ENCLOSURE 4

ENVIRONMENTAL REPORT

Environmental Report for the Columbia Fuel Fabrication Facility

Westinghouse Electric Company, LLC

March 28, 2019

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Acronyms and Abbreviations

ac	acre
ADU	ammonium diuranate
ALARA	As Low As Reasonably Achievable
ANGS	Air National Guard Station
AS/SVE	air sparging and soil vapor extraction [system]
BDC	Baseline Design Criteria
BOD	Biological Oxygen Demand
^{o}C	degrees celsius
CA	Consent Agreement
Ca	calcium
CAA	Controlled Access Area
CaF_2	calcium fluoride
CAS	Chemical Abstract Service
CDTs	Communication Device Transponders
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFFF	Columbia Fuel Fabrication Facility
CFR	Code of Federal Regulations
cfs	cubic foot per second (ft^3/s)
CO	carbon monoxide
CSX	CSX Transportation, Incorporated
COPC(s)	Contaminant(s) of Potential Concern
ft^3	cubic feet
d	Day
DCE	cis-1,2-dichloroethene
DOT	U.S. Department of Transportation
DPT	Direct Push Technology
EA	Environmental Assessment
EH&S, EHS	Environment, Health, and Safety
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
F	fluorine
^{o}F	degrees Fahrenheit
FCC	Federal Communications Commission
ft	feet
GA	Georgia
gal	gallon
gpm	gallons per minute
H_2	hydrogen
H_2O	water

ha	hectare
HEPA	High Efficiency Particulate Air (filter)
HF	hydrogen fluoride or hydrofluoric acid
hr	hour
HVAC	Heating, Ventilation, and Air Conditioning
IBC	Intermediate Bulk Container
IDR	Integrated Dry Route
IFBA	Integral Fuel Burnable Absorber
ISA	Integrated Safety Analysis
JFD	Joint Frequency Distribution
kg	kilogram
km	kilometer
km^2	square kilometer
kt	knots, nautical mile per hour
L	Liter
lbs.	pounds
LLC	Limited Liability Company
LLRW	Low-level radioactive waste
μCi	microcuries
μg	microgram
μm	micrometer
m	Meter
m^2	square meters
m^3/s	cubic meters per second
mCi	millicuries
mg	milligram
mgd	million gallons per day
mi	Mile(s)
mi^2	square miles
mil	One-thousand of an inch
min	minute
mL	milliliter
MM	Modified Mercalli
mph	miles per hour
MPN	most probability number
mrem	millirem
MSA	Metropolitan Statistical Area
MSL	mean sea level
MT	metric ton
MTU	metric tons of uranium
N	nitrogen
N_2	nitrogen
NAAQS	National Ambient Air Quality Standards
NC	North Carolina

NCDC	National Climatic Data Center
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NH_3	ammonia
NH_4F	ammonium fluoride
No.	number
NO_x	nitrogen oxides
NO^{-3}	nitrate
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NWS	National Weather Service
OSHA	Occupational Safety and Health Administration
pCi	picocuries
PCE	Perchloroethylene, perchloroethene, tetrachloroethylene, tetrachloroethene
PGA	peak ground acceleration
PHA	Process Hazard Analysis
psi	pounds per square inch
PSM	Process Safety Management
PSP	Physical Security Plan
S	Secondary State Highway
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SC-DLLR	South Carolina Department of Labor, Licensing and Regulations
SC-DOT	South Carolina Department of Transportation
scf	standard cubic feet
SDC	Seismic Design Category
SEP	Site Emergency Plan
SER	Safety Evaluation Report
s.g.	specific gravity
SNM	Special Nuclear Material
SO_x	sulfur oxides
SOLX	Solvent Extraction Process
SSCs	Safety Significant Controls
TBD	Technical Basis Document
TBP	tributyl phosphate
TCE	trichloroethene
Tc-99	technetium-99
TEDE	total effective dose equivalent
U	uranium
UBC	Uniform Building Code
U_3O_8	uranium oxide
UF_6	uranium hexafluoride
UN	United Nations
UN	uranyl nitrate (solution)
UO_2	uranium dioxide
UO_2F_2	uranyl fluoride

URRS	Uranium Recycling and Recovery Services
U.S.	United States
USGS	U.S. Geological Survey
VC	vinyl chloride
VCC	Voluntary Cleanup Contract
VOC	Volatile Organic Compound
wt-%	weight-percent
yr	Year

Units Conversion Factors

Length

1 centimeter (cm) = 0.3937 inch	1 inch = 2.54 cm
1 centimeter = 0.03281 foot (ft)	1 foot = 30.48 cm
1 meter (m) = 3.281 feet	1 ft = 0.3048 m
1 meter = 0.0006214 mile (mi)	1 mi = 1609 m
1 kilometer (km) = 0.6214 mile	1 mi = 1.609 km

Area

1 square centimeter (cm^2) = 0.1550 square inch (in^2)	1 in^2 = 6.452 cm^2
1 square meter (m^2) = 10.76 square feet (ft^2)	1 ft^2 = 0.09290 m^2
1 square kilometer (km^2) = 0.3861 square mile (mi^2)	1 mi^2 = 2.590 km^2
1 hectare (ha) = 2.4711 acres (ac)	1 ac = 0.4047 ha
	1 ac = 43560 ft^2
1 hectare (ha) = 10,000 square meters (m^2)	1 ft^2 = 0.00002296 ac

Volume

1 cubic centimeter (cm^3) = 0.0610 cubic inch (in^3)	1 in^3 = 16.39 cm^3
1 cubic meter (m^3) = 35.31 cubic feet (ft^3)	1 ft^3 = 0.02832 m^3
1 cubic meter (m^3) = 1.308 cubic yards (yd^3)	1 yd^3 = 0.7646 m^3
1 liter (L) = 1.057 quarts (qt)	1 qt = 0.9464 L
1 liter = 0.2642 gallon (gal)	1 gal = 3.785 L

Mass

1 kilogram (kg) = 2.205 pounds (lb)	1 lb = 0.4536 kg
1 metric ton (mt) = 1.102 tons	1 ton = 0.9072 mt

Radiation

1 becquerel (Bq) = 2.703×10^{-11} curies (Ci)	1 Ci = 3.70×10^{10} Bq
1 sievert (Sv) = 100 rem	1 rem = 0.01 Sv

1.0 INTRODUCTION

The Westinghouse Electric Company, LLC (Westinghouse) Columbia Fuel Fabrication Facility (CFFF) fabricates low-enriched uranium fuel assemblies for commercial light-water nuclear reactors. The CFFF is located 13 km (8 mi) southeast of Columbia, South Carolina (SC) in Richland County. Facility buildings and related support areas occupy about 68 acres of an 1151-acre site. The facility has been in operation from 1969 to the present. The fabrication process involves the chemical conversion of uranium hexafluoride (UF_6) to uranium dioxide (UO_2) using the Ammonium Diuranate (ADU) Process. The UO_2 is formed into ceramic fuel pellets, which are used in the nuclear fuel assembly. The current normal level of production is about 1,500 metric-tons of uranium (MTU)/year by utilizing the five ADU lines with a maximum potential capacity of 1,600 MTU/year.

In accordance with Title 10, Code of Federal Regulations, Part 70 (10 CFR 70) and Part 40 (10 CFR 40), Westinghouse possesses Special Nuclear Material (SNM) License 1107 (SNM-1107) from the U.S. Nuclear Regulatory Commission (NRC) to operate the CFFF. On September 28, 2007, the NRC approved a renewal of the license for a 20-year period. This Environmental Report (ER) was completed to support the site's application for a 40-year license extension, as provided for in NRC Staff Requirements Memorandum SECY-06-0186 "Increasing Licensing Terms for Certain Fuel Cycle Facilities" dated September 26, 2006.

This ER has been prepared in accordance with NRC 10 CFR 51.60 and guidance contained in NUREG-1748 Chapter 6 (NRC 2003). It reflects and updates information Westinghouse provided NRC in prior environmental documentation for the CFFF in 1975, 1983, April 1990, December 2004, December 2014, March 2018 and March 2019; and in support of license renewal applications (Westinghouse 1975, 1983, 2004, and 2019). The March 2019 revision consolidates and supercedes information from the previous submittals of December 2014 and March 2018. The previous NRC reports have documented the Westinghouse CFFF environmental protocol and management program and have concluded that the environmental impact of operating the CFFF is not significant. NRC regulations 10 CFR 51.60 provide for incorporating previously submitted environmental information. Past NRC reviews of CFFF operations, undertaken in accordance with 10 CFR 51.7 requirements regarding the National Environmental Policy Act (NEPA) of 1969, identified no significant environmental impacts. The plant has been safely operated since September 1969, and no events have occurred from 2007 to present which would reverse those previous conclusions.

Major sections of the ER consist of the following:

- 1.0 Introduction
- 2.0 Facility Description
- 3.0 Description of the Affected Environment
- 4.0 Environmental Impacts
- 5.0 Mitigation Measures
- 6.0 Environmental Measurements and Monitoring Programs
- 7.0 Cost Benefit Analysis
- 8.0 Summary of Environmental Consequences
- 9.0 List of References
- 10.0 List of Preparers

The remainder of this section includes Section 1.1, Purpose and Need for the Proposed Action; Section 1.2, Proposed Action and Alternatives; and Section 1.3, Applicable Regulatory Requirements and Permits

1.1 Purpose and Need for the Proposed Action

The global energy crisis supports a potential future growth in carbon free energy sources such as commercial nuclear power worldwide. Westinghouse supports the nuclear industry at CFFF by manufacturing low-enriched uranium fuel for light-water commercial nuclear reactors. The CFFF has a current capacity of about 1,500 MTU/yr utilizing five ADU lines with a maximum potential capacity of 1,600 MTU/yr. Considering future demand for additional uranium fuel within the U.S. and by other countries, Westinghouse believes that continued operation the CFFF is vital to meet this demand.

1.2 Proposed Action and Alternatives

Proposed Action
The proposed action is to grant CFFF a 40 Year License Renewal.

No-Action Alternative
For the purpose of this ER, the No-Action Alternative is defined as a denial by NRC for the 40-year license request. The denial would result in continued CFFF operations in accordance with the existing license, which expires on September 30, 2027.

The No-Action Alternative is the only alternative considered in this ER.

1.3 Applicable Regulatory Requirements and Permits

Commercial nuclear fuel fabrication facilities in the United States must obtain licenses from the NRC to manufacture, produce, receive, acquire, own, possess, use, or transfer special nuclear material (10 CFR 70.3). Each license specifies the authorized special nuclear materials, their chemical and/or physical forms, and the maximum quantity of each material that the licensee is allowed to possess at any one time. License applications for facilities such as CFFF, and applications to modify facilities, require that the applicant provide an ER, which the NRC uses as a basis to prepare an Environmental Assessment (EA) regarding the planned future operations to be covered by the license application. The NRC provides guidance on format and content of ERs prepared by applicants and the EAs prepared by NRC in NUREG-1748 (NRC 2003). Such facilities also require permits from the State that include a National Pollutant Discharge Elimination System (NPDES) permit for liquid discharges and an Air Permit for air pollutant discharges.

In accordance with 10 CFR 70 and 10 CFR 40, Westinghouse possesses Special Nuclear Material License 1107 (SNM-1107) for CFFF from the NRC. In addition, the facility has NPDES (SC0001848) and Air Permits (1900-0050-R1) from the State of South Carolina Department of Health and Environmental Control (SCDHEC). On September 29, 2005, Westinghouse submitted a request to the NRC for a license renewal for a 10 year period. This application included an ER prepared by Westinghouse dated December 2004, which NRC used in preparing an EA. Subsequently, Westinghouse modified the license renewal application for a 20-year period, which was approved by the NRC.

In September 2006 the NRC issued NRC Staff Requirements Memorandum SECY-06-0186, "Increasing Licensing Terms for Certain Fuel Cycle Facilities," in which the NRC approved recommendations to implement maximum license terms of 40 years for license renewals and new applications (NRC 2006). The NRC also approved of license terms for less than 40 years on a case-by-case basis where there are concerns with safety risk to the facility or where a licensee introduces a new process or technology. Such potential license extensions are specific to licensees required to submit integrated safety analysis (ISA) summaries according to 10 CFR Part 70, Subpart H, requirements. Since the CFFF falls in the latter category, Westinghouse has submitted a license renewal application for a license extension to a 40 year period as per the NRC guidance. The purpose of this report is to provide justification at a summary level for such a license extension.

A listing of all Federal, State of South Carolina, and local permits, licenses and certifications for the CFFF currently in effect is presented in Appendix A, Table A-1. Potential stakeholders having an interest in CFFF operations are listed in Appendix A, Tables A-2 and A-3.

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2.0 SITE AND FACILITY DESCRIPTION

This section describes the CFFF in terms of the site and facility operations (Sections 2.1) and summarizes the environmental impacts and cumulative effects of past, present, or reasonably foreseeable future actions at the site (Section 2.2). The No-Action alternative consists of continued operation of the CFFF using the existing five-line ADU Process for the remainder of the current license period which ends on September 30, 2027.

2.1 CFFF Description

This section describes the CFFF in terms of the site and location (Section 2.1.1), facility layout (Section 2.1.2), processes (Section 2.1.3) and the waste confinement and effluent control (Section 2.1.4).

2.1.1 Facility Site Location and Description

The CFFF site is located in the central part of SC in Richland County, in the town of Hopkins, 13 km (8 mi) southeast of the city limits of Columbia along SC Highway 48 (see Figures 2.1-1 and 2.1-2) (Westinghouse, 2019d). The site coordinates are 33° 52' 52" north latitude and 80° 55' 24" west longitude. Figure 2.1-2 shows the area within a radius of 13 km (8 mi; approximately 7.5 minutes). The inner circle represents an 8 km (5-mi) radius around the plant, 90 percent of which falls in Richland County and the remaining 10 percent falls within Calhoun County, to the south. Figure 2.1-3 shows the topographical detail of the site and the surrounding area.

