NA
Selenium (Se) (µg/L)	5/NA
Silver (Ag) (µg/L)	0.06/NA
Sodium (Na) (mg/L)	NA/NA
Sulfate (SO_4) (mg/L)	NA/NA
Thallium (Tl) µg/L	0.047
Total dissolved Solids (mg/L)	NA/NA
Total Nitrogen Calculation, (mg/L)	NA/NA
Total Organic Carbon, (mg/L)	NA/NA
Vanadium, (Va) (µg/L)	NA/NA
Zinc (Zn) (µg/L)	50/NA

NA = Not Available

Sediment and Biota Analyte List and Screening Values

ANALYTE (MDL wet µg/g)	**FISH-TISSUE SCREENING VALUES (µg/g wet weight)**	**SEDIMENT SCREENING VALUES (µg/g wet weight)**
Aluminum (0.0782)	410 (NC), 4,000 (VA)	3,200
Antimony (0.011)	0.16 (NC), 1.6 (VA)	2.0
Arsenic (0.013)	0.27 (NC as total), 0.27 (VA as total; assumes 10% of total As is inorganic)	9.8
Barium (0.017)	82 (NC), 800 (VA)	60
Beryllium (0.015)	1.6 (NC), 8.0 (VA)	NA
Boron (0.245)	82 (NC)	NA
Cadmium (0.008)	0.41 (NC), 4.0 (VA)	0.99
Calcium (20.5)	NA	NA
Chromium (0.0431)	1.2 (NC), 12.0 (VA)	43.4
Cobalt (0.006)	0.12 (NC)	NA
Copper (0.029)	16 (NC,), 40 (VA)	31.6
Iron (0.786)	290 (NC)	
Lead (0.011)	Report any detected concentration	35.8
Lithium (0.014)	0.82 (NC)	NA
Magnesium (22.3)	NA	NA
Manganese (0.044)	58 (NC), 560 (VA)	460
Mercury (0.008)	0.4 (NC), 0.3 (VA)	0.18
Molybdenum (0.044)	NA	NA
Nickel (0.013)	8.2 (NC), 80 (VA)	22.7
Phosphorus (261.8)	NA	NA
Potassium (451.6)	NA	NA
Selenium (0.075)	10 (NC), 20 (VA; human health toxic effects); 8.1 **µg/g <u>dry weight</u>** whole fish, or 11.8 **µg/g** fillet (VA, to prevent fish toxic effects)	2
Silver (0.002)	2.1 (NC), 20 (VA)	0.733
Sodium (26.9)	NA	NA
Strontium (0.022)	NA	NA
Thallium (0.007)	0.00412 (NC), 0.27 (VA WQC-based); 0.040 (newer data)	NA
Tin (3.25)	NA	NA
Titanium (0.130)	NA	NA
Uranium (0.002)	NA	NA
Vanadium (0.014)	2.1 (NC), 40 (VA)	57
Zinc (0.801)	120 (NC), 1,200 (VA)	121

NA = Not Available

Appendix B – North Carolina Department of Environment and Natural Resources Dan River Coal Ash Wastewater Spill Investigation Plan

Dan River Coal Ash Wastewater Spill Investigation Plan

Working Document
Version 1.1 May 13, 2015

NC Division of Water Resources
Water Sciences Section

Purpose

This plan outlines the NC Division of Water Resources' (DWR or Division) plans for assessing the extent of impact and recovery from a spill reported on February 3, 2014 to the DWR Winston-Salem Regional Office. That spill contained coal combustion byproducts (coal ash) from the Eden NC Steam Station. The Water Sciences Section and Winston-Salem Regional Office will be conducting water column, sediment, and biological sampling in the Dan River. The survey will include the Dan River between Eden, NC and the headwaters of the John H Kerr Reservoir in Virginia. This section of the Dan River is approximately 80 miles in length. This study is intended to help quantify the extent of waste product which entered the Dan River, its distribution, and impacts to water quality and aquatic life.

Study Design

First Phase – Immediate Response

The area of concern for the first phase of the study was the Dan River between Eden, NC and John H Kerr Reservoir in Virginia. Within this reach of the river, 10 locations were selected for physical/chemical water quality and sediment sampling (Figure 1 and Table 2). A list of analytes collected at these sites is included as Table 1. Sampling locations were based on proximity to the origin of the discharge of wastewater into the Dan River and areas that exhibit potential concentrations of ash product on the bottom sediment. Specific locations are found in Figure 1 and Table 2.

Second Phase – Ongoing Monitoring

The second phase of the study will focus on data needed to support remediation efforts and will include additional sediment and water chemistry collections as well as fish tissue and benthic macroinvertebrate sampling to monitor long term biological impacts. Site selection for sediment and water chemistry will be determined by accessibility, water intake points, proximity to spill site and potential areas of waste material settling. Parameters to be monitored will be based on those that remain elevated and those of concern based on surface water quality standards and sediment risk levels. Changes to the parameters will be documented and included as Appendix 1 of this working plan. Biological sampling will occur in areas that reflect historic sampling efforts for comparative purposes, as well as areas affected by the distribution of coal ash in the spill area determined by sediment sampling.

Collection of sediment, fish tissue, and macroinvertebrate samples in the reach of the Dan River between Eden, NC and John H Kerr Reservoir is difficult due to lack of access points, limited up and downstream travel by boat, rapidly changing river stage, fast flowing water, and seasonal cold temperatures. All collections performed by DWR staff in this study will follow established monitoring and safety protocols to facilitate staff protection.

As investigation of the coal ash spill continues, this monitoring plan will be adjusted to accommodate expanding or reduced sampling needs. Initial sampling was conducted daily except during adverse weather conditions. Any reductions in frequency of sampling will be based on the type of sampling and the results.

Parameters

NC DWR is sampling for the following parameters using standard operating procedures[1]:

In-Situ Water Chemistry

Physical water conditions will be measured on site with multiparameter water quality meters at all locations in accordance with NC DWR field monitoring protocols. These parameters include: Temperature, pH, Conductivity, and Dissolved Oxygen.

Sediment Chemistry

Surface sediment will be collected from the bottom of the Dan River using either Ekman Dredge or Van Veen samplers. First phase sediment sample analysis includes the parameters shown in Table 1. EPA methods 200.7, 200.8, and 200.9 will be used. Sediment sampling efforts were halted after phase 1, based on results after cleanup efforts and consultation with other agencies.

Water Column Chemistry

Water from the Dan River will be collected as grab samples from below the surface. Water column sampling will occur in conjunction with all sediment sampling at the locations (bank or midstream) where it occurs. First phase water chemistry analysis includes the following parameters shown in Table 1. Parameters sampled were decreased in second phase based on results from initial sampling efforts showing no difference between upstream and downstream samples for 17 parameters. Frequency of sample collection was reduced from daily to weekly to monthly as cleanup progressed and sampling results. Initial daily monitoring efforts changed to weekly sampling on February 24, 2014 and continued through May 2014. From June 2014 on water chemistry monitoring has been monthly.

Analysis used:

- Water Column Metals methods EPA 200.7, 200.8, 200.9
- Major Ions method EPA 300.0
- Solids methods SM 2540B, SM 2540D

Fish Tissue Chemistry

Collection of fish tissue samples will be conducted to assess potential bioaccumulation of coal ash constituents in fish which are typically consumed. Fish absorb chemicals in several ways; directly from water that passes over their gills, through the food they ingest, and by association with sediments. Fish will be collected using standard NC DWR sampling methods in areas accessible by boat from upstream of the spill area to and John H Kerr Reservoir. Parameters to be assessed in fish tissue are listed in Table 1 and will be analyzed using EPA methods: 200.7, 200.8, and 200.9

Initial collection of fish tissue samples will support baseline data for this reach of the Dan River. Continued long term sampling will occur approximately one month, 6 months, one year, one and one half years, and two years after initial collection, to assess bioaccumulation of coal ash constituents.

[1] Available at: http://portal.ncdenr.org/web/wq/ess/isu

Aquatic Insects

Aquatic invertebrates or macrobenthos are indicators of stream health and are used to assess the biological health/water quality of NC streams. Assessment of these benthic organisms as part of the response to the coal ash spill will help evaluate long term effects on aquatic life in the Dan River. Accurate assessment of macroinvertebrates depends heavily on the ability to sample appropriate habitats such as stream riffles and banks. If river stage is too high, sampling is neither appropriate nor safe. Flow and stage levels must be suitable for this monitoring to occur. Measures used to evaluate the Dan River would be:

- Species Richness Mayflies, stoneflies, and caddisflies or EPT (Ephemeroptera, Plecoptera, and Trichoptera)
- Overall, Taxa Richness This includes all taxa of aquatic macroinvertebrates collected, including EPT, Diptera, Odonata, Megaloptera, Gastrapoda, and Crustacea, to name a few.
- EPT abundance A cumulative total of EPT based on semiquantitative ranks of Rare(=1), common (=3), and abundant (=10)
- North Carolina Biotic Index or NCBI This metric scores the benthic community based on established tolerance values of genus or species level taxa. It is a summation score based on abundances, tolerances, and richness of the entire macroinvertebrate community.
- Habitat and Physical-Chemical Parameters Assessed to provide additional information about the stream and whether or not the aquatic fauna is affected by habitat

Table 1. Parameters by Sample Type and Media

	Parameter*	Sediment	Water Column
Chemical First Phase Thru Feb. 10, 2014	Total & Dissolved = Al, Sb, As, Ba, Be , B, Cd, Ca, Cr, Co Cu, Fe, Pb, Li, Mg, Mn, Hg, Mp, Ni, K, Se, Ag, Na, Sr, Tl, Sn, Ti, V, Zn Total Hardness, Sulfate, Chloride, Flouride, TS, TSS	Variable	Daily
Chemical First Phase Thru Feb. 21, 2014	Total & Dissolved = Al, Ca, Mg, Se,Tl, As, Pb, Zn, Ba, V, Cr, Ni, Cu, Mn, Sr, Na, B, K, Cd, Hg, Fe, Ti Total Hardness, Sulfate, Chloride, Flouride, TS, TSS	Variable	Daily
Chemical Second Phase May-June 2014	Total & Dissolved = Al, As, Cd, Cu, Fe, Ni, Zn TS, TSS	NA	Weekly thru May 2014
Chemical Third Phase June 2014-Present	Total = Al, As, Cd, Cu, Fe, Ni, Zn TS, TSS	NA	Monthly
Physical	Temperature, Conductivity, pH, Dissolved Oxygen	With all samples	
Fish Tissue	Al, As, Ba, Cd, Cr, Cu, Fe, Pb, Mg, Mn, Hg, Ni, Se, Ag, Tl, Zn	Whole Body, Fillet	
Benthos	Full Scale	Riffle, other available habitat	

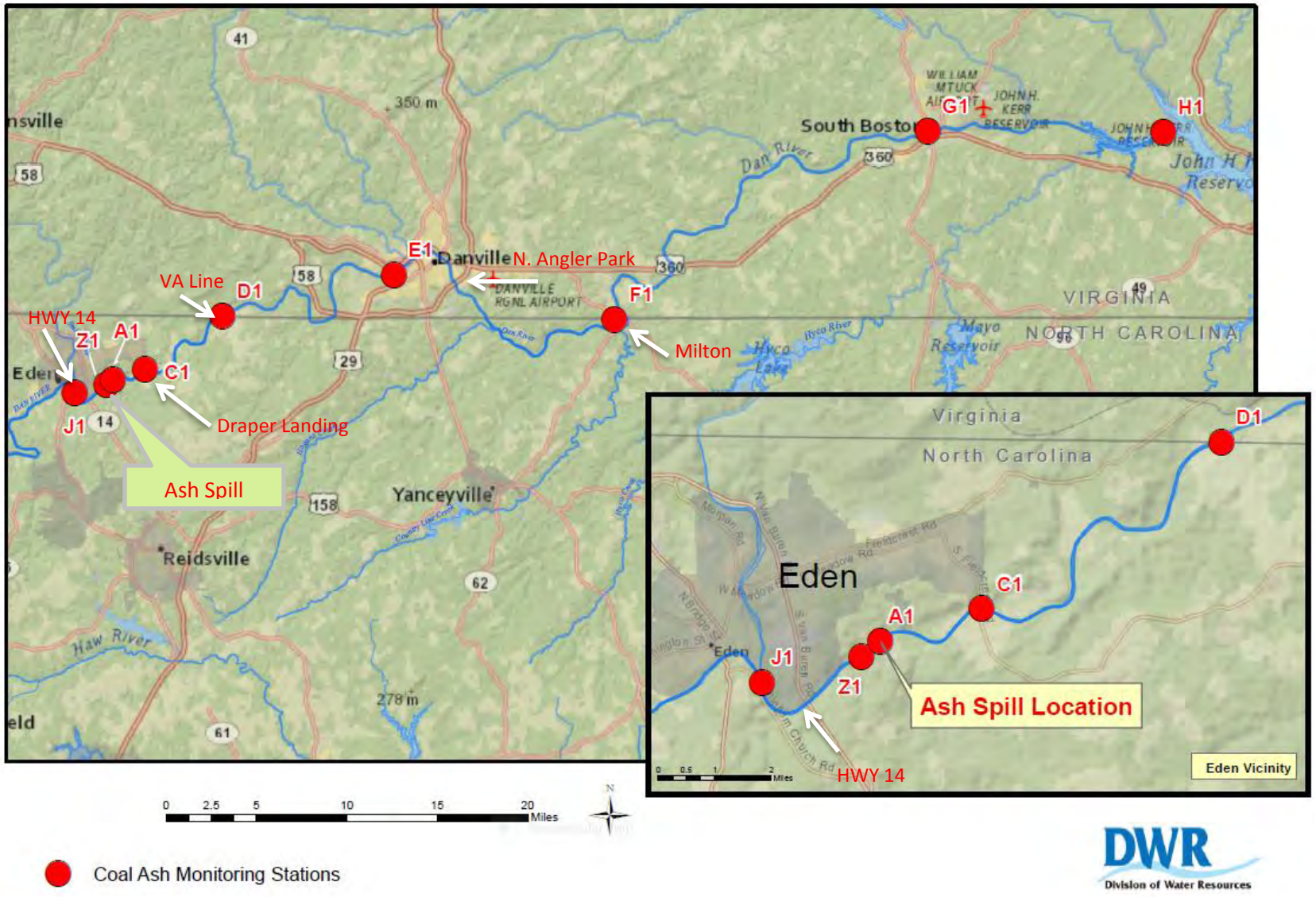
* Parameters may change as data are analyzed from all sources or as deemed necessary by samplers, WSS, and the Regional Office, See Appendix 1 for changes.

