# PURPOSE OF THE PROJECT

Duke Power, a division of Duke Energy Corporation ("Duke," "Duke Power" or "the Company") requests certification to construct two 800 MW (1600 MW total) supercritical pulverized-coal units and related transmission facilities at the Company's existing coal-fired Cliffside Steam Station located on the Cleveland/Rutherford County borders. The project, referred to as the Cliffside Project, will provide baseload capacity to the Duke Power system with the first unit to begin commercial operation by as early as 2010. The required timing of the second unit is contingent on a number of variables including annual updates to the Company's load forecast for 2010 and beyond, other generation alternatives currently under consideration and potential new regulations. Duke Power is filing the enclosed information pursuant to the North Carolina Utilities Commission Rule R8-61(a), which requires filing of certain information 120 days in advance of filing an application for a Certification of Public Convenience and Necessity ("CPCN"). The Company anticipates filing the CPCN application in September.

Duke Power's 2004 Annual Plan, filed with the North Carolina Utilities Commission (NCUC) in September 2004, shows growth in demand of about 1.5% per year. This demand growth results in the need for over 3000 MW of capacity by 2011. The Annual Plan is developed with the objective of meeting customers' need for a highly reliable energy supply at the lowest reasonable cost. In the planning process, which is currently underway for the 2005 Annual Plan, Duke Power assesses various resource options available to meet customers' energy needs. The Company's initial assessment is that a pulverized coal baseload resource is the best choice to meet the capacity need beginning as early as 2010. Duke Power will address these proposed resource additions in the 2005 Annual Plan to be filed in September as well as in testimony to be submitted in support of the CPCN application.

The Company is pursuing certification of two baseload sites. In addition to the Cliffside Project, Duke Power is planning to seek a Certificate of Environmental Compatibility and Public Convenience and Necessity for a site in South Carolina. The two projects are being pursued simultaneously to allow for flexibility in the event that factors outside Duke Power's control (e.g., environmental permits, land acquisition) eliminate a site from consideration and to ensure adequate time for the approval and construction of the project to enable commercial operation by 2010. Duke Power will supplement its CPCN application if there are any significant changes in the status of the South Carolina project certificate proceedings.

Duke Power is not soliciting purchased-power bids to satisfy the baseload capacity needs this project is intended to serve. Although Duke has used the competitive wholesale market to supply peaking needs and currently has a request for proposals outstanding for peaking and intermediate capacity, a self-build baseload option is the most reliable means for Duke Power to meet its service obligations in a cost-effective manner.

# INTRODUCTION

Duke Power Company requests certification to construct two 800 MW (1600 MW total) supercritical pulverized-coal units and related transmission facilities in Cleveland and Rutherford Counties, North Carolina. For the purposes of this document, the project will be referred to as the Cliffside Project. Duke Power will ensure continued compliance with the "Clean Smokestacks" legislation through the retirement of existing generation and/or installation of additional pollution controls.

A coal-fired generating facility uses a boiler, turbine generator, cooling tower and environmental control equipment to generate electricity. Pulverized coal is mixed with hot air and blown into the firebox of the boiler, where it burns in suspension. The heat generated by this combustion turns water into steam, which is then piped to the turbine. The turbine produces mechanical power that is converted to electric power by the generator. Appendix A provides additional equipment and process information.

This document provides the preliminary plans for construction of the new generation project, a 0.95-mile transmission line and related upgrades to transmission facilities pursuant to North Carolina Utilities Commission Rule R8-61. All descriptions, illustrations and information provided herein are based on preliminary engineering and studies, using the most reliable information available to date. Sections 1 through 10 of this document correspond to parts 1 through 10 of NCUC Rule R8-61(a). The following information is included:

- Available site information and discussion of site selection;
- Preliminary information concerning geological, aesthetic, ecological, meteorological, seismic, water supply, population and general load center data;
- Statement of the need for the facility;
- Description of investigations completed, in progress, or proposed;
- Statement of existing or proposed plans for development at or adjacent to the site;
- Statement of existing or proposed environmental evaluation programs;
- Description of transmission line routes;
- List of agencies from which approvals will be sought;
- Statement of estimated cost; and
- Schedule showing the anticipated dates for construction, testing, and commercial operation.

A description of the plant systems and components is presented in Appendix A.

# 1.0 SITE INFORMATION

## 1.1 Site Location

The project is located on a partially wooded site within the existing rail loop at Duke Power's Cliffside Steam Station in Cleveland and Rutherford Counties, North Carolina. The station is located on State Road (SR) 1002 - Duke Power Road, approximately 1.9 miles east of Cliffside, NC. Nearby communities include Shelby (9.3 miles northeast) and Gaffney, SC (11.5 miles southeast). The Broad River flows through the Cliffside Steam Station property.

Figure 1.1-1 shows the project's location in relation to the nearby communities.

## 1.2 Site Description

The existing Cliffside Steam Station property consists of about 1149 acres. A significant portion of the property is occupied by the existing plant systems—powerhouse, electrical substations, laydown yard, coal pile and ash and gypsum storage basins. The station presently consists of five coal-fired units (Units 1 – 5). Units 1- 4 began operating in the 1940s, and Cliffside 5 began operating in 1972.

The project site is located entirely within the existing rail loop, just southeast of Unit 5 and south of the coal pile.

## 1.3 Site Access

State Road (SR) 1002, Duke Power Road in Rutherford County, provides access to Cliffside Steam Station and to the project site. At the Cleveland County line, the name of SR 1002 changes to McCraw Road. Duke Power Road is accessed via US Highway 221 Alternate (US 221-Alt) from the west and NC 150 from the east. Duke Power and McCraw Roads will provide access for all workforce and material delivery during both construction and plant operation.

The site is also directly accessible via CSX Railroad. CSX enters the site on the south side of the property at Duke Power Road and is used to supply coal shipments to the station.

## 1.4 Initial and Ultimate Development

A wet flue gas desulfurization (WFGD) system (or a scrubber) is planned for Unit 5 in 2010. Associated with this is the acquisition of additional land for long term by-product storage. Furthermore, Duke Power intends to construct or have constructed a rail line to Norfolk Southern Railroad. The purpose of this rail line is to increase access to coal supplies and provide better reliability. The proposed rail route has not yet been determined. This CPCN document addresses the development of the Cliffside project site. The development of the rail line will be addressed in other federal or state permit applications.

## 1.5 Site Selection

A comprehensive three-phase siting study was conducted to determine the most appropriate technologies and optimum siting locations for new fossil-fired generation. The technologies studied included sub-critical pulverized, integrated gasification combined cycle, and circulating fluidized bed coal-fired plants for baseload generation.

In Phase I, coarse screening criteria identified locations worthy of further investigation in or near the Duke Power service area. In Phase II, 12 baseload sites were examined in greater detail, with emphasis on initial and annual cost differentials as well as environmental and site-related impacts. In Phase III, five sites were selected for further investigation of key siting criteria, including fuel transportation, electric transmission and environmental issues.

### 1.5.1 Phase I

The following data were modeled in a Geographic Information System (GIS), and weights were assigned to reflect the degree of opportunity or constraint afforded by each:

- Rail Lines
- Duke Power 100 kV, 230 kV and 500 kV Transmission System
- Major Roads
- Restricted Airspace
- Water Supply: Locations of Major Streams, Rivers and Lakes
- EPA Class 1 Air and Non-Attainment Areas
- Population Density
- National and State Parks, Forests, Scenic Rivers and Wildlife Refuges
- Duke Power Property Locations

From these models, opportunity areas were developed; and potential sites were identified. Twelve prospective sites within the opportunity areas were selected for further evaluation.

### 1.5.2 Phase II

Information about natural and cultural resources, property lines and wetlands was gathered and mapped over aerial photography and United States Geological Survey (USGS) 7.5' Quadrangle mapping so that an exact location could be established for each of the prospective sites. Duke performed load studies to determine how a generating facility at a particular location might impact the transmission system and modeled air quality for representative sites. Permitting and related impacts, capital costs (including site preparation and site infrastructure costs) and annual costs (transportation impacts and brownfield savings) were considered. (For the purpose of this study, "brownfield" refers to an existing Duke Power generating facility; "greenfield" indicates any other site, regardless of its current land use.)

### 1.5.3. Phase III

The study considered the potential for 800 MW, 1200 MW, and 1600 MW baseload coal-fired plants at the Phase III sites.

Key areas of focus in Phase III were the following:

- Access to both Norfolk Southern (NS) and CSX rail carrier
- Environmental issues: air permitting, water supply, impacts to wetlands and on-site streams, cultural resources and Natural Heritage sites
- Infrastructure
- Transmission
- Public impacts
- Flexibility
- Cost

As a result of the Phase III evaluations, Duke Power elected to pursue CPCNs for two baseload sites.

## 1.6 Evaluation of Alternate Sites

In addition to the Cliffside Project site, a South Carolina site received detailed evaluation. The alternate sites will be discussed in greater detail in the final CPCN application.

# 2.0 PRELIMINARY SITE ANALYSIS

## 2.1 Historic and Archaeological

### 2.1.1 Historic

Two historic buildings which are potentially eligible for the National Register of Historic Places (NRHP) are located on the Cliffside property. They are the old Cliffside Steam Plant itself and a supporting building. Duke Power has not filed an application for their inclusion in the National Register.

The completed facility will not be visible from any structures listed on the NRHP. Three potentially eligible structures are located within eight thousand feet of the proposed building site. The closest structure, within three thousand feet, could ultimately have a view of the proposed facility, depending upon how clearing is performed. A structure located about five thousand feet southeast of the site would probably have a view of the stack. There probably will be no view of the proposed facility from the last potentially NRHP-registered structure, which is eight thousand feet to the south.

### 2.1.2 Archaeological

No archaeological sites are recorded in the files of North Carolina's Department of Cultural Resources or in local or federal records. An archaeological survey and testing will be conducted at the project site to identify any previously unknown sites.

## 2.2 Aesthetic

### 2.2.1 Visual

The Cliffside Project generating units will be completely surrounded by Cliffside Steam Station property. Additional land must be purchased for gypsum and ash storage. The project site is adjacent to Cliffside Steam Station's existing plant, its coal pile, laydown yard and gypsum and ash storage areas. The proposed new units should have minimal effects on the visual resources and scenic quality of the surrounding area.

A detailed visual analysis of the site will be conducted and documented in the final CPCN.

### 2.2.2 Noise

The existing noise character of the site area is heavily influenced by the presence of Cliffside Steam Station operation. Power plant operations at this site began in 1940 and have continued since. Existing noise sources include equipment such as fans, paging equipment, coal handling and train operations. Additional operations and more frequent rail deliveries will increase the incidence of noise. A vegetative buffer around Cliffside Steam Station will remain in place. It is anticipated that operation of the facility will result in noise levels that will be indistinguishable from the current levels at Cliffside Steam Station.

The closest residence to the proposed project area is located approximately 0.5 miles from the proposed new units. Construction noise may impact several private residences located along County Road 1002. Disturbance would occur principally during daylight hours as a result of heavy equipment operation and general construction vehicle traffic. To evaluate noise impacts due to new plant operation and construction, a noise study is expected to be completed. Results of any study will be submitted with the final CPCN application.

## 2.3 Geology and Seismology

### 2.3.1 Geology

The rocks of the southern crystalline Appalachians are divided based on similar rock types, structures and areal distribution into parallel geologic belts orientated in a southwest to northeast direction. From northwest to southeast, the geologic belts crossing the Carolinas are Blue Ridge, Brevard/Chauga, Inner Piedmont, Kings Mountain, Charlotte and Carolina slate belts (Figure 2.3-1). The sediments of the Coastal Plain overlap the Carolina slate belt in the eastern Carolinas.

The Cliffside Site is located in the Inner Piedmont belt, a fault-bounded composite stack of thrust sheets containing a variety of gneisses, schists, amphibolites, sparse ultramafic bodies, and intrusive granitoids (Figure 2.3-2). The general structure is characterized by irregular foliation of low dip and folds transverse to the northeast regional geologic trend. The stratified rocks of the belt consist of thinly layered mica schist and biotite gneiss which are interlayered with lesser amounts of amphibolite, calc-silicate rocks, hornblende gneiss and quartzite. Protoliths of these rocks were largely sedimentary and in part volcanic. Large and small masses of granite and granodiorite are present throughout the belt and form concordant to semi-concordant bodies in the rock. Some of these granitoid bodies are gneissic and are probably older than the poorly foliated to nonfoliated granitoid facies. Small, ultramafic masses are present along the eastern and western sides of the belt. The rocks of the central core of the Inner Piedmont are in the sillimanite zone of amphibolite metamorphism. The flanks are primarily in the staurolite-kyanite zone of regional metamorphism.

The site is underlain by gray to dark gray, thin to thickly layered, medium-grained biotite gneiss composed primarily of biotite, quartz and feldspar and is in part garnetiferous. It is locally inequigranular and porphyroblastic. Interlayered with the biotite gneiss are layers of sillimanite-mica schist, mica schist and amphibolite. Small masses of granite are present in the biotite gneiss. The nearest major fault is the Kings Mountain shear zone, located about 2.5 miles southwest. The shear zone forms the boundary between the Inner Piedmont and Kings Mountain belts. It has been inactive for at least 250 million years.

The soil is a typical residual soil that develops over crystalline rocks. It consists of clayey topsoil underlain by micaeous sandy silts and silty sands that grade into weathered rock at depth. Borehole data is available for the southwestern portion of the proposed footprint of the new plant, and a number of previous borings have been drilled in the surrounding area. The borings along the extreme southwestern portion of the proposed footprint show depths of 23 to 55 feet to relatively sound rock with 3 to 30 feet of overlying weathered rock. Borings just to the northeast have depths of 13 to 19 feet to relatively sound rock with just 0 to 3 feet of overlying weathered rock. This suggests a weathering boundary between the two areas. Boring data in the area surrounding the proposed footprint has an average depth to sound rock of 37 feet, with an average thickness of 21 feet of overlying weathered rock. The weathered rock is very seamy, with alternating layers of soft and hard rock. Soils overlying the weathered rock are generally firm.

Depending of the depth of excavation for the plant, a shallow foundation may be possible if the shallow sound rock noted northeast of the deeper sound rock in the footprint continues to the northeast. A combination shallow and deep foundation may be needed if the depth of excavation in the extreme southwest corner of the proposed plant footprint does not extend to extremely firm soil or weathered rock. The soils at the site are not expected to present any unique construction problems. Facilities of this type typically do not require complex foundation design, and the foundations are anticipated to be relatively simple (including deep foundations).

### 2.3.2 Seismology

Most earthquakes which occur in the United States are located in the tectonically active western portion of the country (primarily California and Alaska). However, areas of the eastern United States have experienced significant seismic activity, although at a lower rate. Earthquake activity in the eastern United States has included such large earthquakes as the 1811-1812 New Madrid earthquakes in Missouri and Arkansas and the 1886 Charleston, South Carolina, earthquake.

Before regional seismograph stations were installed in the first part of the 20th century, all earthquake data were derived from descriptions of the effects from personal accounts or damage records. Most of the significant damaging earthquakes occurred prior to reliable instrumental recording. In addition, most major earthquakes in the eastern United States have left no observed surface fault rupture. Before 1970, locations and intensity of smaller earthquakes could not be reliably recorded.

The Cliffside site is in Seismic Zone 2, which is defined as moderate damage corresponding to Modified Mercalli Intensity VII. The National Seismic Hazard Mapping program developed by the U.S. Geological Survey gives a peak ground acceleration (PGA) value for the site of 0.06g with a 10% probability of exceedance in 50 years (return period of 476 years), a value of 0.10g with a 5% probability of exceedance in 50 years (return period of 971 years) and a value of 0.18g with a 2% probability of exceedance in 50 years (return period of 2475 years). There are no major seismic concerns for the site as long as appropriate seismic parameters are considered in the final design. Appendix B provides historical seismic activity

## 2.4 Climatological and Air Quality

### 2.4.1 Climatological

The Cliffside Steam Station site is located geographically within the southern Piedmont of North Carolina. The terrain in the Piedmont is characterized by gently rolling hills interspersed with several ranges of steep hills across the region. The Piedmont lies between the two other principal physiographic divisions of North Carolina, the Mountains to the west, and the Coastal Plain to the east. Proximity to both the mountains and the Atlantic Ocean plays an important role in the seasonal climatology of the southern Piedmont of North Carolina.

In the winter, the southern Piedmont is partially protected from the cold Arctic air that frequently moves southeast from Canada into the central US. In a process called "adiabatic warming," air descends the eastern slopes of the Appalachians and is compressed by the region's higher pressures; the air molecules then gain internal energy, and the mean temperature of the air mass increases. This results in a temperate winter climate in which the normal January daily minimum is 30º Fahrenheit (F), and the normal daily maximum is 49 º F (*adapted from 2001 NCDC Publication: Local Climatological Data Annual Summary* for the closest National Weather Service (NWS) station at Charlotte/Douglas Airport). Extreme low temperatures (below 0º F) are very rare in the southern Piedmont region and occur on average once every 10 years. Winter precipitation events are dominated by migratory low pressure systems which frequently develop and deepen off the warm Gulf Stream waters east of the Carolina capes. Snowfall is infrequent during the winter months, with the annual average around 6 inches between December and March. Heavy snowfalls are rare, with an extreme 24- hour total of 12 inches occurring twice in the last 62 years. Freezing rain is common in the winter, although ice accrual up to 0.5 inch radial thickness occurs on average of once every two to three years.

Summer is dominated by the Azores-Bermuda high-pressure system, which results in a maritime tropical climate dominated by warm, humid days and convectively driven precipitation events. The normal July daily minimum temperature is 69º F, and the normal daily maximum temperature is 89º F. Because of the Atlantic Ocean to the east and the Gulf of Mexico to the south, daytime temperatures in the summer seldom exceed 100º F due to higher humidity levels. In summer, precipitation occurs in the form of air mass thunderstorms that develop as a result of diurnal heating and usually occur in the late afternoon and early evening hours. The Piedmont region experiences 42 thunderstorm days annually, with more than half of those days falling between May and September.