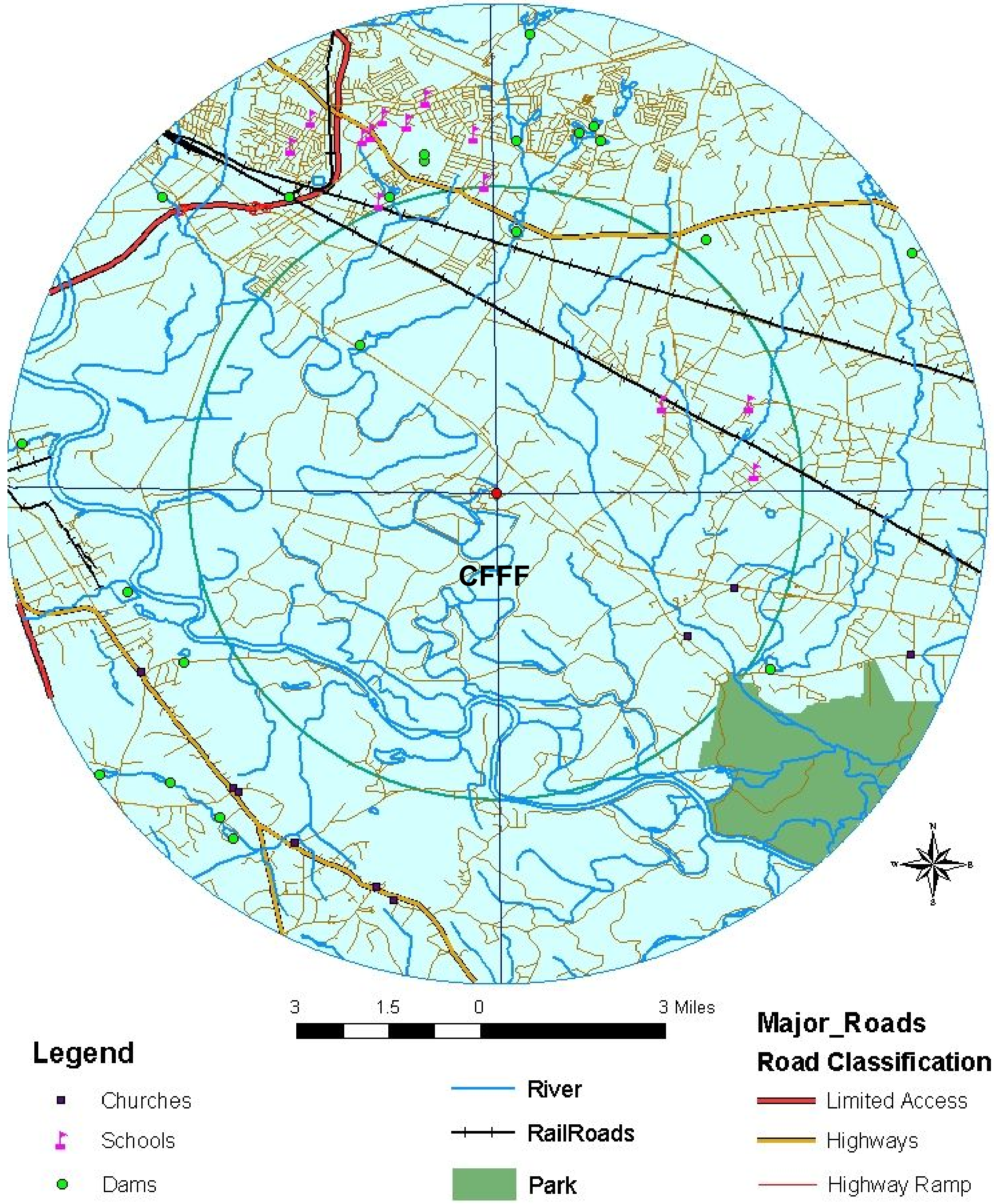
The CFFF is located on a semi-rural plot of approximately 469 ha (1,151 ac). The main manufacturing building, waste treatment areas and treatment lagoons, parking lots, and other miscellaneous buildings occupy approximately 5 percent (24 ha [60 ac]) of the site area. About 445 ha (1,098 ac) of the site remain undeveloped. The facility is at an elevation of approximately 43 m (142 ft) above mean sea level (MSL). Storm water drains from the site drain into Sunset Lake and Mill Creek, which in turn drains into the Congaree River, about 6.4 km (4 mi) distant. Figure 2.1-4 is an aerial photograph of the CFFF.

The CFFF site is bounded by SC 48 (Bluff Road) to the north and by private property owners to the east, south, and west. Figure 2.1-5 shows the CFFF site's property boundary. The "Controlled Area Boundary" is equivalent to the CFFF site's property boundary and encompasses the "Restricted Area." "Off-Site" areas are beyond the site's property boundary.

The manufacturing facilities are located about 490 m (1,600 ft) from the nearest point on the site boundary. The main manufacturing building for the CFFF is set back approximately 760 m (2,500 ft) from the roadway. The main plant road, which connects the CFFF to Bluff Road, provides access for vehicle and truck traffic. A continuously staffed security guard station is located on the main plant road. Access to the site is controlled by a number of security measures, including fencing, security barriers, and natural barriers (e.g., land contours). The "Restricted Area" is defined in the license as the area within the fenced area, including the main manufacturing building on the site. It is restricted in that individuals in this area must enter through security, and outsiders must be escorted. The "Restricted Area" is a physically defined area, bounded on three sides by a security fence and on the fourth side by the administration and main manufacturing building.

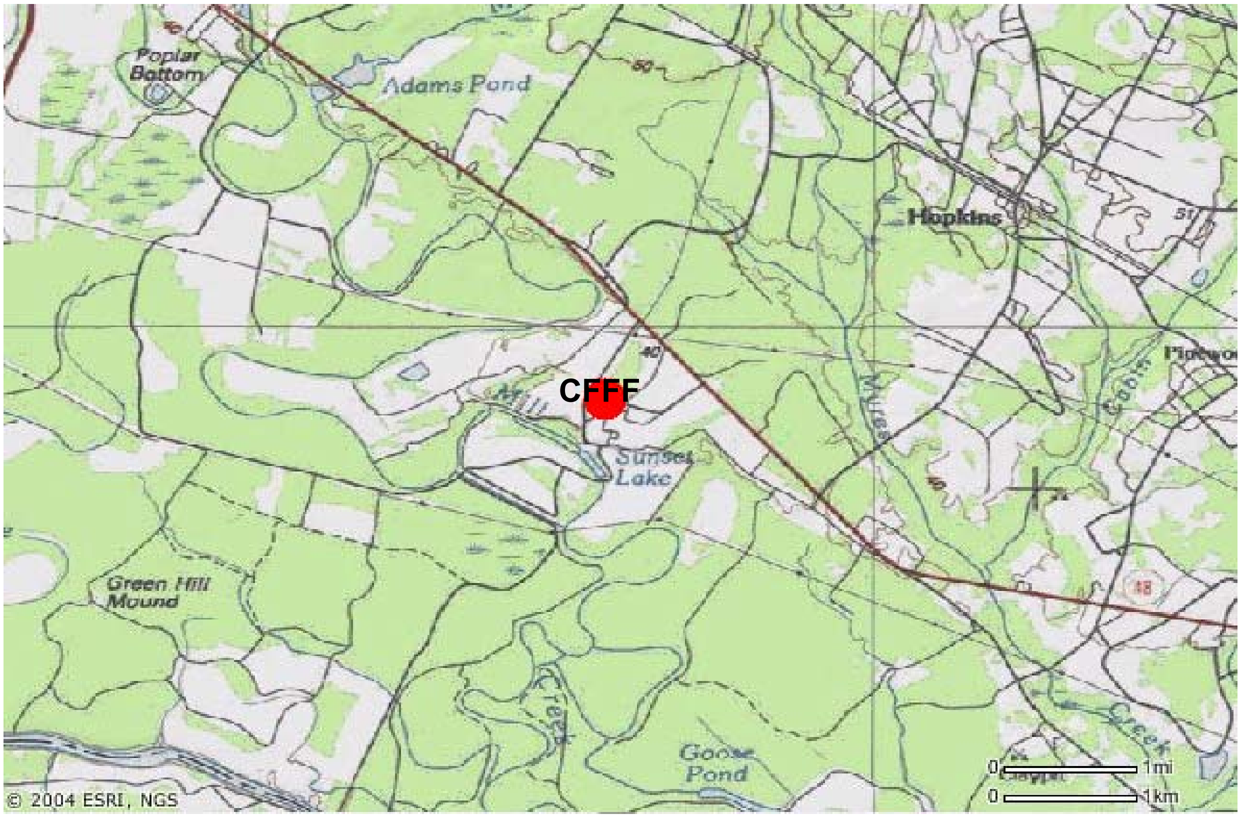
Source: Westinghouse 2019d

Figure 2.1-1 CFFF and Surrounding Area



Source: Westinghouse 2019d

Figure 2.1-2 Area Surrounding the CFFF Site within 5 Miles



Source: Westinghouse 2019d

Figure 2.1-3 Topographical Detail of the CFFF Site and Surroundings

Source: Westinghouse 2019d

Figure 2.1-4 Aerial Photograph of the CFFF

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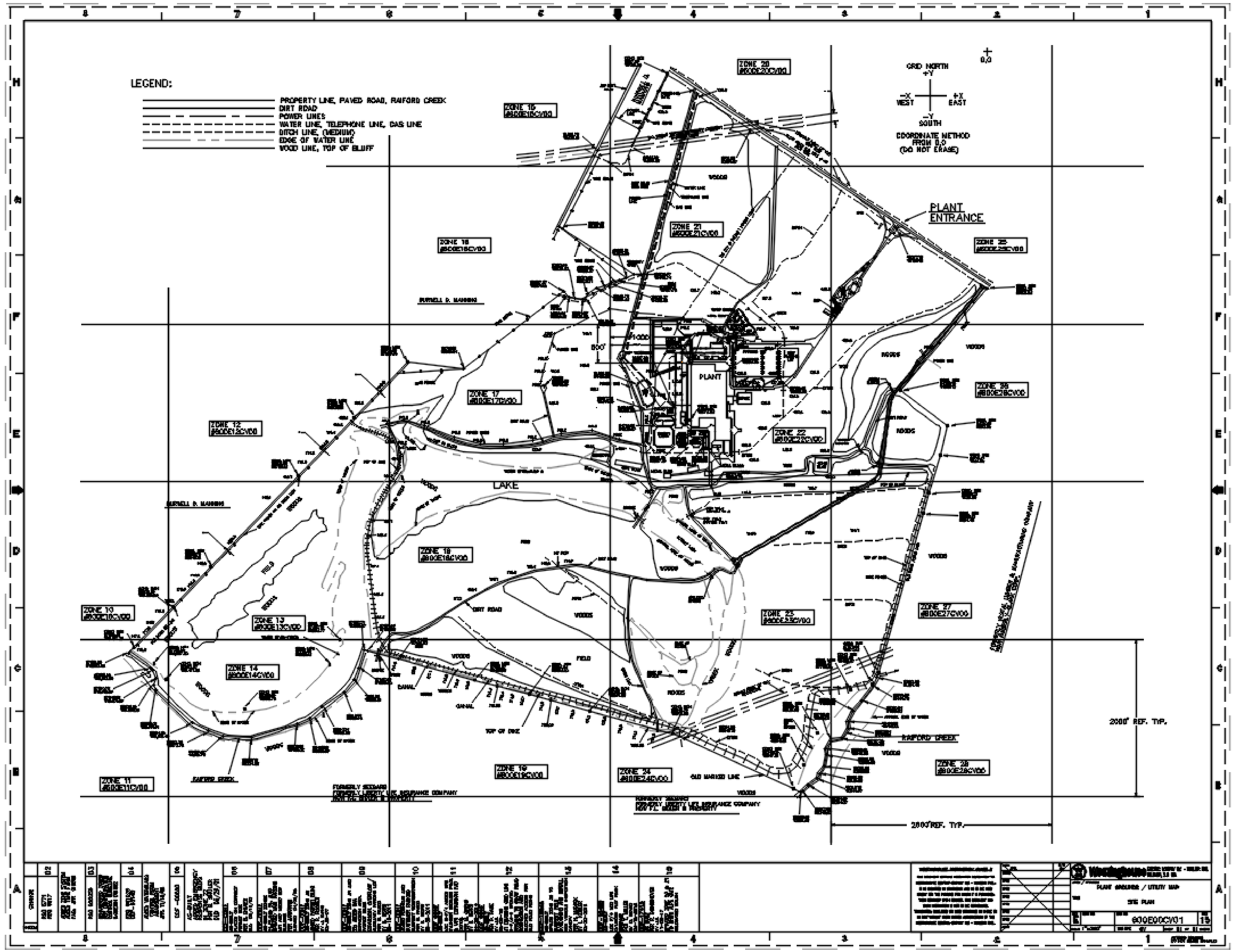

Figure 2.1-5 CFFF Boundary

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The Controlled Access Area (CAA) is routinely monitored and patrolled, and access to this area can be limited (see Figure 2.1-5). In early 2012, Westinghouse extended the CAA fence to allow better control of incoming and outgoing shipments of material related to CFFF operations.

2.1.2 Facility Operations and Layout

The manufacturing operations consist of receiving natural and low-enriched (less than or equal to 5.0 wt% ^{235}U) UF_6 in cylinders; converting the UF_6 to produce UO_2 powder; and processing the UO_2 powder through pellet pressing and sintering, fuel rod loading and sealing, and fuel assembly fabrication. These operations are supported by absorber addition, laboratory, scrap recovery, and waste disposal systems. Most of the manufacturing operations are conducted in the main manufacturing building, which can be divided into two areas: the Chemical Area and the Mechanical Area. Uranium operations conducted in the Chemical Area include UF_6 conversion, powder blending, pellet manufacturing, fuel rod loading, and scrap processing. Uranium operations conducted in the Mechanical Area involve only encapsulated and sealed material, such as rod certification and storage, and final assembly. All manufacturing operations are governed by approved radiation and environmental protection, nuclear criticality safety, industrial safety and health, SNM safeguards, and quality assurance controls.

The site layout is presented in Figure 2.1-6

2.1.3 Facility Processes

Two general systems have been used at CFFF to convert UF_6 to UO_2 powder: Integrated Dry Route (IDR) and the ADU processes. The IDR process within the main manufacturing building operated from approximately 1985 to 1995 with a capacity of approximately 400 MTU/yr. That portion of the facility, however, was inactivated in 1995 for business reasons.

Ammonium Diuranate Process

In the ADU process, UF_6 is received at a maximum enrichment of 5 wt-% ^{235}U in standard 30B cylinders and shipping packages. As needed, a UF_6 cylinder is removed from the UF_6 cylinder storage area and connected to one of the conversion lines. The UF_6 is vaporized by heating the cylinder in one of the steam chambers located in the UF_6 vaporization area adjacent to the conversion lines within the Chemical Area.

The vaporized UF_6 is hydrolyzed to uranyl fluoride (UO_2F_2) by mixing with water. The UO_2F_2 is subsequently converted to an ADU slurry [$(NH_4)_2U_2O_7$ + $4NH_4F$ + $3H_2O$] by adding ammonium hydroxide solution. The ADU slurry is dewatered, dried and then converted to the solid UO_2 product by heat and the introduction of hydrogen. The ammonia, fluorides, and steam in the calciner off-gases are scrubbed by a water scrubber and the gases are then passed through a high-efficiency particulate air (HEPA) filter assembly before discharge to the atmosphere. The dry UO_2 powder is conveyed from the calciner though a milling operation and into storage containers which are sampled, closed, and identified.

Scrap Recovery

Scrap recovery is accomplished by batch operations involving a variety of input materials. The preliminary operations concentrate the material and convert it to forms readily processed as U_3O_8 powder and uranyl nitrate (UN). Not all materials require processing through the entire sequence of operations. The basic processing sequence includes dissolution of solid forms in nitric acid, and the subsequent processing of the UN through the ADU process.

Off-gases from the UN dissolvers are routed through a reflux condenser, a scrubber to remove entrained particles and condensable vapors, and through HEPA filters prior to release. An incineration process is conducted to minimize the need for burial of low-level combustible contaminated waste and economically recycle product-grade material. A solvent extraction process recovers and purifies various contaminated uranium materials.

Pellet and Rod Manufacturing Processes

The product UO_2 powder from the chemical conversion area is then transformed into pellets after a series of operations that include feed preparation, pressing and sintering. To obtain precise dimensions, all pellets are processed through a grinding operation and are dimensionally checked. Following quality control approval, the pellets are loaded into empty fuel tubes, a spring is inserted into the plenum section, and end plugs are inserted and girth welded to the rod. Next the rod is pressurized with helium and seal welded.

Chemical Receipt, Storage and Handling

The CFFF uses a number of chemicals to support manufacturing operations. Chemicals and gases that are stored in bulk in tanks or cylinders include (Westinghouse 2019f):

- Aqueous ammonia
- Argon
- Calcium hydroxide
- Calcium oxide
- Fuel oil
- Gasoline
- Hydrofluoric acid
- Hydrogen
- Nitric acid
- Nitrogen
- Oxygen
- Sodium hydroxide
- Sodium silicate
- Sulfuric acid
- Triuranium octoxide (U_3O_8)
- Uranium dioxide (UO_2)
- Uranium hexafluoride (UF_6)
- Uranyl nitrate (UN)

Use of anhydrous ammonia at CFFF was eliminated in August 2011, and replaced by aqueous ammonium hydroxide (Westinghouse 2019d). A summary of the various hazardous chemicals used on-site is included in Appendix B, Table B-1.