Table 2. Station Descriptions and Frequencies (ambient stations in bold) – Daily sampling started Feb. 3rd at 3 stations

Site Name	Site Description	Latitude Longitude	Sediment - Frequency*	Water - Frequency*	Tissue - Frequency*	Benthos - Frequency*
J1	**Dan River downstream of Smith River @ Eden** (historic fish site)	36.479214 -79.750445			Week of 2/24/14, then 1 month, 6 month, 1yr, 1.5yr, 2yr	
Hwy 14	Dan River upstream of Spill at Hwy 14	36.473775 -79.736214	Once after 2/21/14	Daily thru Feb 21st then weekly through May 2014, then monthly		
Z1	Dan River @ Steam Station boat ramp	36.485979 - 79.718897	2/7/2014 & 2/11/2014	2/7/2014 & 2/11/2014		10/14
A1	Dan River 100 yds downstream of outfall (A1, A2, A3 transect)	36.490020 -79.712940	2/7, 2/11, 2/17/14	With Sediment		
C1 Draper Landing	Dan River @ NC 700	36.498492 -79.680757	2/11, 2/17/14	Daily thru Feb 21st then weekly through May 2014, then monthly		10/14
D1 Virginia Line	**Dan River @ NC/VA state line, Berry Hill Bridge** (historic fish site)	36.541677 -79.604870	2/11, 2/17/14	Daily thru Feb 21st then weekly through May 2014, then monthly	Week of 2/24/14, then 1 month, 6 month, 1yr, 1.5yr, 2yr	
E1	Dan River @ Danville WTP intake	36.575279 -79.434563	2/11, 2/17/14	With Sediment		
B2 N. Angler Park	Dan River nr N. Angler Park	36.560150 -79.361690	2/17/14	With Sediment		
F1 Milton	**Dan River @ NC57 at near Milton** (started 2/8)	36.540497 -79.214862	2/17/14	Daily thru Feb 21st then weekly through May 2014, then monthly	Week of 2/24/14, then 1 month, 6 month, 1yr, 1.5yr, 2yr	
G1	Dan River @ South Boston WTP intake	36.691660 -78.903921	2/17/14	With Sediment		
H1	Headwaters of John H Kerr Reservoir	36.690221 -78.669052	2/17/14	With Sediment	Week of 2/24/14	
Satterwhite Point	Nutbush Arm of John H Kerr reservoir	36.453958 -73.368809			4/9/14 then 1 month, 6 month, 1yr, 1.5yr, 2yr	

* = If no further spills identified and sampling results indicate appropriate.

Figure 1. Duke Power Eden Coal Ash Spill and Monitoring Locations for Dan River, NC



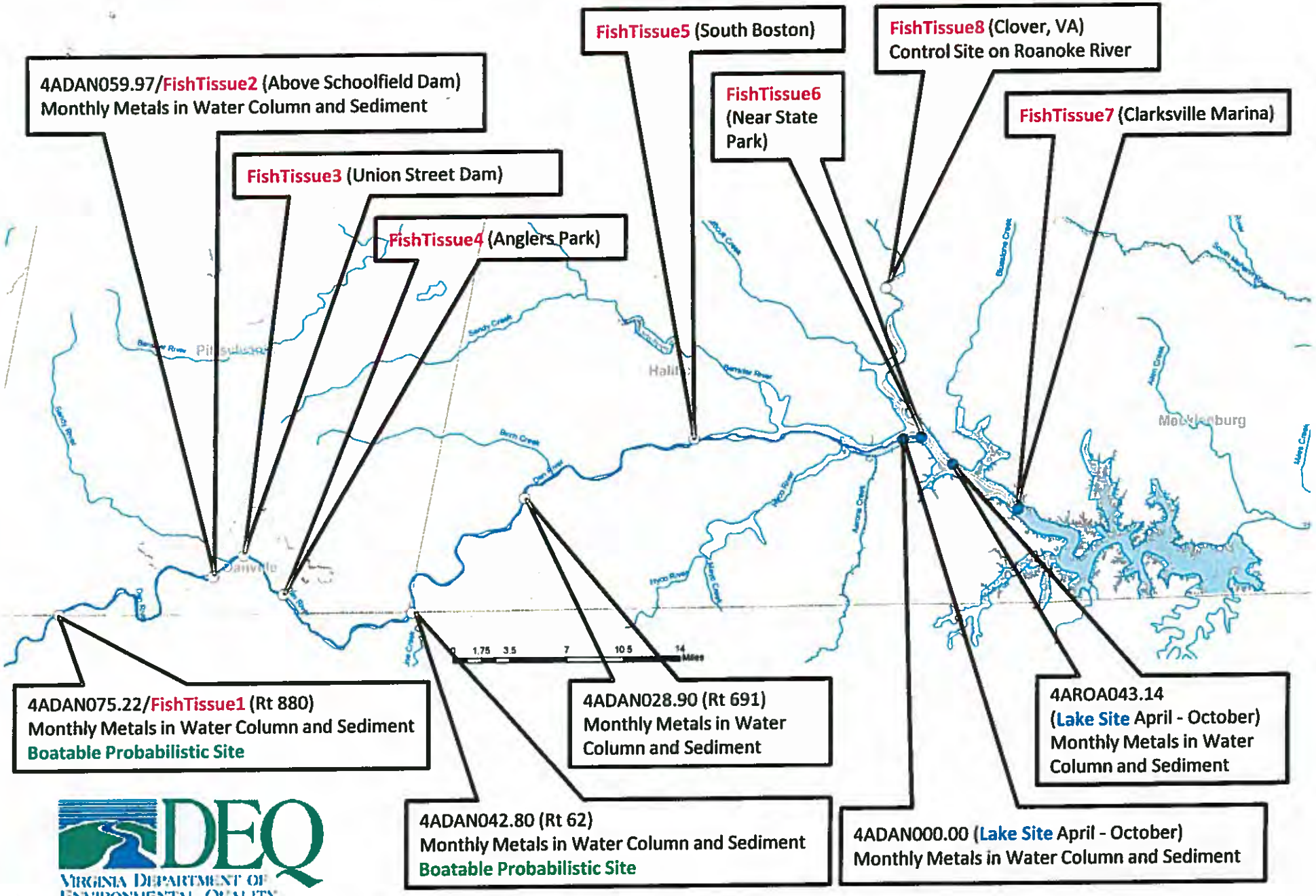
DWR
Division of Water Resources

Appendix 1. Sampling modifications

Analysis of various water, sediment, biological and fish tissue samples from the Dan River collected by DWR staff indicated that levels of coal ash constituents of concern dropped dramatically in the weeks following the spill. Based on consistent low As, Cu, Ba, and Hg concentrations in chemical water quality samples, removal of known coal ash deposits in the Dan River, sediment sampling chemistry results, benthic macroinvertabrate sampling from the spill area downstream, and comparable results from cooperating agencies, the frequency and scale of monitoring performed by NC DWR Monitoring was reduced.

Current ongoing monitoring strategies focus on the potential bioaccumulation of coal ash associated metals in fish tissues from the Dan River. Please refer to Table 2 for summary dates for water chemistry, sediment, benthic macroinvertabrate, and fish tissue sampling. Please see Table 1 to see any changes to parameters for various sampling efforts.

Appendix C – Virginia Department of Environmental Quality Dan River Monitoring Plan



DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Monthly River Monitoring

Station ID	Station Description	Parameters	Comment	LATITUDE	LONGITUDE
4ADAN075.22	RT. 880 BRIDGE AT STATE LINE	TCMET,DCMET,EBMET,YSI,NME11,MET1S		36.54166667	-79.60516667
4ADAN059.97	0.13 Miles upstream of Schoolfield Dam, west of Danville in Abreu Grogan Park	TCMET,DCMET,EBMET,YSI,NME11,MET1S		36.57587778	-79.43386944
4ADAN042.80	Dan R app 1 mile DS of state line	TCMET,DCMET,EBMET,YSI,NME11,MET1S		36.54088889	-79.21438889
4ADAN028.90	Dan R. east of Rt 691 near Paces	TCMET,DCMET,EBMET,YSI,NME11,MET1S		36.6425	-79.08972222

Monthly Lake Monitoring

Station ID	Station Description	Parameters	Comment	LATITUDE	LONGITUDE
4ADAN000.00	Lake Section of Dan River in Kerr Res	TCMET,DCMET,EBMET,YSI,NME11,MET1S, NORMAL LAKE		36.691667	-78.648889
4AROA043.14	Below Confluence of Dan and Roanoke River	TCMET,DCMET,EBMET,YSI,NME11,MET1S, NORMAL LAKE		36.666944	-78.614167

Group	Description
MET1S	Total Recoverable Metals in Sediment
NME11	Solids, Anions
TCMET	Total Recoverable Metals in Water Column
DCMET	Dissolved Metals in Water Column
EBMET	Equipment Blank for DCMET

Sites Collected Using Boatable Probabilistic Monitoring Techniques
Collected once in May and once in August 2014

Station ID	Station Description	Parms	LATITUDE	LONGITUDE
4ADAN075.22	RT. 880 BRIDGE AT STATE LINE	Habitat, Macroinvertebrates, Fish Tissue, Fish Community, ProbMon Chemistry	36.54166667	-79.60516667
4ADAN042.80	Dan R app 1 mile DS of state line	Habitat, Macroinvertebrates, Fish Community, ProbMon Chemistry	36.54088889	-79.21438889

Dan River Fish Tissue Sites
1 Sampling event each - collected between June and August 2014

StationNum	Station Decription	LATITUDE	LONGITUDE
1	RT. 880 BRIDGE AT STATE LINE	36.5416667	-79.6051667
2	Dan R. above Schoolfield Dam	36.5747333	-79.435333
3	Dan R. above Union Street Dam if access is possible	36.5939167	-79.4009333
4	Dan R. near Anglers Park below city of Danville	36.5583833	-79.3571667
5	Dan R. below South Boston near public boat ramp	36.6946833	-79.8821833
6	Dan R. / Kerr Reservoir near State Park upper lake	36.6903833	-78.6693
7	Roanoke R. /Kerr Reservoir near Clarksville Marina middle upper lake	36.6257167	-78.54205
8	Roanoke River near public boat ramp at Clover, Va	36.8268667	-78.6871167

