Marshall Steam Station Ash Basin

Proposed Groundwater Assessment Work Plan

NPDES Permit NC0004987

September 25, 2014
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Executive Summary

Duke Energy Carolinas, LLC (Duke Energy), owns and operates Marshall Steam Station (MSS), which is located on Lake Norman in Catawba County near the town of Terrell, North Carolina (see Figure 1). MSS began operation in 1965 as a coal-fired generating station and currently operates four coal-fired units. The coal ash residue from MSS’s coal combustion process has historically been disposed in the station’s ash basin located to the north of the station and adjacent to Lake Norman. The discharge from the ash basin is permitted by the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Resources (DWR) under the National Pollutant Discharge Elimination System (NPDES) Permit NC0004987.

On August 13, 2014, NCDENR issued a Notice of Regulatory Requirements (NORR) letter to Duke Energy, pursuant to Title 15A North Carolina Administrative Code Chapter (15A NCAC) 02L.0106. The NORR stipulates that for each coal-fueled plant owned, Duke Energy will conduct a comprehensive site assessment (CSA) that includes a Groundwater Assessment Work Plan (Work Plan) and a receptor survey. In accordance with the requirements of the NORR, HDR is in the process of completing a receptor survey to identify all receptors within a 0.5-mile radius (2,640 feet) of the MSS ash basin compliance boundary. This receptor survey will also address the requirements of the General Assembly of North Carolina Session 2013 Senate Bill 729 Ratified Bill (SB 729).

Soil and groundwater sampling will be conducted to provide information pertaining to the horizontal and vertical extent of potential soil and groundwater contamination. This will be performed by sampling existing wells, installing and sampling approximately 34 nested monitoring well pairs (shallow and deep) and one deep (only) monitoring well, and collecting soil and ash samples. In addition, one observation well will be installed between two outer portions of the western extent of the ash basin to characterize groundwater flow direction. This work will provide additional information on the chemical and physical characteristics of site soils and ash, as well as the geological and hydrogeological features of the site that influence groundwater flow and direction and potential transport of constituents from the ash basin. Samples of ash basin water will be collected and used to evaluate potential impacts to groundwater and surface water. In addition, one water sample may be collected from the surface water located southeast of the ash basin.

The information obtained through this Work Plan will be utilized to prepare a CSA report in accordance with the requirements of the NORR. If it is determined that additional investigations are required during the review of existing data or data developed from this assessment, Duke Energy and HDR will notify the NCDENR regional office prior to initiating additional sampling or investigations.

HDR will also perform an assessment of risks to human health or safety and to the environment. This assessment will include the preparation of a conceptual site model illustrating potential pathways from the source to possible receptors.
1.0 Introduction

Duke Energy Carolinas, LLC (Duke Energy), owns and operates Marshall Steam Station (MSS), which is located on Lake Norman in Catawba County near the town of Terrell, North Carolina (see Figure 1). MSS began operation in 1965 as a coal-fired generating station and currently operates four coal-fired units. The coal ash residue from MSS’s coal combustion process has historically been disposed in the station’s ash basin located to the north of the station and adjacent to Lake Norman. The discharge from the ash basin is permitted by the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Resources (DWR) under the National Pollutant Discharge Elimination System (NPDES) Permit NC0004987.

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On behalf of Duke Energy, HDR has prepared this proposed Work Plan for performing the groundwater assessment as prescribed in the NORR. If it is determined that additional investigations are required during the review of existing data or data developed from this assessment, Duke Energy and HDR will notify the NCDENR regional office prior to initiating additional sampling or investigations.

HDR will also perform an assessment of risks to human health or safety and to the environment. This assessment will include the preparation of a conceptual site model illustrating potential pathways from the source to possible receptors.
2.0 Site History

2.1 Plant Description
MSS is a four-unit, coal-fired electric generating plant with a capacity of 2,090 megawatts located in Catawba County, North Carolina, near the community of Terrell. The site is located north of NC Hwy 150, east of Sherrills Ford Road and south of Island Point Road, and the surrounding area generally consists of residential properties, undeveloped land, and Lake Norman (Figure 1). The ash basin is situated between the MSS to the south, primarily residences to the west, residences and undeveloped land to the north, and undeveloped land and Lake Norman to the east. A topographical divide is located along Sherrills Ford Road to the west and along Island Ford Road to the north. The topography at the site generally slopes downward from that divide toward Lake Norman.

2.2 Ash Basin Description
The ash basin system consists of a single cell impounded by an earthen dike located on the southeast end of the ash basin. The ash basin system was constructed in 1965 and is located approximately 2,000 feet northeast of the power plant. The area contained within the ash basin waste boundary, which is shown on Figures 2 and 3, is approximately 382 acres in area.

The full pond elevation for the MSS ash basin is approximately 790 feet. The normal pond elevation of Lake Norman is approximately 760 feet.

The ash basin is operated as an integral part of the station’s wastewater treatment system and receives inflows from the ash removal system, coal pile runoff, landfill leachate, flue-gas desulfurization (FGD) wastewater, the station yard drain sump, stormwater flows, and station wastewater. Due to variability in station operations and weather, inflows to the ash basin are highly variable. Inflows from the station to the ash basin are discharged into the northwest portion of the ash basin.

The discharge from the ash basin is through a concrete discharge tower located in the eastern portion of the ash basin. The concrete discharge tower drains through a 30-inch-diameter slip-lined corrugated metal pipe which discharges into Lake Norman. The ash basin pond elevation is controlled by the use of concrete stop logs in the discharge tower.

Note that there are six permitted landfill areas and one structural fill area located adjacent to the ash basin. Two ash landfills (Permit No. 1804) are located adjacent to the east and northeast portions of the ash basin. The demolition landfill (Permit No. 1804), asbestos landfill (Permit No. 1804), and industrial landfill (Permit No. 1812) are located adjacent to the northern portion of the ash basin. The flue gas desulfurization (FGD) landfill (Permit No. 1809) is located southwest of the ash basin. The structural fill area is located adjacent to and partially on top of the western most portion of the ash basin. The approximate boundary of these landfill/structural fill areas are shown on Figures 2 and 3. Existing groundwater monitoring wells associated with the ash landfills and the FGD landfill are shown on Figure 3.2.3.
2.3 Regulatory Requirements

The NPDES program regulates wastewater discharges to surface waters to ensure that surface water quality standards are maintained. MSS operates under NPDES Permit NC0004987 which authorizes discharge of cooling water and intake screen backwash (Outfall 001); treated wastewater (consisting of metal cleaning wastes, coal pile runoff, ash transport water, domestic wastewater, low volume wastes, and FGD wet scrubber wastewater) (Outfall 002); yard sump overflows (Outfalls 002A and 002B); and non-contact cooling water from the induced draft fan control house (Outfall 003) to the Catawba River (Lake Norman) in accordance with effluent limitations, monitoring requirements, and other conditions set forth in the permit.

The NPDES permitting program requires that permits be renewed every five years. The most recent NPDES permit renewal at MSS became effective on March 1, 2011, and expires April 30, 2015.

In addition to surface water monitoring, the NPDES permit requires groundwater monitoring. Groundwater monitoring has been performed in accordance with the permit conditions beginning in February 2011. NPDES Permit Condition A (11), Version 1.1, dated June 15, 2011, lists the groundwater monitoring wells to be sampled, the parameters and constituents to be measured and analyzed, and the requirements for sampling frequency and reporting results. These requirements are provided in Table 1.

The compliance boundary for groundwater quality at the MSS ash basin site is defined in accordance with Title 15A NCAC 02L .0107(a) as being established at either 500 feet from the waste boundary or at the property boundary, whichever is closer to the waste. The location of the ash basin compliance monitoring wells, the ash basin waste boundary, and the compliance boundary are shown on Figure 2.

The locations for the compliance groundwater monitoring wells were approved by the NCDENR DWR Aquifer Protection Section (APS). All compliance monitoring wells included in Table 1 are sampled three times per year (in February, June, and October). Analytical results are submitted to DWR before the last day of the month following the date of sampling for all compliance monitoring wells.