Laboratories

Various internal laboratories provide services to support production operations and health and safety functions.

- Analytical Services Laboratory
- Chemical Process Development Laboratory
- Health Physics Laboratory
- Product Engineering Test Laboratory
- Metallurgical Laboratory

Shipping and Transportation

All shipments of nuclear materials and wastes are carried out in conformance with NRC, U.S. Department of Transportation (DOT), and State of South Carolina requirements. Completed fuel assemblies are shipped to utility customers in approved containers licensed by the NRC. Low level waste shipments are appropriately packaged and analyzed for uranium content prior to shipment to licensed low-level waste burial grounds.

A summary of the shipments of nuclear materials, chemicals and solid waste (hazardous and non-hazardous) in support of CFFF operations is presented in Appendix B, Table B-2.

UF_6 30B Cylinder Programs

CFFF has 3 distinctive programs for UF_6 30B cylinder management.

1. **Cylinder Wash**: located in the SOLX bay. A heel quantity (less than 40 lbs, typically 25 lbs of UF_6) is removed from a 30B cylinder. Water is utilized in 5-gal quantities to dissolve and remove UF_6 from cylinders. Wash water is sent to the conversion scrap area for processing.

2. **Cylinder Recertification**: located in the LLRW building adjacent to Fire Pump House #2. Empty 30B cylinders are inspected and hydrostatically tested with the water stored in T-1405. New valves and plugs are installed and then the cylinders are pneumatically tested in this facility. Other operations include cylinder drying, drawing a vacuum to establish a tare weight, pressurizing with Nitrogen for shipment, and stamping new recertification dates on the manufacturer's identification plate. The water used to hydrostatically test the cylinder is returned to T-1405 and reused to recertify up to five cylinders. After five cylinders are tested, the water from T-1405 is pumped to T-1160A for temporary holding before being processed through Waterglass for uranium removal. Subsequent cylinder recertifications would require refilling T-1405 with fresh city water.

3. **External Cylinder Washing**: located by the UF_6 pad. Prior to shipping a 30B cylinder offsite, the cylinder is processed through the external cleaning facility. It sprays pressurized water on the cylinder, dries them, and provides a staging area for inspection for visible contamination and frisking. The external cleaning facility drains to the site's contaminated sump.

Environmental, Health and Safety Systems

Inherent in CFFF operations are the design provisions and administrative procedures to ensure 1) worker occupational safety; 2) public health and environmental protection; and 3) nuclear safety, including criticality safety.

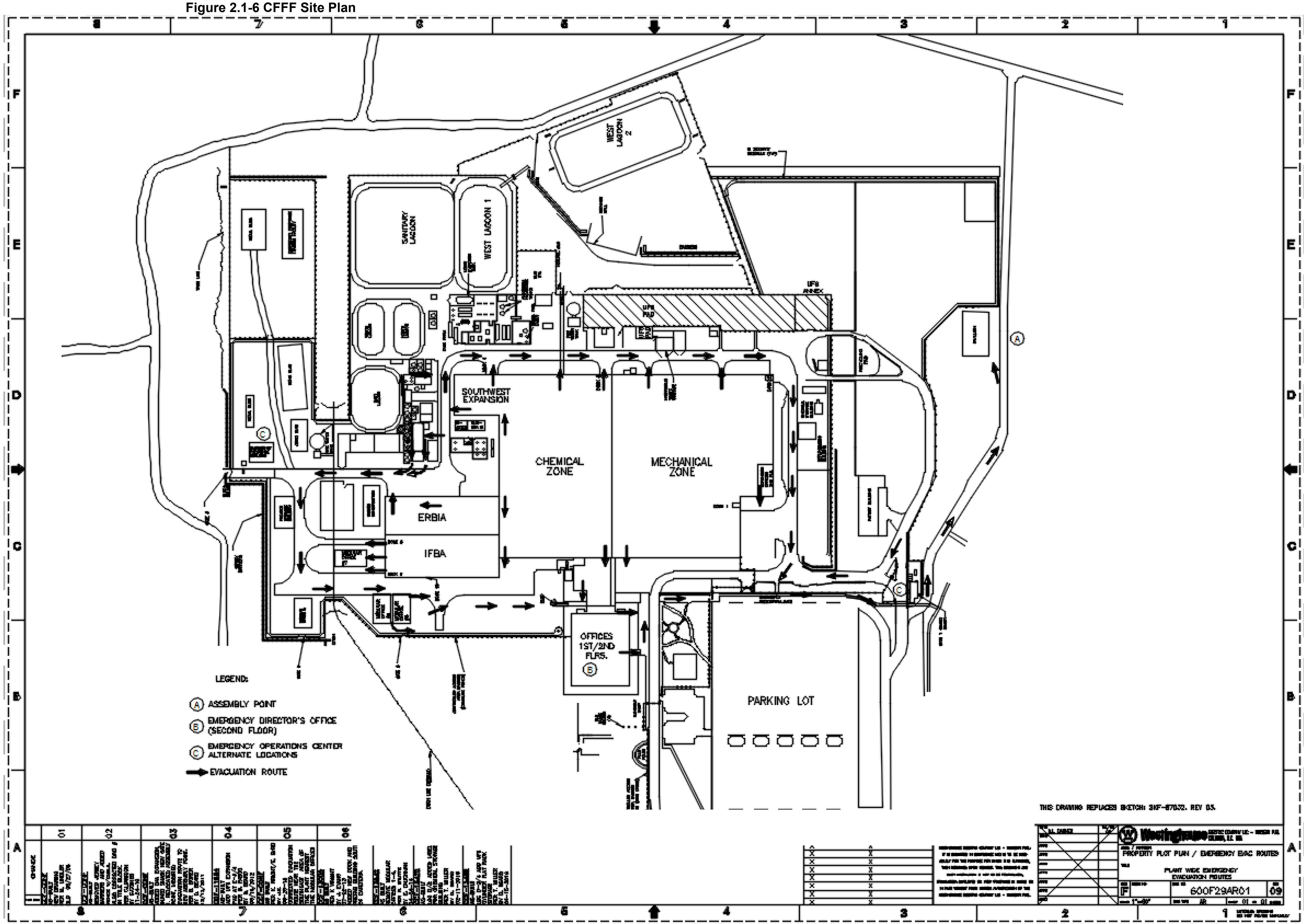
2.1.4 Waste Confinement and Effluent Control

The CFFF operations generate gaseous and particulate emissions and liquid and solid wastes. The following sections describe the types of effluents from CFFF and methods for their control. The monitoring of effluent streams and the environment is addressed in Section 6.0.

Gaseous Effluents

Forty-seven (47) exhaust stacks currently discharge gaseous emissions from the main plant facility. The emissions consist primarily of uranium compounds, ammonia (NH_3), and fluorides (NH_4F and HF). Gaseous effluents are normally treated by HEPA filters, scrubbers, or both prior to discharge through stacks in accordance with 40 CFR 61 and 10 CFR 20. HEPA filtration is installed on systems with the potential to discharge radioactive materials. Each radiological stack is continuously sampled to ensure discharge concentrations are less than the action level. For sampling, a vacuum source draws effluent air through the filter media continuously. The air filter media is then collected, allowed to decay, and counted on a daily frequency. The composition of the uranium mixture will vary depending upon the enrichment of the material being processed; however, in all cases, the bulk of the material by weight will be ^{238}U (95 wt-%), whereas the predominant activity will be ^{234}U (up to 86 percent of the total activity). All 47 discharge points are either short stacks or roof vents, rather than elevated stacks. The ALARA goal and action levels are based on RG 4.16 and the effluent concentrations listed in Appendix B of 10 CFR Part 20.

Figure 2.1-6 CFFF Site Plan



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Operations involving the use of radioactive materials in unsealed physical forms are limited to low-enrichment <5% by weight ^{235}U uranium in the fuel manufacturing facilities or the associated analytical laboratory. The ventilation systems installed in these facilities are designed so that all of the air from zones used to handle or process uranium (U) is treated to remove essentially all the uranium prior to discharge to the atmosphere. Filtration is the predominant method for removing particulate uranium from discharge air streams. HEPA filters with an efficiency of 99.97 percent for >0.3 micrometer (µm) -diameter particles are used to accomplish this. Annual uranium in gaseous effluent discharges from CFFF, for the years 2003 through 2018, are reported in Table 2.1-1 (Westinghouse 2019c). The average release rate during this period was 444 µCi/yr.

Table 2.1-1 Measured Uranium Activity Released in Gaseous Effluents from CFFF

Year	Discharged (µCi)
2003	511
2004	593
2005	531
2006	515
2007	520
2008	417
2009	364
2010	411
2011	402
2012	432
2013	455
2014	395
2015	342
2016	442
2017	399
2018	367
Average	444

Source: Westinghouse 2019c

Process gases from the ADU production lines contain ammonia and fluorides, which are scrubbed prior to their discharge to the atmosphere. After scrubbing, the gases are passed through HEPA filters to remove residual particulate uranium. The average discharge rate for ammonia at the maximum potential capacity of 1,600 MTU/yr is estimated to be 72 lb/d. The fluoride emissions during operation at normal capacity are estimated to be a *de-minimus* quantity.

The fuel manufacturing operations include the use of gas-fired boilers and gas-fired calciners, which discharge airborne criteria pollutants. Although natural gas is the primary fuel, the boilers are fueled with oil during periods of natural gas curtailment and other miscellaneous maintenance work where natural gas may not be available. In addition, there are oil-fired diesel generators at the site, which are tested periodically. The CFFF is classified as a minor-source operator, and operates under an Air Permit from SCDHEC. SCDHEC does not require Westinghouse to directly monitor for non-radiological pollutants. Instead, Westinghouse provides modeled emissions rates that SCDHEC uses to determine compliance. Table 2.1-2 contains the uncontrolled emission potential for various CFFF non-radiological gaseous pollutants.

Table 2.1-2 Emission Summary for CFFF Non-radiological Air Pollutants

Facility Wide Emissions	
Pollutant	Uncontrolled Emissions (TPY)
PM	5.74
PM_{10}	5.39
$PM_{2.5}$	5.39
SO_2	3.04
NO_x	28.47
CO	16.01
VOC	4.11
Nitric Acid (HNO3) [TAP]	0.77

Note: This is the most current information that is available, as newer emissions modeling has not been conducted. The air permit is currently being processed under timely renewal.
Source: SCDHEC 2018

Liquid Effluents

Liquid waste streams from CFFF operations include sanitary wastes and process liquid waste streams. Process liquid waste is primarily contaminated by ammonia and fluorides. Both waste streams are treated onsite prior to their combined discharge into the Congaree River in accordance with NPDES permit and 10 CFR 20 requirements. A 15 cm (6-in) pipeline discharges the plant effluent to the river at a point about 5.6 km (3.5 mi) south of the facility. The pipe submerges into the river, discharging directly into the current near the bottom approximately 6 m (20 ft) from shore.

The flow rates from the process and sanitary waste streams are about the same. The average combined liquid effluent stream flows were measured to be 100,000 gal/d over the ten-year period from 2007-2017.

Storm water runoff is regulated by SCDHEC under a general NPDES permit for Storm Water Discharges Associated with Industrial Activity. As required by this permit, Westinghouse developed a Storm Water Pollution Prevention Plan.

The Uranium Recycling and Recovery Services (URRS) Wastewater Treatment handles uranium recovery and/or disposal of the various process liquid waste streams leaving the Chemical Area of the plant which contain residual or trace uranium. Waste treatment for the removal of uranium, ammonia, and fluorides, consists of filtration, flocculation, lime addition, distillation, and precipitation (in the series of treatment lagoons). Figure 2.1-7 indicates the treatment and flow of liquid wastes at CFFF as part of URRS. Six onsite lagoon storage basins are illustrated in the figure; the locations of these lagoons are shown in Figure 6.2-3, “Locations of Monitoring Wells.” The material of construction for the North, South, West-I and West-II wastewater treatment lagoon liners is 80-mil High Density Polyethylene (HDPE). These lagoons are for settling solids from treated process wastewater prior to discharge to the Congaree River. These lagoons were relined in 2012 in response to groundwater monitoring data that indicated increasing trends of fluoride and nitrate in the groundwater around the lagoons.

The East Lagoon receives non-SNM liquid inputs such as effluent from the Deionized Water Building and rainwater from containment areas such as the chemical tank farm. The East lagoon is monitored for pH and liquid level and is sampled for fluoride, ammonia and Total Suspended Solids (TSS). Once full, the East lagoon is pumped to either the North or South lagoon. Before the North or South lagoon is discharged, a four corner sample is taken and analyzed for pH, TSS, ammonia, fluoride and activity. The East lagoon also provides extra capacity for overflow from other lagoons or for containment in the event of a spill or emergency. No such conditions requiring use of the East lagoon in this capacity have occurred since the 2007 license renewal. The East lagoon liner is constructed of 36-mil Hypalon and was last relined around 1980 when the site's Waterglass system was installed.

Compliance with regulatory limits is verified by passing the waste streams through on-line monitoring systems, or by manual sampling and analysis on a batch-basis. The treatment systems have sufficient holdup capacity to assure the limits are continuously met. Annual uranium discharges in liquid effluents for the years 2003 through 2018 are reported in Table 2.1-3 (Westinghouse 2019c). The average annual discharge of total U during this period was 13.4 mCi. During groundwater sampling in 2010, elevated Gross Beta concentrations were noted. Subsequent investigation identified the presence of technicium-99 (Tc-99). As a result, facility liquid effluent sampling was initiated for Tc-99 in 2010 (Westinghouse 2011b). The average annual discharge of Tc-99 in liquid effluents since Tc-99 monitoring began in 2010 is 10.4 mCi.

Table 2.1-3 Measured Uranium and Tc-99 Activity Released from CFFF in Liquid Effluents

Year	Discharged U, (mCi)	Discharged Tc-99, (mCi)
2003	54.5	Not Sampled[1]
2004	50.0	Not Sampled[1]
2005	25.6	Not Sampled[1]
2006	10.2	Not Sampled[1]
2007	10.5	Not Sampled[1]
2008	10.2	Not Sampled[1]
2009	10.3	Not Sampled[1]
2010	8.12	19.2
2011	6.92	14.1
2012	3.1	18.5
2013	5.2	9.2
2014	3.8	10.1
2015	4.3	10.1
2016	3.9	4.0
2017	4.1	7.2
2018	3.4	1.1
Average	**13.4**	**10.4**

Note: This data is an annual summary of information provided to the NRC semiannually with the "Semi-Annual Assessment of Public Dose from Liquid and Gaseous Effluents" letters.
[1] Prior to 2010, the site did not monitor for Tc-99 or speciate for Tc-99 when gross beta exceeded the action level of 50 pCi/L. Consistent monitoring for Tc-99 began in 2010 after the cylinder recertification overflow that happened that same year.

The main constituents of the process liquid wastes are ammonium fluoride (NH_4F) and uranium. The aqueous process waste solution, primarily filtrate from the ADU process lines, commonly called "aqueous waste",is processed through the Waterglass Liquid Waste Effluent Treatment Facility, (i.e. "Waterglass"). The Waterglass process is used to recover residual uranium from process wastewater streams that service the chemical area of the plant where unencapsulated uranium is used to manufacture nuclear fuel. Another separate feed into Waterglass is the effluent from the cylinder recertification process, which contains trace amounts of uranium from hydrostatic testing of cleaned UF_6 cylinders. Waterglass process streams account for approximately 15,000 gpd. In the Waterglass treatment process, the aqueous waste stream is contacted with sodium silicate solution. Sodium silicate entraps (flocculates) insoluble uranium and precipitates soluble uranium out of the liquid ammonia wastewater. The precipitated uranium is processed through a filter plate system and dewatered before being returned to the conversion process. Through the addition of lime and caustic, the fluoride is converted to insoluble calcium fluoride (CaF_2), which is removed by centrifugation or by settling in a series of holding lagoons. Most of the ammonia is recovered by distillation and returned (as ammonium hydroxide) to the ADU process following pH adjustment with caustic.