Tropical systems are not uncommon to the region, but it is rare for a major hurricane to move into the southern Piedmont. Most tropical systems that impact the southern Piedmont make landfall along the Gulf coast or southeast Atlantic coast and track inland, diminishing in intensity but bringing heavy rainfall to the region. Each year the region can expect a remnant tropical system to bring some rainfall to the region between June and October.

Spring and autumn are transitional seasons. Spring is characterized by warming temperatures and a transition from stratiform rainfall events to convectively driven precipitation events. Autumn is characterized by the breakdown of the Bermuda high and an increasing frequency of cold fronts and intrusions of cool Canadian air masses.

Tornadoes have been recorded in all four seasons, but most occur in the spring. In Cleveland County, twelve tornadoes have been observed between 1950 and 2003 (http://www.nc-climate.ncsu.edu/climate/tornadoes.html). Most tornadoes in the Piedmont are of the F0 or F1 intensity scale. In fact, less than 20% of all tornadoes between 1950 and 2003 in North Carolina were F2 or higher.

Annual precipitation in the southern Piedmont is evenly distributed across all months of the year. The annual average precipitation is 43 inches in the central Piedmont.

The climatology of transport and diffusion of pollutants in the Piedmont region can be characterized by both the diurnal and seasonal differences in mixing heights. The diurnal minimum of mean daily mixing heights for the region does not vary widely between seasons and is around 400 meters. However, there is a big difference between the seasons with respect to afternoon mixing heights. The winter mean mixing height is 1000 meters, and the mean summer height is 1800 meters (*Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States*, Holzworth, George C., EPA, RTP, NC, Jan. 1972; Figures 1-10).

### 2.4.2 Air Quality

National Ambient Air Quality Standards (NAAQS) have been established by the U.S. Environmental Protection Agency (EPA) and adopted by the N.C. Department of Environment and Natural Resources (NCDENR). These standards are contained in Chapter 15A of the North Carolina Administrative Code (NCAC), Subchapter 2D (Air Pollution Control Requirements), Section .0400. These standards establish certain maximum limits on parameters of air quality considered desirable for the preservation and enhancement of the quality of the state's air resources.

The entire state of North Carolina is currently designated as having reached attainment for sulfur dioxide ($SO_2$), particulate matter and particulate matter less than 10 microns aerodynamic diameter (PM and $PM_{10,}$ respectively), carbon monoxide (CO) and nitrogen dioxide ($NO_2$). Portions of the state of North Carolina were designated as non-attainment for ozone ($O_3$) on April 15, 2004, and as non-attainment for particulate matter less than 2.5 microns aerodynamic diameter ($PM_{2.5}$) on December 17, 2004. Rutherford and Cleveland Counties were designated attainment for both ozone and $PM_{2.5}$.

### 2.4.3 Air Quality during Construction

The primary air-quality issue during construction will be dust from non-point sources, such as earthwork and construction traffic on unpaved roads. This type of dust is described as fugitive dust. State-approved erosion-control plans will address maintenance in areas not under construction (e.g., seeding), which will help to minimize fugitive dust. Water trucks will be used to suppress dust as required. Blasting operations are not anticipated. Fugitive dust impact is expected to be equivalent to a normal construction project of this magnitude.

Other potential sources of pollutants during construction are mobile internal combustion engines (earth moving equipment, cranes, etc.) and an increase in vehicle traffic by construction workers. Emissions from these sources should have little impact. Volatile organic compound emissions from the painting of buildings and machinery are also expected to be minimal and have little impact.

### 2.4.4 Air Quality during Operation

Operation of the proposed coal-fired boilers will result in the emission of certain pollutants that are regulated by the EPA and the State of North Carolina. Operating impacts from these pollutants will be addressed through the air-quality permit application process. Air-quality modeling for the proposed facility will be part of this application process. Pollutants requiring modeling per EPA and State regulations for the proposed project will be modeled in accordance with EPA Guidelines on Air Quality Modeling and a Modeling Protocol approved by the North Carolina Division of Air Quality (NCDAQ).

In accordance with requirements of 40 CFR 52.21(m), an analysis of existing ambient air quality data in the area to be affected by the proposed project must be performed. Whether predicted impacts from the proposed project will be below the EPA-specified significant levels for preconstruction monitoring has yet to be determined. Even so, NCDAQ has collected and maintained ambient air quality monitoring data across the state that the Division may deem as representative data for the area of the facility instead of requiring further ambient air monitoring.

## 2.5 Water Quality

### 2.5.1 Present Water Quality

A small stream, Suck Creek, traverses the Cliffside Steam Station property, flowing from headwaters in upper Cherokee County, South Carolina, northward along the eastern side of an existing rail loop (Figure 2.5.1-1). Suck Creek, designated by North Carolina Department of Environment and Natural Resources (NCDENR) as a Class C water body, enters the Broad River within the property boundary, to the east of the project site.

The Broad River is a major river in the southwestern Piedmont of North Carolina and a major tributary of the Santee River Basin of South Carolina. At the Cliffside Steam Station, the Broad River serves as a water source as well as a receiving stream for the project's discharge and is classified as a Class C water body by NCDENR. The project's water intake is located on the south side of the Broad River, on the opposite bank from, and approximately 0.1 mi downstream from, the confluence of the Second Broad River, which is also a Class C stream (Figure 2.5.1-1).

The upstream drainages of the Broad and the Second Broad Rivers encompass a transition from the Mountain to the Piedmont Physiographic Province. The Broad River Basin upstream of the Second Broad River confluence is characterized primarily by forested and, to a lesser extent, by agricultural land use, with a minor urban land-cover component associated primarily with the town of Lake Lure and the town of Saluda near the Green River headwaters. Comparatively, the Second Broad River drainage includes significant agricultural land use, although slightly more urban land use is associated with the towns of Rutherfordton, Spindale and Forest City. Near the confluence of the two streams and in adjacent upstream and downstream segments, the stream bed is predominated by shifting sand and silt. Station operation has required periodic dredging of the water intake over recent years to ensure adequate cooling water availability.

Broad River discharge is monitored by the United States Geological Survey (USGS) approximately 3.5 miles downstream of the project, south-southeast of Boiling Springs, NC (Station No. 02151500; Figure 2.5.1-1). Average annual discharge flow at this station between 1928 and 2002 was 1,488 cubic feet per second (cfs); the median annual discharge over the same period was 1,472 cfs (USGS 2003). The minimum annual flow during the same period, 616 cfs, occurred in the drought year of 2001, while the maximum annual flow, 2,452 cfs, occurred in 1975. The most recently calculated 7Q10 value for climatic years 1926-2003 for this station is 306 cfs (USGS, unpublished data). (The 7Q10 value refers to the lowest consecutive seven-day stream flow that is likely to occur in a ten-year recurrence period; it is commonly used as a regulatory threshold in setting discharge limits.)

Broad River water-quality data collected from near the proposed project is available from NCDENR (2001c). Broad River Station A1520000, located about 25 river miles upstream of the project at State Road (SR) 1181 near Rock Springs, NC, has been monitored historically by NCDENR, Division of Water Quality (DWQ). A summary of 1995 – 2000 water-quality monitoring results for this location is presented in Table 2.5.1-1. An additional nearby water quality monitoring station (A4700000), located approximately six miles downstream of the project at the NC Highway 150 bridge (Figure 2.5.1-1), is also monitored by NCDENR. Water-quality data for this site covering the period 1995 – 2000 are also summarized in Table 2.5.1-1.

Water-quality indicators upstream and immediately downstream of the project (Table 2.5.1-1) typify Piedmont stream water quality. The dissolved oxygen (DO) and pH water-quality standards (DO minimum 5.0 mg/L and pH 6 to 9, respectively; NCDENR 2004) were consistently met, although maximum DO concentrations (16.3 and 13.8 mg/L for the upstream and downstream sites, respectively) appear indicative of episodic super-saturation. Nutrient concentrations were most frequently below levels of concern; however, total phosphorus appeared elevated downstream of the project site and Second Broad River confluence relative to upstream locations. The cause of the maximum observed nitrate + nitrite nitrogen concentration (2.3 mg/L) found at the upstream sampling location was not clear. An apparent tendency in the tabulated data summary (Table 2.5.1-1) for higher maximum nutrients and specific conductance at the downstream site relative to the upstream site may be partially attributable to the influence of the Second Broad River inflow near Cliffside, NC. Four major permitted wastewater dischargers are located on the Second Broad River upstream of the confluence with the Broad River. The farthest downstream discharger on the Second Broad River, Cone Mills at Cliffside, NC, is fewer than two miles upriver from the proposed project. Impacts observed in the lower reach of the Second Broad River near this facility

(NCDENR 2001c) typically include elevated conductivity, slightly increased nutrient (total phosphorus, nitrate + nitrite and ammonia-nitrogen) concentrations and water discoloration. The extent of lateral mixing of the two streams can routinely be delineated, based on stream coloration or conductance sampling just upstream of and adjacent to the project site.

Somewhat higher maximum turbidity and suspended solids concentrations observed at the downstream sampling location relative to upstream is likely reflective of the differences in the degrees of urbanization and agricultural land use in the two respective parts of the basin. Water-quality monitoring during 1995 – 2000 indicated only infrequent concentrations of copper, iron and zinc, which exceeded action levels set by NCDENR (2004). Elevated metal concentrations, in particular iron, are typically associated primarily with the particulate fraction of these samples. Trace element concentrations, including arsenic, cadmium, chromium, lead, mercury and nickel were (with a rare exception for lead) all below applicable North Carolina water quality standards during this period of monitoring (NCDENR 2001c).

### 2.5.2 Impacts on Water Quality during Construction

Construction impacts on the Broad River's water quality caused by erosion will be minimal because there are no streams proximal to the project footprint and because of the distance of the project from the river. Impacts of potential sedimentation to Suck Creek, located across a rail loop to the east of the project, as well as to the Broad River, will be minimized by implementation of best management practices under a NCDENR approved, comprehensive erosion-control plan (ECP) associated with the project.

### 2.5.3 Impacts on Water Quality during Operation

The proposed facility's net consumptive withdrawal of water from the Broad River for cooling-tower operation is estimated at 40 cfs. This withdrawal rate represents 2.7% of the 1928 – 2002 annual median and mean flow (1,472 cfs and 1,488 cfs, respectively); 1.6% of the annual maximum flow (2,452 cfs); 6.5% of the minimum annual flow (616 cfs); and 13% of the 7Q10 flow (306 cfs) for the Broad River, as measured at Boiling Springs (USGS 2003; USGS unpublished data). Under a regime of typical flows, withdrawal of water is not expected to have a measurable impact on Broad River water quality. Under unusually low flow conditions, however, further reduced river flows could lead to a slightly magnified impact of wastewater constituent contributions to downstream concentrations in the river.

Wastewater streams originating within the proposed facility will be generated principally by cooling tower blowdown, the operation of $SO_2$ scrubbers and demineralizer regeneration. Ash collection will be handled by dry methods. Based on design criteria, it is anticipated that, in particular, scrubber-generated wastewater will require pretreatment for reduction of mercury and selenium concentrations before the waste stream is input into the existing ash basin. Due to the introduction of scrubber wastewater into the treatment system, final effluent concentrations of sulfates and chlorides will be measurably increased, since neither will be appreciably removed by treatment. These somewhat elevated effluent anion concentrations are not anticipated to have any impact on use attainment in the Broad River downstream of the discharge; but during extreme low flow periods, downstream river concentrations of these constituents could be measurably increased. The final effluent's volume and various water quality characteristics will be regulated by the discharge limits outlined in the project's National Pollutant Discharge Elimination System (NPDES) permit, in accordance with 40CFR423.

The proposed facility will employ cooling towers similar to Unit 5. Closed–loop cooling towers will require approximately 40 cfs which will be withdrawn from the existing intake structure at units 1-4. This reduced flow requirement, as compared to once-through cooling systems, will allow use of the existing intake and therefore no new intake structure. Net impacts at the intake will be properly addressed relative to 316(b). Cooling tower blowdown will be routed to the station’s existing ash basin for additional cooling and treatment. Cooling tower use will result in no increase in thermal loading to the Broad River.

## 2.6 Terrestrial and Aquatic Resources

### 2.6.1 Terrestrial Resources

#### 2.6.1.1 Botanical Resources

##### 2.6.1.1.1 Botanical Resources

The Cliffside property, in a generally rural area south of State Highway 74, is within both Rutherford and Cleveland Counties and on both sides of the Broad River at the confluence of the Broad River and the Second Broad River. Elevations within the tract range from 690 feet to 885 feet MSL. Within this proposed project tract are the facilities associated with Duke Power's Cliffside Steam Station. These facilities include the power plant, related facilities and substation and several active and inactive ash basins within the central and southeast portions of the site. Several right-of-way corridors, including electrical transmission lines and a sand-dredging operation, are also located on the property. The areas surrounding Cliffside Steam Station consist mostly of pastures and old field habitat, other agricultural areas, woodland and scattered single-family residences.

Vegetative conditions over most of the proposed project tract consist of old field/pasture habitat and disturbed habitat (relic ash basins, transmission rights-of-way and open facility areas). These habitats are permanent early successional areas dominated by herbaceous cover. The vegetation observed in these areas consists of fescue (*Festuca* spp.), broomsedge (*Andropogon virginicus*), sericea (*Lespedeza cuneata*), goldenrod (*Solidago* spp.), dogfennel (*Eupatorium capillifolium*), blackberry (*Rubus* spp.), Japanese honeysuckle (*Lonicera japonica*), kudzu (*Pueraria lobata*), ragweed (*Ambrosia artemisiifolia*), ebony spleenwort (*Asplenium platyneuron*) and smooth sumac (*Rhus glabra*). In each of these areas, most of the woody vegetation has been suppressed through maintenance activities; but a few trees are present, mostly in the sapling stage. These tree species include sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), Virginia pine (*Pinus virginiana*) and tulip poplar (*Liriodendron tulipifera*). The relic ash basins and transmission rights-of-way would not be affected by the project; however, the old field/pasture could be affected.

Most of the remaining areas are 50- to 60-year-old mixed pine hardwood forest habitats (Schatzki 2004). The canopy and midstory species for this hardwood forest habitat consist of shortleaf pine (*Pinus echinata*), loblolly pine (*Pinus taeda*), Virginia pine, red oak (*Quercus rubra*) white oak (*Quercus alba*), scarlet oak *(Quercus coccinea*), black oak (*Quercus velutina*), water oak (*Quercus nigra*), tulip poplar, sweetgum, shagbark hickory (*Carya ovata*), black cherry (*Prunus serotina*), black locust (*Robinia pseudoacacia*) and black walnut (*Juglans nigra*). The sapling and herbaceous layers consist of saplings of the canopy and midstory species and red cedar (*Juniperus virginia*), hornbeam (*Carpinus caroliniana*), flowering dogwood (*Cornus florida*), American holly (*Ilex opaca*), Chinese privet (*Ligustrum sinense*), ebony spleenwort, pipsissewa (*Chimaphila umbellata*), running cedar (*Lycopodium digitatum*), muscadine (*Vitis rotundifolia*), Japanese honeysuckle and greenbriar (*Smilax* spp.). Along the site's drainages, red maple, American sycamore (*Platanus occidentalis*), American beech (*Fagus grandifolia*), elm (*Ulmus* spp.) and green ash (*Fraxinus pennsylvanica*) were observed.

Based on the USGS topographic quadrangle maps, Duke Power maps and the field survey, the only jurisdictional wetlands found within the parcel designated for the proposed facility are a beaver-impounded wetland adjacent to the Broad River at the base of a relic ash basin and a small wetland next to the ball field in one of the relic ash basins. The small wetland was created to collect stormwater from the surface of a relic ash basin and does not appear to be connected to the Broad River. Both wetlands are characterized by vegetation consisting of black willow (*Salix nigra*), soft rush (*Juncus effusus*), broad-leaf cattail (*Typha latifolia*) and sedge (*Carex* sp.). Recent rainfall had caused the wetlands to be flooded during the field survey. Beavers have dammed the outlet of the impounded wetland adjacent to the Broad River and have enlarged it.

Information concerning listed rare plant species in the vicinity of the tract was obtained from the North Carolina Natural Heritage Program inventory database. The current U.S. Fish and Wildlife County List was also reviewed (USFWS Cleveland County Updated: 02/05/2004, and Rutherford County Updated: 02/25/2003). The Heritage Program information shows that no listed species have been found within the project area boundaries (Table 2.6.1-1). One flowering species, the Pursh's wild petunia (*Ruellia purshiana*), was identified approximately 1 mile from the existing facility, on the southwest side of the US Highway 221-A bridge over the Broad River. This species, which inhabits glades, woodlands over mafic and calcareous rock-based soil types, is listed as Significantly Rare-Other (STR-O) by the North Carolina Natural Heritage Program.

A March 2005 survey of the proposed site did identify a possible federal listed species (Threatened status) within the study area. A population of the dwarf-flowered heartleaf (*Hexastylis naniflora*) was located adjacent to and outside the project boundary on a north-facing slope near the northeast region of the site. This population is located in a hardwood forest on a slope to the north of the existing sand-dredge access road. If any impacts are planned for this area due to the project, additional field surveys may be necessary during the spring flowering period (i.e., March through April). This species is currently documented several miles downstream of the existing facility, near the confluence of Sandy Run and the Broad River. Continued plant operation will not affect the botanical resources of the adjacent areas.

#### 2.6.1.1.2 Impacts on Botanical Resources

Site development will involve permanent clearing of the old field/pasture habitat and disturbed habitat (relic ash basins, transmission rights-of-way and open facility areas). These habitats are permanent early successional areas dominated by herbaceous cover. A small portion of the remaining area that consists of mixed pine hardwood forest habitats may also be affected by project site development. The beaver-impounded wetland adjacent to the Broad River may also be affected by the proposed project activities. The Heritage Program information shows that no listed species have been found within the project area boundaries. If any proposed project impacts are planned for the area associated with the existing dwarf-flowered heartleaf, additional field surveys may be necessary during the spring flowering period (i.e., March through April).