The compliance groundwater monitoring system for the MSS ash basin consists of the following monitoring wells: MW-4, MW-4D, MW-10S, MW-10D, MW-11S, MW-11D, MW-12S, MW-12D, MW-13S, MW-13D, MW-14S, and MW-14D (shown on Figures 2 and 3). With the exception of monitoring wells MW-4 and MW-4D, all the compliance monitoring wells were installed in 2010. Monitoring well MW-4 was installed by Duke Energy in 1989 as part of the Marshall Dry Ash Landfill (Permit No. 1804) groundwater monitoring network. Monitoring well MW-4D was installed by Duke Energy in 2006 as part of a voluntary monitoring system. Based on the locations of monitoring wells MW-4 and MW-4D relative to the ash basin, they were incorporated into the ash basin compliance monitoring network.

One or more groundwater quality standards (2L Standards) have been exceeded in groundwater samples collected at monitoring wells MW-4, MW-4D, MW-10S, MW-10D, MW-11S, MW-11D, MW-12S, MW-12D, MW-13S, MW-13D, MW-14S, and MW-14D. Exceedances
have occurred for boron, iron, manganese, pH, sulfate, and/or total dissolved solids (TDS). Table 2 presents exceedances measured from February 2011 through June 2014.

Monitoring wells MW-4\textsuperscript{1}, MW-10S\textsuperscript{2}, MW-11S, MW-12S, MW-13S, and MW-14S were installed with 10-foot to 15-foot well screens placed above auger refusal to monitor the shallow aquifer within the saprolite layer. These wells were installed to total depths ranging from 18 feet below ground surface (bgs) at MW-13S to 52 feet bgs at MW-11S.

Monitoring wells MW-4D\textsuperscript{3}, MW-10D, MW-11D, MW-12D, MW-13D, and MW-14D were installed with 5-foot well screens placed in the fractured rock transition zone. These wells were installed to total depths ranging from 46.5 feet bgs at MW-13D to 95 feet bgs at MW-12D.

Note that monitoring wells MW-6S, MW-6D, MW-7S, MW-7D, MW-8S, MW-8D, MW-9S, and MW-9D were installed by Duke Energy in 2006 as part of a voluntary monitoring system. No groundwater samples are currently collected from these wells under the compliance monitoring program. The voluntary wells are shown on Figure 3.

\textsuperscript{2} Wells other than MW-4 and MW-4D have the boring log and well record found in MACTEC’s Ash Basin Monitoring Well Installation Report (MACTEC Project No. 6228-10-5284) dated August 26, 2010.
3.0 Receptor Information

The August 13, 2014 NORR states:

No later than October 14th, 2014 as authorized pursuant to 15A NCAC 02L .0106(g), the DWR is requesting that Duke perform a receptor survey at each of the subject facilities and submitted to the DWR. The receptor survey is required by 15A NCAC 02L .0106(g) and shall include identification of all receptors within a radius of 2,640 feet (one-half mile) from the established compliance boundary identified in the respective National Pollutant Discharge Elimination System (NPDES) permits. Receptors shall include, but shall not be limited to, public and private water supply wells (including irrigation wells and unused or abandoned wells) and surface water features within one-half mile of the facility compliance boundary. For those facilities for which Duke has already submitted a receptor survey, please update your submittals to ensure they meet the requirements stated in this letter and referenced attachments and submit them with the others. If they do not meet these requirements, you must modify and resubmit the plans.

The results of the receptor survey shall be presented on a sufficiently scaled map. The map shall show the coal ash facility location, the facility property boundary, the waste and compliance boundaries, and all monitoring wells listed in the respective NPDES permits. Any identified water supply wells shall be located on the map and shall have the well owner’s name and location address listed on a separate table that can be matched to its location on the map.

In accordance with the requirements of the NORR, HDR is in the process of completing a receptor survey for MSS to identify all receptors within a 0.5-mile radius (2,640 feet) of the ash basin compliance boundary to be submitted to NCDENR no later than October 1, 2014. This receptor survey will also address the requirements of the General Assembly of North Carolina Session 2013 Senate Bill 729 Ratified Bill (SB 729). The receptors include, but are not limited to, public and private water supply wells (including irrigation wells and unused or abandoned wells) and surface water features within a 0.5-mile radius of the MSS ash basin compliance boundary. The compliance boundary for groundwater quality, in relation to the ash basin, is defined in accordance with Title 15A NCAC 02L .0107(a) as being established at either 500 feet from the waste boundary or at the property boundary, whichever is closer to the source.

The receptor survey will include a map showing the coal ash facility location, the facility property boundary, the waste and compliance boundaries, and all monitoring wells listed in the NPDES permit. The identified water supply wells will be located on the map and the well owner’s name and location address listed on a separate table that can be matched to its location on the map.

During completion of the CSA, HDR will update the receptor information as necessary, in general accordance with the CSA receptor survey requirements. If necessary, an updated receptor survey will be submitted with the CSA report.
4.0 Regional Geology and Hydrogeology

North Carolina is divided into distinct regions by portions of three physiographic provinces: the Atlantic Coastal Plain, Piedmont, and Blue Ridge (Fenneman, 1938). MSS is located in the Charlotte terrane within the Piedmont province. The Piedmont province is bounded to the east and southeast by the Atlantic Coastal Plain and to the west by the escarpment of the Blue Ridge Mountains, covering a distance of 150 to 225 miles (LeGrand, 2004).

The topography of the Piedmont region is characterized by low, rounded hills and long, rolling, northeast-southwest trending ridges (Heath, 1984). Stream valley to ridge relief in most areas range from 75 to 200 feet. Along the Coastal Plain boundary, the Piedmont region rises from an elevation of 300 feet above mean sea level, to the base of the Blue Ridge Mountains at an elevation of 1,500 feet (LeGrand, 2004).

Charlotte terrane bedrock consists primarily of igneous and metamorphic bedrock. The fractured bedrock is overlain by a mantle of unconsolidated material known as regolith. The regolith includes, where present, the soil zone (a zone of weathered, decomposed bedrock known as saprolite) and, where present, alluvium. Saprolite, the product of chemical and mechanical weathering of the underlying bedrock, is typically composed of clay and coarser granular material up to boulder size and may reflect the texture of the rock from which it was formed. The weathering product of granitic rocks are quartz rich and sandy textured; whereas, rocks poor in quartz and rich in feldspar and other soluble minerals form a more clayey saprolite. The regolith serves as the principal storage reservoir for the underlying bedrock (LeGrand 2004).

A transition zone may occur at the base of the regolith between the soil-saprolite and the unweathered bedrock. This transition zone of partially weathered rock is a zone of relatively high permeability compared to the overlying soil-saprolite and the underlying bedrock (LeGrand 2004).

Groundwater flow paths in the Piedmont are almost invariably restricted to the zone underlying the topographic slope extending from a topographic divide to an adjacent stream. LeGrand describes this as the local slope aquifer system. Under natural conditions, the general direction of groundwater flow can be approximated from the surface topography (LeGrand 2004).

Groundwater recharge in the Piedmont is derived entirely from infiltration of local precipitation. Groundwater recharge occurs in areas of higher topography (i.e., hilltops) and groundwater discharge occurs in lowland areas bordering surface water bodies, marshes, and floodplains (LeGrand 2004).
5.0 Site Geology and Hydrogeology

Based on a review of soil boring and monitoring well installation logs provided by Duke Energy, subsurface stratigraphy consists of the following material types: fill, ash, residuum, saprolite, partially weathered rock (PWR), and bedrock. In general, saprolite, PWR, and bedrock were encountered on most areas of the site. Bedrock was encountered across the site ranging in depth from 36 feet on the northwest extent of the site to 94 feet along the western extent of the site and to approximately 85 feet on the southeastern extent of the site near Lake Norman. The general stratigraphic units, in sequence from the ground surface down to boring termination, are defined as follows:

- **Fill** – Fill material generally consisted of re-worked silts and clays that were borrowed from one area of the site and re-distributed to other areas. Fill was used in the construction of dikes and presumably as cover for the landfill and structural fill areas.

