ASHEVILLE STEAM ELECTRIC PLANT
EXECUTIVE SUMMARY

On August 20, 2014, the North Carolina General Assembly passed Session Law 2014-122, the Coal Ash Management Act of 2014 (CAMA). Section § 130A-309.211 of the act requires the owner of a coal combustion residuals surface impoundment to submit a Groundwater Assessment Work Plan (GAP or Work Plan) to the North Carolina Department of Environment and Natural Resources (NCDENR) no later December 31, 2014 and a Groundwater Assessment Report (herein referred to as a Comprehensive Site Assessment [CSA]) no later than 180 days following approval of the Work Plan. Duke Energy Progress, LLC (Duke Energy) submitted a Work Plan to NCDENR for assessment and characterization of the Asheville Steam Electric Plant (Asheville Plant, Plant or Site) ash basin and ash storage areas on December 30, 2014. The Work Plan was subsequently conditionally approved by the NCDENR in correspondence dated February 24, 2015. This CSA report was prepared to comply with CAMA and is submitted to NCDENR within the allotted 180 day timeframe. Data generated during the CSA will be used in development of the Corrective Action Plan (CAP), due 90 days after submittal of this CSA.

The purpose of this CSA is to characterize the extent of contamination resulting from historical production and storage of coal ash, evaluate the chemical and physical characteristics of the contaminants, investigate the geology and hydrogeology of the Site including factors relating to contaminant transport, and examine risk to potential receptors and exposure pathways.

NCDENR prescribed the list of monitoring parameters to be measured at the Asheville Plant. Following receipt of the data, parameters were evaluated to assess those most relevant for the Site. These parameters were determined by examining data from monitoring wells installed in ash and seeps that drain from the ash, and then by comparing these results to the North Carolina Groundwater Quality Standards found in the North Carolina Administrative Code Title 15A, Subchapter 2L.0202 (2L or 2L Standards) and the Interim Maximum Allowable Concentrations (IMAC) established by NCDENR pursuant to 15A NCAC 02L.0202(c). If a constituent concentration exceeded the North Carolina Groundwater Quality Standards in ash pore water wells, as specified in the 2L Standards or the IMACs, it has been designated as a "Constituent of Interest" (COI). COIs are constituents that display correlation to ash basin influence. Some COIs are also present in background monitoring wells and thus require careful examination to determine whether their presence on the downgradient side of the basins is from natural sources (*e.g.*, rock and soil) or the ash basin.

The IMACs were issued in 2010, 2011 and 2012; however NCDENR has not established a 2L for these constituents as described in 15A NCAC 02L.0202(c). For this reason, IMACs noted in this report are for reference only.

The assessment addresses the horizontal and vertical extent of COIs in soil and groundwater. Significant factors affecting constituent transport, and the geological and hydrogeological features influencing the movement, as well as the chemical and physical character of the COIs were evaluated.

Data presented in this assessment report will be the basis for the Corrective Action Plan required within 270 days of the approved work plan to identify alternative strategies to address groundwater impacts at the Site.

In accordance with Sections 3(b) and (c) of CAMA (Session Law 2014-122), Duke Energy will fully excavate the ash basins at the Site, with the material to be safely recycled or reused in a lined structural fill or disposed in a lined landfill. The Corrective Action Plan will include groundwater modeling results of the anticipated ash removal to assess the effects on groundwater. A groundwater monitoring plan will be provided to assess changes in groundwater conditions over time.