After addition of lime and removal of the ammonia in the stripping still, the CaF_2 slurry is discharged to the west lagoon to permit settling of the solids. The liquid is decanted from the top of the west lagoon on a batch basis to the north and south lagoons where additional settling takes place. After settling, the supernate is pumped to the Congaree River, usually together with disinfected effluent from the sanitary treatment system.

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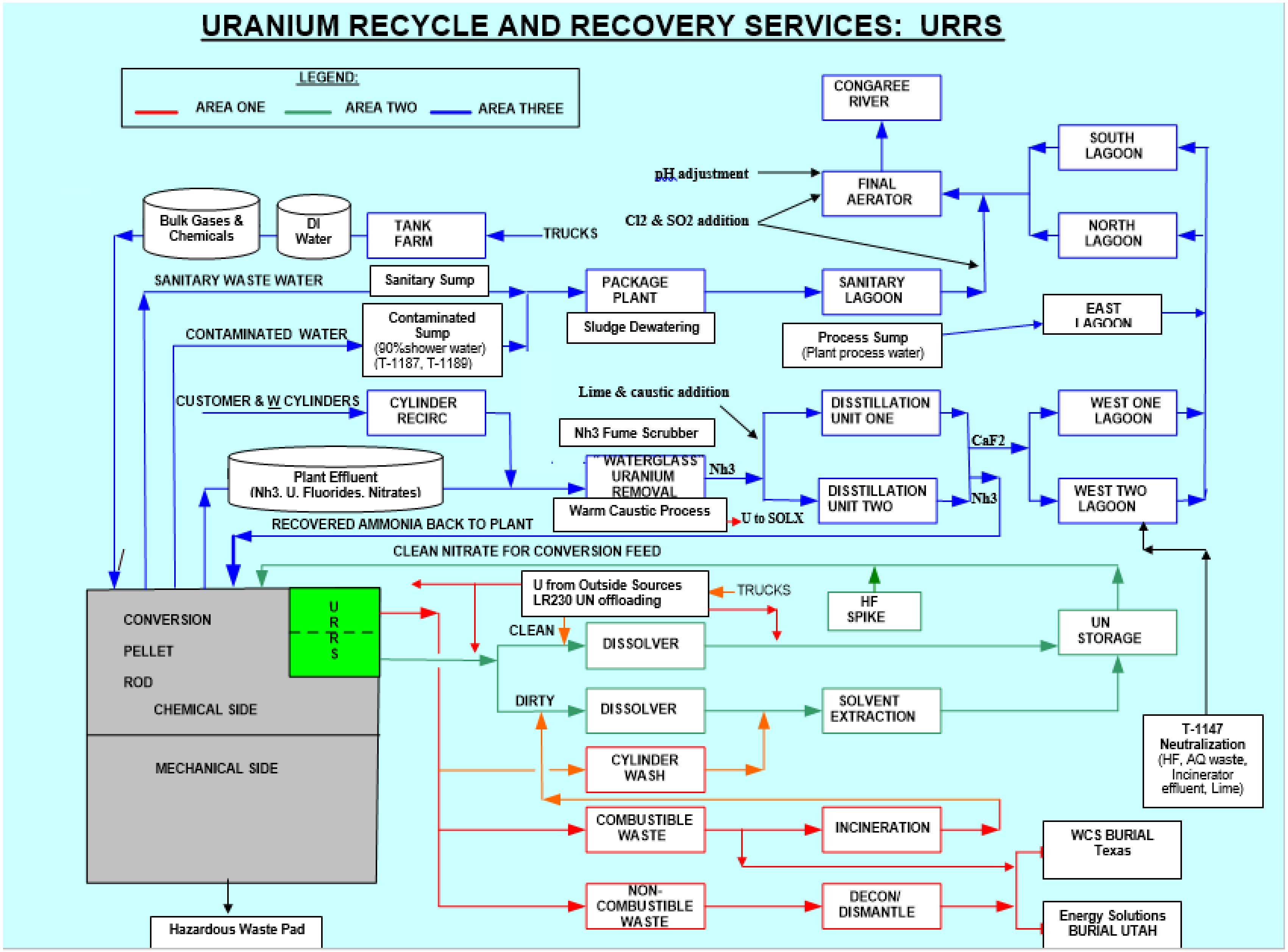

Figure 2.1-7 URRS Waste Treatment for CFFF

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All Domestic-type wastes, shower water, cafeteria water, and several miscellaneous streams are routed to the sanitary system. Site sanitary sewage is treated in an extended aeration package plant and discharged into a biological oxidation/settling-polishing lagoon. The lagoon effluent is then chlorinated and subsequently mixed with treated liquid process waste in an underground line that leads to the facility lift station. The average annual non-radiological quality of the CFFF combined (process plus sanitary) liquid effluent is presented in Table 2.1-4 (Westinghouse2017).

Table 2.1-4 Annual Average Non-radiological Water Quality of CFFF Liquid Effluent Discharge

Parameter[1]	Concentration, mg/L	Quantity, lb/d
pH, units	6-9	-
BOD_5	18	14.8
Fecal coliform, MPN/100 mL	10	-
E.Coli[1], MPN/100 mL	<1	-
Total suspended solids	10.7	9.0
Chemical oxygen demand	48.5	40.9
Oil and grease	<1.17	<1.49
Phenol	<0.003	<0.004
Surfactants	0.123	0.157
Nitrate	1180	1505
Sulfate	199	254
Sulfide	<1.0	<0.99
Ammonia (N)	9.4	7.9
Phosphorus	1.6	-
Cyanide	<0.002	<0.002
Fluoride	3.55	2.93
Barium	0.288	0.37
Iron	0.098	0.13
Manganese	0.01	0.01
Magnesium	2.5	1.5
Zinc	<0.050	<0.06
Molybdenum	0.092	0.12
Boron	0.353	0.45
Bromide	<0.067	<0.09

[1] E. coli replaced fecal coliform as the bacterial parameter in May 2017.

Source: Westinghouse 2017

Solid Waste Storage and Disposal

Westinghouse issues an Environmental Health and Safety (EHS) and Sustainability policy, which is fully supported throughout all levels of the organization. Waste minimization aspects of this policy include:

- Minimizing raw materials and energy usage while reducing waste, preventing pollution, and re-using and recycling materials and resources to the extent that is economically and technically feasible;
- Achieving compliance, at a minimum, with all applicable EHS legal requirements, and any other requirements to which the company subscribes; and
- Continually improving EHS Management Systems and performance

CFFF implements this policy through a formal Environmental Management System (EMS). The CFFF waste minimization program is included in the EMS. Every year, an EHS and Sustainability Improvement Plan is issued, describing the improvement plan for that year.

The CFFF generates both combustible and non-combustible materials during the manufacture of nuclear fuel. Uranium containing combustible materials are incinerated on site and the ash and clinker residue is leached (chemically reacted with nitric acid) to recover uranium in the form of uranyl nitrate. This material is not considered a waste since the uranyl nitrate is recycled / reused by the facility. Combustible materials are packaged in compatible containers, assayed for grams ^{235}U, and stored to await incineration. Alternately, CFFF may ship uranium containing combustible materials or ash to other licensed facilities for processing to recover the usable uranium.

The non-combustible materials generated are either prepared for burial or decontaminated for reuse, recycle, or release by the plant. Noncombustible wastes, and selected combustible wastes, are packaged in compatible containers, compacted when appropriate, measured to verify the uranium content, and placed in storage to await shipment for further treatment, recovery, or disposal.

Figure 2.1-7 illustrates the process flow for the handling of solid contaminated materials, including low-level radioactive waste (LLRW). A summary of waste generation rates and onsite storage capacity is presented below in Table 2-1-5.

Table 2.1-5 Summary of Waste Generation Rates and Storage Capacity

Waste type	Generation rate	Storage capacity
LLRW	680 m^3/yr (24,000 ft^3/yr)	7,711 m^2 (83,000 ft^2) storage pad
Hazardous	105,607 kg/yr (232,824lb/yr)[1]	88.3 m^2 (950 ft^2) storage pad[2]
Nonhazardous		
Liquid	435 kg/yr (960 lbs/yr) (primarily oil)[1]	88.3 m^2 (950 ft^2) storage pad[2]
Liquid[3]	2,000 gal/day maximum	Tanker truck – Contract Service
Solid A[4]	178,446 kg/yr (393,407 lbs/yr)[1]	88.3 m^2 (950 ft^2) storage pad[2]
Solid B[4]	201 MT (221 tons/yr)	None: – Contract Service

1 Values based on FY2017 generation.

2 This is on a 88.3 m^2 (950 ft^2) storage pad that is shared.

3 This is wastewater consisting of a soap/lubricant, originating from the cleaning of one type of fuel assembly and only used a few times per year.

4 Nonhazardous Solid Waste A consists of items such as batteries, computers, oil filters and rags. Nonhazardous Solid Waste B consists of general industrial trash waste generated from office areas, lunch rooms, etc.

Sources: Westinghouse 2014j.

LLRW designated for disposal are packaged in DOT-approved 208-L (55-gal) metal drums or in metal boxes (sealand containers). Wastes consigned to disposal are shipped to a licensed disposal facility. Shipments are made in compliance with all applicable NRC, DOT, U.S. Environmental Protection Agency (EPA) and State regulations and in conformance to disposal site criteria. Limited amounts of mixed waste is generated at CFFF and is also shipped in accordance with established regulations. Mixed Wastes at CFFF consist of contaminated batteries (dry cell, lead acid, lithium), pcb light ballasts, contaminated lamps not able to be free-released, and lead shielding (bricks and battery casings).

Hazardous (chemical) wastes, such as degreasing solvents, lubricating and cutting oils, spent plating solutions, and zirconium laden wastes are generated at the CFFF. These wastes are regulated under 40 CFR Part 261, Identification and Listing of Hazardous Waste; 40 CFR Part 262, Standards Applicable to Generators of Hazardous Waste; and SC Hazardous Waste Regulations R61–79.261. Hazardous Waste Generation Reports are provided quarterly and the waste is disposed of offsite through permitted contractors.

Nonhazardous waste is generated from routine office and industrial activities (including calcium fluoride) and is recycled or disposed of at an offsite state-permitted landfill. The annual CFFF generation rate for nonhazardous waste in 2018 was 8,120 MT, of which >97% was recycled.

In previous years, after fixation with a cement-like binder, the calcium fluoride contaminated with uranium was buried at the low-level radioactive waste burial site in Barnwell, SC. All calcium fluoride generated prior to 1981, approximately 1.6×10^4 m^3 (575,000 ft^3) of material, was handled in this manner. In 1980, a wastewater treatment system was installed at CFFF to remove additional quantities of uranium. After such treatment, calcium fluoride solids contains <30 pCi/g of uranium activity, which is the existing NRC (NRC 1981) guideline for material that may be disposed without restriction of burial method (Westinghouse, 1982). Currently, Westinghouse is only authorized to release such material with <30 pCi/g to a concrete plant (Westinghouse, 2012g).

2.2 Summary of Environmental Impacts

This section summarizes environmental effects under the No-Action Alternative that could result from past, present, or reasonably foreseeable future. This summary is based on information presented in Sections 3.0 through 8.0. In documenting environmental conditions for the CFFF and its environmental impacts, the ER covers the following resource areas in Section 3.0:

- Land Use
- Transportation
- Geology and Soils
- Water Resources
- Ecological Resources
- Meteorology, Climatology, and Air Quality
- Noise
- Historic and Cultural Resources
- Visual/Scenic Resources
- Socioeconomic
- Public and Occupational Health (including Radiation)
- Waste Management

No significant environmental impacts, including cumulative effects, have been identified for the areas within the affected environments described. For example, the water usage for the Congaree River is less than 1 percent of the total water usage in the watershed (Westinghouse 2006c). CFFF is in compliance with relevant environmental standards and regulations, as well as NRC regulations related to radiation dose to the public and facility workers. Further, the facility utilizes an As-Low-As-Reasonably-Achievable (ALARA) program, routine environmental and radiation monitoring, a radiation safety program, a chemical safety program, and an environmental protection program to minimize the associated direct, indirect, and cumulative effects. Westinghouse also conducts program audits and self-assessments to ensure existing programs and processes minimize adverse environmental effects.

Finally, routine environmental monitoring data has been input into a new site tool called a Conceptual Site Model (CSM). The CSM provides an understanding of how a contaminant release may be observed and measured currently in the site environment, and helps to identify the fate and transport of the contaminant in the future. The model incorporates what is known about the site’s hydrogeology, existing and past site activities that may have resulted in contaminant releases to the environment, the locations of those releases, the contaminants of concern, their fate and transport within the environment, and the receptors of those contaminants. Based upon current and historical operations, the facility has established defined Operable Units (OU) with groundwater monitoring wells providing early leak detection or contaminant migration.

Based on site sampling data discussed in the various sections of this ER but particularly 4.4, the groundwater and surface water impacts of the No-Action alternative are not significant. The groundwater is confined in a shallow geologic unit that has little or no potential of being an underground source of drinking water and discharges or will discharge to surface water. Any plumes detected are confined to the property, with little to no possibility of groundwater withdrawals to create drawdown such that contaminants would flow off-site. The lack of contaminant detections in downgradient wells W-20 and W-25 coupled with the years of surface water data collected for the site demonstrate that there is no immediate off-site environmental impact.

A summary of the environmental impacts is presented in Tables 2.2-1 and 2.2-2. Table 2.2-1 summarizes the resources committed and effluents (gaseous, liquid and solid waste) to the environment. Table 2.2-2 summarizes impacts to each environmental resource considered.

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Table 2.2-1 Summary of Resource Use and Effluents

Environmental Considerations	No-Action Alternative & Proposed 40-year Renewal
Natural Resource Use	
Land (ha [ac])	
Undisturbed area	445 (1,098)
Disturbed area	24 (60)
Permanently committed	466 (1,151)
Water (gal/yr)[1,2]	
Consumption	4.4×10^7
Fossil Fuel[1]:	
Electrical energy (MW-hour/yr)	3.92×10^5
Natural gas (ft^3/yr)	1.03×10^8
Effluents-Chemical (MT/yr)	
Gases:	
SO_x	0.56
NO_x	8.2
CO	4.54
Particulates	0.32
Other gases	
NH_3	15.5
Liquids:	
NO^{-3}	100.0
F^-	10.6
NH_3	11.0
Solids (ton/shipment)	
CaF_2 (dry basis) [1]	4,152
Effluents- Radiological	
Gases (μ Ci/yr):	
Uranium	470
Liquids (mCi/yr):	
Uranium	18.4
Solids (off-site) (m^3/yr [ft^3/yr]):	
LLRW	680 (24,000)

[1]**:Averages obtained for calendar year data 2014-2018**
[2]Westinghouse has one source of water, which is the City of Columbia. City water is used for potable and process water. No sub-metering within the facility exists to provide detailed descriptions for how water is consumed by individual workers and areas.