- **Ash** – Although previous exploration activities, for which Duke Energy provided boring logs, did not evaluate ash management areas of the site, ash is expected to be present within the ash basin, ash landfill areas, and the structural fill area.

- **Alluvium** – Alluvium was not encountered in the boring information provided to HDR. However, alluvium is expected to be present beneath the southeastern portion of the ash basin where streams likely existed and flowed toward the Catawba River prior to construction of the ash basin. Alluvium is unconsolidated soil and sediment that has been eroded and redeposited by streams and rivers.

- **Residuum** – Residuum is the in-place weathered soil that generally consists of white, yellow, red, brown, gray, or olive sandy clay to silty sand. This unit was encountered in various thicknesses across the site.

- **Saprolite** – Saprolite is soil developed by in-place weathering of rock similar to the bedrock that consists of white, brown, orange, yellow, red, gray, or green silty sand and sandy silt with trace mica. The primary distinction from residuum is that saprolite typically retains some structure (e.g., mineral banding) from the parent rock. This unit was found in areas across the site and was described as white, brown, orange, yellow, red, gray, or greenish-brown silty sand, course to fine sand, and sandy silt with manganese staining, some quartz rock fragments, and trace mica.

- **Partially Weathered Rock (PWR)** – PWR occurs between the saprolite and bedrock and contains saprolite and rock remnants. This unit was described as white, black, gray, and green medium to very fine sand and sandy silty clay with some rock fragments and manganese staining.

- **Bedrock** – Bedrock was encountered in borings completed around the western, northern, and southeastern extents of the ash basin. Depth to top of bedrock ranged from 36 feet to 94 feet below ground surface. Bedrock was described as biotite-gneiss, quartz-sericite schist, and granite.
6.0 Groundwater Monitoring Results

From February 2001 through June 2014, the compliance groundwater monitoring wells at MSS have been sampled a total of 11 times. During this period, these monitoring wells were sampled in:

- February 2011
- June 2011
- October 2011
- February 2012
- June 2012
- October 2012
- February 2013
- June 2013
- October 2013
- February 2014
- June 2014

With the exception of boron, iron, manganese, pH, sulfate, and TDS, the results for all monitored parameters and constituents were less than the 2L Standards. Table 2 lists the range of exceedances for boron, iron, manganese, pH, sulfate, and TDS for the sampling events listed above.
7.0 Assessment Work Plan

Soil and groundwater sampling will be performed to provide information pertaining to the horizontal and vertical extent of potential soil and groundwater contamination. Based on readily available site background information, and dependent upon accessibility, HDR anticipates collecting soil and/or ash samples from 5 soil boring locations and during installation of approximately 34 nested monitoring well pairs (shallow and deep) and one deep (only) monitoring well. Groundwater samples will be collected from the proposed monitoring wells. In addition, one observation well will be installed between two outer portions of the western extent of the ash basin to characterize groundwater flow direction. The proposed well and boring locations are listed in Table 3 and shown on Figure 3. HDR may also resample select existing monitoring wells to supplement groundwater quality data. This work will provide additional information on the chemical and physical characteristics of site soils and ash, as well as the geological and hydrogeological features of the site that influence groundwater flow and direction and potential transport of constituents from the ash basin.

Samples of ash basin water will also be collected and used to evaluate potential impacts to groundwater and surface water. In addition, one water sample may be collected from the surface water located southeast of the ash basin (SW-6) shown on Figure 3.

A summary of the proposed exploration plan, including estimated sample quantities and depths of soil borings and monitoring wells, is presented in Table 3. If it is determined that additional investigations are required during the review of existing data or data developed from this assessment, Duke Energy and HDR will notify the NCDENR regional office prior to initiating additional sampling or investigations.

7.1 Ash and Soil Sampling Plan

7.1.1 Boring and Sampling Methods

Prior to drilling each boring, all downhole equipment and tools will be cleaned by washing with high pressure hot water. A designated remote cleaning area will be established in the field. Water for cleaning will be obtained from a tap or hydrant (to be designated) at MSS, or supplied by the drilling contractor from an off-site source. Cleaning water will not require collection, treatment, or disposal.

Borings will be advanced using hollow stem auger or roller cone drilling techniques to facilitate collection of downhole data. Standard Penetration Testing (SPT) (ASTM D 1586) and split-spoon sampling will be performed at 2.5-foot to 5-foot increments using an 18-inch split-spoon sampler. The sampler will be decontaminated with a non-phosphate detergent wash between sampling depths. Ash and soil samples will be collected by the Project Scientist/Engineer.

Borings will be logged by the Project Scientist/Engineer and ash/soil samples will be observed, visually classified, and photographed in the field for origin, consistency/relative density, color, and soil type in accordance with the Unified Soil Classification System (ASTM D2487/D2488).
Samples will be identified with a unique boring number and approximate collection depth (e.g., AB-1 (20-22')). Sample containers will be provided by HDR’s contracted laboratory prior to commencement of the on-site investigation. Samples will be delivered to the analytical laboratory in time to extract the samples within their specified hold times (to be provided by the laboratory). HDR will provide the name, phone number, and email address of the laboratory project manager to facilitate sample analysis coordination.

Boring locations will be surveyed for horizontal and vertical control upon completion of the field exploration program.

### 7.1.2 Proposed Soil and Ash Sampling Locations and Depths
HDR anticipates collection of soil and ash samples for laboratory analysis at 21 locations within the ash basin and on the ash basin dike (designated as AB-1 through AB-21), four locations within and immediately adjacent to the ash landfill areas (designated as AL-1 through AL-4), and five soil boring locations in the ash basin and structural fill area (designated as S-1 through S-5). The borings located within the ash basin, ash landfill areas, and the structural fill area will extend approximately 20 feet below the ash/native soil interface or to refusal, whichever is encountered first. In addition, HDR anticipates collection of soil samples at three background locations (designated as BG-1 through BG-3).

Soil samples will not be collected for laboratory analysis during installation of monitoring wells located outside the ash basin waste boundary, the structural fill, and ash landfill areas (designated as GWA-1 through GWA-7). Proposed boring/well locations are shown on Figure 3.

### CONSTITUENT SAMPLING AND ANALYSES
In general, ash is expected to be encountered in AB-series, AL-series, and S-series borings located within the ash basin, the ash landfill areas, and the structural fill area. Where present, ash samples will be collected from shallow and deeper vertical intervals to evaluate variations in type (e.g., fly ash or bottom ash) and chemical profile of the ash. In locations where ash thickness is expected to be greater than 30 feet, a third ash sample may be collected from a depth mid-way between the shallow and deeper intervals in a particular boring. Shallow ash samples will be collected from the 4-foot to 5-foot interval and deeper ash samples will be collected from the 1-foot to 2-foot interval overlying the ash/native soil interface. The depth of deeper ash samples is expected to vary based on ash thickness at each specific boring location. Ash samples will be analyzed by HDR’s subcontract laboratory for total and leachable inorganic compounds, as presented in Table 4.

Soil samples will be collected below the ash/native soil interface and from the terminus of each boring to characterize soil quality beneath the ash management areas. Soil samples will be analyzed by HDR’s subcontract laboratory for total inorganics using the same constituents list proposed for the ash samples.

### INDEX PROPERTY SAMPLING AND ANALYSES
Physical characteristics of ash and soil will be tested both in the field and in the laboratory to provide data for use in groundwater modeling. The location and depth of the index property
samples will be based on site-specific geology and decided upon in the field. Based on HDR’s current understanding of site-specific geology, five hydrostratigraphic units are present on-site.

In general, a minimum of five in-situ permeability tests, either falling or constant head tests, will be performed in each of the hydrostratigraphic units. In addition, a minimum of five packer tests will be performed in bedrock.