Based on the scientific evaluation of historical and new groundwater assessment data presented in this report, the following conclusions are drawn:

- No imminent hazard to human health or the environment has been identified as a result of groundwater migration from the ash basins.
- Recent groundwater assessment results are consistent with previous results from historical and routine compliance boundary monitoring well data.
- Upgradient, background monitoring wells contain naturally occurring metals and other COIs at concentrations greater than 2L or IMAC concentrations. This information is used to evaluate whether concentrations in groundwater downgradient of the basins are also naturally occurring or might be influenced by migration of constituents from the ash basin.
- The historical and new groundwater assessment data indicate the aerial extent of impacted groundwater is limited to within the property boundary with the exception of an area under I-26.
- Groundwater in the surficial aquifer under the ash basin flows horizontally and vertically to the west and discharges into the French Broad River. The river, with

tributaries to the north and south of the Site, provide hydrogeologic boundaries for groundwater migration.

- Boron is the primary constituent that can be identified at concentrations greater than background concentrations and the 2L concentration in a three dimensional area beneath and west (downgradient) of the ash basin in the surficial, transition, and bedrock aquifers.
- Leakage from the lined flue gas desulfurization (FGD) wastewater treatment wetlands was detected as evidenced by elevated FGD blowdown-related constituents (e.g. chloride) to the northwest of the 1964 ash basin.
- Groundwater modeling to be provided with the Corrective Action Plan will be used to evaluate the effects of the planned ash excavation.
- The approximate extent of horizontal migration of boron in the surficial aquifer is shown on **Figure ES-1**.

Brief summaries of the essential portions of the Comprehensive Site Assessment Report are presented in the following sections.

ES1. Source Information

Duke Energy Progress, LLC. (Duke Energy) owns and operates the Asheville Steam Electric Plant (Asheville Plant) located near Asheville, in Buncombe County, North Carolina. The Asheville Plant commenced operations in 1964 and is currently operational. Mineralogical, physical, and chemical properties of the Asheville Plant ash basins have been characterized for use in the hydrogeological Site Conceptual Model (SCM). The ash basins were developed near original ground surface with excavation of Site soils for construction of the earthen dams. The ash basins are situated upgradient of the French Broad River and occupy two former tributary valleys. Ash pore water is connected with the surficial aquifer and underlying transition zone and fractured bedrock flow systems. Groundwater flow is toward the west and discharging into the French Broad River.

ES2. Initial Abatement and Emergency Response

Duke Energy is currently planning to fully excavate the ash basins in accordance with CAMA requirements with the material safely recycled or reused in a lined structural fill or disposed in a lined landfill. Plans are underway to provide an alternate water supply to nearby residences by extending a water line along Bear Leah Trail. This

project is expected to be complete in early fall of 2015. Excavation of the 1982 ash basin has been on-going since 2007.

ES3. Receptor Information

The Asheville Plant lies in a developed area approximately eight (8) miles southeast of Asheville, North Carolina. Surrounding property uses include residential, commercial, industrial and agricultural. Commercial and residential development dominates the land use north and south of the property. Lake Julian is located east of the Plant and I-26 and the French Broad River are located to the west.

ES.3-1 Public Water Supply Wells

Public water supply wells are located more than two miles from the Site. These well locations are upgradient, side gradient or separated by a groundwater discharge area (French Broad River) from the Asheville Plant. These production wells are separated by topographic and groundwater divides; therefore, the likelihood that groundwater from the Asheville Plant could be within the drawdown zone of a well more than two miles away is extremely low.

ES.3-2 Private Water Supply Wells

Inventories of public and private water supply wells have been compiled. NCDENR contacted nearby residents regarding private wells and managed the sampling of the wells in accordance with CAMA. Water quality data indicate that manganese, sulfate, and total dissolved solids (TDS) have been detected in water from drinking water supply wells located on the west side of the French Broad River from the Site. Elevated concentrations of iron and manganese are cited in a USGS report as being the most common water quality issue in the Blue Ridge and Piedmont Provinces (Daniel and Dahlen, 2002). The same study indicates high sulfate (higher than the 2L) and TDS concentrations are interrelated and are common with water from deep supply wells.

ES.3-3 Human and Ecological Receptors

Consumption of groundwater, recreational use of affected surface water, and consumption of fish and game affected by contaminants are the primary exposure pathways for humans in the vicinity of the ash basins.