Table 2.2-2 Summary of Environmental Impacts

Environmental Resource	No-Action Alternative & Proposed 40-year Renewal
Land Use	
Operation (total land occupied, ha [ac])	469 (1,151)
Transportation	Minimal Worker traffic (1,250 employees) 7.4 shipments/day of radioactive and chemical materials
Water Resources	• Onsite groundwater contamination (VOCs, fluoride, nitrate, ammonia, uranium, Tc-99). • Fluoride, nitrate, ammonia plumes are stable and likely decreasing. • All COPC groundwater plumes remain on-site • No surface water data indicating off-site impacts
Geology and Soils	Minimal
Ecological Resources	Minimal
Air Quality	Minimal
Noise	Minimal
Historic and Cultural Resources	Minimal
Socioeconomics	Net benefit through jobs and tax revenues
Public and Occupational Health, Normal	Minimal
Public and Occupational Health, Accidents	Potential exists for accidents leading to releases of radioactive and chemical materials at CFFF and during transportation
Waste Management	Minimal

3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Land Use

The CFFF site is located in the central part of SC in Richland County, some 13 km (8 mi) southeast of the city limits of Columbia along SC Highway 48 (see Figures 2.1-1 and 3.1-1). The site coordinates are 33º 52’ 52” north latitude and 80º 55’ 24” west longitude. Figure 2.1-2 shows a topographic quadrangle map of the area within a radius of 13 km (8 mi). The inner circle represents a 8-km (5-mi) radius around the plant, 90 percent of which falls in Richland County and the remaining 10 percent falls within Calhoun County, to the south (Westinghouse2019d).

Most of the area is swamp-type land, unsuitable for commercial purposes. Much of the land that makes up the site boundary is designated as agricultural. Within a 1.6-km (1-mile) radius of the CFFF site, agricultural use makes up 44 percent of the area (see Figure 3.1-2). The remaining 56 percent is classified as “other.”(Westinghouse 2019d)

The CFFF site lies within the flood basin of the Congaree River, which flows approximately 6.4 km (4 mi) southwest of the main plant. The land consists of timbered tracts and wetland areas penetrated by unimproved roads. (Westinghouse 2019d). A variety of activities are conducted within the undeveloped portion of the site. These activities include management of the forested areas for timber production and harvesting of hay fields. Recreational facilities in the undeveloped portion of the site include a fitness trail and a picnic pavilion for employee use

The CFFF is bounded by private property owners to the east, south, and west. Manufacturing facilities are located about 0.5 km (0.3 mi) from the site boundary, at its nearest point. Farms, single-family dwellings, and light commercial activities are located chiefly along nearby highways. South Carolina Electric and Gas recently constructed a new commercial electrical substation on approximately 2.8 ha (7 ac) along the northwest border of the CFFF property on land purchased from Westinghouse (Westinghouse2019d).

3.1.1 Manufacturing

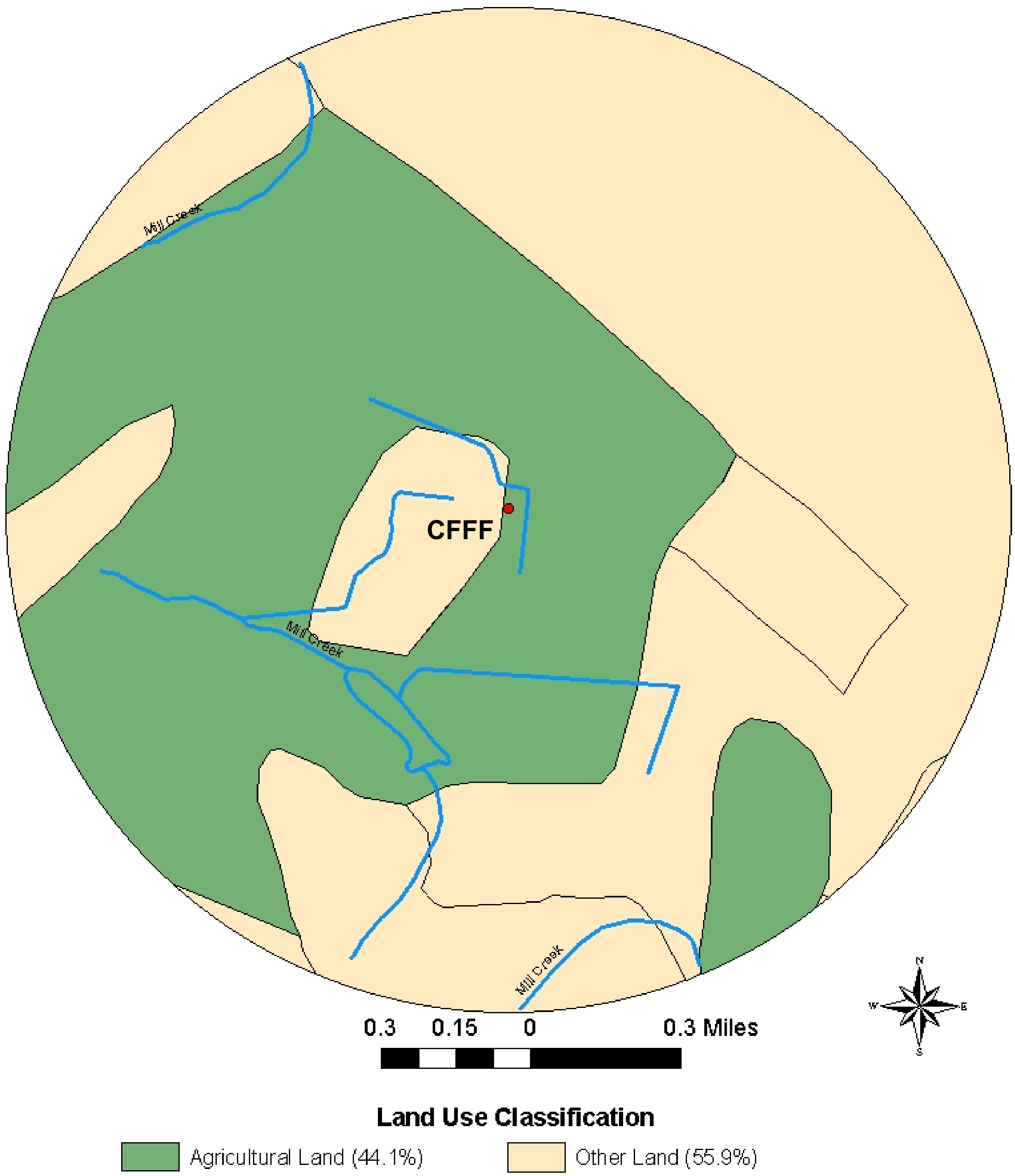
Except for the DAK Americas (formerly Carolina Eastman) plant, which lies 7.6 km (4.75 mi) directly west of the CFFF, all firms with five or more employees were within the 180º sector north of the plant site (Westinghouse 1983). Those facilities with potential significant atmospheric or aquatic effluent loads with which the CFFF effluents could interact include the DAK Americas plant (man-made production fibers), Nephron Pharmaceuticals (eye drop medications, respiratory medicine, vaccines and injectable drugs), Knight’s Redi-Mix (concrete batching plant for commercial use), Schneider Electric (industrial motor control production), Devro (collagen casings for food) and Amazon Distribution Center.

3.1.2 Agriculture

There are five farms within the 5-mile radius of the study area including Manchester Farms, Carolina Bay Farms, Cottle Strawberry Farms, Southland Fisheries, and Softwinds Farm. They offer quail, sustainable food options, strawberries, fish for pond stocking, and full service equestrian services, respectively.

Source: GoogleEarth 3/26/2019

Figure 3.1-1 Land Use Features within 5 Miles of the CFFF



Source: Westinghouse2019d

Figure 3.1-2 Land Use Within 1.6 km (1 mi) of the CFFF

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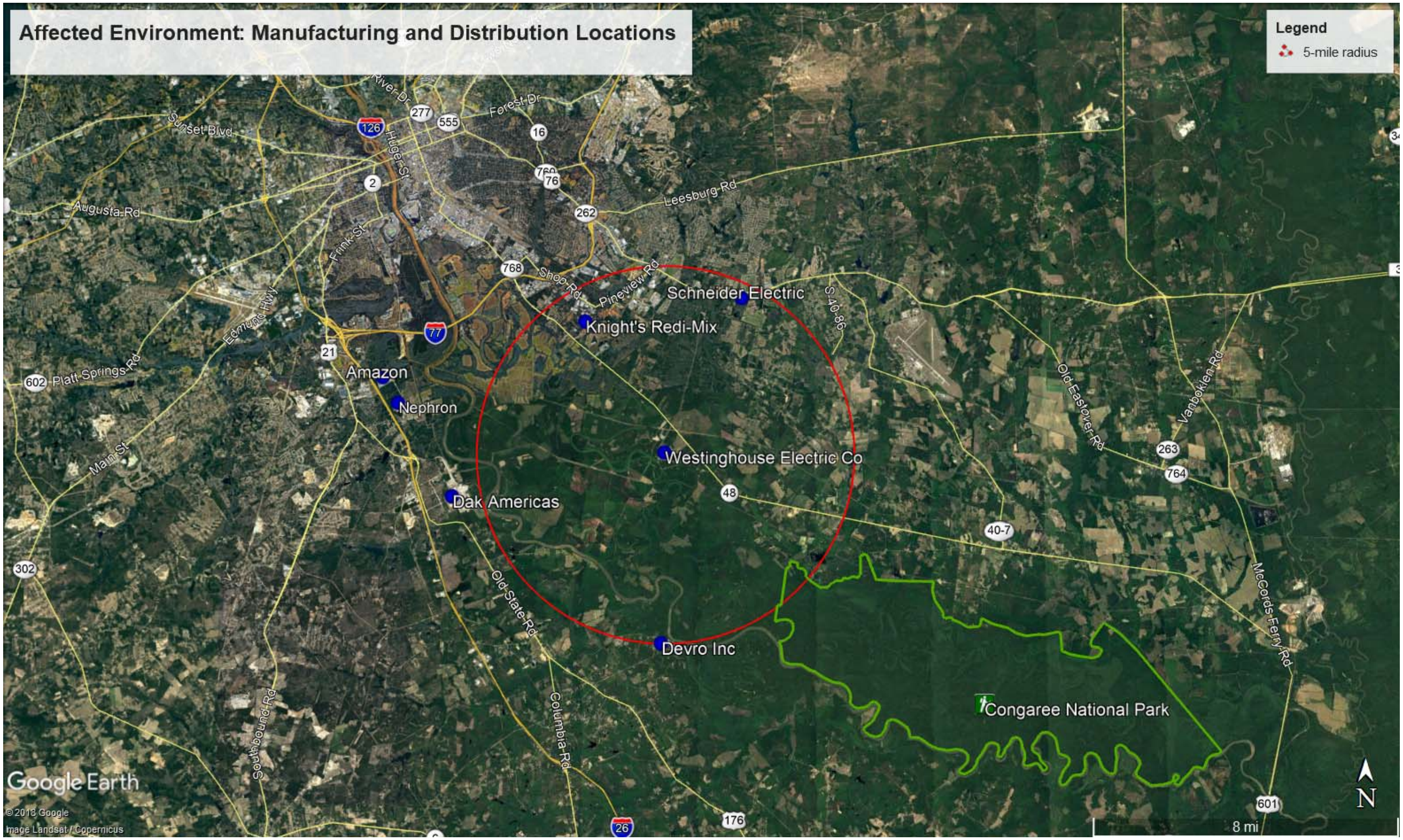
Figure 3.1-3 Affected Environment: Manufacturing and Distribution Locations



Source: GoogleEarth 3/26/2019

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3.1.3 Undeveloped Nonagricultural Land

Forest or swamp forest cover 70 percent of the land in the study area. Extensive forests and swamps lie along the Congaree River west and south of the plant. Water tupelo-sweet gum forest dominates the better-drained sites, whereas the driest sites in the area may be dominated by loblolly pine and hardwoods (oak species, red maple, yellow poplar, etc). (Westinghouse 1983)

The Congaree River Swamp is an 8,500-ha (21,000 ac) forested swamp lying along the Congaree River about 8.5 km (4 mi) southeast of the site. The southeast area of this swamp has been named as a national park. Its forests have been largely undisturbed for over 200 years. This area represents a rare remnant of previously extensive southern-river floodplain forests, but also contains several of the largest trees of their species. (Westinghouse 1983)

3.1.4 Nearby Military Installations and Airports

There are two major military installations in the Columbia area: (1) Fort Jackson U.S. Army Base, located approximately 11 km (7 mi) north of the CFFF site, and (2) McEntire Air National Guard Station (ANGS), located approximately 10 km (6 mi) northeast of the CFFF site. Fort Jackson has a heliport and McEntire ANGS has an airport and heliport.

Airports within a 32-km (20-mi) radius of the CFFF site include: Columbia Metropolitan Airport; Columbia Owens Downtown Airport; Lexington County Airport (in Gaston); Corporate Airport and Eagles Nest – Fairview Airpark (both in Pelion); Alan's Airport and Do-Little Field Airport (both in St. Matthews); and McEntire ANGS. Several hospitals, businesses, and government agencies in the Columbia area own heliports, including Providence Hospital, Palmetto Richland Hospital, Lexington Medical Center, South Carolina Pipeline, South Carolina Law Enforcement Division, Fort Jackson U.S. Army Base, and McEntire ANGS (Westinghouse 2019d).

3.1.5 Nearby Schools and Churches

Of the schools near the CFFF, there are only two schools within an 8 km (5-mile) radius and three just outside the 5-mile radius. Figure 3.1-1 identifies nearby schools and their location relative to the CFFF. Table 3.1-1 provides information about schools near CFFF. Nine churches also lie within the 8-km (5-mi) radius of the site.

Table 3.1-1 Schools Near the CFFF Site

School	Grades	Enrollment[1]	Location
Hopkins Elementary	PK-5	297	6.4 km (4 mi) NE
Hopkins Middle School	6-8	483	7.4 km (4.6 mi) NE
Lower Richland High School	9-12	1,195	9.5 km (5.9 mi)NE
Mill Creek Elementary School	PK-5	385	8.5 km (5.3 mi) NNE
Sandhills School (private)	1-12	75	9.5 km (5.9 mi) NNE

[1] All enrollment data was taken from 2017-2018 SC Annual School Report Card Summary except for Sandhills School. The last confirmed enrollment for Sandhills School was in 2013 through a personal phone call by D. Joyner to the administrative staff.

Source: Westinghouse 2019d

3.1.6 Parks

The Congaree National Park is located just over 8 km (5 mi) to the southeast of the CFFF (see Figure 3.1-1). Originally designated as the Congaree Swamp National Monument in 1976, the area was designated as a National Park by the U.S. National Park Service in November 2003. The park covers an area of 8,984 ha (22,200 ac). The Congaree National Park preserves the last significant (and largest intact) tract of old-growth bottomland hardwood forest in the U.S. and North America, and contains one of the tallest deciduous forests in the world, including numerous national and state champion trees. Its wetlands are widely acknowledged to be the most outstanding example of the Southern bottomland hardwood ecosystem left in the world, providing a habitat for diverse populations of flora and fauna. The park is designated as an International Biosphere, a Globally Important Bird Area, and a National Natural Landmark (Westinghouse2019d).

There are also two public parks located within a 8-km (5-mile) radius of the CFFF: Bluff Road Park, located approximately 7.6 km (3.5 mi) north just off Bluff road (SC 48) and Hopkins Park, located approximately 4.0 km (2.5 mi) east off Lower Richland Blvd (SC 37) (see Figure 3.1-1) (Westinghouse2019d).

3.1.7 Other Land Use

There are no hospitals within a 8 km (5-mile) radius of the CFFF site. The Alvin S. Glenn (Richland County) Detention Center is located 8 km (5 mi) north of the CFFF site, just off Bluff Road (SC 48) (Westinghouse2019d).

3.2 Transportation

Columbia and the surrounding area contain a well-developed and maintained system of interstate, regional and local highways that provide easy year-round access. Three interstate highways serve Columbia. The CFFF site can be accessed by state highway SC 48. Although CSX

Transportation, Incorporated (CSX), operates two rail lines close to the CFFF site, there are no rail lines or spurs on the Westinghouse property.