### 2.6.1.2 Wildlife

#### 2.6.1.2.1 Wildlife Resources

Mixed pine and hardwood forests on and around the tract offer habitat for common game and non-game animal species. In addition, the old field habitat and early successional areas (i.e., fields and existing rights-of-way) adjacent to the project provide seed, insects and small prey as a food source as well as essential cover for typical Piedmont game and non-game species. Some of the species that can be located in these habitats are bobcat (*Lynx rufus*), groundhog (*Marmota monax*), mourning dove (*Zenaida macroura*), eastern bluebird (*Sialia sialis*), brown thrasher (*Toxostoma rufum*), Carolina wren (*Thryothorus ludovicianus*), northern cardinal (*Cardinalis cardinalis*), pine warbler (*Dendroica pinus*) and black snake (*Elaphe guttata*).

The Broad and Second Broad Rivers, the perennial streams (Suck Creek) and the existing ash basin offer habitat for the beaver (*Castor canadensis*), wood duck (*Aix sponsa*), bufflehead (*Bucephala albeola*), Canada goose (*Branta canadensis*), song sparrow (*Melospiza melodia*), eastern phoebe (*Sayornis phoebe*), spring peeper (*Pseudacris crucifer*), southeastern chorus frog (*Pseudacris feriarum*) and southern leopard frog (*Rana sphenocephala*).

Information concerning listed rare animal species in the vicinity of the tract was obtained from the North Carolina Natural Heritage Program inventory database (Table 2.6.1-1). The current U.S. Fish and Wildlife County list was also reviewed (USFWS Cleveland

County Updated: 02/05/2004, and Rutherford County Updated: 02/25/2003). There were no records of rare or endangered animal species occurring on the project area, and the March 2005 field survey did not identify any rare or endangered animal species on the tract.

**2.6.1.2.2 Impacts on Wildlife Resources**

Site development will transform the habitat value of the early successional and forested areas within the project's footprint to project-related uses of little wildlife value. Construction activities within and immediately adjacent to the proposed site will displace some wildlife populations, including amphibians and reptiles, birds and mammals (such as game species and small rodents). During the clearing and earth-moving phases, small and slow moving wildlife species such as mice, some reptiles, and salamanders, will be displaced; however, this will not be a significant impact to the population as a whole. Adjacent areas provide some habitat for both game and non-game species. Facility operation is not anticipated to affect wildlife beyond the proposed facility boundaries.

## 2.6.2 Aquatic

### 2.6.2.1 Macroinvertebrates

#### 2.6.2.1.1 Macroinvertebrate Resources

There are no macroinvertebrate data currently available for Suck Creek, the only perennial stream on the tract. Between 1994 and 2001, macroinvertebrate samples were collected each August at three locations in the vicinity of the Cliffside Steam Station. The sampling methodology is described in Section 4.5.2.1. Water-quality classifications assigned indicate Fair, Good/Fair or Good conditions at the three locations in the Broad River through the reported years (Duke Power Company 1998, 2003). Personnel from NCDENR sample at a similar location upstream of the Cliffside Steam Station and have collected there eight times since 1983 (NCDENR 2001b). In 2000 (the last NCDENR sampling year), the bioclassification for this particular site was Good, while Duke Power data supported a Good/Fair bioclassification.

#### 2.6.2.1.2 Impacts on Macroinvertebrates during Construction

Construction impacts on the macroinvertebrate community in Suck Creek during project construction could be significant. Ash, gypsum and limestone storage areas; a new railroad spur; and the proposed power plant are projected to lie near Suck Creek; and it is anticipated that some sediment impacts may occur during construction. Siltation usually results in lower densities and, depending on the severity of the impact, lower diversity. However, it is anticipated that once construction is concluded and the stream banks are stabilized, excess sediment will be removed from the creek during storm events. Re-colonization from upstream tributaries should restore the macroinvertebrate community to a pre-construction assemblage.

Construction impacts on macroinvertebrates in the Broad River should be minimal and limited to minor siltation from construction. All applicable permits will be obtained by the Company. A comprehensive erosion-control plan will be implemented and adhere to best-technology-available guidelines to protect Suck Creek and the river. Recovery is expected after construction is complete.

#### 2.6.2.1.3 Impacts on Macroinvertebrates during Operation

The effect of project operations on the macroinvertebrate community in Suck Creek should be minimal and limited to the effects of increased runoff during storm events. A Storm Water Management Plan will be implemented using the Best Technology Available and should minimize, to the extent possible, the effects on the macroinvertebrate community.

A revised NPDES permit will be obtained by the Company. The impacts of operation on the macroinvertebrates in the Broad River should be minimal based on the ongoing macroinvertebrate studies on the river (1994-2001) and the associated impact from Cliffside Steam Station.

### 2.6.2.2 Fish

#### 2.6.2.2.1 Fish

One perennial stream, Suck Creek, is located on the Cliffside Steam Station property. Currently, neither Duke Power nor the NCDENR has routinely collected fish in Suck Creek; and little data are available. However, the fish assemblage in the creek is expected to be similar to those in nearby streams where fish community data have been collected (i.e., Second Broad River, Sandy Run Creek, Beaverdam Creek, and Brushy Creek (NCDENR 2001c).

From 1989 to 2001, Duke Power biologists collected fish at eight locations in the Broad River near the Cliffside Steam Station. The sampling methodology is described in Section 4.5.2.2. Electrofishing by Duke Power since 1989 has accounted for 49 species of fish in the piedmont ecoregion of the Broad River near the station. Menhinick (1991) and NCDENR (2001c) document a combined total of 63 species within both the mountain and piedmont ecoregions of the Broad River basin in NC. The most abundant species collected typically include whitefin shiner (*Cyprinella nivea*), spottail shiner (*Notropis hudsonius*), sandbar shiner (*Notropis scepticus*), notchlip redhorse (*Moxostoma collapsum*), brassy jumprock (*Scartomyzon* sp), snail bullhead (*Ameiurus brunneus*), redbreast sunfish (*Lepomis auritus*) and bluegill (*Lepomis macrochirus*). None of the 49 fish species collected receive state or federal protection as threatened or endangered species (NCDENR 2001c). However, the Santee chub (*Cyprinella zanema*) is considered significantly rare by the Natural Heritage Program and has been collected several times in the Broad River since 1989. Based on the diversity and sustainability of the fish community through time, the scarcity of pollution-tolerant species and the presence of necessary food chain species, it has been concluded that a balanced and indigenous fish community exists in the Broad River in the vicinity of the Cliffside Steam Station.

**2.6.2.2.2 Impacts on Fish during Construction**

Construction impacts on the fish community in Suck Creek during construction will be similar to those for macroinvertebrates (see section 2.6.2.1.2) and could be temporarily significant. Ash, gypsum and limestone storage areas; a new railroad spur; and the proposed power plant are projected to lie close to Suck Creek. An Erosion Control Plan will be developed and adhere to Best Technology Available guidelines, but it is anticipated that some sediment impacts may occur. These impacts may temporarily limit the suitability of the habitat for some fish species. However, once construction is concluded and the stream banks stabilized, excess sediment should be removed from the creek during storm events. Recolonization from upstream tributaries should restore the fish community to a pre-construction assemblage.

Construction impacts on the Broad River fish community should be negligible due to the physical distance of the project from the river and use of the existing intake structure and diversion dam for source water.

**2.6.2.2.3 Impacts on Fish during Operation**

The effect on Suck Creek's fish community during project operations is expected to be minor and limited to the effects of increased runoff during storm spates. A Storm Water Management Plan will be implemented using the Best Technology Available and should minimize, to the extent possible, the effects on the Suck Creek fish community.

The effect on the fish community in the Broad River from project operations is anticipated to be negligible. The proposed project will have a consumptive water use of 40 cfs that will be derived from the existing Cliffside Steam Station service water system. This proposed water withdrawal (40 cfs) accounts for less than 6.5% of the lowest mean annual flow of the Broad River (616 cfs in 2001). Cooling tower blowdown will be routed to the ash basin for treatment and eventual discharge to the Broad River. The facility's discharge will be regulated under the conditions described in the project's NPDES permit.

The employment of closed-cycle cooling will also meet the new 316(b) impingement and entrainment performance standards.

## 2.7 Waste Disposal and Fuel Handling

### 2.7.1 Waste Disposal

#### 2.7.1.1 Solid Waste

Solid wastes generated during construction will consist primarily of solid, inert construction debris such as scrap concrete and lumber. These wastes will be re-used beneficially on site or disposed of off site. Debris will likely be disposed of at a Rutherford County site where debris is recycled or transferred to a Duke Power approved landfill.

Upon commercial operation, approval will be sought to dispose of plant-generated wastes to the Rutherford County transfer site and ultimately as needed to the Duke Power-approved landfill. The solid wastes expected during operation include small amounts of employee meal wastes, waste paper, wastes resulting from maintenance and modification activities (such as rags and construction debris) and sludges generated by the plant treatment system.

#### 2.7.1.2 Ash/Gypsum Disposal

Dry ash and gypsum wastes produced during plant operations are expected to be stored at an on-site landfill. Current ash disposal from plant operations is to the station's ash basin pond. The ash and gypsum landfills will be permitted through the Waste Management Division of the NCDENR.

#### 2.7.1.3 Domestic Waste

A contractor using portable toilet facilities or a permitted sewage disposal system will handle domestic sewage generated during construction. Once the project is complete, domestic sewage will be routed to a septic tank and drain field system permitted by the County Health Department.

### 2.7.2 Fuel Handling

It is expected that coal demand will be met through purchase supply contracts and spot agreements. Large amounts of coal are obtained under supply contracts with mining operators who mine both underground and at the surface. It is expected that coal will be sourced primarily through a combination of Central Appalachia (eastern Kentucky, southern West Virginia and southwestern Virginia), Northern Appalachia (southwestern Pennsylvania), Illinois Basin, Powder River Basin (Wyoming) and imported coal. There is an adequate supply from these sources to meet the quantities and qualities anticipated, although prices will fluctuate over time. Coal handling is described in the following subsection.

#### 2.7.2.1 Coal Unloading and Storage

Coal will be received via rail car and unloaded at the coal unloading facility. The unloading facility will be designed to empty rail cars; weigh, sample and prepare coal; and then convey the coal directly into the power plant or to the coal pile for inventory. Under normal conditions, this process should require a maximum of six hours.

#### 2.7.2.2 Coal Transport

Coal will be delivered via unit train (100+ cars) loaded by the coal producer at its load-out facility in the coal production region. Unit trains will move via routes determined by the appropriate Class I railroad or Short-Line operator serving the station.

## 2.8 Population and Demographics

### 2.8.1 Population

The population within one mile of the site is 279, based on the 2000 census. A total of 9,584 people live within five miles, and 53,217 people live within 10 miles of the site. The nearby cities of Shelby, NC, and Gaffney, SC, have populations of 19,477 and 12,968, respectively.

Population statistics of the area based on the 2000 census are as follows:

| Location | Total Population | Density (#/mile$^2$) |
|---|---|---|
| 1-mile radius | 279 | 88.8 |
| 5-mile radius | 9584 | 122.0 |
| 10-mile radius | 53217 | 169.4 |
| 25-mile radius | 401526 | 204.5 |
| Cleveland County, NC | 96287 | 207.2 |
| Rutherford County, NC | 62899 | 111.5 |
| Cherokee County, SC | 52537 | 133.8 |

The site is well suited for industrial uses. One residence is located within 3000 ft of the generating facility.

### 2.8.2 Workforce

The workforce at the start of construction will be approximately 80 people and increase to approximately 1000. The plant will initially employ approximately 80 people full time during normal operation. During scheduled maintenance periods, the workforce could increase by up to 50 people per day.

## 2.9 General Load Center

The Cliffside project will connect to the transmission grid by means of a new 500 kV switching station to be built on the site. Cliffside's 230 kV Tie Station is located within the property boundaries of Cliffside Steam Station. The new interconnecting lines shall be constructed on a dedicated right-of-way strip contained within the property boundaries.

# 3.0 STATEMENT OF NEED

## 3.1. System Needs

Duke Power annually develops a resource plan for meeting customers' energy needs with a combination of existing generation, customer demand-side options, short-term purchase power transactions and self-build options.

Duke Power's 2004 Annual Plan filing in NC and SC describes resource plans to meet customers' energy needs over a 15-year forecast period. Duke's 2004 forecast projects average annual growth in summer-peak demand of 1.5 percent (about 300 MW). Winter peaks are projected to grow at an average annual rate of 1.0 percent, and the average territorial energy at 1.3 percent. Annual resource additions required to maintain a planning reserve margin target of 17% are identified as follows:

| Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|
| Forecast Peak (MW) | 17,448 | 17,330 | 17,626 | 17,929 | 18,228 | 18,535 | 18,847 |
| Generating Capability | 19,174 | 18,880 | 18,874 | 18,766 | 18,551 | 18,443 | 18,347 |
| Purchase Contracts | 660 | 744 | 739 | 739 | 739 | 736 | 117 |
| Demand-side Resources | 722 | 698 | 674 | 651 | 628 | 606 | 584 |
| Resource Additions | -- | -- | 330 | 830 | 1474 | 1,960 | 3,090 |

These resource needs are expected to be met with the proposed coal-fired units, as well as proposed combined-cycle units and purchased power. The load forecast and resource plan will be updated in conjunction with Duke Power's September 2005 Annual Plan filing.

## 3.2 Planning Process

Duke Power's Annual Plan is developed with the objective of meeting customers' need for a highly reliable energy supply at the lowest reasonable cost. In the planning process, Duke Power assesses various resource options and demand-side management ("DSM") options available to meet customers' energy needs.

The risks imposed and opportunities presented by the competitive wholesale peaking and intermediate load power market, combined with the significant increase in demand seen in 2011 and beyond as demonstrated in the 2004 Annual Plan, demand that Duke Power maintain flexible resource portfolio strategies to meet customer needs in a reliable and cost-effective manner. Duke Power is currently performing a least-cost study of potential supply-side alternatives as part of the development of 2005 Annual Plan. The 2005 Annual Plan will incorporate a 15-year load forecast, near-term purchased power contracts, existing generation, DSM, new resource additions and a target planning reserve margin (currently 17%).

### 3.3 Preliminary Results

With an identified need of approximately 3,000 MW by 2011, preliminary analysis indicates that plans incorporating significant baseload and intermediate capacity additions are the most cost effective way to efficiently meet the resource needs as early as 2010 and beyond. Duke Power's initial assessment is that one 800 MW unit is the best resource to meet the earliest baseload generation needs. The analyses also indicate the need for additional baseload generation beginning in 2014. Duke Power is considering nuclear generation as an option to meet that additional baseload need. The Company is seeking to preserve the flexibility to construct the second 800 MW unit, the timing of which is contingent upon factors such as increased load, elimination or delay of the nuclear generation option, retirement of existing generation, or development of new regulations. The needs for these resource additions will be tested and refined in the planning process described above and ultimately addressed in the 2005 Annual Plan to be filed on or before September 1. In addition, Duke Power will submit testimony in support of the CPCN application regarding how the Cliffside project conforms to the 2005 Annual Plan.

# 4.0 SITE INVESTIGATIONS AND METHODOLOGY

## 4.1 Historic and Archaeological

State archaeological site files and the National Register of Historic Places were reviewed to determine if any archaeological or historic site would be affected by the proposed project. Before the final CPCN application is submitted, the site will be tested at 30-meter intervals by means of a screened shovel; and any structures from which the proposed site will be visible will be evaluated.

## 4.2 Aesthetic

The Visual Effect Analysis will be conducted in the following manner: First, a comprehensive field study will be performed to identify sensitive visual resources and characterize existing visual conditions. Second, using U.S. Geologic Survey Digital Elevation Models, a computer-generated "Seen Area Analysis" model will be built to predict which areas within a 5-mile radius might have a view of the proposed plant. The Seen Area Analysis also predicts areas where visibility of the plant will be unlikely. Third, the information and data developed during the first and second steps will be analyzed and interpreted.

## 4.3 Geology and Seismology

Soils on the site are typical of the region and are not expected to present unusual problems. Geotechnical drilling, sampling and testing will be performed as needed to provide data for final foundation designs.

## 4.4 Climatological and Air Quality

Detailed evaluations of air-quality impacts caused by plant operation will be performed in support of the air-quality permit application required for constructing and operating the plant.

## 4.5 Water Quality

Water-flow data were obtained from the United States Geological Survey (USGS) National Water Information System (NWIS) web site (USGS 2003). Data from approximately 3.5 miles downstream of the project (Boiling Springs, NC; Station No. 02151500) were used in evaluating flows in Section 2.5.

Water-quality data were obtained from the most recently available Basinwide Assessment Report for the Broad River Basin (NCDENR 2001c). The report uses chemical and physical data collected from a series of ambient monitoring stations by the North Carolina Division of Water Quality (DWQ). Eight sample locations are presently monitored by DWQ in the Broad River Basin; two are situated on the Broad River, and the remaining six locations are on its tributaries. Water-quality data used for the assessment (see Section 2.5) were obtained from the nearest upstream and downstream Broad River locations, at Rock Springs (Station No. A1520000) and Boiling Springs, NC (Station No. A4700000).

## 4.6 Terrestrial Resources

### 4.6.1 Terrestrial Resources

A field survey was conducted in late March 2005 to document specific resources affected by the proposed project. Resources assessed during this effort included wetlands, water bodies, vegetative communities and rare, threatened, and endangered species (RTE).

During the March fieldwork, all wetlands within the designated property boundaries and any associated areas were reviewed using the 1987 Corps of Engineers (COE) wetland-delineation method (Environmental Laboratory 1987). The “routine on-site determination method” was selected as the most appropriate delineation technique. Wetlands were considered present when observations of vegetation, hydrology and soils indicated that the three-parameter criteria for wetland identification were met. Typically, any identified wetlands are classified using the U.S. Fish and Wildlife’s (USFWS) wetland-classification system (e.g., Palustrine Emergent or Palustrine Forested 1c, for permanently flooded wetlands). The COE-required wetland delineation forms were also prepared.

The 2005 databases of the North Carolina Natural Heritage Program and the United States Fish and Wildlife Service (USFWS) were searched to determine the likelihood of RTE species and unique natural communities in the project area. The agency-provided information was augmented through direct observations made during the field assessment conducted in March 2005. The entire study area was walked, and any likely habitats were searched for rare species. In areas of high potential, several transects in the area of likely habitat were made in an effort to intensify the search. Where natural communities exist, vegetative communities were classified through the use of the Classification of the Natural Communities of North Carolina (Schafale and Weakley 1990).