Laboratory testing of soil and ash collected from SPT samples will include tests for grain size (with hydrometer), specific gravity, and porosity (calculation).

### 7.2 Groundwater Sampling Plan

Groundwater samples will be collected from the proposed 34 nested well pairs (shallow and deep) and one deep (only) monitoring well shown on Figure 3. Groundwater quality data may be supplemented through evaluation of historical data or re-sampling of select existing monitoring wells. The purpose and anticipated construction details of the proposed monitoring wells are as follows:

- **AB-series Wells** – One shallow well screened across the water table (10-foot to 15-foot well screen) and one deep well screened in the transition zone (5-foot well screen in weathered rock below auger refusal) will be installed at each location. The AB-series well locations were selected to provide water quality data in and beneath the ash basin waste boundary.

- **AL-series Wells** – One shallow well screened across the water table (15-foot well screen) and one deep well screened in the transition zone (5-foot well screen in weathered rock below auger refusal) will be installed at locations AL-1 through AL-3. A deep well only will be installed at location AL-4. The AL-series well locations were selected to provide water quality data beneath and adjacent to the ash landfill areas located along the east/northeast extents of the ash basin (i.e., to evaluate potentially impacted groundwater beneath the ash landfills and adjacent to the ash basin).

- **GWA-series Wells** – One shallow well screened across the water table (15-foot well screen) and one deep well screened in the transition zone (5-foot well screen in weathered rock below auger refusal) will be installed at each location. The GWA-series well locations were selected to provide water quality data beyond the waste boundary for use in groundwater modeling (i.e., to evaluate the horizontal and vertical extent of potentially impacted groundwater around the ash basin).

- **OB-series wells** – The observation well (OB-1) will be installed with a 20-foot screen (across the water table) and will be used for measuring water levels only (no water quality samples). OB-1 will be installed between two outer portions of the western extent of the ash basin. The purpose of OB-1 is to characterize groundwater flow in this area.

- **BG-series Wells** – One shallow well screened across the water table (15-foot well screen) and one deep well screened in the transition zone (5-foot well screen in weathered rock below auger refusal) will be installed at each location. The background well locations were selected to provide additional physical separation from possible influence of the ash basin on groundwater. These wells will also be useful in the
statistical analysis to determine the site-specific background water quality concentrations (SSBCs).

7.2.1 Well Installation and Development

SHALLOW MONITORING WELLS
At each monitoring well location specified on Figure 3 with an “S” qualifier in the well name (e.g., AB-1S), a shallow well will be constructed with a 2-inch-diameter, schedule 40 PVC screen and casing. Each of these wells will have a 10-foot to 15-foot well screen (0.010-slot) set to bracket the water table at the time of installation.

DEEP MONITORING WELLS
At each monitoring well location specified on Figure 3 with a “D” qualifier in the well name (e.g., AB-1D), a double-cased deep well will be constructed with a 6-inch-diameter PVC outer casing and a 2-inch-diameter PVC inner casing and well screen. The purpose of installing cased wells at the site is to restrict vertical mixing within the shallow and deeper portions of the unconfined aquifer during well installation. Outer well casings (6-inch casing) will be advanced to auger refusal and set approximately 1 foot into PWR. Note that location-specific subsurface geology will dictate actual casing depths on a per-well basis. Air rotary drilling will be used to advance the borehole a minimum of 10 feet into PWR or bedrock with the intent of setting a 5-foot well screen at least 10 feet below the bottom of the outer casing.

All newly installed monitoring wells will be developed using appropriate measures (e.g., agitation, surging, pumping, etc.). Water quality parameters (specific conductance, pH, temperature and turbidity) will be measured and recorded during development and should stabilize before development is considered complete. Development will continue until development water is visually clear (target < 50 Nephelometric Turbidity Units (NTU) Turbidity) and sediment free. Following development, sounding the bottom of the well with a water level meter should indicate a “hard” (sediment-free) bottom. Development records will be prepared under the direction of the Project Scientist/Engineer and will include development method(s), water volume removed, and field measurements of temperature, pH, conductivity, and turbidity.

7.2.2 Hydrogeologic Evaluation
Hydraulic conductivity (slug) tests will be completed in select monitoring wells under the direction of the Project Scientist/Engineer. Slug tests will be performed to meet the requirements of the NCDENR Memorandum titled, “Performance and Analysis of Aquifer Slug Tests and Pumping Tests Policy,” dated May 31, 2007. Water level change during the slug tests will be recorded by a data logger.

In addition, approximately 5 to 10 packer tests will be conducted during installation of the Type III wells to facilitate permeability testing of the upper five feet of rock.

7.2.3 Groundwater Sampling
Subsequent to monitoring well installation and development, each newly installed well will be sampled using low-flow sampling techniques. During low-flow purging and sampling, groundwater is pumped into a flow-through chamber at flow rates that minimize or stabilize water level drawdown within the well. Indicator parameters are measured over time (usually at
5-minute intervals). When parameters have stabilized within ±0.2 pH units and ±10 percent for temperature, conductivity, and dissolved oxygen (DO), and ±10 millivolts (mV) for oxidation reduction potential (ORP) over three consecutive readings, representative groundwater has been achieved for sampling. Turbidity levels of 10 NTU or less will be targeted prior to sample collection. Groundwater samples will be analyzed by a North Carolina certified laboratory for the constituents included in Table 5. Select constituents may be analyzed for total and dissolved concentrations.

### 7.3 Surface Water Sampling Plan

#### 7.3.1 Ash Basin Surface Water Samples
Surface water samples will be collected from the ash basin at the approximate open water locations shown on Figure 3 (SW-1 through SW-5). At each location two water samples will be collected – one sample close to the surface (i.e., 0 to 1 foot from surface) and one sample at the approximate middle depth of the water body. The middle depth sample will vary based on the water level in the water body. In areas where the water body is less than 5 feet deep, one water sample will be collected from the location at the approximate middle depth of the water body. In addition, one water sample may be collected from the surface water located southeast of the ash basin (SW-6) shown on Figure 3. Surface water samples will be analyzed for the same constituents as groundwater samples (Table 5). Select constituents may be analyzed for total and dissolved concentrations.

### 7.4 Site Hydrogeologic Conceptual Model

The data obtained during the proposed assessment will be supplemented by available reports and data on site geotechnical, geologic, and hydrologic conditions to develop a site hydrogeologic conceptual model (SCM). The NCDENR document, “Hydrogeologic Investigation and Reporting Policy Memorandum,” dated May 31, 2007 (Reference 6), will be used as general guidance. In general, the SCM will utilize site information to characterize the geologic and hydrogeologic characteristics of the area of interest, and, where appropriate, lead directly to the proper construction of a groundwater flow and transport model.

### 7.5 Site-Specific Background Concentrations

Statistical analysis will be performed to determine the SSBCs to assess whether or not exceedances can be attributed to naturally occurring background concentrations or attributed to potential contamination. Specifically, the relationship between exceedances and turbidity will be explored to determine whether or not there is a possible correlation due to naturally occurring conditions and/or well construction.

### 7.6 Groundwater Model

Groundwater flow and chemical constituent fate and transport at the site will be modeled in three dimensions using the MODFLOW-2005 groundwater flow numeric engine and the MT3D transport model with linear isotherm sorption to predict chemical constituent concentrations over time at the compliance boundary.
The groundwater model layers will be developed based on hydrogeologic properties and other data obtained during the site investigation and the SCM. The model will include the effects of recharge from precipitation.

Site soil samples will be collected and used to develop site-specific distribution coefficient, Kd, terms using batch methods (“US EPA Batch-type procedures for estimating soil adsorption of chemicals Technical Resource Document 530/SW-87/006-F”).

The selection of the initial concentrations and the predictions of the concentrations for constituents with respect to time are to be developed with consideration of the following data:

- Site-specific analytical results from leach tests and from total digestion of ash samples taken at varying locations and depths within the ash basin and ash storage piles (if present).
- Analytical results from appropriate groundwater monitoring wells or surface water sample locations outside of the ash basin.
- Analytical results from monitoring wells installed in the ash basin pore-water (screened in ash).
- Published or other data on sequential leaching tests performed on similar ash.