Constituents of potential concern (COPCs) for human and ecological receptors identified using screening level risk assessment methodology for receiving areas at the Site include pH, aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chloride, chromium, cobalt, copper, iron, manganese, mercury, molybdenum, nickel, nitrate (as N), selenium, sulfate, thallium, TDS, vanadium,

and zinc. This list is longer than the list of site specific COIs due to the conservative approach of comparing analytical results to published reference criterion in the risk assessment screening process.

ES4. Sampling / Investigation Results

The Asheville CSA was implemented as planned with a few modifications in well placement due to access. Four wells were relocated due to underground utilities, overhead utilities, or unsuitable terrain. Well locations MW-21 and MW-22 were relocated to the I-26 right of way due to access not provided on private property. Wells were installed in each saturated zone that was of sufficient thickness to discretely monitor. **Figure ES-1** shows the horizontal extent of groundwater impact to the surficial aquifer which can be clearly attributed to migration of constituents from the ash basin. The distribution of boron in groundwater best represents the extent of impact. Other COIs (*e.g.*, cobalt, iron, manganese, and vanadium) are not useful due to their ubiquitous presence in samples from monitoring wells across the Site, including hydraulically upgradient, background wells.

ES.4-1 Nature and Extent of Contamination

Antimony, arsenic, boron, chromium, cobalt, iron, manganese, pH, sulfate, thallium, TDS and vanadium have been identified as Site-specific COIs based on exceedances of the 2L or IMAC in ash pore water. Other metals (e.g. beryllium, cadmium, nickel and selenium) have been detected above the 2L or IMAC and are addressed herein, but are not considered COIs due to apparent isolation from CCR leachate. For example, chloride is not present within ash pore water and is not a COI, yet this constituent exceeds the 2L in areas downgradient from the northwest corner of the 1964 ash basin and has been evaluated during this assessment.

Cobalt, iron, manganese, and vanadium are detected in groundwater at background locations at the Site. Calculation of proposed Site-specific background concentrations will occur when a sufficient number of samples to perform statistical analysis have been collected.

Data suggest antimony, arsenic, boron, chromium, sulfate, thallium, and TDS in groundwater are limited to an area beneath and west of the basins. The horizontal extent of migration is controlled by the French Broad River to the west, which acts as a major groundwater to surface water discharge zone.

Field observations and test results indicate that the fractured bedrock flow system is discontinuous across the Site. COIs have been detected in groundwater

within bedrock wells downgradient of the ash basins prior to discharging into the French Broad River.

ES.4-2 Maximum Contaminant Concentrations

For the COIs identified in groundwater, boron is the most prevalent constituent detected above the 2L and background concentrations. The highest concentration is detected in the surficial aquifer (saprolite) adjacent to the northwest corner of the 1964 ash basin. The extent of boron is defined to the downgradient portion of the Site between the ash basins and the French Broad River. Seep sampling results verify groundwater is emerging at the French Broad River, consistent with the current SCM. Refer to **Figure ES-1** for extent of boron concentrations in excess of the 2L concentration of 700 µg/L.

The highest concentration of thallium was detected near the northern waste boundary of the 1964 ash basin inside the Compliance Boundary.

An area of maximum concentrations of chloride, selenium, sulfate, and TDS was identified and defined during this assessment to the northwest of the 1964 ash basin. The concentrations in this area are influenced by the FGD wastewater treatment wetlands as evident by chemical analysis and hydraulic conditions in the area.

Highest detections of arsenic, beryllium, and nickel occurred in the saprolite below the 1964 ash basin. The CSA data indicate that these constituents have not migrated in groundwater from the immediate vicinity of the ash basin.

The highest concentration of antimony, chromium, and nitrate were identified near the southern corner of the 1982 basin. The CSA data indicate that these constituents have not migrated in groundwater from the immediate vicinity of the ash basin.