## 4.6.2 Aquatic Resources

### 4.6.2.1 Macroinvertebrates

Macroinvertebrate samples were collected at three Broad River locations near the project site each August from 1994-2001: one location upstream, one location immediately below the Cliffside Steam Station discharge and one location downstream of the Cliffside Steam Station. Macroinvertebrates collected at these locations and their assigned bioclassifications by location and dates are presented in Tables 1-3 (Appendix C). Macroinvertebrate data as described in Section 2.6.2.1 can be found in population studies conducted by Duke Power (Duke Power Company 1998, 2003).

The North Carolina Department of Environmental and Natural Resources methodology was used to collect samples at each location (NCDENR 2001b). A variety of collection techniques (described below) were employed to sample all major habitats, and all samples were sorted and preserved in 80% ethanol in the field. A collection at each site was comprised of 10 samples, as follows:

- A coarse-mesh kick net was used to collect two samples downstream of snags and/or root masses;
- Three sweep-net samples (using 1000-micron mesh) were collected in areas of low current, especially bank areas;
- Two samples of epifauna were collected by “washing down” rock and logs in a large plastic pan or bucket. The collection material was washed through a 300-micron nitex net;
- A 300-micron mesh net was also used to collect one sample in a sandy area. The lighter material was separated using a “stir and pour” elutriation technique;
- Leaf packs and small logs were washed in a large bucket sieve to collect a sample of shredders or snag associated organisms;
- Large rocks and logs were carefully inspected to collect species which may have been missed in other collections.

All specimens were identified in the laboratory to the lowest possible taxon. Total taxa richness and taxa richness for Ephemeroptera + Plecoptera + Trichoptera (EPT) were calculated and used to assign a biological classification to each location. Higher taxa richness is associated with better water quality (Appendix C, Table 4).

#### 4.6.2.2 Fish

Since 1989, annual winter (January or February) and summer (July or August) fish collections have been made near Cliffside Steam Station with boat-mounted electrofishing equipment. One-hundred meters of shoreline were sampled at each of eight locations: two upstream, two at the Cliffside Steam Station discharge canal and four downstream of the Cliffside Steam Station discharge canal. All netted fish were identified, measured (total length-mm) and returned to the river. As much as practical, an attempt was made to conduct electrofishing during periods of relatively low river flow to maximize efficiency and minimize sampling variability due to high-water conditions. A listing of the number of species and individuals collected at all sampling locations and the number of each species/100 m of shoreline sampled is listed in population studies conducted by Duke Power (Duke Power Company 1993, 1998 and 2003). Fish data described in Section 2.6.2.2 are based on this sampling program.

# 5.0 AREA DEVELOPMENT PLANS

## 5.1 Existing Utilities and Other Facilities

In addition to state roads and highways described in Section 1.3, there are other facilities near the project site. A rail spur from the CSX railroad (CSX) serves Cliffside Steam Station. The Broad River Greenway is located along the Broad River, about five miles downstream from the plant. A switchyard with 230 kV and 100 kV lines serving Cliffside is located across the Broad River from the plant.

Also near the proposed facility is a significant amount of open rural pasture land, with a few concentrations of high-density residential areas. Among the single-family residential areas are intermittent commercial properties, one multi-family residential property, one church-owned property and two cemeteries (a small cemetery north of the proposed site and a larger one south of the site).

Most of the area's residential and commercial properties are concentrated along US 221-Alt.

## 5.2 Plans for Future Development

While most Duke Power plants are served by only one railroad, either Norfolk Southern (NS) or CSX, the utility has found that having service from both railroads at an individual plant benefits both Duke and its customers. The benefits include reliability, more choices in fuels and better prices. For these reasons, Duke Power intends to install or have installed a second rail line connecting Cliffside to the NS. The actual route for this line has not yet been selected.

A wet flue gas desulfurization (WFGD) system (or a scrubber) is planned for Unit 5 in 2010.

# 6.0 ENVIRONMENTAL EVALUATIONS

## 6.1 Air Quality

The project will be constructed in an area that is classified as having reached attainment for all pollutants subject to National Ambient Air Quality Standards (NAAQS). The Prevention of Significant Deterioration (PSD) provisions of the Clean Air Act apply to new sources of pollutants in attainment or unclassifiable areas; and a pre-construction permit must be issued by the permitting authority, the North Carolina Department of Environment and Natural Resources (NCDENR) based on an evaluation of applicable pollution-control requirements and evaluation of impacts on air quality or air quality-related values. The PSD permit application will include best available control technology (BACT) analysis, monitoring or evaluation of existing ambient air quality, modeling analysis to show compliance with PSD increments and NAAQS, coordination with Federal Land Managers to model additional impact on air quality and visibility in Class I areas and additional impact analysis on vegetation and soils.

Under the PSD provisions, all areas are designated Class I, Class II, or Class III. These class designations are indicative of the amount of air quality protection afforded to an area; a Class I designation provides the greatest degree of protection against air quality degradation. Initially Congress identified certain mandatory Class I areas. These mandatory Class I areas include all international parks; national wilderness areas and national memorial parks exceeding 5,000 acres in size; and national parks exceeding 6,000 acres in size. All other PSD or "clean air" areas were designated Class II. These evaluations must be performed separately for each pollutant that will be emitted in significant amounts as defined by the PSD regulations.

Certain PSD requirements may not be applicable if emissions from the new project will be offset by contemporaneous reductions from existing sources at the facility. Those reductions may be achieved by adding pollution control to those existing sources or by retiring them. If there is no net emissions increase of a particular pollutant, then BACT requirements, vegetation and soils impact analyses, and PSD impacts are not expected to apply for that pollutant. The project must still be evaluated for impacts on NAAQS, impacts on the allowable PSD increment or significant impacts on non-attainment in another area. The Cliffside project will meet all applicable air quality standards, and enable Duke Power to continue to comply with the emission limitations established by N.C. Gen. Stat. §143-215.107D.

## 6.2 Water Quality

The site has a NPDES permit. Preliminary operating plans are to continue using the existing site ash basin for non-ash discharges, which will require a modification of the existing NPDES permit. The NPDES permit modification and Erosion and Sediment Control Plan will determine evaluation programs needed to meet North Carolina-approved limits. Applications for the permits will outline Duke Power's proposed environmental evaluation program. The applications will be reviewed and approved by appropriate state officials.

The new facility is expected to make use of closed-cycle cooling towers. Use of cooling tower technology will minimize both the intake and discharge impacts to the Broad River. Approval for operational changes relative to water intake and discharge requirements will be sought through the appropriate state agencies.

# 7.0 TRANSMISSION LINE ROUTES AND SYSTEM INTERCONNECTION

Duke Power's Jocassee to McGuire 500 kV transmission line (operating name, South Mountain) will be folded in to a new 500 kV switching station from the high side of the generator step-up transformers (GSUs). Cliffside's 230 kV Tie Station is located on property shared with Cliffside Steam Station. The transmission fold-in will consist of two transmission lines running parallel for approximately .95 miles. The transmission line will require that right-of-way be purchased from one property owner.

Cliffside's 230 kV Tie, a major bussing point for Duke's Electric Transmission System, is connected to Shelby Tie Station and Pacolet Tie Station. To accommodate the increased generation, the Cliffside 230 kV bus may need to be connected to the 500 kV system through two 500/230 kV transformers. The tie station currently contains two 230/100 kV autotransformers that serve load out of Cliffside. New 230/100 kV transformer capacity may be necessary. It is also possible that certain 100 kV lines leaving the Cliffside 100 kV switchyard will need to be upgraded or re-built.

# 8.0 AGENCY APPROVALS

## 8.1 Water Quality and Supply

### 8.1.1 NPDES Permit

A National Pollutant Discharge Elimination System (NPDES) permit is required for the discharge of any wastewater to surface water or groundwater from a point source. Wastewater streams include yard drain sump discharges, coal pile runoff, plant boiler and cooling tower blowdown, scrubber wastewater treatment discharge, periodic system cleanings and miscellaneous leakages. The Cliffside site currently has a NPDES-permitted ash settling basin discharge. Wastewater will be routed to the ash basin prior to discharge to the Broad River; thus a modification to the NPDES permit will be required.

### 8.1.2 NPDES Authorization to Construct

The construction or modification of any wastewater treatment system requires an NPDES Authorization to Construct to be issued by the North Carolina Department of Environment and Natural Resources (NCDENR). Authorization will be sought for any sumps/oil-water separators required prior to discharge to the ash basin. These are described in Appendix A.

### 8.1.3 NPDES Stormwater Permit for Construction

An NPDES Stormwater permit, issued by NCDENR will be required for discharge of any site stormwater runoff during the construction phase of the project. As part of the NPDES Stormwater permit, an erosion and sediment-control plan will be developed and submitted to NCDENR. This plan identifies the erosion and sediment-control measures to be employed during construction.

### 8.1.4 Well Permit

The drilling of any well for use in a potable water system or for plant operation must be permitted through NCDENR.

### 8.1.5 Dredge and Fill Permit

Construction of a new intake or wetland impact will require a dredge and fill permit pursuant to Section 404 through the Army Corps of Engineers and an associated Section 401 Water Quality Certification through NCDENR. A site assessment for identification of existing wetlands will be completed. At this time, no new intakes or discharge structures are planned for the project site.

### 8.1.6 Water Distribution System Permit

If needed, a construction permit for any exterior potable water-distribution system will be obtained from NCDENR. The permit includes all potable water piping, storage tanks, pumps, etc., from the water source to the point where the piping enters the building.

## 8.2 Air Quality Permit

A Prevention of Significant Deterioration (PSD) permit will be required. The following activities will be performed in support of the application:

- A Best Available Control Technology (BACT) analysis to determine the optimal technology for limiting emissions, considering both environmental and economic impacts.
- A modeling analysis to demonstrate compliance with PSD increments and National Ambient Air Quality Standards (NAAQS);
- An impact analysis on visibility, growth, vegetation and soils.
- Modeling to evaluate impacts on all Class I areas, as required by the Federal Land Manager.
- Visibility modeling to evaluate Class II area impacts.

Any additional ancillary facilities, including emergency generators, coal and limestone preparation facilities, auxiliary boilers and paint and sandblasting areas may also require air-quality permits. PSD permitting will apply to any of these ancillary facilities if the source will emit more than 100 tons of a regulated pollutant. In addition, zoning consistency reviews for Cleveland and Rutherford Counties will be required.

## 8.3 Solid and Sanitary Waste

### 8.3.1 Landfills

Where possible, construction debris will be re-used beneficially on-site. No construction debris landfill permits are planned, as unusable inert debris produced during construction and solid wastes generated during operation will be disposed of in an off-site landfill. Landfill permits will be sought from NCDENR to dispose of ash and gypsum from the plant scrubber operations.

### 8.3.2. Domestic Waste

The construction of a septic tank and drain field system requires a development permit and septic tank permit issued by the County Health Department. Constructing a domestic sewage-piping system from the point it exits a building to the point of discharge into a municipal system or other waste treatment facility requires a construction permit issued by NCDENR. This permit includes all manholes, pumps, storage tanks, etc., associated with the system.

## 8.4 Miscellaneous Permits

### 8.4.1 Building and Zoning

The construction or modification of any structure that is not for the purpose of generating or transmitting electricity requires a building permit. Construction or modification includes any structural, electrical, plumbing, fire-protection or heating, ventilation and air conditioning (HVAC) work. No zoning permit is required, based upon the present nature and use of the site as an existing electric generating plant.

### 8.4.2 Driveway

Construction of the plant entrance off County Road 1002 may require a driveway permit issued by the North Carolina Department of Transportation (NCDOT).

### 8.4.3 Highway Encroachment

Any construction within the right-of-way of a state-, county- or municipally maintained road which is not covered by a driveway permit requires an encroachment permit issued by NCDOT. Examples are signs, fences, drainage-control construction, erosion-control construction, etc.

### 8.4.4 FAA Notification

Federal Aviation Agency (FAA) notification will be made. A permanent structure (the plant stack) with a height of about 575 feet is planned. The plant site is greater than 20,000 feet from an airport.

### 8.4.5 Local Construction Permit

Local construction permits will be obtained from the counties. This permit will require that construction be performed in accordance with local building codes.

# 9.0 PROJECT COSTS

## 9.1 Capital Costs

Duke Power considers this information proprietary and confidential and it is being provided confidentially as "Attachment 1" under separate cover pursuant to N.C. Gen. Stat. §132-1.2.

## 9.2 Operating Expenses

Duke Power considers this information proprietary and confidential and it is being provided confidentially as "Attachment 1" under separate cover pursuant to N.C. Gen. Stat. §132-1.2.

# 10.0 CONSTRUCTION SCHEDULE

## 10.1 Commencement and Completion of Construction

Construction of the project may begin as early as September 2006, assuming timely authorization to begin fabrication of major plant components, acquire environmental permits, etc. Commercial operation of the first unit may begin as early as 2010.

## 10.2 Commencement and Completion of Testing

Performance and emissions-acceptance tests are required for each unit as part of the contract with the turbine vendor and will occur after the unit is operational.

## References

Algermissen, S. T., 1969, Seismic risk studies in the United States: Proceedings of the 4th World Conference on Earthquake Engineering, Santiago, Chile, v. 1, p. 19-27.

Amick, D. and Gelinas, R., 1991, Paleoliquefaction investigations along the Atlantic Seaboard, results of recent studies and plans for future investigations: EOS Transactions, American Geophysical Union, p.195.

Bollinger, G. A., 1969, Seismicity of the Central Appalachian States of Virginia, West Virginia and Maryland - 1758 through 1968: Bulletin of the Seismological Society of America, v. 58, no. 5, p. 2103-2111.

Bollinger, G. A., 1973, Seismicity of the southeastern United States: Bulletin of the Seismological Society of America, v. 63, no. 5, p. 1785-1808.

Bollinger, G. A., 1975, A catalog of southeastern United States earthquakes 1754 through 1974: Research Division Bulletin 101, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 68p.

Bollinger, G. A., 1977, Reinterpretation of the intensity data for the 1886 Charleston, South Carolina, earthquake, p. 17-32, *in*, Rankin, D. W., ed., Studies related to the Charleston, South Carolina earthquake of 1886 - A preliminary report: U. S. Geological Survey Professional Paper 1028, 204p.

Bollinger, G. A., 1992, Specification of source zones, recurrence rates, focal depths, and maximum magnitudes for earthquakes affecting the Savannah River Site in South Carolina: United States Geological Survey Bulletin 2017, 57p.

Bollinger, G. A., Chapman, M. C., Sibol, M. S., and Costain, J. K., 1985, An analysis of earthquake focal depths in the Southeastern U. S.: Geophysical Research Letters, v. 12, p. 785-788.

Bollinger, G. A., Johnston, A. C., Talwani, P., Long, L. T., Shedlock, K. M., Sibol, M. S., and Chapman, M. C., 1991, Seismicity of the southeastern United States; 1698 to 1986, p. 291-308, in Slemmons, D. B., Engdahl, E. R., Zoback, M. D., and Blackwell, D. D., eds., Neotectonics of North America: Geological Society of America, Decade Map Volume 1, 498p.

Bollinger, G. A. and Wheeler, R. L., 1982, The Giles County, Virginia, seismogenic zone - seismological results and geological interpretations: U. S. Geological Survey Open-File Report 82-585, 136p.

Bolt, B. A., 1988, Earthquakes: W. H. Freeman and Company, New York, 282p.

Butler, J. R., 1991, Metamorphism, p. 127-141, in Horton, J. W., Jr. and Zullo, V. A., eds., The Geology of the Carolinas: The University of Tennessee Press, Knoxville, TN, 406p.

Chapman, M. C., Bollinger, G. A., Sibol, M. S., and Stephenson, D. E., 1990, The influence of the Coastal Plain sedimentary wedge on strong ground motion from the 1886 Charleston, South Carolina, earthquake: Earthquake Spectra, v. 6, no. 4, p.617-640.

Coffman, J. L. and von Hake, C. A., 1973, Earthquake history of the United States: National Oceanic and Atmospheric Administration and United States Geological Survey, Publication 41-1. Revised Edition through 1970.

Conrad, S. C., 1985, Geologic map of North Carolina: State of North Carolina, Department of Natural Resources and Community Development, Division of Land Resources, scale 1:500,000.

Dutton, C. E., 1889, The Charleston Earthquake of August 31, 1886: United States Geological Survey, Ninth Annual Report 1887-1886, p.203-228.

Duke Power Company 1998. *Assessment of balanced and indigenous populations in the Broad River near Cliffside Steam Station*. Duke Energy, Charlotte, NC.

Duke Power Company. 1993. *Thermal limit evaluation report for Buck, Cliffside, and Riverbend Steam Stations.* Duke Power Company, Charlotte, North Carolina.

Duke Power Company 2003. *Assessment of balanced and indigenous populations in the Broad River near Cliffside Steam Station.* Duke Energy, Charlotte, NC.

Duke Power Company. 1999. *The Duke Power Annual Plan*. September 1, 1999.

Duke Power Company. 2000. *The Duke Power Annual Plan*. September 1, 2000.

Environmental Laboratory. 1987. *Corps of Engineers Wetlands Delineation Method*. Dept. of Army Waterways Experiment Station, Corps of Engineers, Vicksburg, MS. Technical Report Y-87-1. 100 pp.

Frankel, A. and Leyendecker, E. V., 2001, Seismic Hazard Curves and Uniform Response Spectra for the United States; User Guide, Software Version 3.10; U. S Geological Survey, 23p.

Frankel, A., Mueller, C., Barnhard, T., Perkins, D., Leyendecker, E. V., Dickman, N., Hanson, S., and Hopper, M., 1996, Interim National Seismic Hazard Maps: Documentation: U. S. Geological Survey, Preliminary Report, 31p.

Goldsmith, R., Milton, D. J., and Horton, J. W., Jr., 1988, Geologic map of the Charlotte 1 x 2 quadrangle, North Carolina and South Carolina: U. S. Geological Survey, Miscellaneous Investigations Series, Map I-1251-E, scale 1:250,000.