The groundwater modeling will be conducted in general conformance with the requirements of the May 31, 2007, NCDENR Memorandum titled, “Groundwater Modeling Policy.”

The groundwater model and the report on the results of the groundwater modeling will be prepared by Dr. William Langley, P.E., Department of Civil and Environmental Engineering, University of North Carolina at Charlotte. Dr. Langley will perform the work under contract with HDR and the groundwater model report will be included as an attachment to the CSA. The groundwater model will be used, as required, to evaluate options for potential corrective action in the subsequent phase of work.
8.0 Proposed Schedule

Duke Energy will submit the CSA Report within 180 days of NCDENR approval of this Work Plan. The anticipated schedule for implementation of field work, evaluation of data, and preparation of the Work Plan is presented in the table below.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start Date</th>
<th>Duration to Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Exploration Program</td>
<td>10 days following Work Plan approval</td>
<td>75 days</td>
</tr>
<tr>
<td>Receive Laboratory Data</td>
<td>14 days following end of Exploration Program</td>
<td>15 days</td>
</tr>
<tr>
<td>Evaluate Lab/Field Data, Develop SCM</td>
<td>5 days following receipt of Lab Data</td>
<td>30 days</td>
</tr>
<tr>
<td>Prepare and Submit CSA</td>
<td>10 days following Work Plan approval</td>
<td>170 days</td>
</tr>
</tbody>
</table>
9.0 References


Tables
## Table 1 – Groundwater Monitoring Requirements

<table>
<thead>
<tr>
<th>Well Nomenclature</th>
<th>Constituents and Parameters</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Arsenic</td>
<td>Copper</td>
</tr>
<tr>
<td></td>
<td>Barium</td>
<td>Iron</td>
</tr>
<tr>
<td></td>
<td>Boron</td>
<td>Lead</td>
</tr>
<tr>
<td></td>
<td>Cadmium</td>
<td>Manganese</td>
</tr>
<tr>
<td></td>
<td>Chloride</td>
<td>Mercury</td>
</tr>
</tbody>
</table>

Note: Frequency: February, June, October
## TABLE 2 – EXCEEDANCES OF 2L STANDARDS FEBRUARY 2011 – JUNE 2014

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Boron</th>
<th>Iron</th>
<th>Manganese</th>
<th>pH</th>
<th>Sulfate</th>
<th>Total Dissolved Solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>µg/L</td>
<td>µg/L</td>
<td>µg/L</td>
<td>SU</td>
<td>mg/L</td>
<td>mg/L</td>
</tr>
<tr>
<td>2L Standard</td>
<td>700</td>
<td>300</td>
<td>50</td>
<td>6.5 - 8.5</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Well ID</td>
<td>Range of Exceedances</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW-4</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
<td>5.5 – 6.0</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-4D</td>
<td>No Exceedances</td>
<td>376</td>
<td>No Exceedances</td>
<td>5.9 – 6.2</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-10S</td>
<td>No Exceedances</td>
<td>373 – 616</td>
<td>65</td>
<td>5.1 – 5.7</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-10D</td>
<td>No Exceedances</td>
<td>371 – 406</td>
<td>59 – 97</td>
<td>6.2 – 6.4</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-11S</td>
<td>No Exceedances</td>
<td>324 – 467</td>
<td>No Exceedances</td>
<td>5.9 – 6.4</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-11D</td>
<td>No Exceedances</td>
<td>325 – 839</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-12S</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
<td>54 – 127</td>
<td>4.9 – 5.7</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-12D</td>
<td>No Exceedances</td>
<td>305 – 970</td>
<td>No Exceedances</td>
<td>5.9 – 6.4</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-13S</td>
<td>No Exceedances</td>
<td>324 – 1,470</td>
<td>54</td>
<td>5.8 – 6.3</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-13D</td>
<td>Exceedances</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
<td>5.9 – 6.4</td>
<td>No Exceedances</td>
<td>No Exceedances</td>
</tr>
<tr>
<td>MW-14S</td>
<td>3,190 – 4,530</td>
<td>322 – 1,270</td>
<td>66 – 192</td>
<td>5.2 – 5.5</td>
<td>280 – 400</td>
<td>570 – 650</td>
</tr>
<tr>
<td>MW-14D</td>
<td>2,750 – 3,660</td>
<td>No Exceedances</td>
<td>51 – 73</td>
<td>5.3 – 5.6</td>
<td>270 – 310</td>
<td>510 – 540</td>
</tr>
</tbody>
</table>
## TABLE 3 – ENVIRONMENTAL EXPLORATION AND SAMPLING PLAN

**MARSHALL STEAM STATION**

<table>
<thead>
<tr>
<th>Exploration Area</th>
<th>Soil Borings</th>
<th>Shallow Monitoring Wells</th>
<th>Deep Monitoring Wells</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boring IDs</td>
<td>Quantity</td>
<td>Estimated Boring Depth (ft bgs)</td>
<td>Well IDs</td>
</tr>
<tr>
<td>Ash Basin</td>
<td>AB-1 through AB-21, SB-1 through SB-5</td>
<td>26</td>
<td>40-90</td>
<td>AB-1S through AB-21S</td>
</tr>
<tr>
<td>Ash Landfill</td>
<td>AL-1 through AL-4</td>
<td>4</td>
<td>65-115</td>
<td>AL-1S, AL-2S, AL-3S</td>
</tr>
<tr>
<td>Beyond Waste Boundary</td>
<td>N/A</td>
<td>0</td>
<td>N/A</td>
<td>GWA-1S through GWA-7S</td>
</tr>
<tr>
<td>Background</td>
<td>BG-1, BG-2, and BG-3</td>
<td>3</td>
<td>55-105</td>
<td>BG-1S, BG-2S, and BG-3S</td>
</tr>
</tbody>
</table>

**Notes:**
1. Estimated boring and well depths based on data available at the time of work plan preparation and subject to change based on site-specific conditions in the field.
2. Laboratory analyses of soil, ash, groundwater, and surface water samples will be performed in accordance with the constituents and methods identified in Tables 4 and 5.
3. Additionally, soils will be tested in the laboratory to determine grain size (with hydrometer), specific gravity, and permeability.
4. During drilling operations, downhole testing will be conducted to determine in-situ soil properties such as horizontal and vertical hydraulic conductivity.
5. Actual number of field and laboratory tests will be determined in field by Field Engineer or Geologist in accordance with project specifications.
### TABLE 4 – SOIL AND ASH PARAMETERS AND ANALYTICAL METHODS

<table>
<thead>
<tr>
<th>INORGANIC COMPOUNDS</th>
<th>UNITS</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>mg/kg</td>
<td>EPA 6020</td>
</tr>
<tr>
<td>Arsenic</td>
<td>mg/kg</td>
<td>EPA 6020</td>
</tr>
<tr>
<td>Barium</td>
<td>mg/kg</td>
<td>EPA 6010</td>
</tr>
<tr>
<td>Boron</td>
<td>mg/kg</td>
<td>EPA 6010</td>
</tr>
<tr>
<td>Cadmium</td>
<td>mg/kg</td>
<td>EPA 6020</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/kg</td>
<td>SM4500-Cl-E</td>
</tr>
<tr>
<td>Chromium</td>
<td>mg/kg</td>
<td>EPA 6010</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/kg</td>
<td>EPA 6010</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/kg</td>
<td>EPA 6010</td>
</tr>
<tr>
<td>Lead</td>
<td>mg/kg</td>
<td>EPA 6020</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/kg</td>
<td>EPA 6010</td>
</tr>
<tr>
<td>Mercury</td>
<td>mg/kg</td>
<td>EPA Method 7470A/7471</td>
</tr>
<tr>
<td>Nickel</td>
<td>mg/kg</td>
<td>EPA 6010</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>EPA 9045</td>
</tr>
<tr>
<td>Selenium</td>
<td>mg/kg</td>
<td>EPA 6020</td>
</tr>
<tr>
<td>Thallium (low level)</td>
<td>mg/kg</td>
<td>EPA 6020</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg/kg</td>
<td>EPA 6010</td>
</tr>
</tbody>
</table>