The highest concentration of cobalt was detected below the 1964 ash basin within the transition zone. Iron was detected at the highest level within a bedrock well along the French Broad River. Highest concentrations of manganese are found within the saprolite beneath the 1964 ash basin. The highest concentration of vanadium is found south of the 1982 basin. Cobalt, iron, manganese, and vanadium are detected in groundwater at Site background locations at concentrations greater than the 2L or IMAC. Calculation of proposed Site-specific background concentrations will occur when a sufficient number of samples to perform statistical analysis have been collected.

ES.4-3 Source Characterization

Data indicates the ash within the 1964 and 1982 ash basins is the primary source of COIs in nearby groundwater as shown on **Figure ES-1**. Naturally occurring concentrations of cobalt, iron, manganese, and vanadium that exceed the 2L or IMAC are found within Site background wells. Collectively these ash basins encompass 78 acres. Ash placement within the 1964 basin ceased in the early 80's and dewatering and excavation of ash from the 1982 basin began in 2007. Ash within the basins is between 36 and 59 feet thick. The bottom of the 1964 ash basin is approximately 2,094 feet msl and the 1982 basin 2,097 msl near the deepest portion of each basin. The basins continue to collect rainwater resulting in saturated conditions near the base. In June 2015, approximately 35 feet of saturated ash was measured in the 1964 basin. Dewatering of the 1982 basin to facilitate excavation currently controls the groundwater level, resulting in 20 feet of saturated ash measured in a small area of the basin not excavated at that time. The toes of the dams are designed to allow ash pore water to discharge. Recently the seepage flow through the dike from the 1964 basin was captured and routed through NPDES Outfall 001. The seepage flow below the 1982 basin continues to be monitored at an outfall structure with two weirs. The treatment wetlands appear to be a secondary source of constituents in the groundwater. Design information indicates it was lined. However, groundwater data from nearby wells indicate some leakage from the FGD wastewater treatment constructed wetlands.

ES.4-4 Receptor Survey

A receptor survey was conducted in accordance with CAMA during 2014 and has been updated herein with additional available information. During 2015, NCDENR managed the sampling of water supply wells in the area. Only manganese, sulfate, and TDS were reported at concentrations greater than 2L or IMAC. These constituents are known to cause water quality issues in the region and cannot be directly attributed to the ash basins.

The three closest public water supply wells are over two miles from the Site. Forty private supply wells have been identified within one half mile of the Site. These private well locations are upgradient, side gradient or separated by a groundwater discharge area (French Broad River) from the Asheville Plant. Five private water supply wells are located to the south of the Site and east of the French Broad River. These potential receptors are being mitigated by the installation of a municipal water supply line to these residences. This project is scheduled for completion by the fall of 2015.

ES.4-5 Regional Geology and Hydrogeology

The Blue Ridge Physiographic province is dominated by the Blue Ridge geologic belt. The Blue Ridge belt is an extensive thrust sheet separated from the Piedmont geologic belt on the southeast by the Brevard zone and bounded from the northwest by low angle thrust faults that have created the Valley and Ridge Physiographic province in eastern Tennessee. The Brevard zone is characterized by major faults trending SW-NE and associated cataclastic rocks with a typical dip toward the SE. This zone, as marked by two major thrust faults in the Skyland Quadrangle, passes approximately 1.3 miles to the southeast of the Site. In a general perspective, the area underwent folding and faulting along with several periods of metamorphism with igneous intrusion. Folding and faulting of the bedrock creates preferential pathways that impact both groundwater flow direction and velocity.