A well-developed and maintained system of interstate, regional and local highways provide easy, year-round access for commuter, business, and freight traffic to the Columbia area. Three interstate highways run through the Columbia area, I-20, I-26, and I-77. Interstate 20 (which runs east to west from Florence, SC, to Augusta, GA) is approximately 22.4 km (14 mi) north of the CFFF. Interstate 26 (which runs northwest to southeast from Spartanburg to Charleston) is slightly more than 12.8 km (8 mi) west of the CFFF. Interstate 77 (which runs from I-26 south of Columbia to Charlotte, NC) is approximately 9.6 km (6 mi) to the northwest. The plant is located just off of SC 48. Other major roads in the vicinity of the CFFF site include US- 21 [11.2 km (7 mi.) west], US 76/378 [about 9 km (5 mi) north], and SC 37 (Lower Richland Blvd.), which is approximately 2.4 km (1.5 mi) to the southeast. Two rail lines in the vicinity of the CFFF site are both operated by CSX, which are about 6.4 km (4 mi) and 9.0 km (5 mi) northeast, respectively (Westinghouse 2004, 2019d).

The primary highway supporting traffic into and out of the site is SC 48. The South Carolina Department of Transportation (SC-DOT) provides annual average daily traffic (AADT) counts by highway and highway segment online at the SC-DOT webpage. Two traffic counting stations exist on SC-48 on each side of the site's entrance. The AADT count in 2017 for station #244, which is north of the site entrance and headed toward the City of Columbia was 6,800 (S-960, Longwood Road to S-87). The count in 2017 for station #241, which is south of the site entrance and heading towards Gadsden was 4,300 (S-87 to S-734, Old Bluff Road).

3.3 Geology and Soils

3.3.1 Regional Geology

The area surrounding the CFFF site is just south of the Fall Line zone and the northwestern edge of the Coastal Plain Province. The terrain is characterized by low to moderate hills and gently rolling lowlands. Small streams in the area are for the most part dendritic, but the larger streams such as the Congaree River are better developed in a direction perpendicular to the strike of the underlying Tuscaloosa formation. The CFFF site lies in the flood plain of the Congaree River. Within the Congaree River flood plain are small dendritic streams that feed into the Congaree River, such as Mill Creek.

A generalized geologic map of SC is presented in Figure 3.3-1 (Westinghouse 2019d). The Coastal Plain is composed of sediments that range in age from Late Cretaceous to recent. These sediments consist of unconsolidated sand, clay, gravel, and limestone that have been deposited on the beveled surface of the Piedmont province rocks. The formations exposed in Richland, Lexington, and Calhoun counties are described below. Coastal Plain deposits are generally the result of sediments left from the rising of sea level. The contact between rocks of the Piedmont province and the Coastal Plain dips approximately 6 m per km (30 ft per mi) towards the Atlantic coast.

The oldest formation of the Coastal Plain is the Late Cretaceous Tuscaloosa Formation. The Tuscaloosa Formation typically consists of arkosic sands and gravels interbedded with clays that were deposited in a nonmarine environment. These deposits are the result of the erosion and subsequent deposition of Piedmont rocks. The Tuscaloosa Formation is very thin near Columbia and gradually thickens to more than 244 m (800 ft) in the south coastal area.

The next oldest formation of the Coastal Plain is the Late Cretaceous Black Creek Formation, which consists of gray to black laminated clay and micaceous sands that were deposited in a marine environment. This formation marks the onset of the sea-level rise that resulted in the deposition of sediments of marine origin. The formation has an average dip of about 4 m per km (23 ft per mi) to the south-southeast and is approximately 183 m (600 ft) thick near the coast.

Overlying the Late Cretaceous units is the Black Mingo Formation at the base of the Tertiary units. The Black Mingo Formation is Paleocene to Eocene in age. It is a laminated sandy shale with layers of clay and sand that was deposited in a marine environment. Deposited on the Black Mingo Formation is the Santee Limestone Formation of Eocene age. The Santee Limestone is a white to yellow fossiliferous limestone that was deposited in a restricted marine environment.

The next oldest unit is the Barnwell Formation of Eocene age, which was also deposited in a marine environment. It consists of fine- to coarse-grained massive red sandy clay and clayey sand with minor ferruginous sandstone layers 2.54 cm to 0.9 m (1 in. to 3 ft) in thickness. Overlying the Barnwell Formation are Quaternary alluvial and fluvial deposits that fill present day stream and river channels (Westinghouse 2019d).

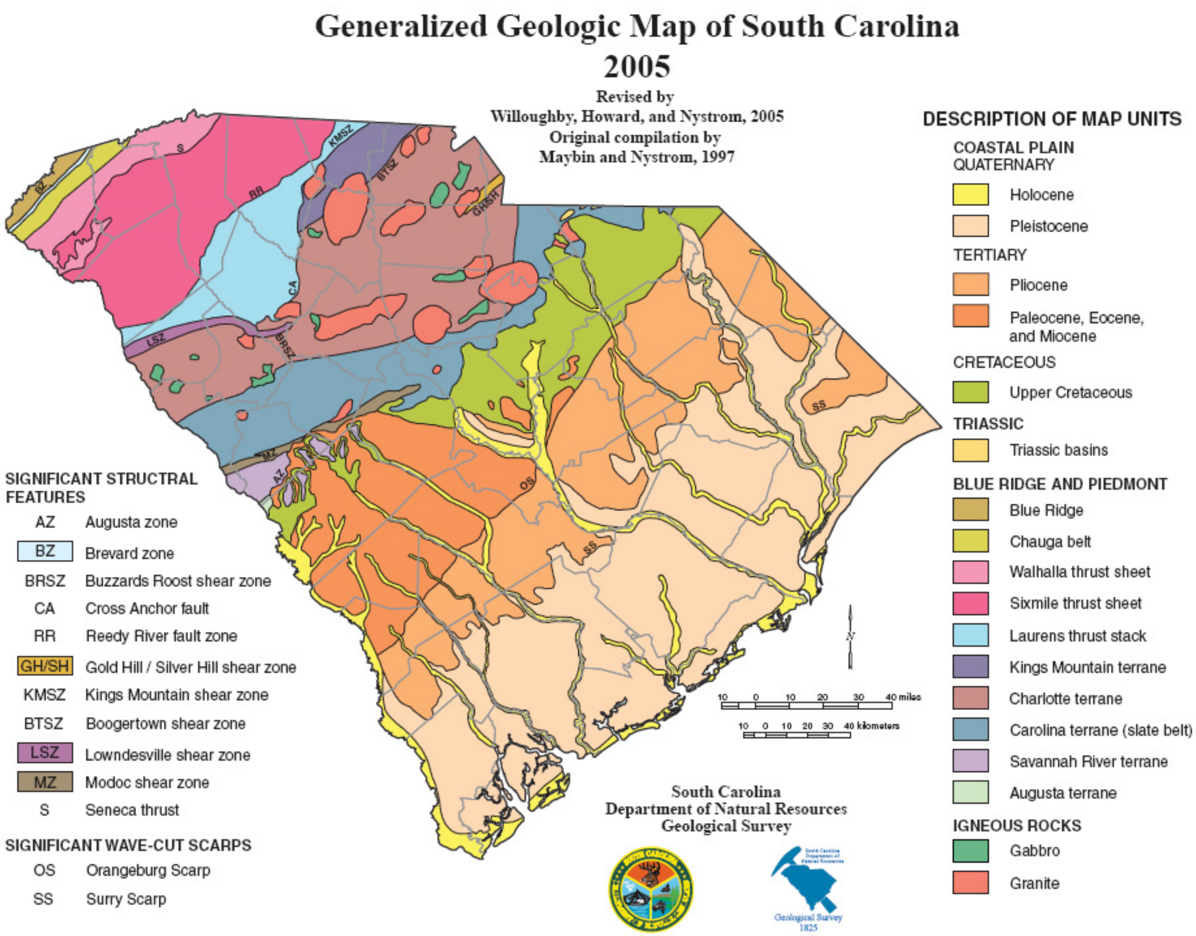


Figure 3.3-1 Generalized Geologic Map of South Carolina

3.3.2 Site Geology and Soils

The CFFF site is situated on a shelf to the northeast of the Congaree River, just off SC Highway 48. The average elevation of the Congaree River flood plain at the site is 34 m (110 ft) above MSL. The CFFF site elevation ranges from 34 to 35 m (112 - 115 ft) (above MSL) on the southwest portion of the site, around Mill Creek and Sunset Lake, to 41 to 44 m (136 - 144 ft) (above MSL) on the northeast portion of the site, around the main manufacturing building, tank farm, lagoons, and parking lots (Westinghouse 2019d).

The CFFF is located in the Upper Coastal Plain physiographic province and is situated on approximately 73.2 m (240 ft) of undisturbed and unconsolidated post-Triassic Coastal Plain sediments. The Upper Coastal Plain of SC is bounded to the southeast by the Orangeburg Scarp and by the crystalline rocks of the Piedmont province to the northwest. The sedimentary units of the Coastal Plan form a wedge of accumulation that thickens from the fall line to the coast. These units directly overlie crystalline basement (bedrock) composed of metamorphic and igneous rock. Bedrocks of the area are primarily metamorphic gneisses and schists with some local granite intrusions. The bedrock has weathered in-place to form the overburden soils. The upper soils are the most highly weathered and are often composed of silty clays or clayey silts. With depth, these upper materials transition into less cohesive silty sands and sandy silts with varying mica content. Weathering processes, which are dependent on fractures in the rock, changing groundwater levels, rock mineralogy, and other factors, result in an extremely variable surface of the bedrock. Also, hard rock layers and boulders are often encountered within the overburden soil or the weathered rock.

The Congaree River floodplain has completely eroded away the surficial aquifer at the site and sediments deposited within the flood plain are younger (Holocene) than those above the bluff (Pleistocene). Due to the thickness and depth below land surface of the Black Mingo confining clay, the Congaree River did not erode through this clay layer (SC-DNR 2011).

Beneath the surficial aquifer and Congaree River deposited sediment is a confining bed composed of dry silt/clay and brittle shale of the upper Black Mingo Formation. Beneath the clay confining unit is an artesian sand aquifer within the lower Black Mingo Formation known as the Black Mingo aquifer. There are currently three monitoring wells (W-3A, W-49, and W-50) screened within the Black Mingo aquifer. Previous geologic cross sections (AECOM 2013) indicate that the Black Mingo confining bed ranges in thickness from 39 feet at the monitoring well W-3A to 83 feet at monitoring well W-50.

The Middendorf Formation occurs below the Black Mingo Formation, overlies bedrock and also contains artesian sand aquifers. Sediments of the Middendorf Formation generally consist of multi-colored clay interbedded with fine to coars grained sand. Pervious subsurface investigations have not extended into the Middendorf aquifer.

The onsite sediments are described in Table 3.3-1.

Table 3.3-1 Description of the Coastal Plain Sediments at the CFFF[1]

Formation Name	Age	Thickness	Description
Okefenokee	Plio-Pleistocene	6.1 to 12.2 m [20-40 ft]	Stratified but poorly sorted mixture of clay, silt, sand, and gravel
Black Mingo	Paleocene to Eocene	22.9 m [75 ft]	Upper clay unit and lower sand unit
Tuscaloosa	Late Cretaceous	38.1 to 44.2 m [125-145 ft]	Multicolored clay interbedded with fine to coarse grade sand

[1] Source: Westinghouse 2004.

The nature of the soils in the area is important in the assessment of CFFF buildings. The soils must support structures or holding ponds, soil permeability must not allow effluents to escape into aquifers, and the engineering designs for new facilities must overcome any limits of the soils with respect to swelling, shrinking, corrosion, and flooding potential.

The CFFF plant is situated on soils in the Craven-Leaf-Johns association. Craven series soils are moderately well drained, gently sloping Coastal Plain soils. The surface layer is loam, with a clay subsoil that is very firm and slowly permeable. Clayey sediments interfinger with sand lenses below. The Leaf association is poorly drained with a silt-loam surface and silty-clay subsoil (NUREG-1118).

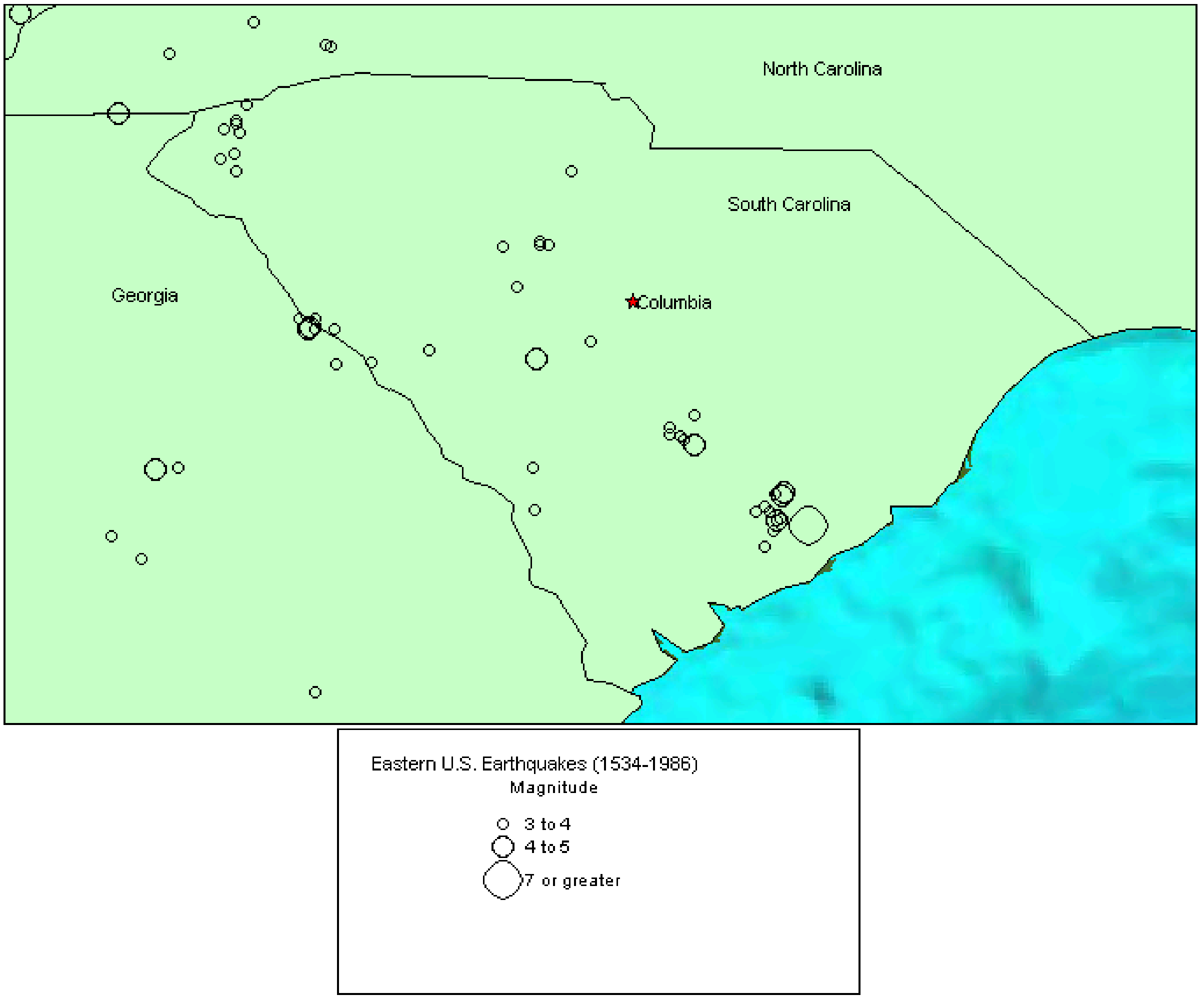
Both soil series in the association have certain limitations. They are highly corrosive to both concrete and steel, and they have high shrink-swell potential and severe wetness and flooding potential because of seasonal high water tables (NUREG-1118).