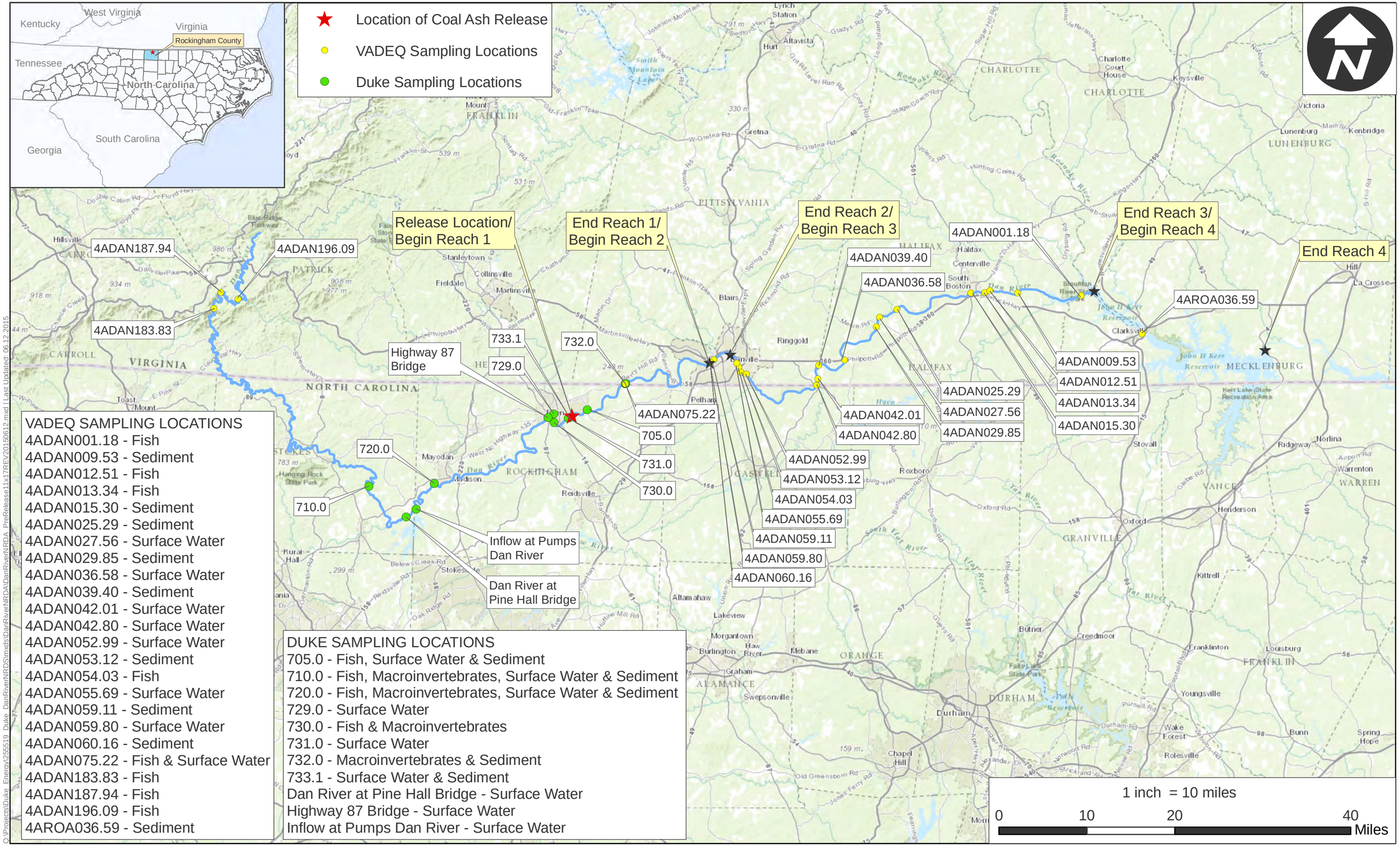
PARAMETERS
Recommend testing for metals, PAH, and PCB at all sites

Group Code	Holding time HRS.	Parameter	STORET Code	Lower Detection Limit	Reporting Units	Method Description	Method
Total Metals in Water Column							
TCMET	4320	CALCIUM, TOTAL (MG/L AS CA)	00916	0.5	mg/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	MAGNESIUM, TOTAL (MG/L AS MG)	00927	0.5	mg/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	ARSENIC, TOTAL (UG/L AS AS)	01002	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	BARIUM, TOTAL (UG/L AS BA)	01007	5	ug/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	BERYLLIUM, TOTAL (UG/L AS BE)	01012	0.1	ug/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	CADMIUM, TOTAL (UG/L AS CD)	01027	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	CHROMIUM, TOTAL (UG/L AS CR)	01034	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	COPPER, TOTAL (UG/L AS CU)	01042	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	IRON, TOTAL (UG/L AS FE)	01045	50	ug/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	LEAD, TOTAL (UG/L AS PB)	01051	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	MANGANESE, TOTAL (UG/L AS MN)	01055	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	THALLIUM, TOTAL (UG/L AS TL)	01059	0.1	ug/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	NICKEL, TOTAL (UG/L AS NI)	01067	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	SILVER, TOTAL (UG/L AS AG)	01077	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	ZINC, TOTAL (UG/L AS ZN)	01092	1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	ANTIMONY, TOTAL (UG/L AS SB)	01097	0.5	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	ALUMINUM, TOTAL (UG/L AS AL)	01105	1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	SELENIUM, TOTAL (UG/L AS SE)	01147	0.5	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	HARDNESS, CA MG CALCULATED (MG/L AS CACO3)	46570	1	ppm	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
TCMET	4320	MERCURY-TL,UNFILTERED WATER,ULTRATRACE METHOD NG/L	50092	1.5	ng/l	Mercury in Water by Cold Vapor Atomic Fluorenscence Spectrometry	EPA 245.7
Dissolved Metals in Water Column							
DCMET	4320	CALCIUM, DISSOLVED (MG/L AS CA)	00915	0.5	mg/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	MAGNESIUM, DISSOLVED (MG/L AS MG)	00925	0.5	mg/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	ARSENIC, DISSOLVED (UG/L AS AS)	01000	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	BARIUM, DISSOLVED (UG/L AS BA)	01005	10	ug/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	BERYLLIUM, DISSOLVED (UG/L AS BE)	01010	0.1	ug/l	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	CADMIUM, DISSOLVED (UG/L AS CD)	01025	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	CHROMIUM, DISSOLVED (UG/L AS CR)	01030	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	COPPER, DISSOLVED (UG/L AS CU)	01040	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	IRON, DISSOLVED (UG/L AS FE)	01046	50	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	LEAD, DISSOLVED (UG/L AS PB)	01049	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	MANGANESE, DISSOLVED (UG/L AS MN)	01056	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	THALLIUM, DISSOLVED (UG/L AS TL)	01057	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638

Group Code	Holding time HRS.	Parameter	STORET Code	Lower Detection Limit	Reporting Units	Method Description	Method
DCMET	4320	NICKEL, DISSOLVED (UG/L AS NI)	01065	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	SILVER, DISSOLVED (UG/L AS AG)	01075	0.1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	ZINC, DISSOLVED (UG/L AS ZN)	01090	1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	ANTIMONY, DISSOLVED (UG/L AS SB)	01095	0.5	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	ALUMINUM, DISSOLVED (UG/L AS AL)	01106	1	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	SELENIUM, DISSOLVED (UG/L AS SE)	01145	0.5	ug/L	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	HARDNESS, CA MG CALCULATED (MG/L AS CACO3)	46570	1	ppm	Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma/Mass Spectrometry	EPA 1638
DCMET	4320	MERCURY-TL, FILTERED WATER, ULTRATRACE METHOD	50091	1.5	ng/l	Mercury in Water by Cold Vapor Atomic Fluorenscence Spectrometry	EPA 245.7
Solids, Anions							
NME11	672	SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)	00095	0.05	umhos/cm	Specific Conductance	SM 18th Ed. 2510-B
NME11	48	BOD, 5 DAY, 20 DEG C	00310	2	mg/l	Biochemical Oxygen Demand or Carbonaceous Biochemical Oxygen Demand	SM 18th Ed. 5210B
NME11	672	PH, LAB, STANDARD UNITS	00403	1	SU	Alkalinity	SM 18th Ed.2320B
NME11	672	PH, LAB, STANDARD UNITS	00403	1	SU	pH	SM 18th Ed.4500-H+
NME11	672	ALKALINITY, TOTAL (MG/L AS CACO3)	00410	1	mg/l	Alkalinity	SM 18th Ed.2320B
NME11	672	ALKALINITY, TOTAL (MG/L AS CACO3)	00410	1	mg/l	pH	SM 18th Ed.4500-H+
NME11	168	RESIDUE, TOTAL (MG/L)	00500	5	mg/l	Solids, Total	USGS I-3750-85
NME11	168	RESIDUE, TOTAL VOLATILE (MG/L)	00505	5	mg/l	Solids, Total	USGS I-3750-85
NME11	168	RESIDUE, TOTAL FIXED (MG/L)	00510	5	mg/l	Solids, Total	USGS I-3750-85
NME11	168	RESIDUE, TOTAL FILTRABLE (DRIED AT 105C)	00515	5	mg/l	Total Dissolved Solids	USGS I-1750-85
NME11	168	RESIDUE, TOTAL NONFILTRABLE (MG/L)	00530	3	mg/l	Total Suspended Solids	USGS I-3765-85
NME11	168	RESIDUE, VOLATILE NONFILTRABLE (MG/L)	00535	3	mg/l	Total Suspended Solids	USGS I-3765-85
NME11	168	RESIDUE, FIXED NONFILTRABLE (MG/L)	00540	3	mg/l	Total Suspended Solids	USGS I-3765-85
NME11	672	CHLORIDE, TOTAL IN WATER	00940	1	mg/l	Anions by IC	EPA 300.1
NME11	672	SULFATE, TOTAL (MG/L AS SO4)	00945	1	mg/l	Anions by IC	EPA 300.1
NME11	168	RESIDUE, TOTAL FILTRABLE (DRIED AT 180C)	70300	5	mg/l	Total Dissolved Solids	USGS I-1750-85
NME11	48	TURBIDITY, LAB NEPHELOMETRIC TURBIDITY UNITS	82079	0.1	NTU	Turbidity	SM 18th Ed. 2130-B
Metals in Sediments							
MET1S	4320	ARSENIC IN BOTTOM DEPOSITS (MG/KG AS AS DRY WGT)	01003	5	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	ARSENIC IN BOTTOM DEPOSITS (MG/KG AS AS DRY WGT)	01003	5	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	BERYLLIUM IN BOTTOM DEPOSITS(MG/KG AS BE DRY WGT)	01013	5	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	BERYLLIUM IN BOTTOM DEPOSITS(MG/KG AS BE DRY WGT)	01013	5	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	CADMIUM, TOTAL IN BOTTOM DEPOSITS (MG/KG, DRY WGT)	01028	1	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	CADMIUM, TOTAL IN BOTTOM DEPOSITS (MG/KG, DRY WGT)	01028	1	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	CHROMIUM, TOTAL IN BOTTOM DEPOSITS (MG/KG, DRY WGT)	01029	5	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1

Group Code	Holding time HRS.	Parameter	STORET Code	Lower Detection Limit	Reporting Units	Method Description	Method
MET1S	4320	CHROMIUM,TOTAL IN BOTTOM DEPOSITS (MG/KG,DRY WGT)	01029	5	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	COPPER IN BOTTOM DEPOSITS (MG/KG AS CU DRY WGT)	01043	5	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	COPPER IN BOTTOM DEPOSITS (MG/KG AS CU DRY WGT)	01043	5	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	LEAD IN BOTTOM DEPOSITS (MG/KG AS PB DRY WGT)	01052	5	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	LEAD IN BOTTOM DEPOSITS (MG/KG AS PB DRY WGT)	01052	5	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	MANGANESE IN BOTTOM DEPOSITS (MG/KG AS MN DRY WGT)	01053	10	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	MANGANESE IN BOTTOM DEPOSITS (MG/KG AS MN DRY WGT)	01053	10	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	NICKEL, TOTAL IN BOTTOM DEPOSITS (MG/KG,DRY WGT)	01068	5	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	NICKEL, TOTAL IN BOTTOM DEPOSITS (MG/KG,DRY WGT)	01068	5	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	SILVER IN BOTTOM DEPOSITS (MG/KG AS AG DRY WGT)	01078	1	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	SILVER IN BOTTOM DEPOSITS (MG/KG AS AG DRY WGT)	01078	1	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	ZINC IN BOTTOM DEPOSITS (MG/KG AS ZN DRY WGT)	01093	10	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	ZINC IN BOTTOM DEPOSITS (MG/KG AS ZN DRY WGT)	01093	10	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	ANTIMONY IN BOTTOM DEPOSITS (MG/KG AS SB DRY WGT)	01098	5	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	ANTIMONY IN BOTTOM DEPOSITS (MG/KG AS SB DRY WGT)	01098	5	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	ALUMINUM IN BOTTOM DEPOSITS (MG/KG AS AL DRY WGT)	01108	500	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	ALUMINUM IN BOTTOM DEPOSITS (MG/KG AS AL DRY WGT)	01108	500	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	SELENIUM IN BOTTOM DEPOSITS (MG/KG AS SE DRY WGT)	01148	1	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	IRON IN BOTTOM DEPOSITS (MG/KG AS FE DRY WGT)	01170	500	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	IRON IN BOTTOM DEPOSITS (MG/KG AS FE DRY WGT)	01170	500	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	THALLIUM DRY WGTBOTMG/KG	34480	5	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1
MET1S	4320	THALLIUM DRY WGTBOTMG/KG	34480	5	ug/g	Determination of Trace Elements in Water and Wastes by ICP/MS-Revision 5.4 (App. at 40 CFR Part 141	EPA 200.8
MET1S	4320	MERCURY,TOT. IN BOT. DEPOS. (MG/KG AS HG DRY WGT)	71921	0.1	ug/g	Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry	EPA 245.1