ES.4-6 Site Geology and Hydrogeology

Geology at the Site consists of overburden, also referred to as regolith, and metamorphic bedrock. In stream valleys, fluvial deposits, also referred to as alluvium, overlie the bedrock. The metamorphic bedrock, primarily schist and gneiss, tends to be exposed on the ground surface along topographic ridges, road cuts, and in stream or river valleys. Where metamorphic bedrock has been weathered into saprolite, silt, sand and clay are found overlying the bedrock. Due to the limited aerial and vertical extent of the alluvial deposits, alluvium and saprolite are both categorized in the surficial flow regime. The transition zone, a combination of partially weathered rock and saprolite, typically found above competent bedrock, can be a significant hydrogeologic feature in the system. Therefore, the transition zone is considered its own flow regime. The third flow regime encountered at the Asheville Plant is composed of fractured bedrock, which transports groundwater through secondary porosity. Each of the three described flow regimes (surficial, transition zone, and bedrock) are present at the Asheville Plant.

The groundwater table generally follows topography but will vary based on Site-specific factors. Hydraulic data indicate groundwater flows to the west towards the French Broad River. The first occurrence of water is heavily reliant upon the nature of regolith (if present), since it is the primary storage unit that feeds bedrock fractures. The regolith-fractured bedrock aquifer groundwater flow regime of the Asheville Plant is bounded on the south and west by an unnamed tributary and the French Broad River and to the north and east by Lake Julian

and Powell Creek, which flows west and empties in the French Broad adjacent to the NPDES Outfall 001.

ES.4-7 Existing Groundwater Monitoring Data

NPDES compliance groundwater monitoring data provide evidence that iron and manganese are consistently detected above 2L concentrations in background wells. Historical water level data indicate a lowering water table surface near the southeast corner of the 1982 basin coincident with the dewatering for the ash removal project.

ES.4-8 Development of Site Conceptual Model

The geologic and hydrogeologic framework for the Asheville Plant is consistent with the basic slope-aquifer system SCM as defined by LeGrand (2004). This hydrogeological SCM was developed with data generated during previous assessments and confirmed with the 2015 groundwater assessment activities. In general, the French Broad River and its tributaries are groundwater discharge zones for groundwater at the Site. Groundwater under the ash basin source area flows to the west towards the French Broad River where groundwater emerges as seeps. The highest concentrations of COIs in groundwater occur to the northwest of the 1964 ash basin and are likely due to leakage from the treatment wetlands. This is the result of impacted groundwater flowing in that direction.

The Asheville Plant is bordered to the east by Lake Julian, to the north by Powell Creek, to the south by an unnamed tributary and to the west by the French Broad River. Powell Creek flows south to north to the confluence of Lake Julian. Below the Lake Julian dam, Powell Creek flows east to west to the confluence of the French Broad River. The unnamed tributary located to the south of the Plant also flows east to west to the confluence of the French Broad River. Both streams represent groundwater discharge zones and flow into the French Broad River. The French Broad River flows south to north near the Site.

ES5. Identification of Data Gaps

The horizontal extent of groundwater impact has been defined and the vertical extent is understood to be controlled by the depth of water-bearing zones in fractured bedrock. Source area and groundwater characterization data will be used to support preparation of flow and transport groundwater modeling for the Site. The SCM provided herein will also support the modeling and the preparation of the Corrective Action Plan (CAP). There are no data gaps that will be limiting factors in the execution of the groundwater model or development of the CAP.

However, the following additional information would be useful:

1. Speciation analysis was conducted for geochemical model input information. The hexavalent chromium data is inconclusive with regards to source and extent. Therefore, additional speciation analysis for hexavalent chromium is proposed for the Asheville Plant; and

2. The installation of approximately 15 stream gauges will be used to further refine the hydraulic conditions at the Site and provide useful input for the evolving SCM and future performance monitoring.

ES6. Conclusions

1. The CSA evaluated the horizontal and vertical extent of groundwater contamination at the Site, and found that the sources of contamination (shown on **Figure ES-1**) are the coal ash contained in the ash basins and leakage from the FGD wastewater treatment wetlands. The cause of contamination is the leaching of constituents from the coal ash and FGD wastewater into the underlying soil and groundwater.