Hatcher, R. D., Jr., 1978a, Tectonics of the western Piedmont and Blue Ridge, southern Appalachians: review and speculation: American Journal of Science, v. 278, p. 276-304.

Hatcher, R. D., Jr., 1978b, Synthesis of the southern and central Appalachians, U.S.A., in IGCP Project 27, Caledonian - Appalachian Orogen of the North Atlantic Region: Geological Survey of Canada, paper 78-13, p. 149-157.

Hatcher, R. D., Jr., Thomas, W. A., Geiser, P. A., Snoke, A. W., Mosher, S., Wiltschko, D. V., 1989, Alleghanian orogen, p. 233-318, in Hatcher, R. D., Jr., Thomas, W. A., and Viele, G. W., eds., The Appalachian-Ouachita orogen in the United States: Geological Society of America, The Geology of North America, V. F-2, 767p.

Hooper, M. G. and Bollinger, G.A., 1971, The earthquake history of Virginia, 1774 to 1900: Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Horton, J. W., Jr. and McConnell, K. I., 1991, The Western Piedmont, p. 36-58, in Horton, J. W., Jr. and Zullo, V. A., eds., The Geology of the Carolinas: The University of Tennessee Press, Knoxville, TN, 406p.

Jarrell, Jerry D., Max Mayfield, Edward N. Rappaport and Christopher W. Landsea. "U.S. Mainland Hurricane Strikes by State, 1900-2004." http://www.nhc.noaa.gov/paststate.html.

Johnston, A. C., Reinbold, D. J., and Brewer, S. I., 1985, Seismotectonics of the southern Appalachians." Bulletin of the Seismological Society of America, v. 75, p. 291.

McSween, H. T., Jr., Speer, J. A., and Fullagar, P. D., 1991, Plutonic rocks, p. 109-126, *in*, Horton, J. W., Jr. and Zullo, V. A., eds., The Geology of the Carolinas: The University of Tennessee Press, Knoxville, Tennessee, 406p.
Mississippi.

Menhinick, E. F. 1991. The freshwater fishes of North Carolina. North Carolina Wildlife Resources Commission, Raleigh, North Carolina.

Menhinick, E.F. and A.L. Braswell (editors). 1997. Endangered, threatened, and rare fauna of North Carolina: Part IV. A reevaluation of the freshwater fishes. Occasional papers of the Museum of Natural Sciences and the North Carolina Biological Survey, No. 11, North Carolina State Museum of Natural Sciences, Raleigh, North Carolina.

North Carolina Department of Environment and Natural Resources (NCDENR). 2001(a). Standard operating procedure. Biological monitoring: stream fish community assessment & fish tissue. NCDENR, Division of Water Quality, Water Quality Section. Raleigh, North Carolina.

NCDENR. 2001(b). Standard operating procedures for benthic macroinvertebrates. North Carolina Department of Environment and Natural Resources. Division of Water Quality. Water Quality Section. Raleigh, NC.

NCDENR 2001(c). Basinwide assessment report: Broad River basin. NCDENR, Division of Water Quality, Water Quality Section. Raleigh, North Carolina.

NCDENR. 2004. NCDENR – Division of Water Quality "Redbook": Surface Waters and wetlands Standards. NC Administrative Code 15A NCAC 02B .0100, .0200 & .0300, Amended Effective: August 1, 2004. 130 p.

Nuttli, O. W., Bollinger, G. A., and Griffiths, D. W., 1979, On the relation between Modified Mercalli Intensity and body-wave magnitude: Bulletin of the Seismological

Olmsted, L.L. 1977. Editor. *Proceeding of the first symposium on freshwater larval fish*. Sponsored by the Southeastern Electric Exchange. Charlotte, NC 24-25 February 1977.

Rodgers, J., 1970, The tectonics of the Appalachians: John Wiley & Sons, Inc. New York, 271p.

Sibol, M. S., Bollinger, G. A., and Birch, J. B., 1987, Estimation of magnitudes in central and eastern North America using intensity and felt areas: Bulletin of the Seismological Society of America, v. 77, no. 5, p.1635-1654.

Schafale, M.P. and A.S. Weakley. 1990. *Classification of the Natural Communities of North Carolina: Third Approximation*. North Carolina Natural Heritage Program, Division of Parks and Recreation, Department of Environment and Natural Resources.

Schatzki, Fred. 2004. Forest Management Plan for the Cliffside Steam Station, Duke Energy Corporation.

South Carolina 1997. *Air Quality Annual Report*, Fig. 3-4, pg. 31.

South Carolina Department of Natural Resources. 2000. *Rare, Threatened, and Endangered Species Inventory Database*. South Carolina Heritage Trust, Columbia, SC.

Sibol, M. S. and Bollinger, G. A., 1984, Seismicity of the southeastern United States: Southeastern U.S. Seismic Network Bulletin No 12A, Seismological Observatory, V.P.I. & S.U., Blacksburg, Virginia, 44p.

State Climate Office of North Carolina. "History of North Carolina Hurricanes." http://www.nc-climate.ncsu.edu.

Stover, C. W. and Coffman, J. L., 1993, Seismicity of the United States, 1568-1989 (Revised): U. S. Geological Survey Professional Paper 1527, 418p.

Talwani, P., 1982, Internally consistent pattern of seismicity near Charleston, South Carolina: Geology, v. 10, p.654-658.

Talwani, P. and Collinsworth, K., 1988, Recurrence intervals for intraplate earthquakes in Eastern North America from paleoseismological data: Seismological Research Letters, v. 59, no. 41, p.207-211.

The Tornado Project 2000. "The Tornado Project." http://www.tornadoproject.com.

United States Fish and Wildlife Service. 2000. *Endangered, Threatened, and Candidate Species and Federal Species of Concern, By County, In North Carolina*. Raleigh Field Office, NC. 51 pp.

United States Geological Survey – National Earthquake Information Center, 2005, USGS/NEIC 1973-Present Earthquake Catalog: Web Site: wwwneic.cr.usgs.gov.

United States Geological Survey – National Earthquake Information Center, 2005, Eastern, Central and Mountain States of U.S. 1534-1986 Earthquake Catalog: Web Site: wwwneic.cr.usgs.gov.
United States Geological Survey (USGS). 2003. NWISWeb Data for the Nation. Web address: http://waterdata.usgs.gov/nwis.

# APPENDIX A

# DESCRIPTION OF PLANT SYSTEMS AND COMPONENTS

The supercritical pulverized-coal (SCPC) station's mechanical and electrical components and systems and major structures that make up the project are described in more detail in the following subsections.

## PROJECT DESCRIPTION AND OVERVIEW

The proposed Cliffside project will consist of two new nominal 800 MW net baseload supercritical pulverized-coal electric generating unit(s). The SCPC technology is more advanced than conventional coal-combustion technologies currently in operation. This technology allows water to be heated to higher temperatures and pressures so that the energy content of the steam delivered to the turbines is much greater. Higher plant efficiencies result, and less fuel is burned per unit of electrical output.

SCPC technology is defined by the operating temperature and pressure capability of the steam generator. This technology involves heating water to a temperature and pressure that exceeds its critical point. The critical point of water is at a pressure of about 3,208 pounds per square inch absolute (psia) and a temperature of 705 degrees Fahrenheit (°F). Above the critical point, distinct liquid and vapor (gas) phases no longer exist, and the state of the water is that of a supercritical fluid. Since the high-pressure steam will be produced at a pressure and temperature above the critical point, the plant is referred to as a supercritical unit. In the supercritical range, water does not actually boil but is continuously transformed from the liquid phase to a supercritical fluid, which has thermal dynamic properties that are between those of a pure liquid and gas. Therefore, a steam drum used to separate water vapor from liquid water is not required in a supercritical steam generating facility.

The SCPC unit(s) use higher temperatures for main (high-pressure) and reheat steam than those conventionally used in domestic subcritical power plants. Newer alloys, proven effective by their successful application in the industry in recent years, will allow the steam temperatures to be higher and thus increase the efficiency of the unit. Higher temperatures and pressures achieved using a supercritical steam generator increase the energy content of the fluid delivered to the turbines. Efficiency is elevated by increasing the energy, or enthalpy drop, across the turbines. Use of cold water in the condenser further increases plant efficiency. The use of colder water reduces the pressure at which the steam condenses and allows the steam to expand further, thus increasing the amount of useful energy derived from the steam.

Greater plant efficiency means less fuel burned per unit of electrical output. Air emissions per unit of electrical output will also decrease by an amount proportional to efficiency gains that are made as compared to a conventional subcritical steam generator. Solid wastes and waste water production decrease as well.

New coal handling systems will be located in the existing common coal storage yard, and the storage yard will be expanded to accommodate the additional capacity. The lime handling and storage system will be located adjacent to the existing coal pile and new cooling towers.

## Major Power Generation Equipment

### Steam Generator

The steam generator will be a supercritical steam pressure and temperature, pulverized-coal, balanced-draft unit. The power plant will be designed to operate as a baseload facility, but one of the advantages of the planned sliding pressure SCPC boiler included in the design is that it will simplify cycling the unit to accommodate load-flow fluctuations required by the electrical system demand. The typical steam generator-related equipment is listed and briefly described below.

The initial step of the steam generation process involves pumping water (“feedwater”) through the economizer to recover heat from the combustion gases exiting the steam generator. Downstream of the economizer, the heated feedwater is directed through to the water-wall circuits enclosing the furnace. After passing through the lower and upper radiant walls, pendent and platen furnace circuits in sequence, the fluid passes through the convection enclosure circuits to the superheater section of the steam generator. The fluid is mixed in crosstie headers at various locations throughout the path.

The steam then exits the steam generator to the high-pressure (HP) section of the steam turbine. As the steam energy is converted to shaft power in the HP turbine, its temperature and pressure are reduced. The cooled and lower-pressure steam exits the HP turbine, returns to the steam generator and passes through the reheater section of the steam generator, where the steam temperature is raised back to the expected intermediate-pressure (IP) turbine inlet temperature of 1,050°F. This step is called reheat, and it is used to increase the efficiency of the cycle. The steam then returns to the IP turbine. From the IP turbine, the steam is directed to the low-pressure (LP) turbine, where it further expands to convert energy to turbine shaft power to drive the electric generator.

### Air and Combustion System

Air from the forced draft fans is heated in the air preheaters, recovering heat energy from the steam generator exhaust gases on their way to the stack. This air is distributed to the burner windbox as secondary air.  The primary air (PA) fans supply a portion of the combustion air.  This air is also heated in the air preheaters and then used to dry the fuel being pulverized.  A portion of the air from the PA fans is routed around the air heaters and is used as tempering (cooling) air for the pulverizers.  Preheated air and tempering air are mixed at each pulverizer to obtain the desired pulverizer fuel-air mixture outlet temperature.

The pulverized coal and combustion air mixture flows to the coal nozzles at the various elevations of the furnace.  The low-nitrogen oxide (NOx) burners receive the fuel and air mixture and inject it into the furnace where it is ignited.  The hot combustion products provide radiant heat to the furnace walls, rise to the top of the steam generator and pass horizontally through the superheater and reheater in succession.  The gases then turn downward, passing in sequence through the additional convective superheat surface and economizer.  The gases exit the steam generator at this point and flow to the selective catalytic reduction (SCR) system, preheater, dry electrostatic precipitator (ESP), flue gas desulfurization (FGD) system, wet ESP, induced draft fans and stack.

### Fuel Feed

Coal is fed from coal silos, through gravimetric feeders and then to the pulverizers.  The pulverized coal exits each pulverizer via the coal piping and is distributed to the coal nozzles into the furnace.

### Ash Removal

Bottom ash discharged from the furnace bottom is received, cooled and dewatered by a bottom ash submerged scraper conveyor located directly beneath the boiler.  Ash collected in the economizer hoppers and rejects from the pulverizing mills is also transferred to the receiving trough of the submerged scraper conveyor.  After dewatering, the commingled material is transferred to an existing storage pad and later loaded into trucks and transported offsite for utilization.

### Burners

A steam generator of this capacity uses multiple coal nozzles located at several elevations.  Each burner is designed as a low-NOx configuration, with staging of the coal combustion to minimize NOx formation.  In addition, there may be at least one elevation of overfire air to complete the combustion process and further inhibit NOx formation.

### Ignitors

Fuel oil-fired ignitors are provided for each coal burner for ignition and flame stabilization at startup and low loads. Flame stabilization is not normally required during other modes of operation. The igniter capacity will be no less than 10 percent of the heat input of each main coal burner.

### Air Heaters

The steam generator will be furnished with at least two vertical shaft regenerative-type air heaters to preheat the incoming primary and secondary air using heat recovered from the flue gas leaving the boiler.

### Soot Blowers

This system will provide on-line fireside cleaning of the heat-absorbing surfaces in the furnace. The purpose of this system is to maintain proper heat transfer capacity that would otherwise be lost from ash build-up, and it prevents sections of the steam generator from becoming severely plugged. The soot-blowing medium may be steam for superheater, reheater, economizer and regenerative air heater surfaces and high-pressure water for the radiant furnace walls. This system uses an array of retractable nozzles and lances.

### Steam Turbine

The steam turbine consists of a combined HP and IP casing and two double-flow LP sections. High-energy fluid from the steam generator passes through the stop valves and control valves and enters the turbine at approximately 3,600 pounds per square inch gauge (psig) and 1,050°F. The supercritical fluid initially flows through the HP turbine and then returns to the steam generator for reheating. The reheated steam flows through the reheat stop valves and intercept valves and enters the IP section. After passing through the IP section, the steam enters a crossover/cross-under pipe, which transports the steam to the two LP sections. The steam divides into four paths and flows through the LP sections, exhausting downward into the condenser.

## Emissions Control Equipment

Several types of emissions control systems are planned. NOx control will be achieved by a combination of low-NOx burners and a SCR system. Particulate and sulfur dioxide ($SO_2$) emissions will be controlled by a combination of dry ESP, wet FGD scrubber and wet ESP.

## Nitrogen Oxide Control

Nitrogen oxide production will be minimized through the use of low-NOx burners. NOx emissions from the steam generator are subsequently reduced by the SCR system. In a SCR system, NOx reacts with ammonia in the presence of a catalyst to form nitrogen gas and water. Ammonia is vaporized and introduced to the SCR upstream of the catalyst bed through a series of injection nozzles. A SCR system must be operated within a narrow temperature range (about 600-800 °F) to achieve efficient NOx removal. The SCR system will be located between the economizer and air heaters, where gas temperature will typically fall within this range.

## Sulfur Dioxide and Particulate Removal

Sulfur dioxide and particulate emissions will be controlled by a dry ESP, wet limestone based FGD system and a wet ESP. The wet scrubbers are located between the air heater and the wet ESP. The flue gas from the scrubbers enters the inlet plenum of the wet ESP and is distributed among the modules. Gas enters each module through an inlet near the bottom of the module. The gas then turns upward and is uniformly distributed through the modules, depositing the particles on the surface of the plates. Clean gas passes through the plates and into the clean gas outlet duct. From the wet ESP, the gas enters the ID fan.

## Hazardous Air Pollutants (HAPs) Control

Hazardous Air Pollutant (HAPs) emissions will be controlled by the utilization of a wet FGD system and wet ESP. Future maximum achievable control technology (MACT) may require installation of mercury control technology. As a result, future design provisions for a sorbent injection system located between the air heater and the wet FGD system will be provided in the design. The overall design integration of the pollution control systems will provide for optimum environmental performance.

The planned use of low-NOx burners has been shown to increase the carbon content of the fly ash. HAPs and mercury emissions can be potentially reduced through adsorption onto the fly ash carbon and subsequent capture in the wet FGD and wet ESP. Although the SCR does not directly capture the HAPs, the SCR may help in the downstream capture of mercury by at least partially oxidizing part of the elemental mercury to the oxidized form that can be collected in a particulate control device. The SCR, wet FGD and wet ESP system will aid in controlling mercury emissions.

# AUXILIARY FACILITIES

### Limestone Storage, Handling and Reagent Preparation System

The function of the limestone storage, handling and reagent preparation system is to receive, store and transfer limestone to the wet FGD system's reagent preparation equipment. There, the limestone will be processed into a slurry and sprayed into the FGD system.

## Bottom and Fly Ash By-Product Storage and Handling System

The function of the ash handling system is to remove, temporarily store and/or condition the coal combustion products for transport. Ash is conditioned for reuse markets or placement in landfills.

## Bottom Ash Conveying and Storage

Bottom ash discharged from the steam generator will be received, cooled and dewatered by a bottom ash submerged scraper conveyor located directly beneath the boiler. Ash collected in the economizer hoppers and rejects from the pulverizing mills are also transferred to the receiving trough of the submerged scraper conveyor. After dewatering, the commingled material is transferred to an existing approved storage pad and later loaded into trucks and transported offsite for beneficial reuse.

## Fly Ash Conveying and Storage

Fly ash collected in the air heater hoppers are conveyed to the byproduct storage silo. The material is removed from the respective hoppers and transferred to the storage silo by means of a pneumatic transport system. Byproduct in the storage silo may be unloaded dry into enclosed trucks or rail cars. It can also be conditioned (wetted to prevent fugitive dusting) and loaded into open bed trucks for transport to an offsite landfill.

## Auxiliary Boiler

An auxiliary boiler fired by Number 2 Fuel Oil will be included. The purpose of the auxiliary boiler is to provide steam for various purposes during periods when the plant is not running. The auxiliary boiler will supply steam to the auxiliary steam system. The auxiliary boiler for the new unit will supply steam for use as an energy source for building heating and supply the steam used for starting up the new unit when the preferred source of steam from the existing unit is not available. Steam is used in the startup of a unit for various purposes, including supplying steam to the steam turbine's steam seal system.