Appendix D – Locations of Pre- and Post-Release Sampling Stations



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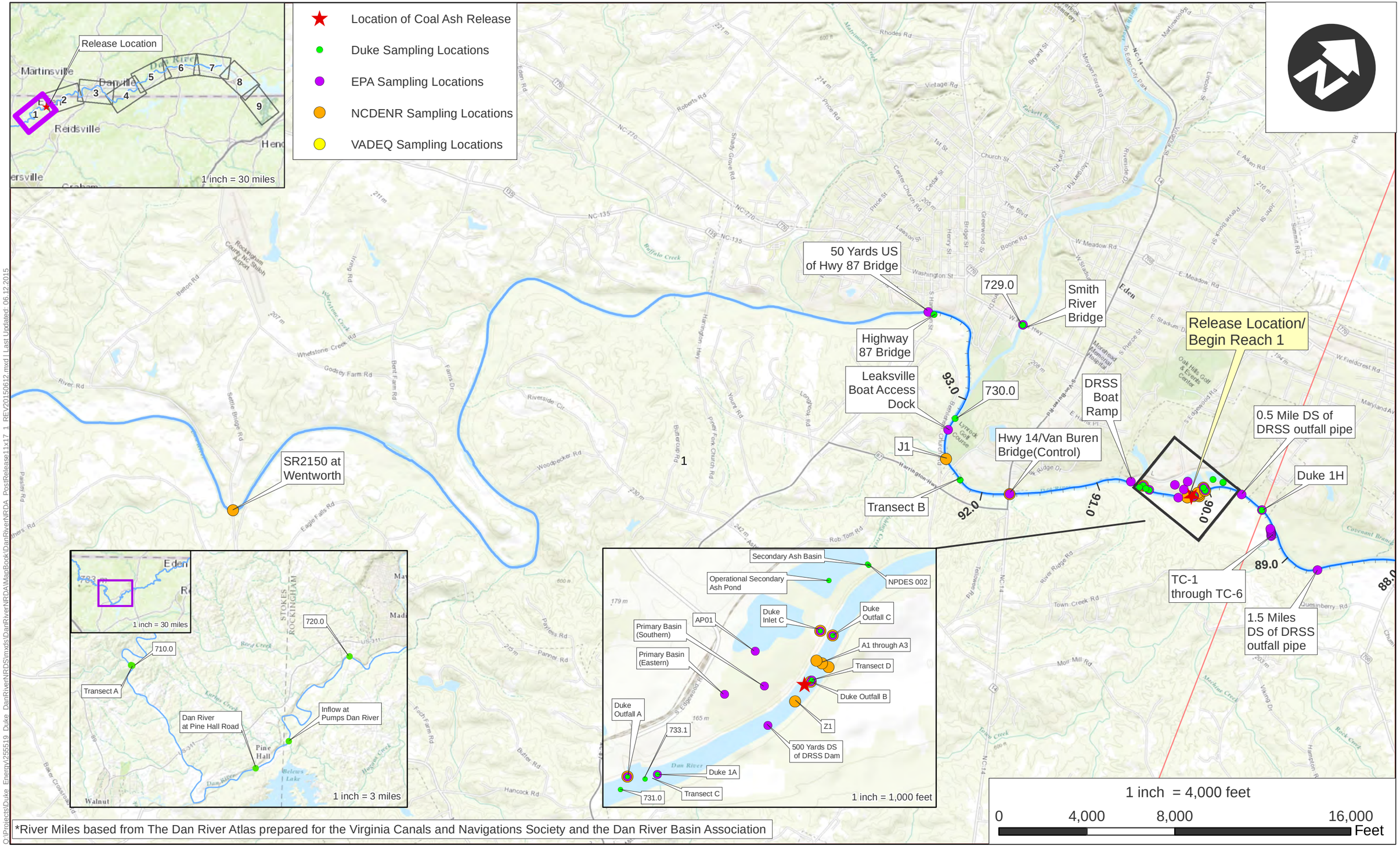
Dan River - Pre Release Sampling Locations Figure 1

Duke Energy



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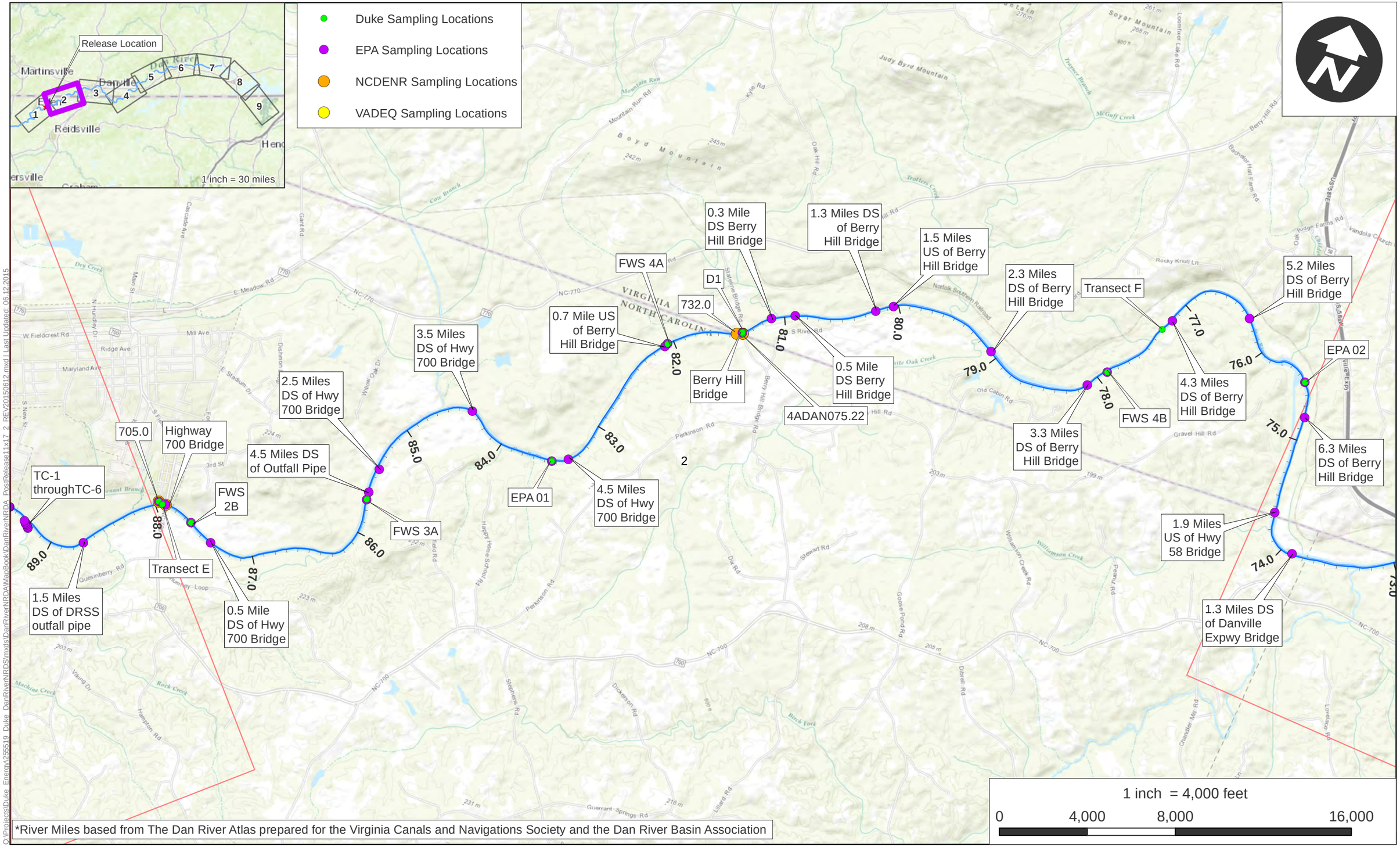
Dan River - Post Release Sampling Locations

Figure 2-1

Duke Energy



*River Miles based from The Dan River Atlas prepared for the Virginia Canals and Navigations Society and the Dan River Basin Association

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River - Post Release Sampling Locations **Figure 2-2**

Duke Sampling Locations

EPA Sampling Locations

NCDENR Sampling Locations

VADEQ Sampling Locations

Release Location

1 in = 30 miles

End Reach 2/
Start Reach 3

End Reach 1/
Start Reach 2

100 Yards US
of VA Hwy
86 Bridge

Danville WTP
Clarifier

Danville WTP
Effluent

EPA 04

EPA 05

100 Yards US
of Dan Daniel
MP Island

3.0 Miles DS
of Hwy 58
Bridge

4.0 Miles
DS of Hwy
58 Bridge

Danville
Impoundment B

SFI 2

Transect G

SFI 4

SFDA-2A

E1

SFI 3

Danville
Impoundment A

2.0 Miles DS
of Hwy 58 Bridge

16.5 Miles
DS of Hwy
700 Bridge

SFI 1

5.0 Miles
DS of
Hwy 58 Bridge

1.0 Mile
DS of Hwy
58 Bridge

6.3 Miles
DS of Berry
Hill Bridge

15.5 Miles
DS of Hwy
700 Bridge

1.9 Miles
US of Hwy
58 Bridge

Highway
58 Bridge

1.3 Miles DS
of Danville
Expwy Bridge

B3

B4

Site B

B2

B1

Duke
DR B

64.0

65.0

63.0

62.0

61.0

60.0

59.0

58.0

57.0

69.0

70.0

71.0

72.0

73.0

74.0

66.0

67.0

68.0

6.0 Miles DS of Hwy 58 Bridge

SFDA-1B

SFDA-1A

SFDA-2B

SFDA-2A

SFDA-2C

SFDA-3B

SFDA-1C

SFDA-3A

SFDA-3C

EPA 03

Danville WTP Midpoint

SFDA-4B

4ADAN059.97

SFDA-4A

SFDA-5B

SFDA-5A

SFDA-6B

SFDA-4C

Danville WTP Intake

SFDA-6A

SFDA-5C

SFDA-7B

Abreu-Grogan Park

SFDA-7A

SFDA-6C

SFDA-8B

SFDA-8A

SFI 5

SFDA-7C

SFDA-8C

Danville Impoundment G

1 inch = 500 feet

1 inch = 4,000 feet

0 4,000 8,000 16,000

*River Miles based from The Dan River Atlas prepared for the Virginia Canals and Navigations Society and the Dan River Basin Association

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River - Post Release Sampling Locations

Figure 2-3

Duke Energy

Duke Sampling Locations

EPA Sampling Locations

NCDENR Sampling Locations

VADEQ Sampling Locations

Release Location

1 inch = 30 miles

Duke DR B

Duke DR E

Duke SB D

6.3 Miles DS of Danville Expwy Bridge

4ADAN042.01

4ADAN042.80

F1

Milton

0.1 Mile US of Highway 62 Bridge

57.0 56.0 55.0 54.0 53.0 52.0 51.0 50.0 49.0 48.0 47.0 46.0 45.0 44.0 43.0 42.0 41.0

NORTH CAROLINA

VIRGINIA

*River Miles based from The Dan River Atlas prepared for the Virginia Canals and Navigations Society and the Dan River Basin Association