3.3.3 Regional Seismicity

The CFFF site is located near Columbia far from any centers of significant earthquake activity. Several major earthquakes have occurred at distant points, and some minor to moderate shocks have occurred nearer to the site. No significant earthquake has been located nearer than about 20 mi from the site. Figures 3.3-2a and 3.3-2b show the locations of past earthquakes in the SC region. (Westinghouse 2019d).

South Carolina has experienced a moderate amount of earthquake activity in the last two centuries. Figure 1.12 shows epicentral locations of earthquakes with known magnitudes in the region of South Carolina. This includes the large, magnitude 7.0 Charleston earthquake of August 31, 1886, which is the strongest earthquake documented in the southeastern United States in historic time. The earthquake was located about 90 mi southeast of Columbia and was felt in an area of about 2 million square miles that includes locations as far away as Boston, Milwaukee, New York City, Cuba, and Bermuda. A maximum intensity of X on the Modified Mercalli (MM) intensity scale has been estimated for the event (see Figure 3.3-3). Damage from the earthquake was reported in Columbia, where MM intensities of VII–VIII were observed. The most serious damage was reported in Charleston and nearby cities, where an estimated $23 million damage was incurred and some 60 people died. Damage in Charleston was generally correlated with local soil conditions, with structures constructed on filled-in areas experiencing the greatest damage. Cracks, sand boils, and bent railroad tracks were also observed in the epicentral region.

The majority of the earthquakes occurring in the coastal plain of SC are associated with the Charleston seismic zone. This earthquake activity is confined to a relatively localized area that corresponds to a discrete structural anomaly possibly related to zones of weakness in the basement rocks. Studies based on seismicity recorded by regional seismic networks indicate that zones of high seismicity correspond to the intersection of a northwest-trending zone of weakness and northeast-trending Triassic basins. Alternative explanations include the hypothesis that horizontal nodal planes observed for earthquakes in the Summerville area represent a large-scale regional fault surface associated with a postulated Appalachian decollement. There is little evidence, however, to support a sub-horizontal shear of this size. The reactivation of northwest-dipping or southeast-dipping Triassic tensional faults by present-day northwest-oriented compressional stresses has also been suggested to explain current seismic activity in the Charleston seismic zone. Although the reactivation of some northeast-trending structures in the Cenozoic has generally been recognized, the age of the lateral movement is not well known or defined. In summary, there is no conclusive evidence that would suggest that the seismogenic structure responsible for the earthquake activity in the Charleston seismic zone extends to the northwest as far as Columbia.



Source: Westinghouse 2019d

Figure 3.3-2a Earthquakes of Magnitude 3.0 or Greater in the South Carolina Region

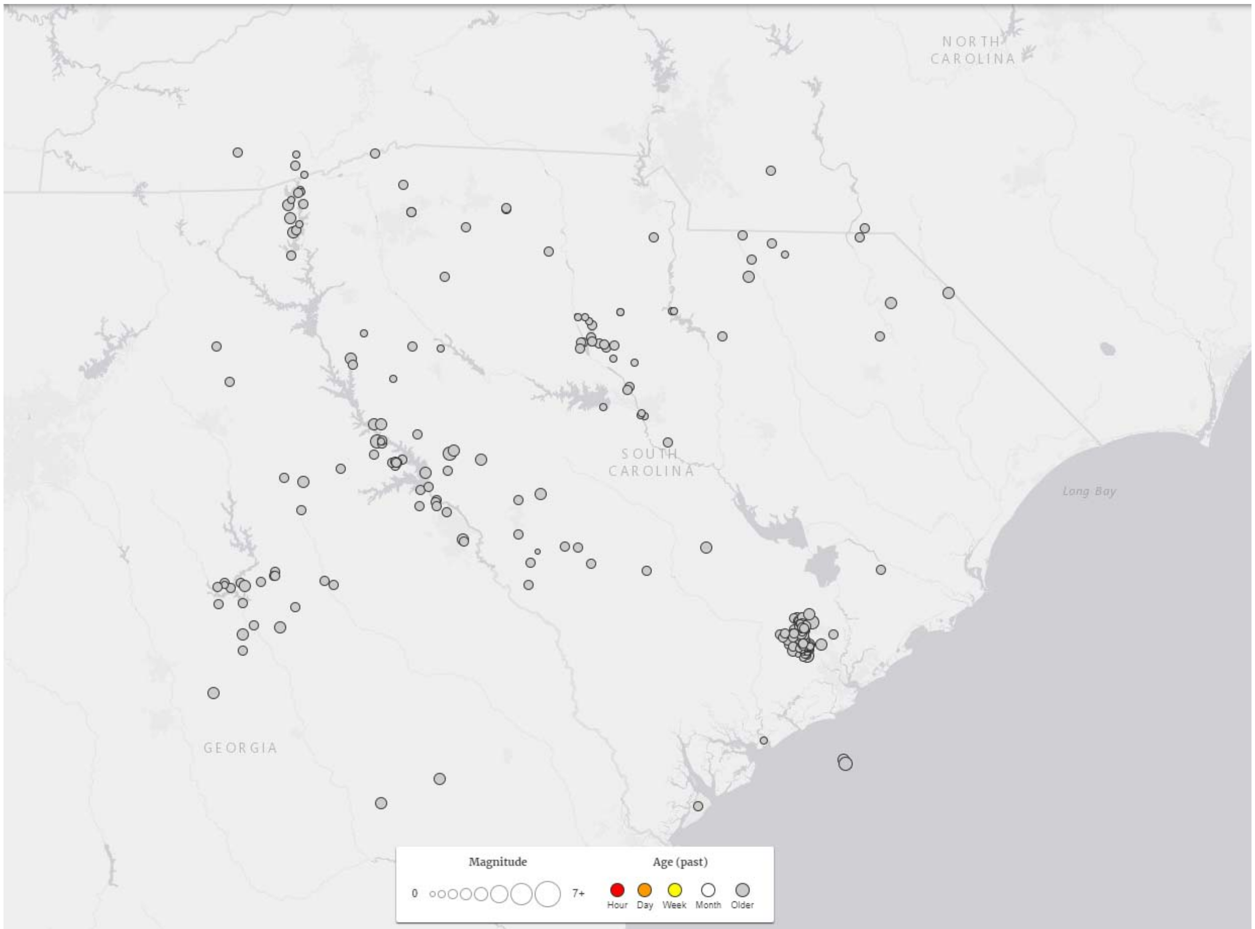
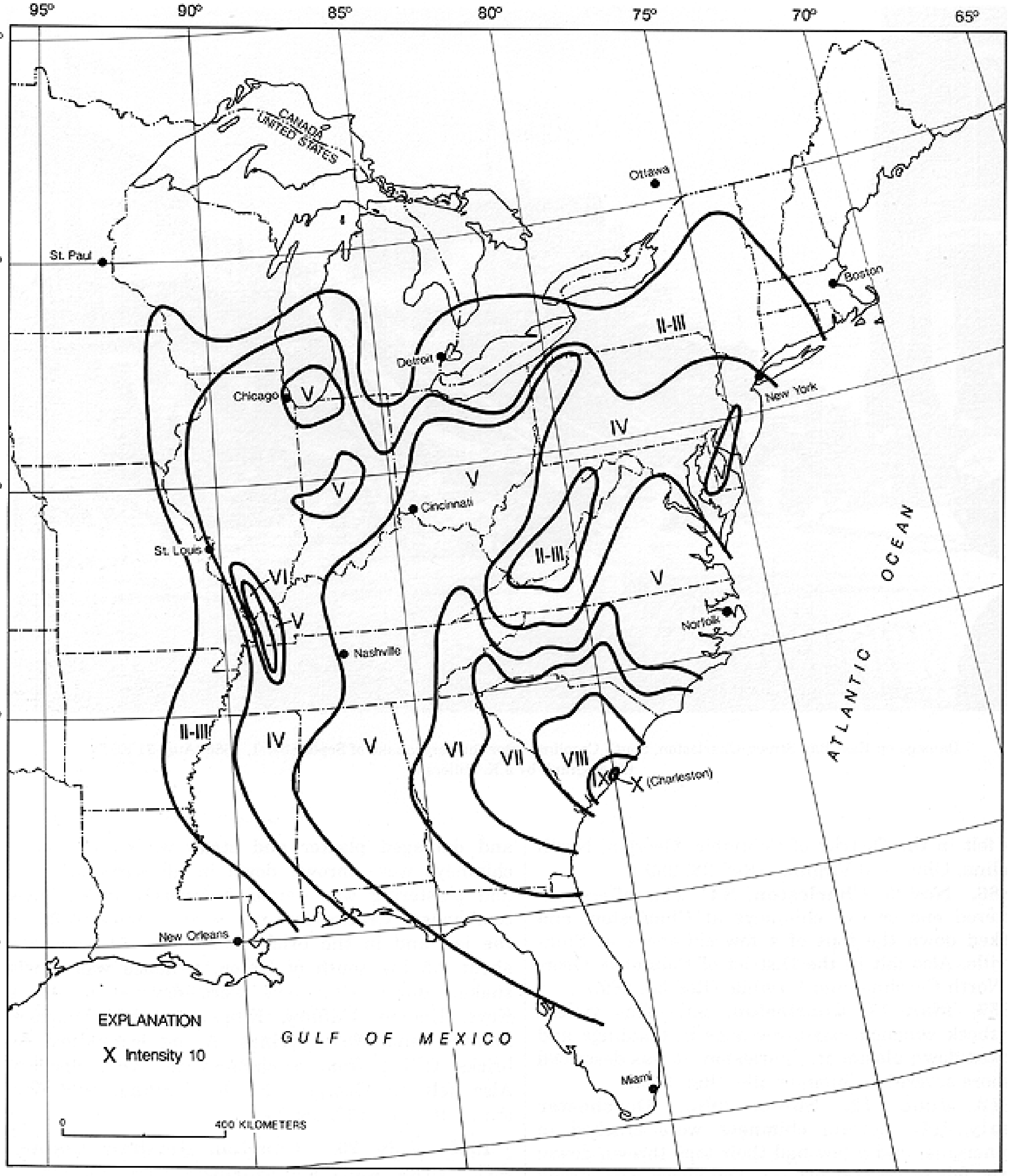


Figure 3.3-2b Earthquakes since 1900 in the Greater SC Region in USGS Data Sources

In addition to the Charleston earthquake of 1886, other significant historic earthquakes include the Summerville earthquake of June 12, 1912, and the Union County earthquake of January 1, 1913. The 1912 Summerville earthquake caused some damage to chimneys and had an estimated maximum MM intensity of VII. An MM intensity VI was observed at Charleston, about 32 km (20 mi) southeast of the earthquake. The earthquake was felt in an area of about 90,650 km^2 (35,000 mi^2) that included the cities of Brunswick and Macon, GA; Greenville, SC; and Wilmington, NC. The 1913 Union County earthquake occurred about 128 km (80 mi) northwest of Columbia and was felt over an area of 111,370 km^2 (43,000 mi^2). In the city of Union, cracks appeared in many brick buildings and many chimneys were damaged. The maximum MM intensity of the 1913 Union County earthquake was estimated at VI–VII (Westinghouse 2019d).



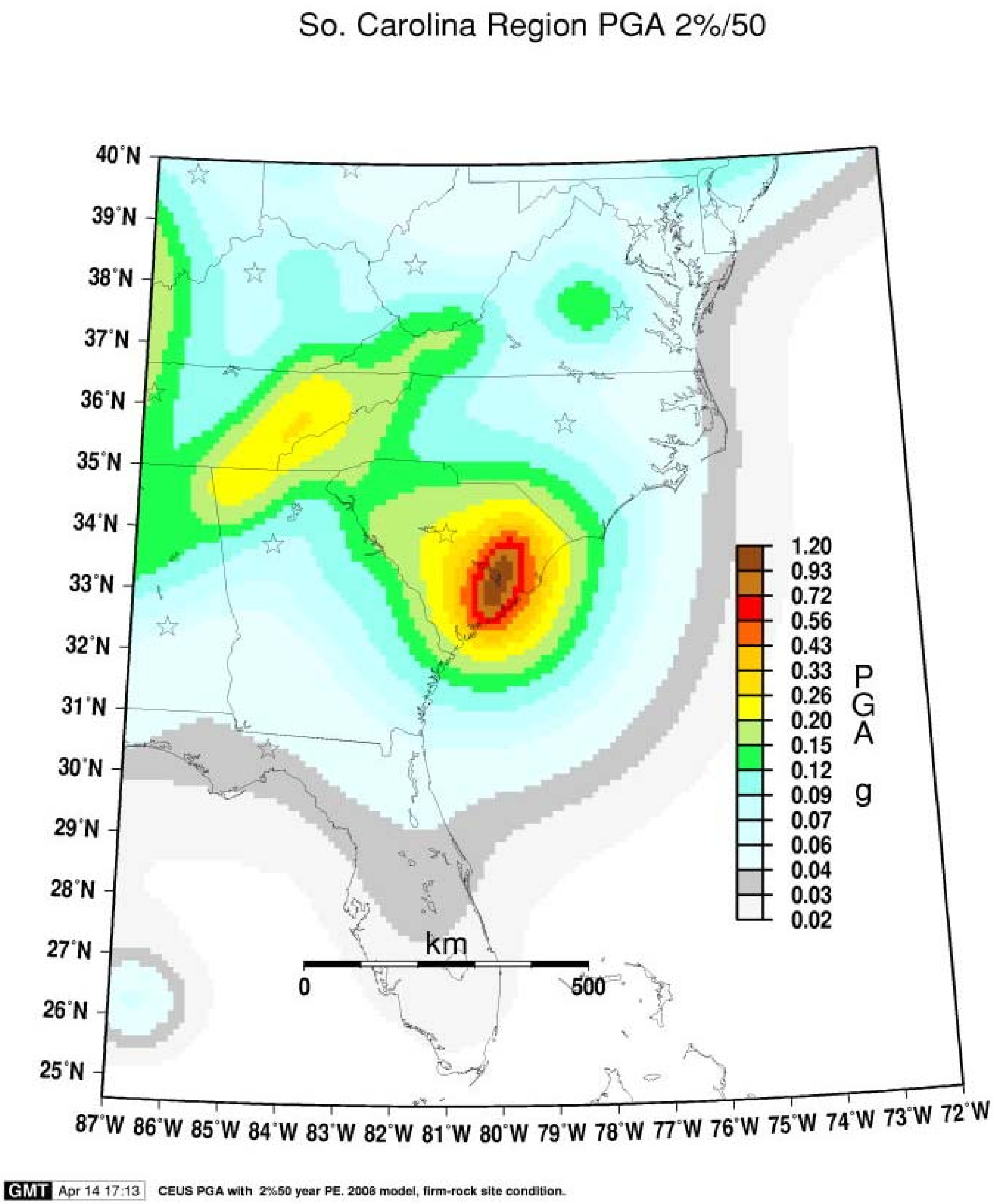
Source: Westinghouse 2019d

Figure 3.3-3 Isoseismal Map of the August 31, 1886 Charleston, SC, Earthquake

The nearest earthquake to the CFFF site occurred on April 20, 1964. The event had a magnitude of 3.5 and was located about 24 km (15 mi) southwest of Columbia, SC. The earthquake was felt in Fairfield, Florence, Lexington, and Richland counties. Vibrations were reported to last over 4 minutes. The maximum reported MM intensity was V in Gaston and Jenkinsville, where a trembling motion was felt by all residents. Intensity IV was reported in Cayce, Irmo, and Lexington accompanied by rumbling noises but no damage. Intensity I-III was reported at Columbia, Florence, and Pelion (Westinghouse 2019d).

In conclusion, the CFFF site area is in a region of relatively low seismicity in the Coastal Plain physiographic province of the southeastern U.S. The nearest significant seismic source is located about 145 km (90 mi) to the southeast in the Charleston seismic zone. The site would thus be primarily affected by seismic vibrations from large distant earthquakes such as the Charleston earthquake of 1886 (Westinghouse 2019d).