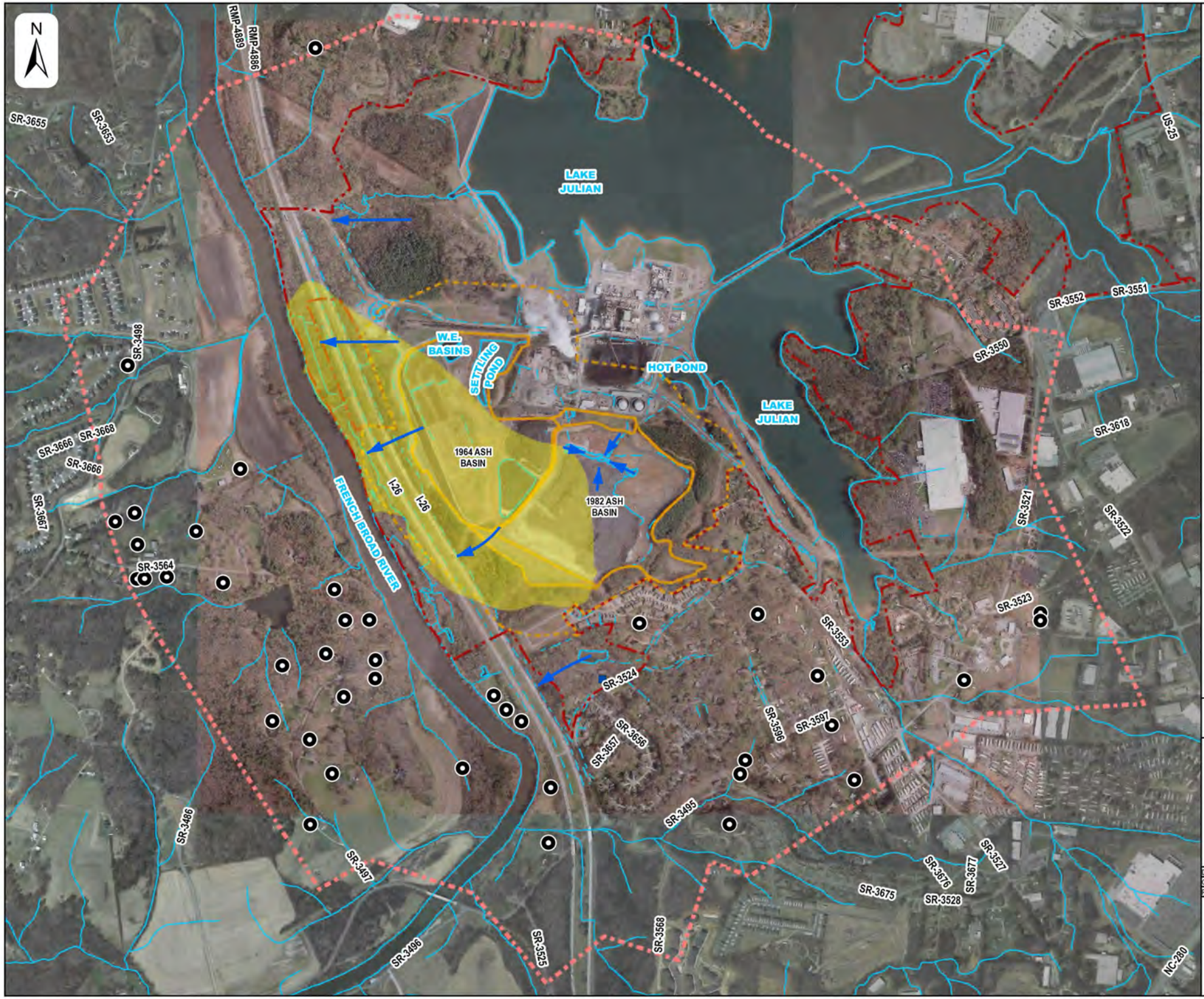
2. Duke Energy plans to excavate the ash basins at the Site in accordance with CAMA requirements. The impact of the ash excavation on long-term groundwater quality will be evaluated as part of the groundwater flow and transport modeling to be provided in the CAP.