**Notes:**

1. Soil samples to be analyzed for Total Inorganics using USEPA Methods 6010/6020 and pH using USEPA Method 9045, as noted above.
2. Ash samples to be analyzed for Total Inorganics using USEPA Methods 6010/6020 and pH using USEPA Method 9045; select ash samples will also be analyzed for leaching potential using SPLP Extraction Method 1312 in conjunction with USEPA Methods 6010/6020. SPLP results to be reported in units of mg/L for comparison to 2L Standards.
### TABLE 5 – GROUNDWATER AND SURFACE WATER PARAMETERS AND ANALYTICAL METHODS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UNITS</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIELD PARAMETERS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>Field Water Quality Meter</td>
</tr>
<tr>
<td>Specific Conductance</td>
<td>mmho/cm</td>
<td>Field Water Quality Meter</td>
</tr>
<tr>
<td>Temperature</td>
<td>ºC</td>
<td>Field Water Quality Meter</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>mg/L</td>
<td>Field Water Quality Meter</td>
</tr>
<tr>
<td>Oxidation Reduction Potential</td>
<td>mV</td>
<td>Field Water Quality Meter</td>
</tr>
<tr>
<td><strong>NPDES CONSTITUENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antimony</td>
<td>µg/L</td>
<td>EPA 200.8 or 6020</td>
</tr>
<tr>
<td>Arsenic</td>
<td>µg/L</td>
<td>EPA 200.8 or 6020</td>
</tr>
<tr>
<td>Barium</td>
<td>µg/L</td>
<td>EPA 200.7 or 6010</td>
</tr>
<tr>
<td>Boron</td>
<td>µg/L</td>
<td>EPA 200.7 or 6010</td>
</tr>
<tr>
<td>Cadmium</td>
<td>µg/L</td>
<td>EPA 200.8 or 6020</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>EPA 300.0</td>
</tr>
<tr>
<td>Chromium</td>
<td>µg/L</td>
<td>EPA 200.7 or 6010</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/L</td>
<td>EPA 200.7 or 6010</td>
</tr>
<tr>
<td>Iron</td>
<td>µg/L</td>
<td>EPA 200.7 or 6010</td>
</tr>
<tr>
<td>Lead</td>
<td>µg/L</td>
<td>EPA 200.8 or 6020</td>
</tr>
<tr>
<td>Manganese</td>
<td>µg/L</td>
<td>EPA 200.7 or 6010</td>
</tr>
<tr>
<td>Mercury</td>
<td>µg/L</td>
<td>EPA 245.1</td>
</tr>
<tr>
<td>Nickel</td>
<td>µg/L</td>
<td>EPA 200.7 or 6010</td>
</tr>
<tr>
<td>Nitrate as Nitrogen</td>
<td>mg-N/L</td>
<td>EPA 300.0</td>
</tr>
<tr>
<td>Selenium</td>
<td>µg/L</td>
<td>EPA 200.8 or 6020</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>EPA 300.0</td>
</tr>
<tr>
<td>Thallium (low level)</td>
<td>µg/L</td>
<td>EPA 200.8 or 6020</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>EPA 160.1 or SM 2540C</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg/L</td>
<td>EPA 200.7 or 6010</td>
</tr>
<tr>
<td><strong>ADDITIONAL GROUNDWATER CONSTITUENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkalinity (as CaCO3)</td>
<td>mg/L</td>
<td>SM2320B</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/L</td>
<td>EPA 200.7</td>
</tr>
<tr>
<td>Ferrous Iron</td>
<td>mg/L</td>
<td>SM4500-Fe</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/L</td>
<td>EPA 200.7</td>
</tr>
<tr>
<td>Potassium</td>
<td>mg/L</td>
<td>EPA 200.7</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg/L</td>
<td>EPA 200.7</td>
</tr>
<tr>
<td>Sulfide</td>
<td>mg/L</td>
<td>SM4500S-F</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>mg/L</td>
<td>SM5310</td>
</tr>
</tbody>
</table>

Note:
1. Select constituents may be analyzed for total and dissolved concentrations.
Appendix A

August 13, 2014

CERTIFIED MAIL 7004 2510 0000 3651 1168
RETURN RECEIPT REQUESTED

Paul Newton
Duke Energy
526 South Church Street
Charlotte, NC 28202

Subject: Notice of Regulatory Requirements
Title 15A North Carolina Administrative Code (NCAC) 02L .0106
14 Coal Ash Facilities in North Carolina

Dear Mr. Newton:

Chapter 143, North Carolina General Statutes, authorizes and directs the Environmental Management Commission of the Department of Environment and Natural Resources to protect and preserve the water and air resources of the State. The Division of Water Resources (DWR) has the delegated authority to enforce adopted pollution control rules.

Rule 15A NCAC 02L .0103(d) states that no person shall conduct or cause to be conducted any activity which causes the concentration of any substance to exceed that specified in 15A NCAC 02L .0202. As of the date of this letter, exceedances of the groundwater quality standards at 15A NCAC 02L .0200 Classifications and Water Quality Standards Applicable to the Groundwaters of North Carolina have been reported at each of the subject coal ash facilities owned and operated by Duke Energy (herein referred to as Duke).

Groundwater Assessment Plans

No later than September, 26 2014 Duke Energy shall submit to the Division of Water Resources plans establishing proposed site assessment activities and schedules for the implementation, completion, and submission of a comprehensive site assessment (CSA) report for each of the following facilities in accordance with 15A NCAC 02L .0106(g):

- Asheville Steam Electric Generating Plant
- Belews Creek Steam Station
- Buck Steam Station
- Cape Fear Steam Electric Generating Plant
- Cliffside Steam Station
Dan River Combined Cycle Station
H.F. Lee Steam Electric Plant
Marshall Steam Station
Mayo Steam Electric Generating Plant
Plant Allen Steam Station
Riverbend Steam Station
Roxboro Steam Electric Generating Plant
L.V. Sutton Electric Plant
Weatherspoon Steam Electric Plant

The site assessment plans shall include a description of the activities proposed to be completed by Duke that are necessary to meet the requirements of 15A NCAC 02L .0106(g) and to provide information concerning the following:

(1) the source and cause of contamination;
(2) any imminent hazards to public health and safety and actions taken to mitigate them in accordance to 15A NCAC 02L .0106(f);
(3) all receptors and significant exposure pathways;
(4) the horizontal and vertical extent of soil and groundwater contamination and all significant factors affecting contaminant transport; and
(5) geological and hydrogeological features influencing the movement, chemical, and physical character of the contaminants.

For your convenience, we have attached guidelines detailing the information necessary for the preparation of a CSA report. The DWR will review the plans and provide Duke with review comments, either approving the plans or noting any deficiencies to be corrected, and a date by which a corrected plan is to be submitted for further review and comment or approval. For those facilities for which Duke has already submitted groundwater assessment plans, please update your submittals to ensure they meet the requirements stated in this letter and referenced attachments and submit them with the others.

Receptor Survey

No later than October 14th, 2104 as authorized pursuant to 15A NCAC 02L .0106(g), the DWR is requesting that Duke perform a receptor survey at each of the subject facilities and submitted to the DWR. The receptor survey is required by 15A NCAC 02L .0106(g) and shall include identification of all receptors within a radius of 2,640 feet (one-half mile) from the established compliance boundary identified in the respective National Pollutant Discharge Elimination System (NPDES) permits. Receptors shall include, but shall not be limited to, public and private water supply wells (including irrigation wells and unused or abandoned wells) and surface water features within one-half mile of the facility compliance boundary. For those facilities for which Duke has already submitted a receptor survey, please update your submittals to ensure they meet the requirements stated in this letter and referenced attachments and submit them with the others. If they do not meet these requirements, you must modify and resubmit the plans.
The results of the receptor survey shall be presented on a sufficiently scaled map. The map shall show the coal ash facility location, the facility property boundary, the waste and compliance boundaries, and all monitoring wells listed in the respective NPDES permits. Any identified water supply wells shall be located on the map and shall have the well owner’s name and location address listed on a separate table that can be matched to its location on the map.