# APPENDIX B
# DISCUSSION OF HISTORICAL SEISMIC ACTIVITY

Historical seismicity in the Blue Ridge and Valley and Ridge Physiographic/Geologic provinces shows a general northeasterly trend, paralleling and generally lying within the Paleozoic thrust and fold belts from Alabama to west-central Virginia (Figure 2.3-3). The largest earthquake known in this region is the May 31, 1897 Giles County, Virginia event (MMI=VIII; $m_b$=5.8; Figure 2.3-4). Reliable hypocentral locations are available for the two most active regions in the Blue Ridge and Valley and Ridge provinces: Giles County, Virginia seismic zone and Eastern Tennessee-Western North Carolina seismic zone (Figure 2.3-3). The earthquakes in the Giles County area define a 40-km long, steeply dipping, northeast-trending seismogenic zone that includes the probable epicenter of the 1897 earthquake. The orientation of the Giles County seismic zone differs from the trend of surface geological structure; also the earthquakes occur at depths ranging from 5 to 25 km, entirely beneath the Paleozoic sedimentary cover rocks. Results from earthquake monitoring obtained in a zone extending from eastern Tennessee and western North Carolina through northwest Georgia and into northeast Alabama show significant similarities to those of the Giles County seismic zone. Most hypocenters are located beneath the Paleozoic cover rocks and crystalline thrust sheets, at depths between 3 and 29 km, with a concentration in the depth range 9 to 15 km. Epicenters located by modern seismic networks show a spatial pattern similar to that exhibited by the earlier, pre-network data set. The most apparent difference between the two data sets is the Blue Ridge region of western North Carolina is currently less active than it was in the past on the basis of the earlier historical record. There is also a corresponding increase in activity in eastern Tennessee, perhaps because instruments to record seismic activity have been available for only a relatively short time or because activity in more populated areas received more notice.

The May 31, 1897 Giles County, Virginia, earthquake epicenter was near Pearisburg, Virginia (Figure 2.3-4). Damage and effects from the earthquake included cracked and damaged brick chimneys, sliding of unstable rock, loud noises, and mud-filled springs. The epicentral Modified Mercalli Intensity (MMI) was estimated at VII-VIII based on newspaper reports and eyewitness accounts. The earthquake was felt as far away as Indianapolis, Indiana, 530 km. The felt area was about 686,000 $km^2$.

Microearthquakes continue in the epicentral zone up to the present. Two other significant earthquakes have occurred in the Blue Ridge province: the 1916 Skyland, North Carolina, earthquake and the 1926 Mitchell County earthquake (Figure 2.3-4). The Skyland event occurred on February 21, 1916, and was felt over a large portion of the southern Appalachians. The event was felt from Georgia to Virginia, but no significant damage was reported. The epicentral MMI was estimated to be VII, with the epicenter near Skyland, North Carolina. The felt area was reported to be about 518,000 $km^2$. A magnitude ($m_b$) of 5.2 was estimated for the event. The Mitchell County event occurred on July 8, 1926, and caused light damage (epicentral MMI=VII) in a small area of southern Mitchell County. It was reported that houses rattled, chimneys and building foundations cracked, a water pipe broke and glassware was displaced. The event was estimated to be $m_b$ 5.2, but may be overestimated, since no personal accounts were reported; and the magnitude is based on the epicentral intensity only.

Historical earthquakes in the Piedmont province of the southern Appalachians have occurred primarily in central Virginia and South Carolina (Figure 2.3-3). Recent instrumental data defines a cluster of activity in central Virginia; however, the Piedmont of South Carolina has been less active, according to instrumental data. The instrumental data comes primarily from central Virginia and South Carolina. Network monitoring of these regions has shown that seismicity occurs at shallow depths in the upper crust, from near surface to about 15 km. The average depth is about 8 km, and 90% of the earthquakes occur at depths of 11 km or less. This contrasts with results for the Blue Ridge province to the west, where seismicity occurs at mid-crustal depths (9 to 15 km). Network monitoring shows that hypocentral locations in the Piedmont as a whole are spatially diffuse, both vertically and horizontally. This is interpreted to indicate that multiple structures are responsible for the seismicity in the Piedmont rather than several singular predominant structures. The Appalachian Piedmont is an area of crystalline rock characterized by relatively shallow earthquakes, and the region is notable for the occurrence of reservoir-induced seismicity limited to parts of South Carolina and Georgia.

The largest event in the Piedmont province was the August 31, 1861, Wilkesboro, North Carolina, earthquake, with an epicentral MMI VII (Figure 2.3-4). It was felt over most of the middle Atlantic region and in areas as widespread as Cincinnati, Ohio; Washington, D.C., Columbus, Georgia, and Charleston, South Carolina. The felt area was reported as 777,000 $km^2$. Magnitude ($m_b$) was estimated at 5.2. The other significant earthquake in the Piedmont region is the January 1, 1913, Union County, South Carolina, event (Figure 2.3-4). The earthquake was felt in parts of North and South Carolina. The event had epicentral MMI VII with an estimated $m_b$ 4.8.

Outside of the Charleston, South Carolina, area, the Coastal Plain of the Carolinas has experienced a few scattered earthquakes since records were first kept. Charleston has a long history of earthquakes. At least ten earthquakes were felt in the vicinity of Charleston prior to 1886, dating back to 1698. Only one damaging earthquake has occurred within the historical record, the August 31, 1886, event at Charleston (Figure 2.3-4). However, paleoliquefaction evidence supports several prehistoric earthquakes capable of liquefying soils. The evidence suggests that earthquakes large enough to cause liquefaction features have a return period of about 600 years. In general, the minimum magnitude ($m_b$)

required for liquefaction is assumed to be 5.5. Most of the paleoliquefaction features are interpreted to have been caused by earthquakes in the Charleston zone. Instrumentally located recent earthquakes have resolved the location of most of the Charleston activity into one zone at depths as great as 14 km.

The main earthquake in the Coastal Plain province was the August 31, 1886 Charleston, South Carolina, event (Figure 2.3-4). The main shock lasted about one minute and resulted in about 60 deaths and severe damage to the city of Charleston. The evaluation of earthquake damages and effects indicated that the maximum Modified Mercalli Intensity (MMI) associated with this earthquake was 9. Effects in the epicentral area included distorted and dislocated railroad tracks; mud and sand ejected from fissures in the ground, resulting in craters; damage to most buildings; and areas of marked horizontal displacement. The liquefaction features were common in an area of about 1550 $km^2$ centered on Charleston. Damage from the earthquake generally diminished away from Charleston. The event was felt throughout most of the eastern United States from the Mississippi Valley up to the Great Lakes. The intensities reported at any one location were greatly affected by the nature of the subsurface. A long sequence of aftershocks followed the main event. The magnitude of the 1886 Charleston earthquake has been estimated to have been from $m_b$ 6.5 to 7.1. The other significant earthquakes in the Charleston region are the February 3, 1972, Bowman, South Carolina, event and the November 22, 1974, Charleston, South Carolina, event. The 1972 Bowman earthquake had an instrumental magnitude $m_b$ 4.5 and was felt in a 67,400 $km^2$ area of South Carolina and adjacent Georgia and North Carolina. The 1974 Charleston earthquake had an instrumental magnitude $m_b$ 4.7.

Earthquakes have been associated with a number of reservoirs in the southeastern United States. The lakes having various degrees of induced seismicity are Monticello Reservoir, Lake Keowee, Lake Jocassee, Clark Hill Reservoir (now Strom Thurmond Reservoir), Russell Lake, Lake Oconee and Lake Sinclair. All of these are within the Piedmont province, which is characterized by small, shallow earthquakes. Reservoir-induced seismicity has not occurred at any of the lakes near this site.

The Cliffside Site is within an area of low seismicity in the Piedmont geologic province near the North Carolina and South Carolina border (Figures 2.3-3 and 2.3-4). Within a 50-mile radius of the site, eleven earthquakes of $MMI_o \geq V$ or $m_b \geq 3.5$ have occurred (Figure 2.3-3).

The historical maximum intensity from an earthquake in the Piedmont region is MMI VII (Central Virginia earthquake of 1875; Union County, South Carolina, earthquake of 1913; and the Wilkesboro, North Carolina, earthquake of 1861; Figure 2.3-4). The Wilkesboro, North Carolina, earthquake on August 31, 1861, with an epicentral Modified Mercalli Intensity of VI-VII and an estimated magnitude ($m_b$) of 5.2, is the historical maximum event (magnitude) in the Piedmont (Figure

2.3-4). The epicenter of the 1861 Wilkesboro earthquake is approximately 72 miles north of the project site (Figure 2.3-4). This earthquake was felt at the site with MMI III-IV.

The 1913 Union County earthquake epicenter is about 36 miles southwest of the site and was felt with intensity MMI V at the site (Figure 2.3-4). The 1916 Skyland, North Carolina, earthquake (a Blue Ridge event) epicenter is about 46 miles northwest of Cliffside and was felt with intensity MMI IV at the site (Figure 2.3-4). The 1926 Mitchell County, North Carolina, earthquake (a Blue Ridge event) occurred approximately 50 miles northwest of the site (Figure 2.3-4). Only the epicentral intensity is known for this event. The largest earthquake in the southeastern United States occurred on August 31, 1886 near Charleston, South Carolina. The epicentral intensity of this event was MMI X and the intensity at the Cliffside area from the earthquake ranged from MMI VI to VII.

# APPENDIX C

## MACROINVERTEBRATE DATA FOR THE BROAD RIVER

Table 1. Macroinvertebrates collected upstream of Cliffside Steam Station (Location A). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **ABOVE CLIFFSIDE (Location A)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| Annelida | | | | | | | | |
| Hirudinea | | | | | | | | |
| Rhynchobdellida | | | | | | | | |
| Glossiphoniidae | | | | | | | | |
| *Placobdella spp .* | | | | | | | R | |
| Oligochaeta | | | | | | | | |
| Haplotaxida | | | | | | | | |
| Naididae | | | | | | | | |
| *Allonais pectinata* | | | | | | R | | |
| *Dero trifida* | | | | | | | | R |
| *Nais behningi* | | | | | R | | | |
| Tubificidae | | | | | | C | R | |
| *Branchirua sowerbyi* | | | | | | | R | R |
| *Limnodrilus hoffmeisterei* | | | | | | R | | R |
| *Tasserkidrilus harmani* | | | | | | R | | |
| *Tubifex tubifex* | | | | | | R | | |
| Lumbriculida | | | | | | | | |
| Lumbriculidae | C | R | | | C | | C | C |
| *Lumbriculus spp.* | | | | | | R | | R |
| Arthropoda | | | | | | | | |
| Acari | | | | | | R | | |
| Crustacea | | | | | | | | |
| Decapoda | | | | | | | | |
| Cambaridae | R | | C | R | R | | R | |
| *Cambarus spp.* | | | | | | | | |
| *Cambarus bartonii* | | C | | | | | | |
| Isopoda | | | | | | | | |
| Asellidae | | | | | | | | |
| *Caecidotea spp.* | | | | R | | | | R |
| Insecta | | | | | | | | |
| Coleoptera | | | | | | | | |
| Curculionidae | | | | | | R | | |
| Dryopidae | | | | | | | | |
| *Helichus spp.* | | | | | | | | |
| *Helichus lithophilus* | | R | | C | | C | C | R |
| Dytiscidae | | | | | | | | |
| *Bidessus spp.* | | | | | | | R | R |
| *Hydroporus spp .* | | | | | R | | | |
| Elmidae | | | | | | | | |
| *Ancyronyx variegatus* | C | R | C | C | R | | | |
| *Macronychus glabratus* | A | A | A | A | C | | R | |
| *Promoresia spp.* | | | | | | | | R |
| *Promoresia elegans* | | | | | | C | | |
| *Stenelmis spp.* | A | C | | R | C | R | | C |
| Gyrinidae | | | | | | | | |

Table 1. Macroinvertebrates collected upstream of Cliffside Steam Station (Location A). An R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **ABOVE CLIFFSIDE (Location A)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Dineutus spp.* | R | | C | A | | A | | |
| Noteridae | | | | | | | | |
| *Suphisellus spp.* | | | | | R | | | |
| Ptilodactylidae | | | | | | | | |
| *Anchytarsus bicolor* | | | | | | | | |
| Diptera | | | | | | | | |
| Ceratopogonidae | | | | | | | | |
| *Palpomyia-Bezzia complex* | R | | | | | R | | |
| Chaoboridae | | | | | | | | |
| *Chaoborus spp.* | | | | | | | R | |
| Chironomidae-Chironominae | | | | | | | | |
| *Chironomus spp.* | | | | | R | | | |
| *Cladotanytarsus spp.* | | | | | | | R | |
| *Cryptochironomus spp.* | | | | | R | R | R | C |
| *Cryptotendipes spp.* | | | | | | | | R |
| *Cryptotendipes emorsus* | | | | | R | R | | |
| *Demicryptochironomus cuneatus* | | | | | R | | | |
| *Dicrotendipes neomodestus* | | | | | R | | | |
| *Microtendipes pedellus gp.* | | | | | | R | | |
| *Paracladopelma spp.* | | | | | | | | |
| *Paratendipes spp.* | | | | | | | | R |
| *Phaenopsectra spp.* | | C | | | R | A | | |
| *Polypedilum spp.* | | | | R | | R | | |
| *Polypedilum convictum* | | | R | | R | | | |
| *Polypedilum fallax* | | | R | | R | | | |
| *Polypedilum flavum* | | | | | | | R | C |
| *Polypedilum halterale* | | | | | | | | |
| *Polypedilum illinoense* | R | R | C | | R | C | R | |
| *Polypedilum scalaenum* | | R | R | | C | R | | C |
| *Rheotanytarsus spp.* | | C | C | R | R | R | | |
| *Robackia demeijerei* | | C | R | R | | | | |
| *Stenochironomus spp.* | R | R | | | R | | | |
| *Stictochironomus spp.* | R | R | | R | | | | |
| *Tanytarsus spp.* | | | R | | | R | | |
| *Tribelos spp.* | | | | R | | | | R |
| Chironomidae-Orthocladiinae | | | | | | | | |
| *Brillia spp.* | | | | R | | | | |
| *Cricotopus spp.* | | | | | | | | |
| *Cricotopus albiforceps* | | | | | | R | | |
| *Cricotopus bicinctus* | | C | R | | | | | |
| *Cricotopus politus* | | | | | | | | |
| *Lopescladius spp.* | | | | R | | | | |
| *Nanocladius spp.* | | | | | R | | | |
| *Nanocladius downesi* | | | | R | | | | |
| *Orthocladius spp.* | | | | | | | | |

Table 1. Macroinvertebrates collected upstream of Cliffside Steam Station (Location A). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **ABOVE CLIFFSIDE (Location A)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Orthocladius obumbratus* | | | | | | | | |
| *Rheocricotopus spp.* | | R | R | | | | | |
| *Rheocricotopus tuberculatus* | R | | R | | | | | |
| *Thienemanniella spp.* | | R | R | | | | | |
| *Tvetenia spp.* | | | | | | | | |
| *Tvetenia discoloripes* | | | | C | | | | |
| Chironomidae-Tanypodinae | | | | | | | | |
| *Ablabesmyia spp.* | | | R | | R | C | | |
| *Ablabesmyia annulata* | | | | | | R | | |
| *Ablabesmyia mallochi* | R | R | | | R | | | |
| *Clinotanypus spp.* | | | | | | | | R |
| *Conchapelopia gp.* | | | | | | | | |
| *Labrundinia spp.* | R | | | | | | | |
| *Natarsia spp.* | | | | | | C | | |
| *Nilotanypus spp.* | | | | | | | | |
| *Paramerina spp.* | | | | | | | | |
| *Procladius spp.* | | R | | | | | | |
| *Thienemannimyia spp.* | | R | | | | | | |
| Culicidae | | | | | | | | |
| *Anopheles spp .* | | | | | | | R | |
| Empididae | | | | | | | | |
| *Hemerodromia spp.* | | | | | | | R | |
| Simuliidae | | | | | | | | |
| *Simulium spp .* | | R | C | A | R | R | A | A |
| *Simulium venustum* | | | | | | | | |
| Tanyderidae | | R | | | | | | |
| *Protoplasa fitchii* | | | | | | | | |
| Tipulidae | | | | | | | | |
| *Antocha spp.* | | | | | | | | |
| *Dicranota spp.* | | | R | | | | | |
| *Hexatoma spp.* | | R | | | | | | |
| *Tipula spp.* | | R | R | | R | R | | C |
| Ephemeroptera | | | | | | | | |
| Baetidae | | | | | | | | |
| *Acentrella spp.* | | | | | | R | | |
| *Baetis spp.* | | | | | R | | | |
| *Baetis anoka* | | | | | | | | C |
| *Baetis bimaculatus* | | | | | C | | | |
| *Baetis brunneicolor* | | C | | | | | | |
| *Baetis ephippiatus* | C | R | | | | | | |
| *Baetis intercalaris* | | | R | | C | R | R | |
| *Heterocloeon spp.* | | | | | | | | R |
| *Heterocloeon curiosum* | | C | | R | C | | R | |
| *Heterocloeon petersi* | | | | | R | | | |
| *Plauditus spp.* | | | | | | | | |

Table 1. Macroinvertebrates collected upstream of Cliffside Steam Station (Location A). An R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **ABOVE CLIFFSIDE (Location A)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Pseudocloeon spp.* | | | | | | R | | |
| Caenidae | | | | | | | | |
| *Caenis spp .* | R | C | R | | | | | |
| Ephemerellidae | | | | | | | | |
| *Ephemerella catawba* | | | | | C | | | |
| *Serratella deficiens* | | C | | A | | | | |
| *Serratella molita* | | | R | R | | | | |
| Ephemeridae | | | | | | | | |
| *Hexagenia spp .* | R | R | | | | A | | C |
| Heptageniidae | | | | | | | | |
| *Heptagenia marginalis* | R | | | | C | | | |
| *Leucrocuta spp.* | | | | | | R | R | |
| *Stenacron carolina* | | R | | | | | | |
| *Stenacron interpunctatum* | | R | R | | R | | | |
| *Stenonema exiguum* | C | | | | C | R | | |
| *Stenonema modestum* | R | A | R | A | C | A | C | C |
| *Stenonema terminatum* | C | | | | A | | | |
| Oligoneuriidae | | | | | | | | |
| *Isonychia spp .* | | A | | A | A | A | A | A |
| Tricorythidae | | | | | | | | |
| *Leptohyphes robacki* | | | | | A | R | | |
| *Tricorythodes spp .* | C | | | | R | C | C | R |
| Hemiptera | | | | | | | | |
| Nepidae | | | | | | | | |
| *Ranatra spp.* | | | | | | | | R |
| Veliidae | | | | | | | | |
| *Microvelia spp.* | | | | C | | | | |
| *Rhagovelia obesa* | | | | | | C | | |
| Megaloptera | | | | | | | | |
| Corydalidae | | | | | | | | |
| *Corydalus cornutus* | | C | R | R | A | C | C | R |
| *Nigronia fasciatus* | | R | | | | | | |
| *Nigronia serricornis* | R | R | | | | | | |
| Sialidae | | | | | | | | |
| *Sialis spp.* | | | | | | R | | |
| Odonata-Anisoptera | | | | | | | | |
| Aeshnidae | | | | | | | | |
| *Boyeria grafiana* | | | | C | R | R | | |
| *Boyeria vinosa* | C | A | C | C | | | | |
| Gomphidae | | | | | | | R | |
| *Dromogomphus spp.* | | | | | | | | R |
| *Gomphurus spp.* | | | | | | R | | |
| *Gomphus spp.* | | | | | | C | | |
| *Hagenius brevistylus* | | R | | | | R | | |
| *Hylogomphus spp.* | | R | R | | C | | | |