3. Background monitoring wells contained naturally-occurring metals and other constituents at concentrations that exceeded their respective 2L or IMAC values. These constituents included cobalt, iron, manganese and vanadium.

4. Five private wells have been identified south of the Site on the east side of the French Broad River. Prior to initiating this assessment, a plan was underway to remove this potential hazard to receptors by extending a water line to these properties. This project is expected to be complete in early fall of 2015.

5. The human health and ecological screening-level risk assessments did not specifically identify the presence of health or environmental risks; however, the results indicate that constituents in environmental media could be of concern and further investigation by a Site-specific risk assessment may be warranted. No imminent hazards to human health and the environment were identified during the screening-level risk assessments.

6. A plan for interim groundwater monitoring is presented in Section 16 of this report. The CAP, based on the data presented in this report and subsequent groundwater modeling, will be submitted within 90 days.



LEGEND

- WATER SUPPLY WELL[1]
- DUKE ENERGY WATER SUPPLY WELL[1]
- AREA OF CONCENTRATIONS IN GROUNDWATER ABOVE NC2L[2]
- GENERALIZED GROUNDWATER FLOW DIRECTION
- ASH BASIN BOUNDARY
- ASH BASIN COMPLIANCE BOUNDARY
- HALF-MILE OFFSET FROM ASH BASIN COMPLIANCE BOUNDARY
- DUKE ENERGY PROGRESS ASHEVILLE PLANT SITE BOUNDARY
- DITCH
- STREAM

NOTES:

[1] FROM DRINKING WATER WELL AND RECEPTOR STUDY (APPENDIX B).

[2] BORON EXHIBITS THE GREATEST THREE-DIMENSIONAL EXTENT OF MIGRATION FROM THE ASHEVILLE STEAM ELECTRIC PLANT ASH BASIN. The NORTH CAROLINA 2L (NC2L) FOR BORON IS 700 µg/L.

[3] APRIL 17, 2014 AERIAL ORTHOPHOTOGRAPHY OBTAINED FROM WSP.

[4] 2013 AERIAL ORTHOPHOTOGRAPHY OBTAINED FROM THE NC CENTER FOR GEOGRAPHIC INFORMATION AND ANALYSIS. (http://services.nconemap.gov/)

[5] PARCEL BOUNDARY WAS OBTAINED FROM THE NC CENTER FOR GEOGRAPHIC INFORMATION AND ANALYSIS. (http://services.nconemap.gov/)

[6] DRAWING HAS BEEN SET WITH A PROJECTION OF NORTH CAROLINA STATE PLANE COORDINATE SYSTEM FIPS 3200 (NAD83/2011).

GRAPHIC SCALE

500 0 500 1,000 1,500 2,000

IN FEET

synTerra
148 RIVER STREET, SUITE 220,
GREENVILLE, SC 29601
864-421-9999
www.synterracorp.com

DUKE ENERGY PROGRESS
ASHEVILLE STEAM ELECTRIC PLANT
200 CP & L DRIVE
ARDEN, NORTH CAROLINA

DRAWN BY: R. SPRING	DATE: 08/20/2015
CHECKED BY: J. MEADOWS	DATE: 08/20/2015
PROJECT MANAGER: T. PLATING	

FIGURE ES-1
SITE CONCEPTUAL MODEL - PLAN VIEW
ASHEVILLE STEAM ELECTRIC PLANT

P:\DUKE ENERGY PROGRESS 1026500 GIS BASE DATA\ASHEVILLE\MAP_DOCS\CSA_DRAFT\FIGURE ES-1 EXECUTIVE SUMMARY FIGURE.MXD