Failure to comply with the State’s rules in the manner and time specified may result in the assessment of civil penalties and/or the use of other enforcement mechanisms available to the State.

We appreciate your attention and prompt response in this matter. If you have any questions, please feel free to contact S. Jay Zimmerman, Water Quality Regional Operations Section Chief, at (919) 807-6351.

Sincerely,

John E. Skvarla, III

Attachment enclosed

cc: Thomas A. Reeder, Director, Division of Water Resources
Regional Offices – WQROS
File Copy
GUIDELINES FOR COMPREHENSIVE SITE ASSESSMENT

This document provides guidelines for those involved in the investigation of contaminated soil and/or groundwater, where the source of contamination is from:

- Incidents caused by activities subject to permitting under G.S. 143-215.1
- Incidents caused by activities subject to permitting under G.S. 87-88
- Incidents arising from agricultural operations, including application of agricultural chemicals, but not including unlawful discharges, spills or disposal of such chemicals

Comprehensive Site Assessment (CSA)

NOTE: Regional Offices may request additional information in support of the CSA to aid in their review and will not approve the CSA if any of the elements specified below have not been included or have not been sufficiently addressed

Minimum Elements of the Comprehensive Site Assessment Report:
A. Title Page
   - Site name, location and Groundwater Incident number (if assigned) and Permit Number;
   - Date of report;
   - Responsible Party and/or permittee, including address and phone number;
   - Current property owner including address and phone number;
   - Consultant/contractor information including address and phone number;
   - Latitude and longitude of the facility; and
   - Seal and signature of certifying P.E. or P.G., as appropriate.

B. Executive Summary
The Executive Summary should provide a brief overview of the pertinent site information (i.e., provide sufficient information to acquaint the reader with the who, what, when, where, why and how for site activities to date).

1. Source information:
   - Type of contaminants
2. Initial abatement/emergency response information.
3. Receptor information:
   - Water supply wells;
   - Public water supplies (wells, surface water intakes);
   - Surface water bodies;
   - Wellhead protection areas;
   - Deep aquifers in the Coastal Plain physiographic region;
   - Subsurface structures; and
   - Land use.

4. Sampling/investigation results:
   - Nature and extent of contamination;
   - Maximum contaminant concentrations;
   - Site hydrogeology.

5. Conclusions and recommendations.

C. Table of Contents
   - First page number for each section listed.
   - List of figures (all referenced by number and placed in a single section following contents text).
   - List of tables (all referenced by number and placed in a single section following contents text).
   - List of appendices.

D. Site History and Source Characterization
   - Provide a history of property ownership and use. Indicate dates of ownership, uses of the site, and potential sources of contaminants.
   - Discuss the source(s) of contamination, including primary and secondary sources.
   - For permitted activities, describe nature of activity, permitted waste, application of all instances of over-application/irrigation of wastes or water
   - Summarize assessment activities and corrective actions performed to date including emergency response, initial abatement, primary and secondary source removal.
   - Discuss geographical setting and present/future surrounding land uses.

E. Receptor Information
   - Provide a site map showing labeled well locations within a
minimum of 1500 feet of the known extent of contamination. Key to the table and maps described.

**NOTE:** *As the known extent of contamination changes, the receptor survey must be updated to reflect the change. This applies throughout the Receptor Information section.*

- In table format, list all water supply wells, public or private, including irrigation wells and unused wells, (omit those that have been properly abandoned in accordance with 15A NCAC 2C .0100) within a minimum of 1500 feet of the known extent of contamination. Note whether well users are also served by a municipal water supply.
- For each well, include well number, well owner and user names, addresses and telephone numbers, use of the well, well depth, well casing depth, well screen interval, and distance from source of contamination;

**NOTE:** *It will often be necessary to conduct any or all of the following in order to ensure reliability in a water supply well survey:*

  - Call the city/county water department to inquire about city water connections;
  - Visit door-to-door (make sure that you introduce yourself and state your purpose to residents prior to examining their property) to obtain accurate description of water usage, and if some residents are not at home, ask surrounding neighbors who are home about the water usage at those residences. *Even if a public water line is available, some residents still use their well water and are not connected to the public water system; and*
  - Search for water meters and well houses.

- Site map showing location of subsurface structures (e.g., sewers, utility lines, conduits, basements, septic tanks, drain fields, etc.) within a minimum of 1,500 feet of the known extent of contamination;
- Table of surrounding property owner addresses;
- Discuss the availability of public water supplies within a minimum of 1,500 feet of the source area, including the distance and location to the nearest public water lines and the source(s) of the public water supply;
- Identify all surface water bodies (e.g., ditch, pond, stream, lake, river) within a minimum of 1,500 feet of the source of contamination;
- Determine the location of any designated wellhead protection areas as defined in 42 USC 300h-7(e) within a minimum of 1,500 feet of the source of contamination. Identify and discuss the location of the water supply well(s) for which the area was designated a wellhead protection area, and the extent of the protected area. Include information about the well owner, well-construction specifications (especially at screened intervals), pumping rate and pumping schedule. Information regarding designated wellhead protection areas may be obtained by contacting the Public Water Supply Section at (919) 707-9083;
- Discuss the uses and activities (involving possible human exposure to contamination) that could occur at the site and adjacent properties. Examples of such activities and uses include but are not limited to use of a property for an office, manufacturing operation, residence, store, school, gardening or farming activities, recreational activities, or undeveloped land;
- Determine whether the contaminated area is located in an area where there is recharge to an unconfined or semi-confined deeper aquifer that is being used or may be used as a source of drinking water. Based on a review of scientific literature on the regional hydrogeology and well construction records and lithological logs for deeper wells in the area, identify and describe the deep aquifers underlying the source of contamination. Include information on the depth of the deep aquifer in relation to the surficial saturated zone, the lithology and hydraulic conductivity of the strata between the surficial aquifer and the deeper aquifer, and the difference in groundwater head between the surficial aquifer and the deeper aquifer. Discuss the local and regional usage of the deep aquifer and the draw down from major pumping influences. Also, specify the distance from the source of contamination to major discharge areas such as streams and rivers. Cite all sources and references used for this discussion.

NOTE: This requirement (last bullet) only pertains to
contamination sources in the Coastal Plain physiographic region as designated on a map entitled “Geology of North Carolina” published by the Department in 1985. However, recharge/discharge, hydraulic conductivity, lithology, head difference, etc. is also important information at mountains and piedmont sites.

F. Regional Geology and Hydrogeology

Provide a brief description of the regional geology and hydrogeology. Cite all references.

G. Site Geology and Hydrogeology

- Describe the soil and geology encountered at the site. Use the information obtained during assessment activities (e.g., lithological descriptions made during drilling, probe surveys, etc.). This information should correspond to the geologic cross sections required in N. below; and
- Based on the results of the groundwater investigation, describe the site hydrogeology, including a discussion of groundwater flow direction, hydraulic gradient, hydraulic conductivity and groundwater velocity. Discuss the effects of the geologic and hydrogeological characteristics on the migration, retardation, and attenuation of contaminants.

H. Soil Sampling Results

Using figures and tables to the extent possible, describe all soil sampling performed to date and provide the rationale for sample locations, number of samples collected, etc. Include the following information:

- Location of soil samples;
- Date of sampling;
- Type of soil samples (from excavation, borehole, Geoprobe, etc.);
- Soil sample collection procedures (split spoon, grab, hand auger, etc.)
- Depth of soil samples below land surface;
- Soil sample identification
- Soil sample analyses;
- Soil sample analytical results (list any contaminant detected above the method detection limit); and
Identify any sample analytical results that exceed the applicable cleanup levels.