1 inch = 4,000 feet

0 4,000 8,000 16,000 Feet

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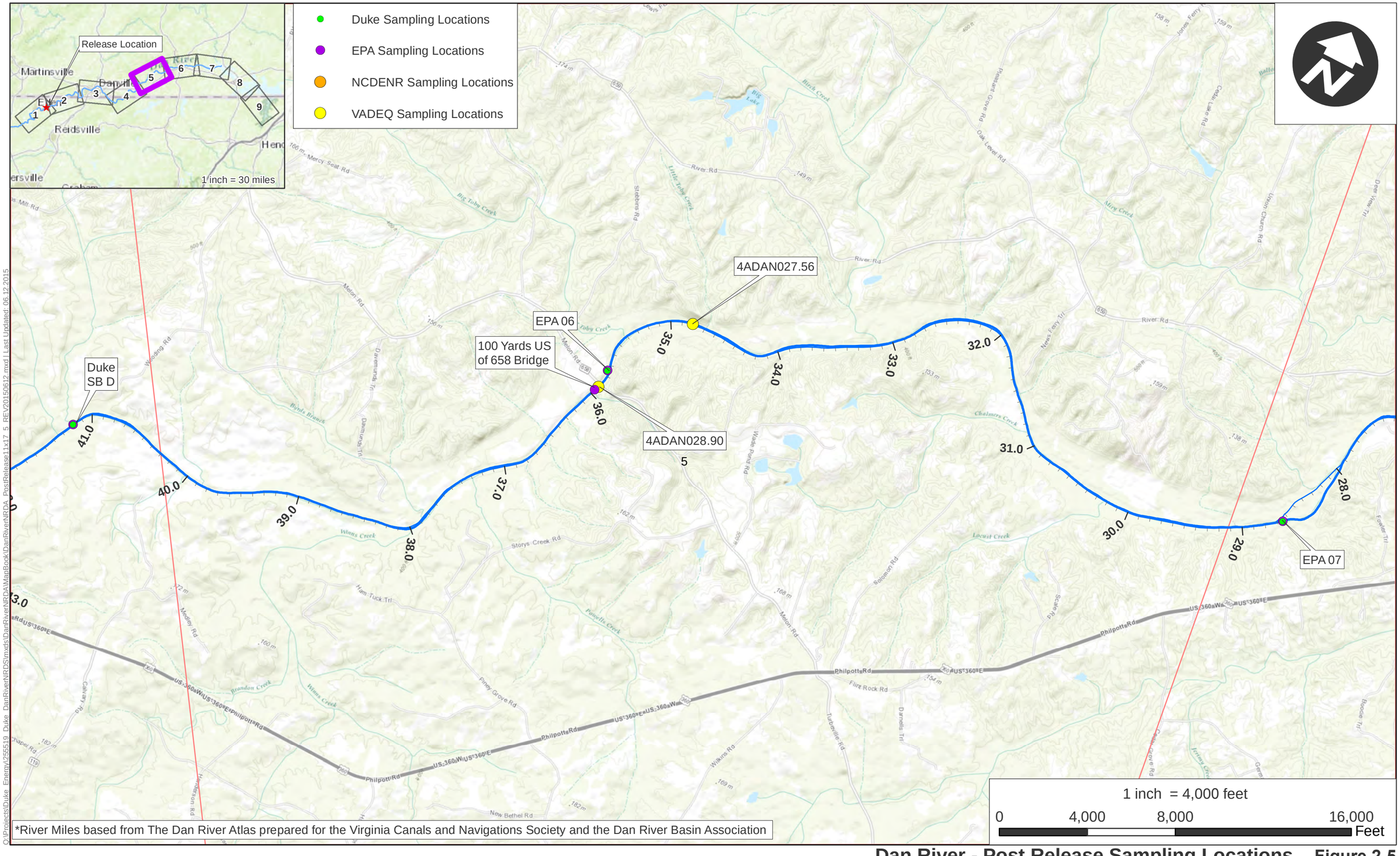
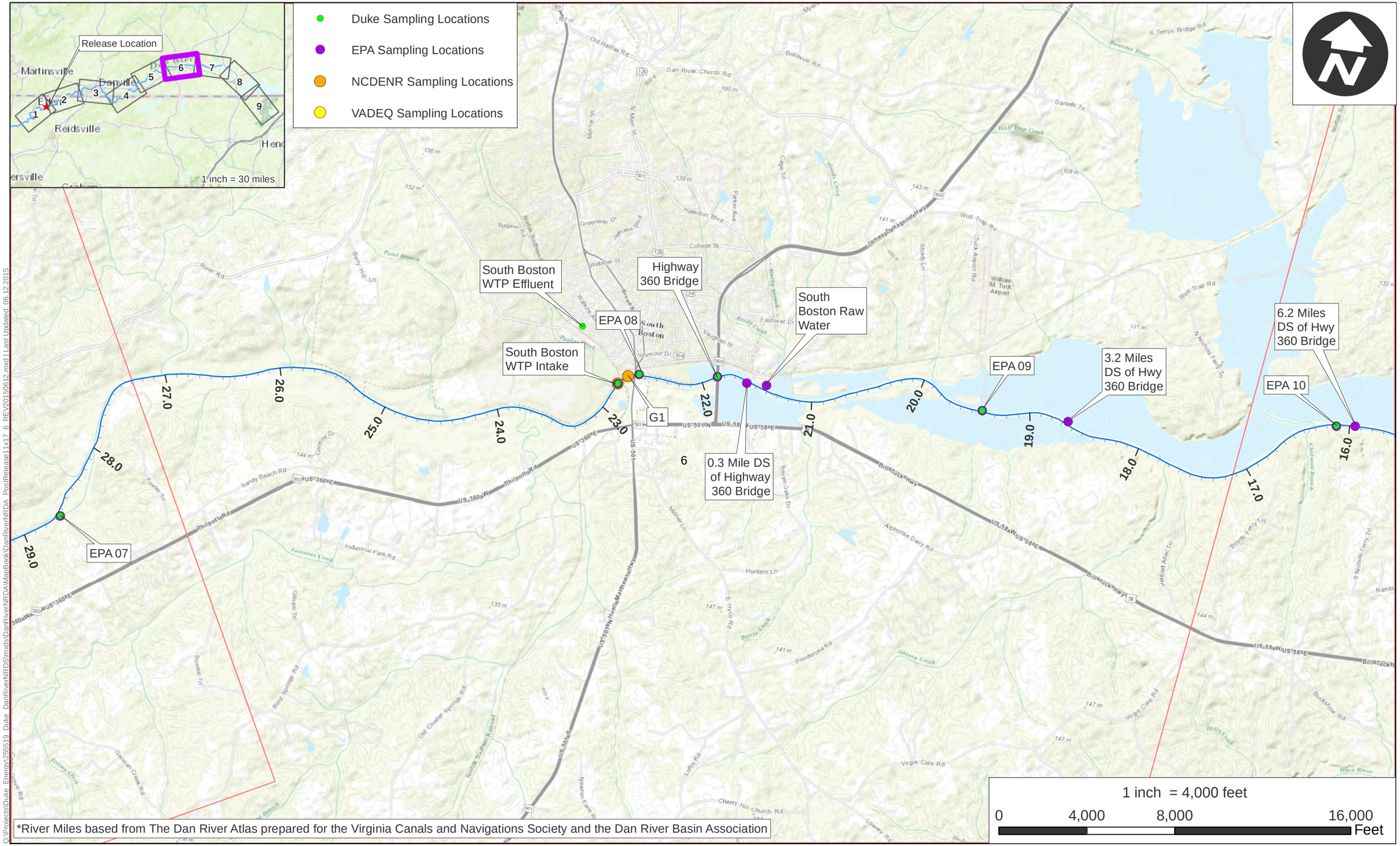
Dan River - Post Release Sampling Locations

Figure 2-4



*River Miles based from The Dan River Atlas prepared for the Virginia Canals and Navigations Society and the Dan River Basin Association

Dan River - Post Release Sampling Locations **Figure 2-5**



*River Miles based from The Dan River Atlas prepared for the Virginia Canals and Navigations Society and the Dan River Basin Association

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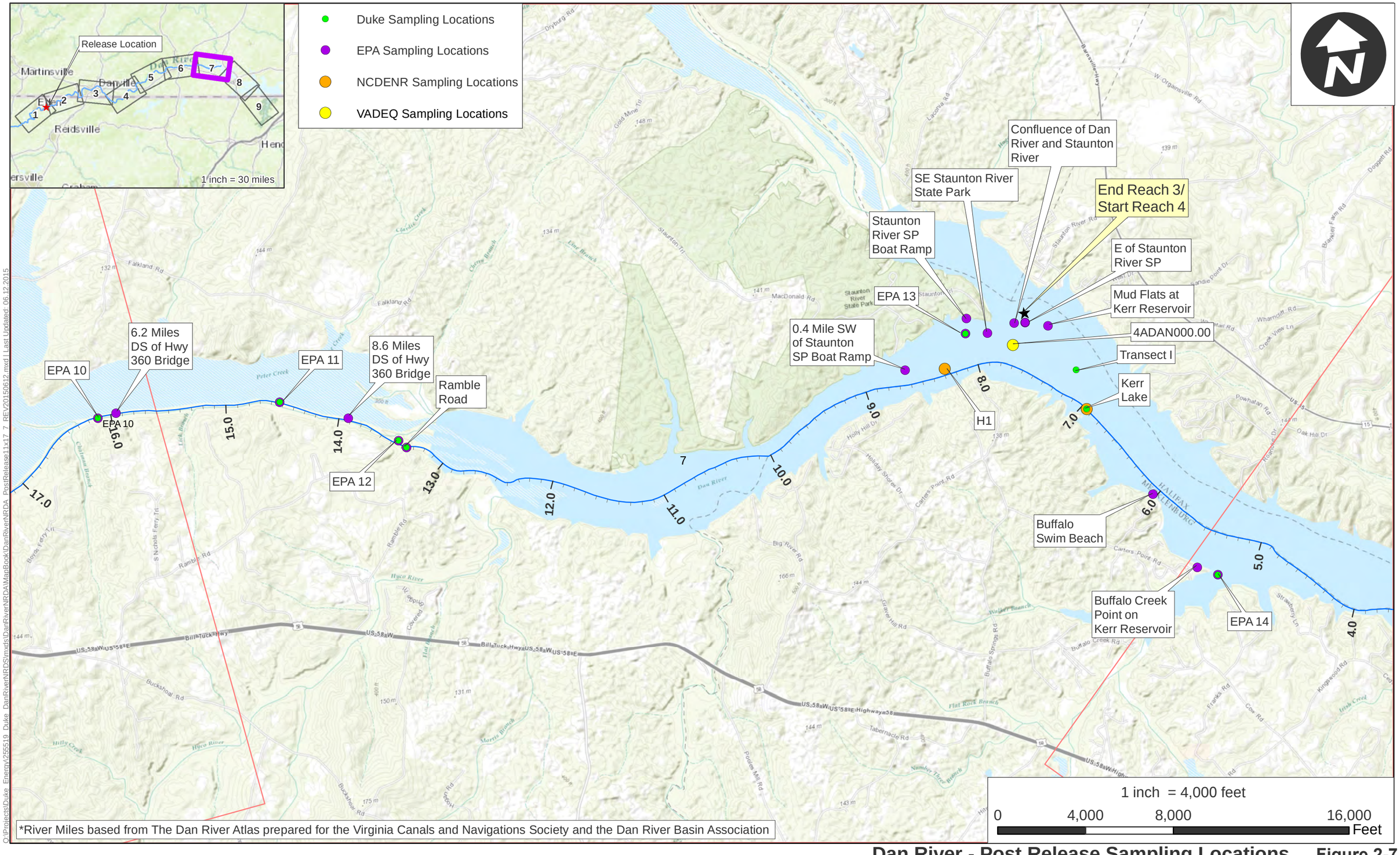
Dan River - Post Release Sampling Locations **Figure 2-6**



*River Miles based from The Dan River Atlas prepared for the Virginia Canals and Navigations Society and the Dan River Basin Association

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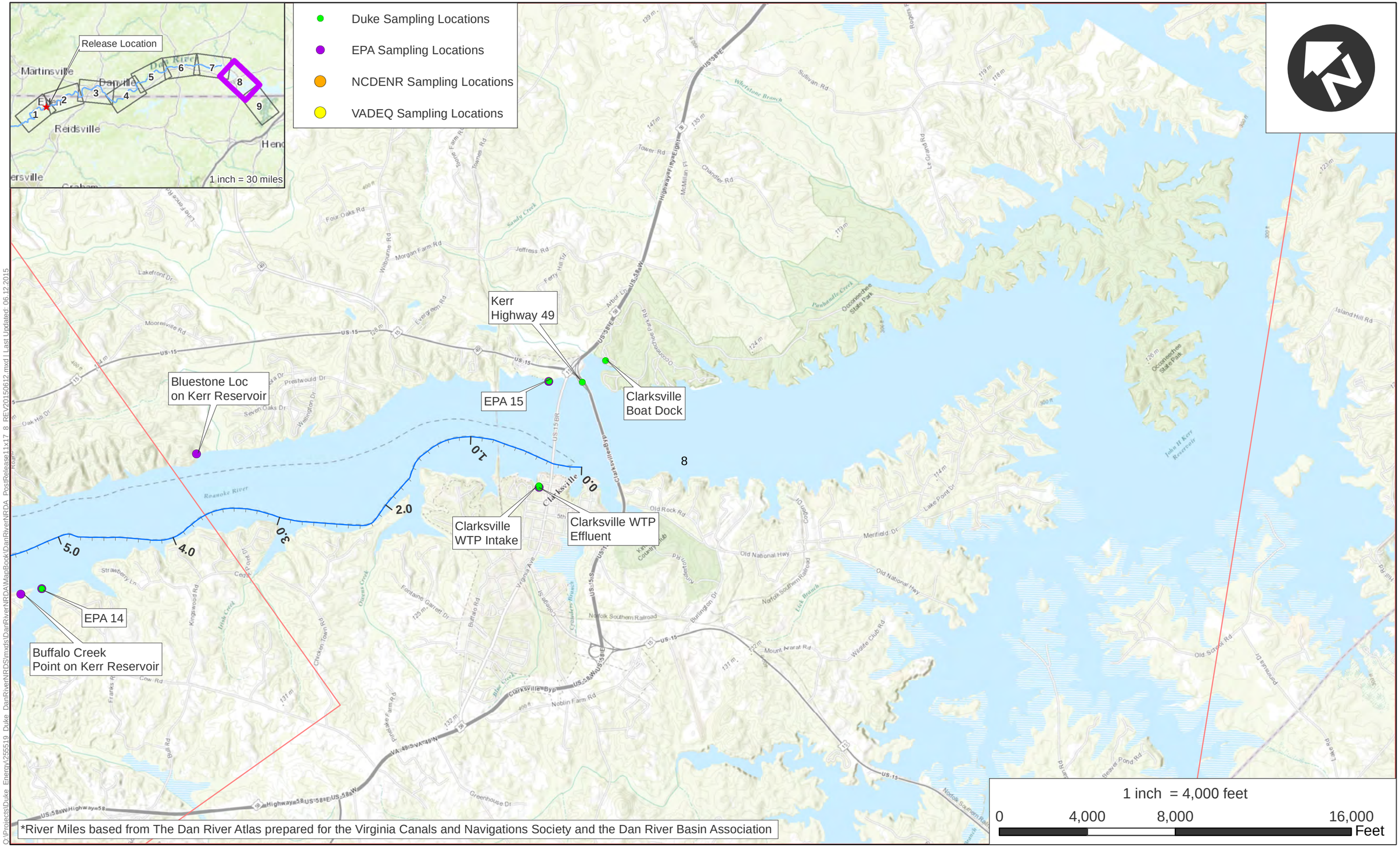
Dan River - Post Release Sampling Locations **Figure 2-7**



*River Miles based from The Dan River Atlas prepared for the Virginia Canals and Navigations Society and the Dan River Basin Association

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Dan River - Post Release Monitoring Locations **Figure 2-8**

Duke Energy

- Duke Sampling Locations
- EPA Sampling Locations
- NCDENR Sampling Locations
- VADEQ Sampling Locations

Henderson WTP Intake

Kerr Reservoir

Henderson WTP Final

VIRGINIA

NORTH CAROLINA

9

*River Miles based from The Dan River Atlas prepared for the Virginia Canals and Navigations Society and the Dan River Basin Association

1 inch = 4,000 feet

0 4,000 8,000 16,000 Feet

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Dan River - Post Release Sampling Locations **Figure 2-9**

Duke Energy

Appendix E – Duke Energy Ash Deposition Monitoring Plan Dan River Steam Station Ash Release

Duke Energy

Ash Deposition Monitoring Plan

Dan River Steam Station Ash Release

July, 2014, Updated for NRDAR April 2015

Table of Contents

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Attachments

Attachment 1. Ash deposition survey locations

Attachment 2. GPS coordinates for transects and other monitoring stations

Attachment 3. Transect selection and sampling procedures

Attachment 4. Ash deposition survey field data collection sheet

Introduction

This Ash Deposition Monitoring Plan (Plan) describes and documents the approach for future ash deposition survey activities to inform NRDAR injury assessment activities. A separate Quality Assurance Project Plan (QAPP) provides the details of field sampling procedures, laboratory procedures and quality assurance programs followed during the assessment activities. A separate Sampling and Analysis Plan (SAP) describing Duke's long-term water quality and biological monitoring program for the Dan River has been prepared in cooperation with the US Fish & Wildlife Service and state natural resource trustees as part of the Natural Resource Damage Assessment and Restoration (NRDAR) process.