Table 1. Macroinvertebrates collected upstream of Cliffside Steam Station (Location A). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **ABOVE CLIFFSIDE (Location A)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Ophiogomphus spp.* | | | | R | | | | |
| *Progomphus spp.* | | | | | | | | |
| *Stylurus spp.* | C | C | | | | | | |
| *Stylurus spiniceps* | | | | | | R | | |
| Macromiidae | | | | | | | | |
| *Macromia spp .* | | | | | | R | | |
| *Macromia georgina* | C | R | R | | C | | | R |
| Odonata-Zygoptera | | | | | | | | |
| Calopterygidae | | | | | | | | |
| *Calopteryx spp.* | | | | | | | | |
| *Hetaerina spp .* | | R | | | | | | R |
| *Hetaerina americana* | | | | | | C | | |
| Coenagrionidae | | | | | | | | |
| *Argia spp.* | R | | | | R | C | | R |
| Plecoptera | | | | | | | | |
| Peltoperlidae | | | | | | | | |
| *Tallaperla spp .* | | | | R | | | | |
| Perlidae | | | | | | | | |
| *Acroneuria abnormis* | C | A | C | A | C | | | |
| *Neoperla spp.* | | | | | | | | |
| *Paragnetina fumosa* | | | | | R | | | |
| *Paragnetina immarginata* | | C | R | R | | | | |
| Pteronarcyidae | | | | | | | | |
| *Pteronarcys spp .* | R | R | R | C | | | | |
| *Pteronarcys dorsata* | | A | | A | | | | |
| Trichoptera | | | | | | | | |
| Brachycentridae | | | | | | | | |
| *Brachycentrus nigrosoma* | | C | | A | R | | | |
| *Brachycentrus numerosus* | C | C | | R | | R | | |
| *Micrasema wataga* | | R | | R | | | | |
| Glossosomatidae | | | | | | | | |
| *Glossosoma spp.* | | | | | | R | | |
| Hydropsychidae | | | | | | | | |
| *Cheumatopsyche spp.* | C | A | R | A | A | A | R | |
| *Diplectrona modesta* | | R | | | | | | |
| *Hydropsyche phalerata* | | | | | A | R | R | |
| *Hydropsyche rossi* | | | | | A | R | | |
| *Hydropsyche simulans/rossi* | R | C | C | C | | | | |
| *Hydropsyche slossonae* | | | | A | | | | |
| *Hydropsyche sparna* | | A | | A | | | | |
| *Hydropsyche venularis* | | | R | A | A | A | C | A |
| *Macrostenum spp.* | | | | | R | | | |
| Lepidostomatidae | | | | | | | | |
| *Lepidostoma spp.* | | | | | R | C | R | R |
| Leptoceridae | | | | | | | | |

Table 1. Macroinvertebrates collected upstream of Cliffside Steam Station (Location A). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **ABOVE CLIFFSIDE (Location A)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Nectopsyche spp.* | R | A | | | | | | |
| *Nectopsyche exquisita* | | | | C | R | | R | |
| *Oecetis spp.* | C | C | R | | C | C | | |
| *Oecetis cinerascens* | | | | C | | | | |
| *Oecetis persimilis* | | | | | | | R | |
| *Oecetis scala gr.* | | | | | | | R | |
| *Triaenodes ignitus* | | | | | R | | | |
| *Triaenodes injusta* | | | | | | C | R | |
| *Triaenodes tardus* | R | C | C | A | | | | |
| Limnephilidae | | | | | | | | |
| *Pycnopsyche divergens* | | | | R | | | | |
| *Pycnopsyche guttifer* | | R | | | | | | |
| *Pycnopsyche lepida* | | R | | R | | | | |
| Philopotamidae | | | | | | | | |
| *Chimarra spp.* | | | | | | | | |
| Polycentropodidae | | | | | | | | |
| *Cyrnellus fraternus* | | | | | R | R | | |
| Mollusca | | | | | | | | |
| Gastropoda | | | | | | | | |
| Lymnophila | | | | | | | | |
| Lymnaeidae | | | | | | | | |
| *Pseudosuccinea columella* | | | | | | R | | |
| Mesogastropoda | | | | | | | | |
| Hydrobiidae | | C | | | R | | | A |
| Pleuroceridae | | | | | | | | |
| *Elimia spp* . | | A | C | A | A | | | |
| *Leptoxis spp.* | | | | | | A | A | A |
| Pulmonata | | | | | | | | |
| Planorbidae | | | | | | | A | |
| Pelecypoda | | | | | | | | |
| Heterodonta | | | | | | | | |
| Sphaeriidae | | | | | | R | | |
| Heterodontida | | | | | | | | |
| Corbiculidae | | | | | | | | |
| *Corbicula fluminea* | R | C | C | R | A | A | A | A |
| Nemertea | | | | | | | | |
| Enopla | | | | | | | | |
| Hoplonemertea | | | | | | | | |
| Tetrastemmatidae | | | | | | | | |
| *Prostoma graecens* | | | | | R | | | R |
| Platyhelminthes | | | | | | | | |
| Turbellaria | | | | | | | | |
| Tricladida | | | | | | | | |
| Planariidae | | | | | | | | |

Table 1. Macroinvertebrates collected upstream of Cliffside Steam Station (Location A). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **ABOVE CLIFFSIDE (Location A)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Dugesia spp .* | | | | | | R | | |
| **Total Taxa Found** | **35** | **61** | **38** | **47** | **61** | **64** | **35** | **37** |
| **Total EPT Found** | **16** | **26** | **12** | **22** | **25** | **16** | **6** | **19** |
| **Bioclassification** | **G** | **G** | **GF** | **G** | **G** | **G** | **GF** | **GF** |

**Bioclassification Abbreviations**
**E = Excellent**
**G = Good**
**GF = Good/fair**
**F = Fair**
**P = Poor**

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location C). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **CLIFFSIDE DISCHARGE (Location C)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| Annelida | | | | | | | | |
| Hirudinea | | | | | | | | |
| Rhynchobdellida | | | | | | | | |
| Glossiphoniidae | | | | | | | | |
| *Helobdella spp.* | | | | | | | | |
| Oligochaeta | | | | | | | | |
| Haplotaxida | | | | | | | | |
| Enchytraeidae | | | | R | | | R | |
| Naididae | | | | | | | | |
| *Bratislavia unidentata* | | | | R | | | | |
| *Nais behningi* | | | | | | | R | |
| *Nais communis* | | | | R | | | | |
| *Nais pardalis* | | | | R | | | R | |
| *Nais variabilis* | | | | | | | | C |
| *Pristina breviseta* | | | | | | R | | |
| *Pristina sima* | | | | | | C | | |
| *Pristinella osborni* | | | | | | R | R | |
| Tubificidae | | | | | R | C | | |
| *Branchirua sowerbyi* | | R | | C | | C | R | R |
| *Limnodrilus hoffmeisterei* | | | | | | | | |
| *Tasserkidrilus harmani* | | | | | | R | | |
| Lumbriculida | | | | | | | | |
| Lumbriculidae | R | A | R | C | R | R | | |
| *Eclipidrilus spp.* | | R | | A | | | | |
| *Lumbriculus spp.* | | | | | | | | R |
| Arthropoda | | | | | | | | |
| Acari | | | | | R | | | |
| Insecta | | | | | | | | |
| Coleoptera | | | | | | | | |
| Dryopidae | | | | | | | | |
| *Helichus spp.* | | | | | | | | |
| *Helichus lithophilus* | | | R | C | R | R | | |
| Elmidae | | | | | | | | |
| *Ancyronyx variegatus* | R | | | C | | | | |
| *Dubiraphia spp.* | | | | | | | | |
| *Macronychus glabratus* | C | C | R | C | | C | | R |
| *Optioservus spp.* | | | | R | | | R | |
| *Promoresia elegans* | | C | R | R | | C | C | |
| *Stenelmis spp.* | A | R | C | A | R | A | A | R |
| Gyrinidae | | | | | | | | |
| *Dineutus spp.* | C | R | | R | | | | |
| Diptera | | | | | | | | |
| Athericidae | | | | | | | | |
| *Atherix lantha* | R | | | | | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location C). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **CLIFFSIDE DISCHARGE (Location C)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| Ceratopogonidae | | | | | | | | |
| *Palpomyia-Bezzia complex* | | | | | | | | |
| Chironomidae-Chironominae | | | | | | | | |
| *Cladopelma spp* | | | | | | | | |
| *Cladotanytarsus spp.* | | | | | | R | | |
| *Cryptochironomus spp.* | | | R | | C | | | |
| *Cyphomella spp.* | | R | | | | | | |
| *Dicrotendipes neomodestus* | | | | | R | R | R | |
| *Glyptotendipes spp.* | | | | | | | | |
| *Paralauterborniella nigrohalterale* | | | | | R | | | |
| *Phaenopsectra spp.* | | | | | | R | | |
| *Polypedilum spp.* | | | | R | | | | |
| *Polypedilum convictum* | C | | | | C | | | |
| *Polypedilum fallax* | | | | R | R | | | |
| *Polypedilum flavum* | | | | | | | R | R |
| *Polypedilum halterale* | | | | | | | | |
| *Polypedilum illinoense* | | | R | R | C | R | R | |
| *Polypedilum simulans/digitifer* | | | | R | | | R | |
| *Rheotanytarsus spp.* | C | C | C | C | C | | | |
| *Robackia demeijerei* | | | C | | C | | | |
| *Stenochironomus spp.* | | R | R | R | R | C | | |
| *Stictochironomus spp.* | | C | | C | | | | |
| *Tanytarsus spp.* | | | | | | R | R | R |
| *Tribelos spp.* | R | | | A | | | | |
| Chironomidae-Orthocladiinae | | | | | | | | |
| *Cardiocladius spp.* | | | | | | | | R |
| *Cardiocladius obscurus* | | | | | | | | |
| *Corynoneura spp.* | | | | | | | R | |
| *Cricotopus albiforceps* | | | | | | C | | |
| *Cricotopus bicinctus* | | | R | | R | | | |
| *Cricotopus politus* | | | | | | | | R |
| *Cricotopus vierriensis* | | | | | C | | | |
| *Eukiefferiella spp.* | | | | | C | | R | |
| *Nanocladius spp.* | | | | | | | | |
| *Nanocladius downesi* | | | | | | | R | |
| *Orthocladius spp.* | | | | | | | R | |
| *Orthocladius obumbratus* | | | | | R | C | | |
| *Rheocricotopus spp.* | | | | | | | R | R |
| *Rheocricotopus tuberculatus* | R | | | | | | | |
| *Synorthocladius spp.* | | | | | | | | R |
| *Thienemanniella spp.* | R | | | | | | R | |
| Chironomidae-Tanypodinae | | | | | | | | |
| *Ablabesmyia spp.* | | R | | | R | | | |
| *Clinotanypus pinguis* | | | | | | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location C). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **CLIFFSIDE DISCHARGE (Location C)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Conchapelopia gp.* | | | | | C | | | |
| *Labrundinia spp.* | | | | | | | | |
| *Nilotanypus spp.* | | | | | | | | |
| *Rheopelopia spp.* | R | | | | R | | | |
| Simuliidae | | | | | | | | |
| *Simulium spp .* | | A | A | A | A | | C | A |
| *Simulium tuberosum* | A | | | | | | | |
| *Simulium venustum* | | | | | | | | |
| Tabanidae | | | | | | | | |
| *Tabanus spp.* | | | | | | | | |
| Tipulidae | | | | | | | | |
| *Antocha spp.* | | | | | | | | |
| *Dicranota spp.* | | | R | | | | | |
| *Tipula spp.* | | C | R | | | | | |
| Ephemeroptera | | | | | | | | |
| Baetidae | | | | | | | | |
| *Acentrella amplus* | | | | | | | R | |
| *Baetis anoka* | | | | | | | | R |
| *Baetis bimaculatus* | | | | | R | | | |
| *Baetis ephippiatus* | C | | R | | | | | |
| *Baetis intercalaris* | | R | C | R | C | | R | C |
| *Baetis propinquus* | | | | R | C | | | |
| *Baetis punctiventris* | | | | | | | | R |
| *Heterocloeon spp.* | | | | | | | | C |
| *Heterocloeon curiosum* | C | C | C | | C | | R | |
| *Plauditus spp.* | | | | | | | | |
| Caenidae | | | | | | | | |
| *Caenis spp .* | | | | R | | | | R |
| Ephemerellidae | | | | | | | | |
| *Serratella deficiens* | R | | | | | | | |
| *Serratella molita* | | R | R | | | | | |
| Ephemeridae | | | | | | | | |
| *Hexagenia spp .* | | | | | | | R | |
| Heptageniidae | | | | | | | | |
| *Heptagenia marginalis* | | | | | | | R | |
| *Stenacron interpunctatum* | | | | | | | | |
| *Stenonema exiguum* | R | R | C | R | R | C | C | |
| *Stenonema ithaca* | | | | | | | | |
| *Stenonema meririvulanum* | | | | | R | | | |
| *Stenonema modestum* | A | C | C | A | C | A | C | C |
| *Stenonema terminatum* | C | | | | | | | |
| Oligoneuriidae | | | | | | | | |
| *Isonychia spp .* | A | C | C | C | A | | A | R |
| Tricorythidae | | | | | | | | |
| *Leptohyphes robacki* | | | | | A | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location C). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| CLIFFSIDE DISCHARGE (Location C) | YEAR | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Tricorythodes spp .* | C | | | R | | C | C | C |
| Hemiptera | | | | | | | | |
| Nepidae | | | | | | | | |
| *Ranatra spp.* | | | | | | | | R |
| Gerridae | | | | | | | | |
| *Trepobates spp.* | | | | | | R | | |
| Veliidae | | | | | | | | |
| *Rhagovelia obesa* | | | | | | R | | |
| Megaloptera | | | | | | | | |
| Corydalidae | | | | | | | | |
| *Corydalus cornutus* | C | C | A | C | A | | A | C |
| *Nigronia serricornis* | | R | R | | C | R | | |
| Sialidae | | | | | | | | |
| *Sialis spp.* | | | | | C | | | |
| Odonata-Anisoptera | | | | | | | | |
| Aeshnidae | | | | | | | | |
| *Boyeria grafiana* | | | | C | | | | |
| *Boyeria vinosa* | C | R | C | R | C | | C | |
| Corduliidae | | | | | | | | |
| *Neurocordulia spp .* | | | | R | C | R | | |
| *Neurocordula molesta* | | R | R | | | | | |
| Gomphidae | | | R | C | C | | C | |
| *Dromogomphus spinosus* | | | R | | | | | |
| *Gomphus spp.* | | | | | | C | | |
| *Hagenius brevistylus* | R | | | | R | | | |
| *Hylogomphus spp.* | | | | | | | | R |
| *Ophiogomphus spp.* | | R | | | | | | R |
| *Ophiogomphus mainensis* | | | R | | | | | |
| *Progomphus obscurus* | R | | | | | | | |
| *Stylurus spiniceps* | R | | | | | | | |
| Macromiidae | | | | | | | | |
| *Macromia spp .* | | | | | | C | R | |
| *Macromia georgina* | R | R | C | C | C | C | | R |
| Odonata-Zygoptera | | | | | | | | |
| Calopterygidae | | | | | | | | |
| *Calopteryx maculata* | | | R | | | | | |
| *Hetaerina spp .* | | | | | | | R | R |
| *Hetaerina titia* | | | | C | | | | |
| Coenagrionidae | | | | | | | | |
| *Argia spp.* | | C | R | C | R | A | A | C |
| Plecoptera | | | | | | | | |
| Leuctridae | | | | | | | | |
| *Leuctra spp.* | R | | | R | | | | |
| Perlidae | | | | | | | | |
| *Acroneuria abnormis* | C | R | | | C | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location C). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **CLIFFSIDE DISCHARGE (Location C)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Paragnetina fumosa* | | | | | | | | |
| Pteronarcyidae | | | | | | | | |
| *Pteronarcys spp .* | R | | R | A | C | | R | |
| *Pteronarcys dorsata* | C | C | | | | | | |
| Trichoptera | | | | | | | | |
| Brachycentridae | | | | | | | | |
| *Brachycentrus nigrosoma* | | | | R | | | | |
| *Brachycentrus numerosus* | C | | | C | C | | | |
| Hydropsychidae | | | | | | | | |
| *Cheumatopsyche spp.* | C | C | A | C | C | R | C | C |
| *Hydropsyche phalerata* | | | | | | | | |
| *Hydropsyche rossi* | | | | | C | | | |
| *Hydropsyche scalaris* | | | | | | | | |
| *Hydropsyche simulans/rossi* | C | C | R | C | | | | |
| *Hydropsyche venularis* | A | A | C | C | A | A | A | A |
| *Macrostenum spp.* | | | C | | R | | | |
| Hydroptilidae | | | | | | | | |
| *Hydroptila spp .* | | | | R | R | | | R |
| Leptoceridae | | | | | | | | |
| *Nectopsyche spp.* | R | C | | | | | | |
| *Nectopsyche exquisita* | | | C | A | C | A | A | R |
| *Oecetis spp.* | | R | R | C | R | | | |
| *Oecetis persimilis* | | | | | | R | C | |
| *Oecetis scala gr.* | | | | | | | R | |
| *Triaenodes spp.* | R | | | | | | | R |
| *Triaenodes ignitus* | | | | | A | C | C | |
| *Triaenodes tardus* | | C | A | A | | | | |
| Philopotamidae | | | | | | | | |
| *Chimarra spp.* | | | | | | | | |
| Polycentropodidae | | | | | | | | |
| *Neureclipsus spp.* | | | | | | | | |
| *Polycentropus spp.* | | | | | R | | | |
| Mollusca | | | | | | | | |
| Gastropoda | | | | | | | | |
| Basommatophora | | | | | | | | |
| Physidae | | | | | | | | |
| *Physella spp .* | | R | | | | R | | R |
| Mesogastropoda | | | | | | | | |
| Hydrobiidae | | C | R | | A | C | | R |
| Pleuroceridae | | | | | | | | |
| *Elimia spp .* | | | | | | | | |
| *Leptoxis spp.* | | | | | | R | | R |
| Pulmonata | | | | | | | | |
| Planorbidae | | | | | | R | R | |
| *Helisoma spp.* | | | | | R | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location C). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **CLIFFSIDE DISCHARGE (Location C)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| Pelecypoda | | | | | | | | |
| Heterodontida | | | | | | | | |
| Corbiculidae | | | | | | | | |
| *Corbicula fluminea* | | A | A | A | A | A | A | C |
| Nemertea | | | | | | | | |
| Enopla | | | | | | | | |
| Hoplonemertea | | | | | | | | |
| Tetrastemmatidae | | | | | | | | |
| *Prostoma graecens* | | | | R | | | | |
| Platyhelminthes | | | | | | | | |
| Turbellaria | | | | | | | | |
| Tricladida | | | | | | | | |
| Planariidae | | | | | | | | |
| *Dugesia spp .* | | R | | | | | | |
| Nematoda | | | | | | | | |
| **Total Taxa Found** | **37** | **39** | **41** | **51** | **55** | **40** | **44** | **36** |
| **Total EPT Found** | **18** | **13** | **14** | **18** | **21** | **8** | **16** | **13** |
| **Bioclassification** | **G** | **GF** | **G** | **G** | **G** | **F** | **GF** | **GF** |