NOTE: Information related to H. above should correspond to the sampling location and sampling results maps required in N. below.

I. Groundwater Sampling Results

Using figures and tables to the extent possible describe the groundwater sampling performed to date and provide the rationale for sample locations (based on source and contaminant type), number of samples collected, etc. Include the following information:

- Location of groundwater samples and monitoring wells;
- Date of sampling;
- Groundwater sample collection procedures (bailer, pump, etc.);
- Groundwater sample identification and whether samples were collected during initial abatement, CSA, etc.;
- Groundwater sample analyses;
- Groundwater sample analytical results (list any contaminant detected above the method detection limit; and
- Identify all sample analytical results that exceed 15A NCAC 2L or interim standards.

NOTE: Information related to I. above should correspond to the sampling location and sampling results maps required in N. below.

J. Hydrogeological Investigation

Describe the hydrogeological investigation performed including all methods, procedures and calculations used to characterize site hydrogeological conditions. The following information should be discussed and should correspond to the maps and figures required below:

- Groundwater flow direction;
- Hydraulic gradient (horizontal and vertical);
- Hydraulic conductivity;
- Groundwater velocity;
- Contaminant velocity;
- Slug test results; *
- Aquifer test results; *
- Plume's physical and chemical characterization; and
- Fracture trace study if groundwater in bedrock is impacted.
* Check with the Regional Office prior to performing these tests and study to see if necessary for the site.

K. Groundwater Modeling Results

Groundwater modeling or predictive calculations may be necessary at some sites (source area proximate to surface water, source area located within wellhead protection area or source area overlying semi-confined or unconfined deeper Coastal Plain aquifer) to verify, based on site specific hydrogeological conditions, whether groundwater contamination poses a risk to receptors. For contamination shown to pose a risk to receptors, groundwater modeling may be necessary to determine an appropriate cleanup level for contaminated groundwater. Modeling should illustrate the input data used to complete the model and will generally be required for natural attenuation proposals (see Groundwater Modeling Policy at http://portal.ncdenr.org/web/wq/aps/gwpro/policy).

NOTE: Input data for models should be derived from site specific information with limited assumptions or estimates. All assumptions and estimated values including biodegradation rates must be conservative (predict reasonable worst-case scenarios) and must be well documented.

L. Discussion

- Nature and extent of contamination, including primary and secondary source areas, and impacted groundwater and surface water resources;
- Maximum contaminant concentrations;
- Contaminant migration and potentially affected receptors

M. Conclusions and Recommendations

If corrective action will be necessary, provide a preliminary evaluation of remediation alternatives appropriate for the site. Discuss the remediation alternatives likely to be selected. Note that for impacts to groundwater associated with permitted activities, corrective action pursuant to 15A NCAC 2L .0106(k), (l) and (m) is not applicable, unless provided for pursuant to 15A NCAC 2L .0106(c) and (e) or through a variance from the Environmental Management Commission (EMC).

N. Figures

- 7 1/2 minute USGS topographic quadrangle map showing an area
within a minimum of a 1,500-foot radius of the source of contamination and depicting the site location, all water supply wells, public water supplies, surface water intakes, surface water bodies, designated well head protection areas, and areas of recharge to deeper aquifers in the Coastal Plain that are or may be used as a source for drinking water;

- Site map locating source areas, site boundaries, buildings, all water supply wells within a minimum of 1,500 feet, named roads/easements/right-of-ways, subsurface utilities, product or chemical storage areas, basements and adjacent properties, scale and north arrow;

- At least two geologic cross sections through the saturated and unsaturated zones intersecting at or near right angles through the contaminated area using a reasonable vertical exaggeration. Indicate monitoring well/sample boring/sample locations and analytical results for soil samples. Identify the depth to the water table. Provide a site plan showing the locations of the cross sections;

- Site map(s) showing the results of all soil sampling conducted. Indicate sampling identifications, sampling depths, locations and analytical results;

- Site map(s) showing the results of all groundwater sampling conducted. Indicate sampling locations, monitoring well identifications, sample identifications, and analytical results;

- Separate groundwater contaminant iso-concentration contour maps showing total volatile organic compound concentrations, total semi-volatile organic compound concentrations and concentrations for the most extensive contaminant. Maps should depict the horizontal and vertical extent. Contour line for applicable 2L standard should be shown in bold;

- Site map(s) showing the elevation of groundwater in the monitoring wells and the direction of groundwater flow. Contour the groundwater elevations. Identify and locate the datum (arbitrary
100', USGS, NGVD) or benchmark. Indicate the dates that water level measurements were made. There should be one map for each series of water level measurements obtained;

- Groundwater contaminant iso-concentration contour cross-section; and

- Site map(s) showing the monitoring wells.

**NOTE:**  *If possible, use a single base map to prepare site maps using a map scale of 1 inch = 40 feet (or a smaller scale for large sites, if necessary). Maps and figures should include conventional symbols, notations, labeling, legends, scales, and north arrows and should conform to generally accepted practices of map presentation such as those enumerated in the US Geological Survey pamphlet, "Topographic Maps".*

O. Tables

- List all water supply wells, public or private, including irrigation wells and unused wells, (omit those that have been properly abandoned in accordance with 15A NCAC 2C .0100) within a minimum of 1500 feet of the known extent of contamination. For each well, include the well number (may use the tax map number), well owner and user names, addresses and telephone numbers, use of the well, well depth, well casing depth, well screen interval and distance from the source of contamination;

- List the names and addresses of property owners and occupants within or contiguous to the area containing contamination and all property owners and occupants within or contiguous to the area where the contamination is expected to migrate;

- List the results for groundwater samples collected including sample location; date of sampling; sample collection procedures (bailer, pump, etc.); sample identifications; sample analyses; and sample analytical results (list any contaminant detected above the method detection limit in bold); and

- List for each monitoring well, the monitoring well identification
numbers, date water levels were obtained, elevations of the water levels, the land surface, top of the well casing, screened interval and bottom of the well.

P Appendices

- Boring logs and lithological descriptions;
- Well construction records;
- Standard procedures used at site for sampling, field equipment decontamination, field screening, etc.;
- Laboratory reports and chain-of-custody documents;
- Copies of any permits or certificates obtained, permit number, permitting agency, and
- Modeling data and results;
- Slug/pumping test data; and
- Certification form for CSA
DIVISION OF WATER RESOURCES
Certification for the Submittal of a Comprehensive Site Assessment

Responsible Party and/or Permitee: _________________________________
Contact Person: __________________________________________________
Address: __________________________________________________________
City: ___________________ State: _______ Zip Code: _______

Site Name: _________________________________________________________
Address: __________________________________________________________
City: ___________________ State: _______ Zip Code: _______

Groundwater Incident Number (applicable): _______________

I, __________________________________, a Professional Engineer/Professional Geologist
(circle one) for __________________________(firm or company of employment) do hereby certify that the information indicated below is
enclosed as part of the required Comprehensive Site Assessment (CSA) and that
to the best of my knowledge the data, assessments, conclusions,
recommendations and other associated materials are correct, complete and
accurate.

(Each item must be initialed by the certifying licensed professional)

1. ___________ The source of the contamination has been identified. A list of all
potential
   sources of the contamination are attached.

2. ___________ Imminent hazards to public health and safety have been identified.

3. ___________ Potential receptors and significant exposure pathways have been
   identified.

4. ___________ Geological and hydrogeological features influencing the movement
   of groundwater have been identified. The chemical and physical character of the
   contaminants have been identified.

5. ___________ The CSA sufficiently characterizes the cause, significance and
   extent of groundwater and soil contamination such that a Corrective Action Plan
   can be developed. If any of the above statements have been altered or items not
   initialed, provide a detailed explanation. Failure to initial any item or to provide
   written justification for the lack thereof will result in immediate return of the CSA to
   the responsible party.

(Please Affix Seal and Signature)