Executive Summary of Monitoring Plan

Assessments of water quality, sediment, and ash presence in the Dan River began on February 3, 2014, immediately following discovery of the ash release. These assessments evolved as the incident investigation proceeded and were conducted to support agency understanding of the nature and extent of the incident and decision-making regarding ash recovery from the river. Following is a brief summary of the phases of assessment activity, including the plan for future monitoring activities. Details of these activities are presented in this monitoring plan.

Emergency Response - Immediate

Immediately following discovery of the ash release, Duke initiated surface water and drinking water sampling at several locations along the Dan River. Duke cooperated with EPA and US FWS to conduct ash deposition reconnaissance surveys in the river, involving multiple float trips and core sampling to make observations regarding the presence, extent and thickness of ash deposited in the river from the Dan River Steam Station to Kerr Reservoir. EPA teams collected ash and sediment samples to characterize the released material. Results of these initial phase efforts were used to inform the design of a formal ash deposition transect study.

Emergency Response – Removal Phase

By late March, 2014 the formal ash deposition transect study was designed and efforts initiated to collect data at 30 defined transect locations. Visual observations were recorded and samples of sediment analyzed from each transect for percent ash, arsenic and selenium during three rounds of transect surveys – April, May and June, 2014. The results of these surveys and analyses were used to assess presence, thickness and condition of ash in the river and support decision-making regarding ash recovery efforts. Three areas in the Dan River and the intake basins of the water treatment facilities at Danville and South Boston, Virginia were identified for ash removal and those removal efforts have been completed. Data from the reconnaissance and removal phases were provided to the sediment transport modeling team to aide in model setup and calibration.

Location-Specific Assessment – Post-removal

With ash recovery completed at the three identified locations and the water treatment facilities in Danville and South Boston, Virginia, plans were developed for location-specific assessment of ash presence and movement within the river system to inform EPA's further decision-making regarding ash removal needs. The location-specific assessment program included sediment sampling at five locations, sediment transport modeling to predict ash behavior in the river system, and use of a decision tree to evaluate the need for future ash recovery actions. The sediment sampling locations were selected based on two criteria: future ash removal decisions and monitoring of ash movement. Location specific sampling was to be performed quarterly for one year and considered in light of the EPA decision tree. If, after one year, all conditions of the decision tree are met with no further actions required for any locations the assessment effort for EPA's purposes will be considered complete. Quarterly monitoring has occurred in September and November 2014 and March 2015. It is expected that the final round of

monitoring locations for EPA will be in May 2015. For NRDAR, location specific sampling will be performed quarterly for four quarters after completion of the sampling period for the EPA ash removal assessment, i.e. 3rd and 4th quarters in 2015 and 1st and 2nd quarters in 2016. In addition, one background location and one conveyance location will be sampled one time in 3rd quarter 2015.

Ash Deposition Surveys and Sediment Sampling

Initial Reconnaissance Surveys

During the emergency response phase immediately following the release, river-based reconnaissance of ash deposition was completed (between February 8 and February 19, 2014). That reconnaissance was conducted by the U.S. Fish and Wildlife Service (USFWS), Duke Energy, Virginia Department of Game and Inland Fisheries (VADGIF), and US EPA by visually identifying depositional areas (such as sandbars or other areas where sediment and other materials naturally accumulate based on physical and hydrologic features of the river) during boat-based surveys between the Facility and Kerr Lake headwaters and recording observations of ash depth overlying native sediments. That reconnaissance identified a coal ash bar about 75 feet long and 15 feet wide which had as much as five feet of ash or ash/sand mix over the natural stream bottom immediately downgradient of the release point. Other ash deposits were found covering natural sediment over five inches thick atop sand bars within two miles of the spill site, and two inches thick to the North Carolina/Virginia line about nine miles downstream. Further downstream as far as South Boston, Virginia, observations included one-eighth to one-half inch of ash on sandbars and other depositional areas, and visual traces of suspected ash in other sections of the river.

The initial reconnaissance during the emergency response phase provided a foundation for repeated sampling efforts. On February 27-28, 2014, repeated observations were performed within the first 25 river miles downstream of the facility (including areas between the Facility boat ramp and Schoolfield Dam in Danville, VA) following a period of elevated flow (relative to historic median daily statistics for the period of record at USGS 02071000 gauge in near Wentworth, NC) between February 14 and February 28 associated with snow melt and other precipitation events (USGS 2014). Results of repeat observations suggest movement of sediment and ash material occurred in response to elevated river flow conditions; these results also informed the development of the standardized protocol for future ash and sediment measurements detailed in this work plan.

Study Design - Ash Distribution and Migration Monitoring

The primary objective of the transect surveys was to expand on initial reconnaissance efforts following the release to identify the nature and extent of deposited ash material in the Dan River system through repeated surveys of sediment and ash material. Visual, chemical, and physical sediment measurements were conducted throughout the river system. Surveys targeted both areas of sediment deposition and conveyance with transects assigned to each of the following geomorphic classes: depositional bars, pools or impoundments, riffles/shoals, and runs. Transect locations are intended to place priority on known depositional areas as informed by river-based reconnaissance efforts and physical or hydrologic conditions favorable to natural accumulation (e.g. known river flow obstructions such as dams and large snags, and identified areas of acquiescence such as a tributary confluence, river bend or braided channel area). Measurements associated with each focal area are summarized below.

Measurements: Three locations per transect should be assessed as follows: mid-channel (thalweg), left and right of thalweg. Visual observations will include measured depth of material (native sediment, coal ash, and ash/sediment mix) in grab samples to a minimum depth of 6 inches, though typically to the depth of refusal using a gravity core sampler. Samples that cannot be taken by gravity corer will be taken using an impact corer, usually in the mid-channel point of the transect. A visual survey of the shoreline will also be conducted at each transect location to record any collection of ash material areas above the waterline. Chemical characterization of grab samples (to a sampling depth of 6 inches) will include analyses for percent ash, total and dissolved As and Se (ash-related metalloids), grain size distribution and total organic carbon. In addition to sediment observations and collection, at one location per transect (targeted to a depositional area) water column grab samples (total and dissolved As and Se and total organic carbon) will be collected to assess water quality conditions at the sediment/water interface. In-situ temperature (º C), pH, conductivity (µS/cm), dissolved oxygen (mg/L) and turbidity (NTU) will also be recorded. Sediment, sediment/water interface grab samples and in-situ water quality parameters will be collected from the point on the transect considered most depositional by the field team. All other core samples on the transect will be photographed and characterized.

Another objective of the ash deposition assessment approach is to determine the physical properties of the material. At all sites where core samples are collected for visual or chemical measurements, ash material or suspected ash material retrieved will be visually inspected to assess the potential consolidation/cementation of the material. Observations will be noted on the field data sheet. Additionally, bulk sediment/ash samples will be collected for the purpose of conducting shear tests (refer to SOP, Attachment 3) and an evaluation of the consolidation/cementation potential of the material (refer to SOP, Attachment 3). Finally given the potential for ash to become mixed with native sediment throughout the Dan River system, the penetration potential of the ash material into representative native sediment and substrate types will be assessed via visual and physical testing (refer to SOP, Attachment 3).

With these factors in mind, the assessment area focused between the spill and the Schoolfield Dam. Additional areas of focus are the water intakes at South Boston and Clarksville, and public access points in or around Kerr Reservoir.

The initial transect survey was completed in April 2014 for 1 location upstream of the spill and 29 locations from just downstream of the spill to Kerr Reservoir. Transect survey locations are indicated on the maps in Attachment 1. GPS coordinates for the sampling locations are presented in Attachment 2. Sampling was also conducted in May and June 2014. It was anticipated that this sampling frequency would bracket high flow events (1” or greater precipitation event within the reaches) that might occur during this period. Efforts were made to conduct transect sampling during discharge flow conditions that were within +500 cfs of the average flow conditions following the initial spill.

Safety

Field teams will comply with existing training and safety protocols as applicable to operations. All boat crews will prepare and file a float plan, identifying on-shore contacts and call-in times. SPOT GPS units or other location technology will be used on each boat. Prior to commencement of field activities, a person or persons to whom study participants may report any safety concerns will be identified. Such person(s) will take action to address and resolve reported concerns. All field teams (and boat captains, where applicable) will be required to abide by the safety protocols of Incident Command and respective participating collaborators.

Data Recording and Handling

Field Data Recording – Blank data sheets and directions for completing them are provided in Attachment 4. These data sheets will be completed daily by each field team, and all field team members will sign the data sheet at the end of the day to certify the accuracy of the data recorded. Should discrepancies arise in the field, they should be noted and initialed by each observer prior to signature.

Field Data Transfer – Field teams will share all data sheets (photos or scanned originals), GPS way points and/or track logs, analytical results and official photographs among the collaborators to this assessment plan. Field data (including data sheets, GPS information, and photographs) will be distributed to points of contact for each collaborating agency within 2 business days barring conditions preventing distribution (e.g., prolonged field activities, technical difficulties, etc) if desired.

Laboratory Results – The electronic preliminary data with pre-validated analytical results will undergo quality assurance/quality control (QA/QC) procedures on the LADP consistent with the authorized Quality Assurance Project Plan, after which time the validated/QA/QC'd data shall be made available to all collaborators. Should any party show a critical operational need for data prior to validation/QA/QC, any released data will be clearly marked "preliminary/ unvalidated" and made available to all collaborators.

Location-Specific Assessment – Post-removal

With ash recovery completed at the three identified locations and the water treatment facilities in Danville and South Boston, Virginia, plans were developed for location-specific assessment of ash presence and movement within the river system. The location-specific assessment program included sediment sampling at five locations, sediment transport modeling to predict ash behavior in the river system,

The sediment sampling locations were selected based on two criteria:

- The EPA decision tree requires monitoring based on the data collected from the three rounds of sampling at the 30 transect locations (two locations)
- Sampling will provide information on ash movement in the river (three locations).

Location-specific sampling has been performed quarterly in accordance with the procedures and protocols outlined in this plan. Additional sampling locations may be added based on predictions of the sediment transport model, visual identification of new ash deposits, or suspected ash movements/accumulations. Sampling at a location that meets the EPA decision tree criteria (currently 2 locations) will end when the decision tree indicates "no further action" required for two consecutive quarters. Sampling at locations that provide information on ash movement in the river (currently 3 locations) will end when either the data show no significant ash movement for two consecutive quarters, or the sediment transport model predicts minimal ash movement. Results from the transect surveys and model runs has been provided to EPA on a regular basis and results will be considered in accordance with the decision tree to evaluate whether additional action will be required. If after one year all conditions of the decision tree are met with no further actions required for any locations the assessment effort will be considered complete. If after one year the decision tree requires monitoring at any locations, Duke and the EPA will meet to re-evaluate additional assessment and/or removal actions required to bring closure to this process.

For NRDAR, location specific sampling will be continued quarterly for four quarters after completion of the sampling period for the EPA ash removal assessment, i.e. 3rd and 4th quarters in 2015 and 1st and 2nd quarters in 2016. In addition, one background location and one conveyance location will be sampled one time in 3rd quarter 2015. Sampling methods for the conveyance location are being evaluated, and will include techniques that prevent or minimize mobilization of sediment during sample collection. These methods could include isolation of the sampling location from stream flow and/or capture of sediment using nets or collection vessels. While there is no standard protocol for this type of sampling, related techniques found to be acceptable to EPA and Virginia for other projects are being field tested to determine the best approach for this project.