**Bioclassification Abbreviations**
**E = Excellent**
**G = Good**
**GF = Good/fair**
**F = Fair**
**P = Poor**

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location D). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **BELOW CLIFFSIDE (Location D)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| Annelida | | | | | | | | |
| Hirudinea | | | | | | | | |
| Rhynchobdellida | | | | | | | | |
| Glossiphoniidae | | | | | | | | |
| *Helobdella spp.* | R | | | | | | | |
| Oligochaeta | | | | | | | | |
| Branchiobdellida | | | | | | | | |
| Branchiobdellidae | | | | | R | | | |
| Haplotaxida | | | | | | | | |
| Naididae | | | | | | | | |
| *Allonais pectinata* | | | R | | | | | |
| *Bratislavia unidentata* | | | R | | | | | |
| *Nais communis* | | | | | R | | | |
| *Pristinella osborni* | | | | | R | | | |
| Tubificidae | | | | R | | | | R |
| *Aulodrilus pluriseta* | | | | R | | | | |
| *Branchirua sowerbyi* | | R | | | | | | |
| Lumbriculida | | | | | | | | |
| Lumbriculidae | C | R | R | | R | R | C | R |
| *Eclipidrilus spp.* | | | | R | | | | |
| *Kincaidiana freidrius* | | | | | | | R | |
| *Lumbriculus spp.* | | | | R | | | | |
| Arthropoda | | | | | | | | |
| Crustacea | | | | | | | | |
| Decapoda | | | | | | | | |
| Cambaridae | R | C | | C | R | C | R | |
| Insecta | | | | | | | | |
| Coleoptera | | | | | | | | |
| Dryopidae | | | | | | | | |
| *Helichus spp.* | | | | | | | | |
| *Helichus lithophilus* | C | A | C | C | C | C | A | |
| Elmidae | | | | | | | | |
| *Ancyronyx variegatus* | C | | C | R | C | R | | C |
| *Dubiraphia vittata* | R | | | | | | | |
| *Macronychus glabratus* | C | C | C | | A | A | R | R |
| *Promoresia elegans* | | | R | R | R | R | | |
| *Stenelmis spp.* | A | R | C | C | C | R | | C |
| Gyrinidae | | | | | | | | |
| *Dineutus spp.* | | C | C | R | A | C | A | A |
| *Dineutus discolor* | R | | | | | | | |
| *Gyrinus spp.* | | | | | | | | |
| Ptilodactylidae | | | | | | | | |
| *Anchytarsus bicolor* | | | | | | | | |
| Diptera | | | | | | | | |
| Athericidae | | | | | | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location D). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **BELOW CLIFFSIDE (Location D)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Atherix lantha* | | | | | | | | R |
| Ceratopogonidae | | | | | | | | |
| *Palpomyia-Bezzia complex* | | | | | | | | |
| Chironomidae-Chironominae | | | | | | | | |
| *Chironomus spp.* | | R | R | | | | | R |
| *Cladopelma spp.* | | | | | | | | |
| *Cladotanytarsus spp.* | | | | | | | | |
| *Cryptochironomus spp.* | R | | | | | | | |
| *Cryptotendipes emorsus* | | | C | | | | | |
| *Dicrotendipes neomodestus* | | | | | | | | |
| *Paracladopelma spp.* | | | | | | | | |
| *Paratendipes spp.* | | | | | | | | R |
| *Phaenopsectra spp.* | R | R | | | | | | |
| *Polypedilum spp.* | | | | R | | | | |
| *Polypedilum convictum* | R | | | R | R | | | |
| *Polypedilum fallax* | | R | C | | R | | | |
| *Polypedilum flavum* | | | | | | | | |
| *Polypedilum halterale* | | | | | | | | |
| *Polypedilum illinoense* | | | | R | C | | | R |
| *Polypedilum laetum* | | | | | | | | |
| *Polypedilum scalaenum* | C | | C | | | | | |
| *Polypedilum simulans/digitifer* | R | | | | R | | | |
| *Rheotanytarsus spp.* | R | | R | C | R | | | |
| *Robackia demeijerei* | | | | | R | R | | |
| *Stenochironomus spp.* | | | | R | | | | |
| *Stictochironomus spp.* | | R | | | | | | |
| *Tanytarsus spp.* | | | | | R | | | |
| *Tribelos spp.* | | | C | C | | | | |
| Chironomidae-Orthocladiinae | | | | | | | | |
| *Cricotopus spp.* | | | | | | | | |
| *Eukiefferiella spp.* | | | | | R | | | |
| *Nanocladius spp.* | | | | | C | R | | |
| *Nanocladius downesi* | | | | | | | R | |
| *Orthocladius spp.* | | | | | | | | |
| *Parametriocnemus spp.* | | | | | R | | | |
| *Rheocricotopus spp.* | | | | | C | | | C |
| *Thienemanniella spp.* | | | R | | | | | |
| *Tvetenia discoloripes* | | | R | | | | | |
| *Tvetenia vitracies* | | | | | R | R | | |
| *Xylotopus par* | | | | | R | | R | |
| Chironomidae-Tanypodinae | | | | | | | | |
| *Ablabesmyia spp.* | | | R | | | | | |
| *Ablabesmyia annulata* | | | | | | | | |
| *Ablabesmyia janta* | | | | | | | | |
| *Ablabesmyia mallochi* | | | R | | | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location D). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **BELOW CLIFFSIDE (Location D)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Clinotanypus pinguis* | | | | | | | | |
| *Nilotanypus spp.* | | | | R | | | | |
| *Procladius spp.* | | | | | | | | |
| *Rheopelopia spp.* | | | | | R | | | |
| Empididae | | | | | | | | |
| Simuliidae | | | | | | | | |
| *Simulium spp .* | R | R | C | C | A | | C | C |
| *Simulium venustum* | | | | | | | | |
| Tanyderidae | | | | | | R | | |
| Tipulidae | | | | | | | | |
| *Hexatoma spp.* | | | | | R | | | |
| *Ormosia spp.* | | | | | | | | R |
| *Tipula spp.* | | R | C | | | R | C | R |
| Ephemeroptera | | | | | | | | |
| Baetidae | | | | | | | | |
| *Acentrella spp.* | | | | | | | | |
| *Baetis spp.* | | | | | R | | | |
| *Baetis intercalaris* | R | R | C | | C | | | C |
| *Baetis pluto* | | | | | | | | R |
| *Baetis propinquus* | | | | | | | | R |
| *Baetis punctiventris* | | | | | | | | R |
| *Heterocloeon curiosum* | R | A | R | C | C | | | |
| *Heterocloeon curiosum* | | | | | | | | |
| *Heterocloeon petersi* | | | | | R | | | |
| *Pseudocloeon spp.* | | C | | R | | | | |
| Caenidae | | | | | | | | |
| *Caenis spp .* | | | | | | | | R |
| Ephemerellidae | | | | | | | | |
| *Ephemerella catawba* | | | C | | | | | |
| *Serratella deficiens* | | | | | | R | | R |
| *Serratella molita* | R | C | | | | | | |
| Ephemeridae | | | | | | | | |
| *Hexagenia spp .* | | | | | | | | A |
| Heptageniidae | | | | | | | | |
| *Heptagenia marginalis* | | R | | | | R | | |
| *Stenacron interpunctatum* | | | | | | | | |
| *Stenacron pallidum* | | | R | | | | | |
| *Stenonema exiguum* | R | R | R | | C | R | | |
| *Stenonema meririvulanum* | | | | | | C | | |
| *Stenonema modestum* | A | A | A | A | C | A | R | R |
| *Stenonema pudicum* | | | A | | | | | |
| *Stenonema terminatum* | | | | R | A | | | |
| Leptophlebiidae | | | | | | | | |
| *Paraleptophlebia spp.* | | | | | | | | |
| Oligoneuriidae | | | | | | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location D). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **BELOW CLIFFSIDE (Location D)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Isonychia spp .* | A | A | A | A | A | A | | C |
| Tricorythidae | | | | | | | | |
| *Leptohyphes robacki* | | | | | R | | | |
| *Tricorythodes spp .* | A | R | | R | | | | |
| Hemiptera | | | | | | | | |
| Heteroptera | | | | | | | | |
| Nepidae | | | | | | | | |
| *Ranatra spp.* | | | | | | | | |
| *Ranatra buenoi* | | R | | | | | | |
| Gerridae | | | | | | | | |
| *Gerris spp.* | | | | R | | | | |
| *Trepobates spp.* | | | | | R | | | |
| Veliidae | | | | | | | | |
| *Rhagovelia obesa* | | C | | | C | | | |
| Megaloptera | | | | | | | | |
| Corydalidae | | | | | | | | |
| *Corydalus cornutus* | C | A | C | C | A | C | C | C |
| *Nigronia serricornis* | R | | | R | | | R | |
| Sialidae | | | | | | | | |
| *Sialis spp.* | | | | | | | | |
| Odonata-Anisoptera | | | | | | | | |
| Aeshnidae | | | | | | | | |
| *Boyeria grafiana* | | | | C | C | | | |
| *Boyeria vinosa* | C | C | C | | C | R | C | |
| Gomphidae | | R | R | R | | R | | |
| *Dromogomphus spp.* | | | | | | | | |
| *Gomphus spp.* | C | | | R | | | | |
| *Hagenius brevistylus* | R | | | | | R | | |
| *Hylogomphus spp.* | C | | | | | | | |
| *Ophiogomphus spp.* | | | | | | | R | |
| *Ophiogomphus mainensis* | | R | | | | | | |
| *Progomphus obscurus* | C | | | | | | | |
| *Stylurus spp.* | | | | R | C | | | |
| *Stylurus spiniceps* | R | | | | | | | |
| Macromiidae | | | | | | | | |
| *Macromia spp .* | | | R | | | | | |
| *Macromia georgina* | R | | | C | | | | |
| Odonata-Zygoptera | | | | | | | | |
| Calopterygidae | | | | | | | | |
| *Calopteryx spp.* | | | | R | | | | |
| *Hetaerina spp .* | | | | | R | | | |
| *Hetaerina americana* | C | | | | | | | |
| *Hetaerina titia* | | R | | | | | | |
| Coenagrionidae | | | | | | | | |
| *Argia spp.* | | C | R | R | | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location D). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **BELOW CLIFFSIDE (Location D)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| Plecoptera | | | | | | | | |
| Peltoperlidae | | | | | | | | |
| *Tallaperla spp .* | | | | | R | | | |
| Perlidae | | | | | | | | |
| *Acroneuria abnormis* | R | R | R | | A | C | | R |
| *Agnetina spp.* | | | | | | | | |
| *Paragnetina fumosa* | | | | | | | | R |
| *Paragnetina immarginata* | R | | R | | | | | |
| *Perlesta placida* | | | | | | | | |
| Pteronarcyidae | | | | | | | | |
| *Pteronarcys spp .* | | | C | | C | R | R | R |
| *Pteronarcys dorsata* | | C | | | C | C | | |
| Trichoptera | | | | | | | | |
| Brachycentridae | | | | | | | | |
| *Brachycentrus nigrosoma* | | | | | C | R | | |
| *Brachycentrus numerosus* | R | | | R | | C | | |
| *Micrasema sprulesi* | | | | | | | R | |
| *Micrasema wataga* | | | R | | C | | | |
| Glossosomatidae | | | | | | | | |
| *Glossosoma spp.* | | | | | | | | |
| Hyalopsychidae | | | | | | | | |
| *Phylocentropus spp.* | | | R | | | | | |
| Hydropsychidae | | | | | | | | |
| *Cheumatopsyche spp.* | C | C | C | C | C | C | R | C |
| *Hydropsyche betteni* | | | | | R | | | |
| *Hydropsyche demora* | | | | | | | | |
| *Hydropsyche morosa* | | | | | A | | | |
| *Hydropsyche phalerata* | A | R | C | C | | | | |
| *Hydropsyche rossi* | | | | | C | | | |
| *Hydropsyche simulans/rossi* | C | A | A | C | | | | |
| *Hydropsyche sparna* | | | | R | | C | | C |
| *Hydropsyche venularis* | A | A | A | A | A | C | R | C |
| *Macrostenum spp.* | C | C | R | R | | | | |
| Lepidostomatidae | | | | | | | | |
| *Lepidostoma spp.* | | | R | R | | C | R | R |
| Leptoceridae | | | | | | | | |
| *Nectopsyche spp.* | C | R | | | | | | |
| *Nectopsyche exquisita* | | | | C | C | | | R |
| *Oecetis spp.* | | | R | R | C | | | |
| *Oecetis persimilis* | | | | | | | | R |
| *Triaenodes spp.* | | | | | | | | |
| *Triaenodes ignitus* | | | | | A | A | | |
| *Triaenodes tardus* | R | | C | A | | | | |
| Limnephilidae | | | | | | | | |
| *Pycnopsyche divergens* | | | | | R | | | |

Table 2. Macroinvertebrates collected below the Cliffside Steam Station discharge (Location D). R = Rare (1-2 macroinvertebrates collected), C = Common (3-9 macroinvertebrates collected) and A = Abundant (10 or more macroinvertebrates collected).

| **BELOW CLIFFSIDE (Location D)** | **YEAR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAXON** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** |
| *Pycnopsyche guttifer* | R | | | | | | | |
| Philopotamidae | | | | | | | | |
| *Chimarra spp.* | | | | | C | | | R |
| Polycentropodidae | | | | | | | | |
| *Cyrnellus fraternus* | | | | R | | | | |
| *Polycentropus spp.* | | | R | | | | | |
| Mollusca | | | | | | | | |
| Gastropoda | | | | | | | | |
| Basommatophora | | | | | | | | |
| Physidae | | | | | | | | |
| *Physella spp .* | | | | | | R | | |
| Ancylidae | | | | | | | | |
| *Ferrissia spp.* | | | | | | R | | |
| Lymnaeidae | | | | R | | | | |
| Mesogastropoda | | | | | | | | |
| Hydrobiidae | A | A | R | C | C | A | | |
| Pleuroceridae | | | | | | | | |
| *Elimia spp .* | A | A | A | A | C | | | |
| *Leptoxis spp.* | | | | | | A | A | R |
| Pulmonata | | | | | | | | |
| Planorbidae | | | | | | | C | |
| Pelecypoda | | | | | | | | |
| Heterodontida | | | | | | | | |
| Corbiculidae | | | | | | | | |
| *Corbicula fluminea* | A | C | A | C | C | A | A | A |
| Nemertea | | | | | | | | |
| Enopla | | | | | | | | |
| Hoplonemertea | | | | | | | | |
| Tetrastemmatidae | | | | | | | | |
| *Prostoma graecens* | | R | | | R | | | |
| Platyhelminthes | | | | | | | | |
| Turbellaria | | | | | | | | |
| Tricladida | | | | | | | | |
| Planariidae | | | | | | | | |
| *Dugesia spp .* | | R | R | | | | | |
| **Total Taxa Found** | **47** | **43** | **52** | **50** | **63** | **38** | **23** | **36** |
| **Total EPT Found** | **17** | **16** | **22** | **18** | **27** | **20** | **14** | **8** |
| **Bioclassification** | **G** | **G** | **G** | **G** | **G** | **GF** | **G** | **GF** |

**Bioclassification Abbreviations**
**E = Excellent**
**G = Good**
**GF = Good/fair**
**F = Fair**
**P = Poor**

Table 4. Taxa richness criteria for assigning water-quality classifications to NC Piedmont streams (NCDENR 2001b). EPT refers to the total number of Ephemeroptera, Plecoptera and Trichoptera, the least tolerant groups.

| **Classification** | **EPT** |
|---|---|
| Excellent | > 31 |
| Good | 24 to 31 |
| Good/Fair | 16 to 23 |
| Fair | 8 to 15 |
| Poor | 0 to 7 |