The transects proposed for NRDAR study are:

Transect ID	Lat	Long	Reason
FWS 4A	36.536620	-79.616170	Ash previously observed
FWS 4B	36.55114	-79.55020	Selenium Eco-Exceedance, 27% ash content
FWS SFI-4	36.57591	-79.45229	Selenium Eco-Exceedance, 20% ash content
FWS SFI-5 - Abreu-Grogan Park near Intake	36.57674	-79.43434	Ash Transport – known depositional area and city water intake
EPA 13	36.68401	-78.72597	Ash Transport – Recreational Area

One time sampling will be performed at a representative riffle area (700 Bridge) and an upstream reference location (historic Duke sampling location "A")

Transect ID	Lat	Long	Reason
700 Bridge/Draper's Landing/LTM Transect E	36.498545	-79.681610	Riffle/Conveyance zone
Historic location "A" for Belews/Dan River monitoring program	TBD	TBD	Background/upstream location

Sediment Transport Model

The National Center for Computational Hydroscience and Engineering (NCCHE) at the University of Mississippi will provide engineering services for modeling and simulation of the transport and fate of coal ash and some selected contaminants in the Dan River downstream of the spill location and Kerr Reservoir. CCHE1D and CCHE2D models, developed by NCCHE, have been used to create one- and two-dimensional models with the following components

- Unsteady hydrodynamic flow model using measured and/or forecasted discharges and operation of the manmade flow control structures, such as weirs, intakes and dams.
- Unsteady non-equilibrium sediment transport and fluvial morphodynamics model for tracking multiple size fractions of bed material (native river sediments) and the released coal ash throughout the river-reservoir system based on erosion, transport and deposition processes.
- Contaminant transport and fate model for advection and dispersion of selected contaminants released into the Dan River in dissolved and particulate form by taking into account the processes of adsorption/desorption, and first order chemical reactions and decay, etc.

NCCHE is performing this work in collaboration with Dr. Steve Scott at U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) in Vicksburg, Mississippi, (now retired) who provides technical oversight and general assistance to Duke Energy for the sediment and constituent transport analysis of the Dan River and Kerr Reservoir.

The specific modeling and simulation tasks to be performed by NCCHE are described below.

One-Dimensional (1D) Modeling of Dan River and Kerr Reservoir System

NCCHE will create a 1D model of Dan River from Wentworth, North Carolina (NC), to John H. Kerr Dam in Virginia (VA). The main channel of Kerr Reservoir will be represented as river cross sections. The model will take into account the discharges contributed by all important tributaries, such as Smith River, Banister River, Roanoke River, etc. The 1D model will include (1) Unsteady stream-flow hydrodynamics model; (2) Unsteady non-uniform, non-equilibrium sediment transport and fluvial morphodynamics model; and (3) Contaminant transport and fate model.

Hydrodynamic component of 1D model will be calibrated using observed stream gage data. Detailed sediment transport data is not available in the study reach. The sediment rating curve generated using the suspended sediment data measured at the USGS gage 02075500 Dan River at Paces, VA, will be used for calibration of the sediment transport model. In addition, NCCHE will create one-dimensional models of Roanoke River and Banister River to provide the tributary discharges for the 1D and 2D models:

- NCCHE has a 1D model of Roanoke River from a previous study. This model was developed to study transport and fate of radioactive contaminants due to the failure of a hypothetical tailings dam upstream. The model will be adapted for the present project and shortened to the reach extending from USGS gage 02066000 on Roanoke (Staunton) River at Randolph, VA, to the mouth of Roanoke River in Kerr Reservoir. The 1D model will include (1) Unsteady stream-flow

hydrodynamics module; and (2) Unsteady non-uniform, non-equilibrium sediment transport and fluvial morphodynamics module. The hydrodynamics model will be calibrated using the available stream gage data. Only some old sediment transport measurements are available at the USGS gage in Randolph. Sediment transport model will make use of the rating curve obtained based on this limited data.

- NCCHE has a 1D model of Banister River from a previous study. This model was also developed to study transport and fate of radioactive contaminants due to the failure of a hypothetical tailings dam upstream. The model will be adapted for the present project and shortened to the reach extending from USGS gage 02077000 on Banister River at Halifax, VA, to the confluence with the Dan River. The 1D model will include (1) Unsteady stream-flow hydrodynamics module; and (2) Unsteady non-uniform, non-equilibrium sediment transport and fluvial morphodynamics module. The hydrodynamics model will be calibrated using the available stream gage data. No sediment transport information is available for Banister River. Sediment transport model will make use of a rating curve similar to the one used for Roanoke River.

1D model of Dan River will be used for the following short-term and long-term simulations:

Short-Term Simulations:

Simulation of the stream-flow hydrodynamics and sediment transport and bed morphodynamics in Dan River and Kerr Reservoir based on the observed hydrologic data from two weeks prior to spill up to the current date. These simulations will focus on short-term impacts. They will help to identify the zones of erosion, transport and deposition and the interaction with the existing bed material. Similar simulations will also be carried out without the release of coal ash (existing conditions). The differences between these simulations will provide information on the impact of the released coal ash on the river morphodynamics. The model will need to take into account the dredged sediment and coal ash amounts based on the information provided by Duke Energy.

Based on the results of the stream-flow hydrodynamics and sediment transport and bed morphodynamics simulations, NCCHE will perform contaminant transport and fate for a selected number of contaminants, such as arsenic, lead, mercury, selenium, thallium, and cadmium. Contaminant transport and fate simulations will take into account relevant physicochemical processes. The simulations will provide information on concentration levels in the water column and the bed sediments.

The results of these simulations will be useful for guiding the cleanup efforts and assessing the short-term environmental impact. In addition, they will provide boundary conditions for 2D models of the Dan River and Kerr Reservoir.

Long-Term Simulations:

Long-term simulations of the stream flow hydrodynamics and sediment transport and bed morphodynamics in Dan River and Kerr Reservoir based on the synthetic hydrologic data generated for a period of 2 years, for example. The synthetic data can also be generated based on past observed stream

discharge data. This will be discussed and agreed upon together with Duke Energy and Dr. Steve Scott. These simulations will provide information on long term movement of coal ash through the river-reservoir system.

Based on the results of the stream-flow hydrodynamics and sediment transport and bed morphodynamics simulations, NCCHE will also perform contaminant transport and fate for a selected number of contaminants, such as arsenic, lead, mercury, selenium, thallium, and cadmium. Contaminant transport and fate simulations will take into account relevant physicochemical processes. The simulations will provide information on concentration levels in the water column and the bed sediments.

These simulation results will be useful for planning of remediation efforts and for long-term assessment of the impact on water quality and aquatic habitat. They will provide information on the possibility of re-suspension of contaminated sediments during subsequent floods and the resulting concentration levels. In addition, they will provide boundary conditions for 2D models of the Dan River and Kerr Reservoir.

Two-Dimensional (2D) Modeling of Dan River

One-dimensional model of the Dan River cannot provide detailed information on the spatial distribution of erosion and deposition zones in the lateral direction. To overcome this difficulty, NCCHE will create a 2D model of Dan River from the downstream of the weir near the Dan River Steam Station to the river mouth in Kerr Reservoir. The 2D model will include (1) Unsteady stream-flow hydrodynamics model; (2) Unsteady non-uniform, non-equilibrium sediment transport and fluvial morphodynamics model; and (3) Contaminant transport and fate model.

The model will be calibrated using the same data as in Task 1. The results of the 1D simulations will be used as boundary conditions. The hydrodynamic model will be calibrated using the measured gage data.

2D model of Dan River will be used for the following short-term and long-term simulations:

Short-Term Simulations:

Simulation of the stream-flow hydrodynamics and sediment transport and bed morphodynamics in Dan River and Kerr Reservoir based on the observed hydrologic data from two weeks prior to spill up to the current date. These simulations will especially focus on short-term impacts in the critical areas that will be identified in agreement with the Duke Energy and Dr. Steve Scott from USACE-ERDC. The focus area will probably be the reach extending from the spill location to the Schoolfield Dam in Danville, VA. The simulations will provide information on the lateral variation of the erosion, and deposition patterns and the interaction with the existing bed material. The 2D short-term simulation of the Dan River will also be repeated without the release of coal ash. Comparison between the results of the simulation with and without the release of coal ash will provide an understanding of the contribution of the coal ash to the processes of bed morphodynamics. The model will need to take into account the dredged sediment and coal ash amounts based on the information provided by Duke Energy.

Long-Term Simulations:

Long-term simulations of the stream flow hydrodynamics and sediment transport and bed morphodynamics in Dan River and Kerr Reservoir will be carried out based on the same synthetic hydrologic data generated for long-term 1D simulations. The initial conditions will be taken from short-term 2D simulations. The long-term 2D simulations of coal ash will also be performed with and without the release of the coal ash.

These simulation results will be useful for planning of remediation efforts and for long-term assessment of the impact on water quality and aquatic habitat. They will provide information on the possibility of re-suspension of contaminated sediments during subsequent floods and the resulting concentration levels, mixing of coal ash with the bed material (existing sediments), and burying of coal ash by sediments transported from upstream of the spill location.

Two-Dimensional (2D) Modeling of Kerr Reservoir

NCCHE has already a 2D finite element model of Dan River from a previous study. The mesh is composed of 122,470 quadrilateral elements. The mesh is based on a Digital Elevation Model (DEM), which was created with topographic data from two different sources. The topography below the elevation 300 ft NAVD 88 was obtained by digitizing contour lines from paper maps prior to the construction of the dam in 1947. The topography between elevations 300-330 ft was added directly from USGS NED at 10m resolution. The 2D model of Kerr Reservoir will include (1) Unsteady stream-flow hydrodynamics model; (2) Unsteady non-uniform, non-equilibrium sediment transport and fluvial morphodynamics model; and (3) Contaminant transport and fate model.

The existing two-dimensional model will be revised and improved as necessary and adapted for running the simulations of coal ash transport and fate. All three components of the model will be initialized using the short term simulations with 1D models. The upstream boundary representing the inflows (including the sediment and contaminant fluxes) into the Kerr Reservoir will be taken from 1D modeling of Dan-Banister River and Roanoke River and 2D model of Dan River. At the downstream end discharges released from the dam and the water surface elevations are available. These will be used as boundary condition.

After initialization, long-term simulations of Kerr Reservoir with all three components of the model will be carried out for the scenarios with and without coal ash release. The inflow and outflow boundary conditions will be taken from the long-term 1D simulations of Dan-Banister River and Roanoke River model, and the long-term 2D simulation of Dan River. These simulations will provide long-term estimates of sediment and contaminant concentrations in the reservoir, transit times of the contaminants in the reservoir. The results can be used to investigate the potential impact on water quality and aquatic habitat.

Data Analysis, Sensitivity Analysis and Reporting

NCCHE will analyze, classify and validate all available data before it is used in the model. The models studies include sensitivity analysis by varying some of the model parameters (such as adaptation length for bed load and suspended load, critical shear stress, partition coefficient). to assess their influence on the final results.

There are a number of manmade structures along the Dan River. Based on the characteristics operation modes of these structures, 1D and 2D models of the Dan River may have to be studied in separate reaches.

Intermediate reports will be provided at intervals to be decided with the Duke Energy. A final report summarizing the results of the entire study will be provided at the end of the project.

Model use for future ash survey or recovery decision-making

After the initial modeling is completed, NCCHE will re-run the model annually for two years to evaluate changes in the river system and potential effects on the movement of sediment and ash in the river system over that period. Should results of the model predict additional ash deposition in modeled areas, Duke will review the model results with EPA and, if needed, conduct additional ash deposition transect surveys to field-verify the model predictions. If field surveys, sampling data and the decision tree indicate the need for further ash recovery, it will be performed in accordance with the ash recovery work plans submitted previously to EPA.

References

U.S. Geologic Survey. 2014. USGS 02071000 Dan River near Wentworth, NC. Available: http://waterdata.usgs.gov/usa/nwis/uv?site_no=02071000. Accessed: March 4, 2014.

Virginia DEQ, Standard Operating Procedures Manual , Section 4.6.4, Sediment Sampling – "Scoop and Pan" Method.

Equipment List:

PFDs/float coats/mustang suits

Paddles

Anchors

Pre-programmed GPS (at least one per boat)

Copy of field data collection SOP

Field Data Sheets (write in the rain paper preferred)

Gloves

Digital camera

Waders

Sufficient line to tether boat to shore; canoe (if applicable)

First aid kit

1 deep sediment corers w/hammer, lexane tube, lines and caps per boat

5 gallon decon bucket

spray bottle(s) with luminox cleaner

Scrub brushes

1 stainless steel bowls and 2 stainless steel spoons per boat

Sample bottles (sediment chemistry, water chemistry, particle size)

1 water quality meter

2 5ft lexane tubes w/caps

1 8ft lexane tube w/caps

1 water sampler

paper towels

Copy of Maps w/GPS coordinates

Cell phone with pre-programmed emergency contacts and agency POCs for river ops

Rulers

Sharpies

Ball point pens/pencils

Plastic bags

Coolers/ice

Protocol:

1. Pre-program GPS coordinates of transects and transect stations into GPS units to be used in the field.

2. Travel to the GPS location of transect you are trying to collect via boat.

3. A minimum of 3 visual observations of sediment cores (right descending [RD], left descending [LD], and thalweg [C]) should be assessed on each transect. Sediment and sediment/water interface water grab samples should be collected from the point on the transect deemed most depositional in nature by the field collection team.

4. For depositional transect establishment, identify a depositional area[†] in the vicinity of the targeted GPS location (characterized by sandbars, braided channel island with depositional material on the margins, organic deposits, etc), typically on the right descending (RD) or left descending (LD) side of the thalweg (or primary channel flow). If no depositional areas are present at the targeted GPS location, continue reconnaissance until such an area is identified and establish the transect at this new location.

5. At the site on the transect deemed most depositional in nature (typically LD or RD of thalweg; if transect has been collected before, refer to existing GPS location). When you arrive at GPS location, conduct reconnaissance of the area to determine the most depositional area on a bar or collection point (e.g., typically the tail/downstream end or inside bend):

    a. Collect a core sample (minimum depth of 6 inches, but more typically to the depth of refusal using core sampler) and fill out the ash assessment form with visual observations as follows

[†] Depositional area includes portions of the river system such as sandbars or other areas of where sediment and other materials naturally accumulate based on physical and hydrologic features of the river. Likely depositional areas include known river flow obstructions such as dams and large snags, and identified areas of quiescence such as a tributary confluence, river bend or braided channel area where accumulated material can be confirmed

i. Record sample ID following format Station Name – location on transect (e.g., EPA1-LD) where location is LD (left descending), C (thalweg), or RD (right descending).

ii. Record latitude and longitude (decimal degrees) of exact location. Should be approximate to location pre-programmed in GPS for transect.

iii. Record time of day for water and sediment sample collection, respectively. If no water sample taken, record "N/A".

iv. Note the depth in inches of each obvious layer of native sediment (N), ash (A), sediment-ash mix (N-A), or undetermined (U) material in the core sample (with Layer 1 being the surficial layer of material).

v. If site is near LD or RD bank, evaluate bank material for visible evidence of ash and record if present.

vi. Record the water depth (estimated in feet) at the point of sample collection.

vii. Take a photo of the recovered core with a ruler for reference. Photo IDs should be recorded as default numbering identified on camera; renaming photos after field effort is complete should follow format: TransectID_MMDDYYYY_Photo#.

viii. If an ash (A) or native sediment-ash (N-A) layer is present in the core, assess whether compaction/cementation is evident (e.g., slight core refusal before penetration, resistant to separation, etc) and note on field data sheet .

b. Collect a sediment grab sample(s) (assuring that a minimum of 6" of material is recovered; the core used for visual observation may be retained for the grab sample).

i. Pour off excess water from core, but do so slowly to minimize disturbance to top layer sediments.

ii. Retain the 0-6 in layer as the surficial grab sample. If there is evidence of a suspected ash layer(s) or band(s) that occur below the surficial sample, retain the material separately by layer. Discard the unused portion of the core.

iii. Pour 0-6in sediment layer into a clean stainless steel bowl. Retain the sub-surface suspected ash material in a separate bowl or bowls (depending on the number of layers retained).

iv. Repeat coring process until enough sediment is collected for split samples. (4 cores for the 2" lexane tube, 3 cores for the 3" lexane tube). Make sure replicate cores are representative of one another in terms of visual observation of the composition of the core.

v. Homogenize the sample(s) in the bowl(s) using clean stainless steel spoon(s).

vi. Fill sample containers for analysis. Put lid on tight and clean with paper towel.

vii. Label jars with location id (ex. EPA1-LD), Date (MM/DD/YYYY), and Time and place samples in cooler on ice. If a sub-surface suspected ash layer or more is retained, label jars with a site ID followed by the corresponding core layer number as "SiteID-Layer#" (e.g., EPA1-LD-L3).

viii. Split samples (sample for Duke Energy; particle size sample for USFWS)

c. Collect a water sample of the sediment/water interface.

i. More than 1 fill of the sampler will be required to collect the desired sample volume (X bottles as follows :). During splits, make sure to pour an entire analysis volume for each agency from the same sample volume.

ii. Fill sample containers for analysis. (EPA analyzing for Total and Dissolved Metals (w/Hg, B, Mo, Silica), Anions, Alkalinity, Hardness, TOC, TSS, and TDS). Put lid on tight and dry with paper towel.

iii. Label bottles with location id (ex. EPA1-LD), Date (MM/DD/YYYY), and Time (format) and place in cooler on ice.

iv. Record water quality data at the sampling location collected using YSI. Minimum parameters to record on field data sheet include temperature, pH, conductivity, DO, and turbidity.

6. Find the thalweg. (If the transect has been collected before, using existing GPS location.) Collect a core sample and fill out the ash assessment form in regards to the retained sediment.

7. Find the less depositional area outside of the thalweg (RD or LD). (If the transect has been collected before, using existing GPS location.) Collect a core sample and fill out the ash assessment form in regards to retained sediment. Take a photo of the recovered core with a ruler for reference. Evaluate bank material for visible evidence of ash and record if present. Follow core visual observation and ash assessment protocol per above (see bullet #3).

8. When each transect is complete, decontaminate lexane tubes, lexane tube caps, stainless steel bowl, and stainless steel spoon.

a. River rinse.

b. Spray with luminox solution.

c. Scrub with brushes.

d. Triple river rinse.

e. Repeat until clean.

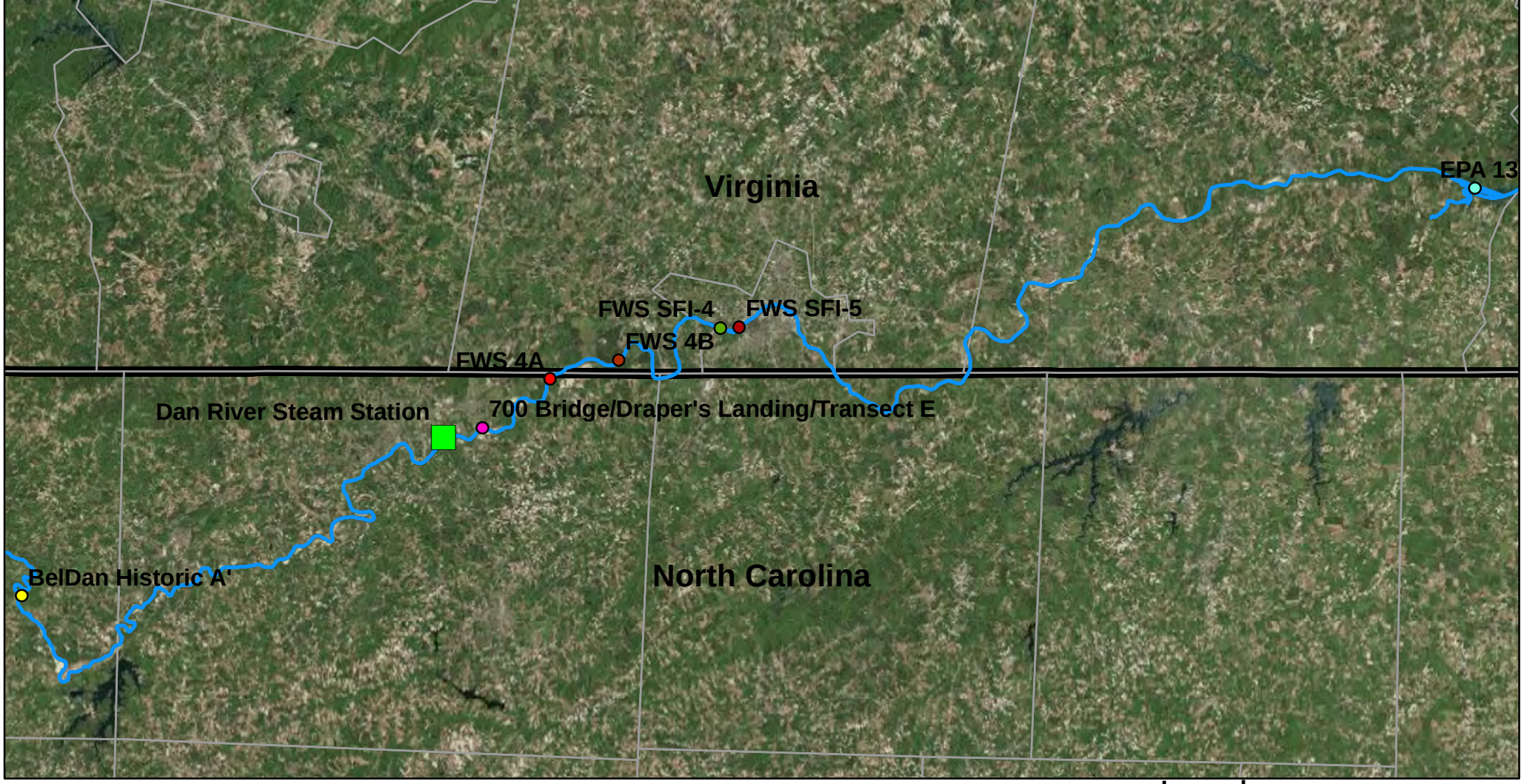
9. Field data sharing protocol

   a. All parties should initial data sheets and assure fields on sheet are complete (or appropriately marked as N/A or drawn as a strike through for columns not addressed).

   b. At a minimum, photo of data sheet(s) should be taken and distributed to all field team members and points of contact (POCs) for cooperating agencies within 2 business days if practical and desired.

Photos taken in the field with the original photo IDs (corresponding to IDs recorded on the data sheet) should be distributed to all field team members and POCs for cooperating agencies within 2 business days if practical and desired.

Sample ID	Latitude	Longitude
Duke-1A-LD	36.48854	-79.71394
Duke-1A-C	36.48861	-79.71370
Duke-1A-RD	36.48848	-79.71339
Duke-1H-RD	36.49143	-79.70156
Duke-1H-C	36.49169	-79.70131
Duke-1H-LD	36.49195	-79.70131
FWS-2B-RD	36.49641	-79.67454
FWS-2B-C	36.49654	-79.67450
FWS-2B-LD	36.49671	-79.67431
FWS-3A-LD	36.50815	-79.65262
FWS-3A-C	36.50814	-79.65224
FWS-3A-RD	36.50809	-79.65195
EPA-1-LD	36.51957	-79.62882
EPA-1-C	36.51903	-79.62805
EPA-1-RD	36.51902	-79.62610
FWS-4A-RD	36.53662	-79.61617
FWS-4A-C	36.53675	-79.61636
FWS-4A-LD	36.53679	-79.61671
EPA-2-RD	36.55744	-79.52145
EPA-2 -C	36.55725	-79.52145
EPA-2-LD	36.55734	-79.52106
FWS-SFI-5-LD	36.57674	-79.43434
FWS-SFI-5-C	36.57658	-79.43380
FWS-SFI-5-RD	36.57616	-79.43332
EPA-3-LD	36.57455	-79.44329
EPA-3-C	36.57383	-79.4435
EPA-3-RD	36.5731	-79.4438
FWS-SFI-4-LD	36.57591	79.45229
FWS-SFI-4-C	36.57549	-79.45214
FWS-SFI-4-RD	36.57515	-79.45284
FWS-SFI-3-LD	36.57991	-79.46500
FWS-SFI-3-C	36.57939	-79.46507
FWS-SFI-3-RD	36.58273	-79.46472
FWS-SFI-2-LD	36.58273	-79.48796
FWS-SFI-2-C	36.58249	-79.48759
FWS-SFI-2-RD	36.58192	-79.48763
FWS-SFI-1-RD	36.56923	-79.49638
FWS-SFI-1-C	36.56953	-79.49669
FWS-SFI-1-LD	36.56919	-79.49714
Duke DR BA-LD	36.53271	-79.33318
Duke DR BA-RD	36.53206	-79.33290
Duke DR BA-C	36.53223	-79.33220
Duke DR E-LD	36.51621	-79.28779
Duke DR E-C	36.51636	-79.28429
Duke DR E-RD	36.51584	-79.28458
Duke SB D-LD	36.60857	-79.15966
Duke SB D-C	36.60826	-79.15932
Duke SB D-RD	36.60822	-79.15907
EPA 4-LD	36.59283	-79.39224
EPA 5-LD	36.57718	-79.37680
EPA 6-C	36.64295	-79.08970
EPA 6-RD	36.64261	-79.08952
EPA 6-LD	36.64318	-79.09012
EPA 7-LD	36.66790	-78.98593
EPA 7-C	36.66719	-78.98562
EPA 7-RD	36.66698	-78.98574
EPA-8-RD	36.69370	-78.90007
EPA-8-LD	36.69388	-78.90008
EPA-8-C	36.69520	-78.89946
EPA-9-LD	36.69523	-78.84910
EPA-9-C	36.69285	-78.84924
EPA-9-RD	36.69960	-78.79202
EPA-10-LD	36.69906	-78.79167
EPA-10-C	36.69906	-78.79167
EPA-10-RD	36.69906	-78.79167
EPA-11-RD	36.69576	-78.75945
EPA-11-C	36.69603	-78.75903
EPA-11-LD	36.69666	-78.75858
EPA-12-LD	36.68433	-78.72618
EPA-12-C	36.68901	-78.72597
EPA-12-RD	36.68371	-78.72664
EPA-13-LD	36.69614	-78.65443
EPA-13-C	36.68401	-78.72597
EPA-13-RD	36.69006	-78.65540
EPA-14-RD-UP	36.66121	-78.62447
EPA-14-C	36.69006	-78.65540
EPA-14-RD-Down	36.65840	-78.62251
EPA-15-C	36.62982	-78.55073
EPA-15-RD	36.62728	-78.55335
EPA-15-LD	36.63651	-78.54235


Virginia
North Carolina
EPA 13
FWS SFI-4
FWS SFI-5
FWS 4B
FWS 4A
Dan River Steam Station
700 Bridge/Draper's Landing/Transect E
BelDan Historic A'
0
8,000
16,000
32,000
48,000
64,000
Meters
N
Legend
FWS SFI - 5
FWS SFI - 4
FWS 4B
FWS 4A
EPA 13
BelDan Historic A'
700 Bridge Draper's Landing
Dan River Steam Station
Dan River
County Line
Virginia/North Carolina State Line