Ground motion maps prepared by the U.S. Geological Survey (USGS) indicate that the greatest earthquake hazard in South Carolina is associated with the Charleston seismic zone. Figure 3.3-4 shows the expected peak ground acceleration (PGA) calculated for South Carolina by the USGS National Seismic Hazard Mapping Project for a 2,475-yr return period (Westinghouse 2019d, USGS 2008)



(Peak Ground Acceleration [% g] with a 2% Probability of Exceedance in 50 Years. Obtained from the US Geological Survey's (USGS) 2008 seismic hazard model at http://earthquake.usgs.gov/hazards/)

Figure 3.3-4 Peak Ground Acceleration Calculated for South Carolina for a 2,475-Yr Return Period

3.4 Water Resources

The CFFF site lies within the Congaree River Basin, shown in Figure 3.4-1, encompasses 1,782 km^2 (688 mi^2) and 7 watersheds. The Congaree River Basin is mainly located within the Sandhills region of SC, but extends to the Upper Coastal Plain region near its confluence with the Catawba-Santee Basin. The watershed specific to the CFFF is the Congaree River watershed, which occupies 56,746 ha (140,217 ac) of the Sandhills and Upper Coastal Plain regions. The Congaree River is formed by the confluence of the Broad and Saluda rivers in the capitol city of Columbia. The CFFF site is located approximately 19 km (12 mi) southeast of this confluence. The CFFF discharge permit is NPDES No. SC0001848.

Land cover for the Congaree River watershed falls within the following categories:

- Urban land: 9.45 percent
- Agricultural land: 9.45
- Scrub/shrub land: 2.22
- Barren land: 0.09
- Forested land: 61.76
- Forested wetland (swamp): 16.45
- Water: 2.79

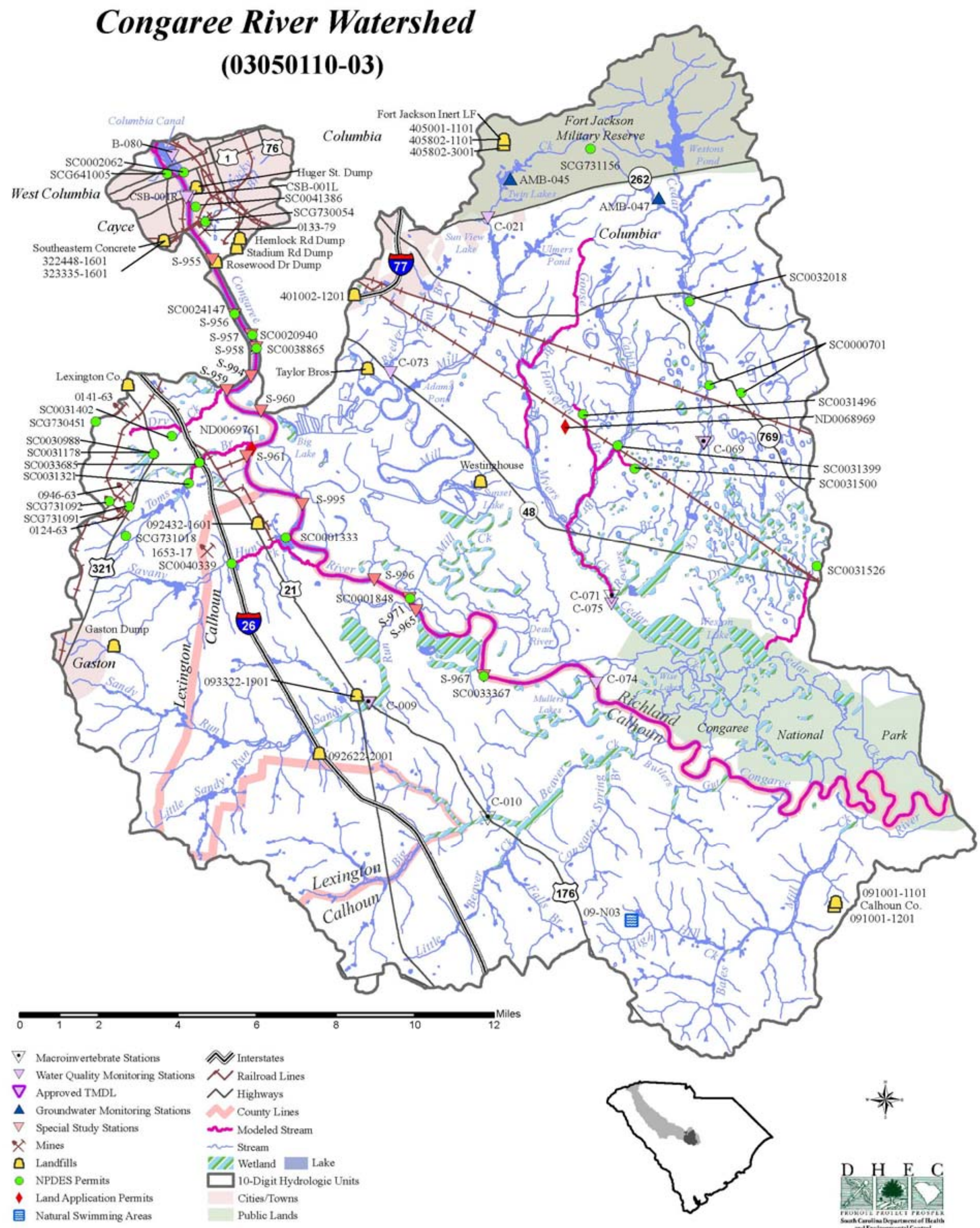


Figure 3.4-1 Congaree River and Sandy Run Watershed Map

In addition to the Congaree River, other important surface water features in the vicinity of the CFFF include Sunset Lake, which is located 0.4 km (0.25 mi) south of the CFFF's main manufacturing building (see Figure 2.1-3). The lake originally consisted of two parts, Upper Sunset Lake and Lower Sunset Lake. The two were connected by a channel passing under a causeway. The upper lake was fed by Mill Creek, a tributary of the Congaree River, flowing through the channel into the lower lake. The upper lake is now a swamp area, and the lower lake is still present as an open water area of approximately 3.24 ha (8 ac). Mill Creek continues as an outflow from Sunset Lake, meandering through the swampland, discharging into the Congaree River 4.0 km (2.5 mi) downstream from the CFFF site. Other water bodies near the CFFF site include Adams Pond, approximately 4.8 km (3 mi) to the northwest, Goose Pond, approximately 4.8 km (3 mi) to the south, and Myers Creek, which lies approximately 3.2 km (2 mi) to the east (Westinghouse 2019d).There is also a man-made pond on site, commonly referred to as the "Gator Pond" located approximately 500 feet southwest of the WWTP within a stepdown area of the bluff. The pond is fed by a spring and does not have a constructed spillway. Water discharges from the pond are through groundwater seepage or overland flow during periods of high precipitation. The Gator Pond was created by the original landowners at the edge of escarpment just north of Sunset Lake.

Both groundwater and surface water are derived from precipitation within the region. Rainfall totals for SC were below normal for the years 1999, 2000, and 2001. Near Columbia, the rainfall totals were 41 percent, 27 percent, and 39 percent below normal for the 3 years, respectively, resulting in poorly sustained base flows. In the area around Columbia, the average annual precipitation is approximately 1.2 m (48 in.) per year.

Rainfall intensity values (in inches per hour) provided by the SC Department of Transportation for Columbia are given in Table 3.4-1.

Table 3.4-1 Rainfall Intensity for the Columbia Area

Frequency (yr)	Rainfall Intensity (inches per hour)[1]		
	tc=5 min	tc=10 min	tc=15 min
2	5.44	4.82	4.32
5	6.42	5.66	5.05
10	7.12	6.25	5.57
25	8.16	7.14	6.34
50	9.03	7.86	6.96
100	9.88	8.57	7.57

[1] tc:time duration
Source: Westinghouse 2019d

3.4.1 Groundwater

Groundwater levels reflect both the climatic conditions of the region and groundwater withdrawals. The groundwater level also depends upon a combination of the permeability of the strata and the hydraulic head. The inclination of different strata may cause the water tables in the surrounding area to be higher or lower than the water level in the nearby Congaree River since movements of the groundwater are, to a large extent, independent of the river. Because of friction encountered by water in its passage through pervious strata, the water table is not always horizontal. Several water tables may exist at different levels, separated by impermeable strata.

Regional Area

Groundwater in the Upper Coastal Plain occurs in multiple aquifer systems, mostly under artesian or confined conditions. These aquifers consist of rocks of Paleozoic age and are typically composed of one to several layers of eastward thickening, permeable sands or limestone split by discontinuous, clay-rich materials. Confining units, consisting of clay-rich sediments, exist above and below the aquifers. Aquifers found below the site are the Peedee, Black Creek, and Upper Cape Fear with the Peedee aquifer being the closest to the surface. In large portions of these aquifers, sands and limestone materials are so well connected that withdrawals cause pressure reductions many miles from the pumping center.

The upper Cape Fear aquifer is present in the western portions of the Coastal Plain at elevations of 90 m to 463 m (295 ft to1,519 ft), with an average elevation of 76.2 m (250 ft). The upper Cape Fear aquifer varies in thickness from 2.4 to 203 m (8 to 665 ft) thick and averages 46 m (50 ft) thick. The aquifer is composed of very fine to coarse sands and occasional gravels. Wells typically yield 757 to 1,514 L/min [200 to 400 gpm].

The Black Creek aquifer is present in the central and southwestern portions of the Coastal Plain. Elevations range from 97 m to 368 m (317 ft to 1207 ft) and average 41 m (135 ft). The thickness of the Black Creek aquifer ranges from 5 -296 m (18 to 972 ft) thick, averaging about 53 m (175 ft) thick. The aquifer is composed of very fine to fine "salt and pepper" sands. Wells typically yield 757 to 1514 L/min (200 to 400 gpm).

The Peedee aquifer is present in the central to southeastern portion of the Coastal Plain at an average elevation of -9 m (–30 ft). Elevations vary from 35 m to -243 m (114 ft to –796 ft). The thickness of the aquifer ranges from 2.4 m to 123 m (8 to 404 ft) thick and averages about 41 m (135 ft) thick. The Peedee aquifer is composed of fine to medium sand, and wells typically yield up to 757 L/min (200 gpm).

Site Area

The average depth to the water table in the area of the CFFF site is approximately 4.6 m (15 ft). Since September 1971, the highest mean water level recorded was at 0.9 m (2.95 ft) below the land-surface datum, and the lowest level was 13.66 m (44.83 ft) below the land-surface datum.

The sediments occurring beneath the site can be divided into four hydrogeologic units: surficial aquifer, floodplain sediment aquifer, Black Mingo aquifer, and Middendorf aquifer. The uppermost hydrogeologic unit is sediments of the Okefenokee Formation (Colquhoun, 1965) referred to as the surficial aquifer at the site. According to the DNR Geologic Survey Fort Jackson South Geologic Quadrangle map, surficial aquifer sediments are Pleistocene age terrace material consisting of mixtures of alluvial clay and poorly sorted silty fine to coarse sand with subrounded granules and gravel. This Okefenokee Formation may contain remnants of preserved channel morphology and other fluvial landform scars (DNR, 2011). It is likely that there is a hydraulic connection between the Okefenokee Formation and the Congaree River floodplain sediments and/or surface water in Sunset Lakes. This potential connection will be evaluated through additional environmental sampling as part of the site's consent agreement (CA) and the results will be input into the site's Conceptual Site Model (CSM) as discussed in Section 4.4.1.

Surficial aquifer sediments generally occur to a depth of 20 to 40 feet at the plant site, depending on topography, and can be differentiated into an upper firm clayey, silty sand unit (10 to 20 feet thick) and a lower loose sand and silty sand unit (also 10 to 20 feet thick). Groundwater in the surficial aquifer occurs under unconfined (water table) conditions where the water table generally is a subdued replica of the topography. Thus, groundwater in the surficial aquifer generally flows from areas of higher topography in the vicinity of the plant building towards areas of lower topography in the floodplain of the Congaree River and its local tributary, Mill Creek.

For the purpose of discussion about existing groundwater monitoring wells within the surficial aquifer above the bluff, there are two categories of screened intervals: upper surficial aquifer and lower surficial aquifer. Lower surficial aquifer monitoring wells are screened at depths between five feet above and/or on top of the Black Mingo confining clay. All other monitoring wells within the surficial aquifer are upper surficial aquifer monitoring wells.

Based upon data collected during previous investigations, groundwater in the upper surficial aquifer can be inferred to flow toward the southwest in western areas of the site, including the vicinity of the WWTP lagoons. The upper surficial groundwater flow direction shifts toward the south with components of flow to the southeast in areas south of the plant building.

Groundwater flow in the lower surficial aquifer varies in direction from northwest to west to southwest. Groundwater within the lower surficial aquifer flows toward the southwest in areas west and south of the sanitary lagoon; similar to groundwater flow in the upper surficial aquifer. However, groundwater flow within the lower surficial aquifer diverges from flow direction of the upper surficial aquifer to a western and slightly northwestern direction in areas near and west of West II Lagoon.

Groundwater flow in the Black Mingo aquifer is inferred to be to the southwest based upon groundwater elevations from the three monitoring wells that are screened within this aquifer.

Based upon previous hydraulic characterization, the average linear flow velocity in the surficial aquifer was estimated to be 0.42 feet per day or 153 feet per year. The potential for flow between the surficial aquifer and the Black Mingo aquifer was assessed to be downward at vertical hydraulic gradients ranging between 0.04 and 0.1 feet per feet. However, low moisture content and low vertical hydraulic conductivities (less than 10^{-7} centimeters per second; Soil and Material Engineers [S&ME], 1982) throughout the 39 to 83 foot thickness of the Black Mingo confining clay preclude significant transfer of fluid between the surficial aquifer and the Black Mingo aquifer.

There is a dynamic relationship between surface water in the ditches that transect the site and groundwater in the surficial aquifer. The bottom of the northern areas of the ditches is often above the water table and thus the ditches at these locations are dry, as demonstrated during previous surface water and sediment sampling (Rust Environment and Infrastructure [Rust], 1995). Runoff from precipitation that enters the dry portions of the ditches may infiltrate to the water table, temporarily recharging the surficial aquifer. The bottom of the southern areas of the ditches is below the water table and continually receives discharge of groundwater from the surficial aquifer. Middle portions of the ditches may recharge the shallow aquifer during low water table conditions and may receive groundwater discharge during high water-table conditions.

Currently there are two monitoring wells installed within the floodplain of Congaree River; therefore additional data will be collected to better understand subsurface stratigraphy and hydrogeology in the floodplain as part of the site's CA in order to inform the CSM.

The state of South Carolina regulations R61-68, "Water Classifications and Standards".considers all groundwaters to be drinking waters.

3.4.2 Surface Water

Stream flow for the Congaree River is dependent on recharge within the Broad River and Saluda River basins. Regulation of stream flow at the Parr Shoals Dam on the Broad River and the Lake Murray Dam (also called the Saluda Dam) on the Saluda River confines the watersheds in these basins that are relevant to stage levels for the Congaree River near the CFFF site. The Broad River represents 70 percent of the Congaree River watershed while the Saluda River represents 30 percent.

The Broad River Basin encompasses 21 watersheds and 5,833 km^2 (2,252 mi^2) within SC. The watershed that has the most influence on stage levels for the Congaree River near the CFFF site is the Broad River watershed. The Broad River watershed is located in Richland, Newberry, and Fairfield counties and consists primarily of the Broad River and its tributaries from the Parr Shoals Dam to its confluence with the Saluda River. The watershed occupies 65,125 ha (160,922 ac) of the Piedmont region of SC.

The Saluda River Basin covers 6,524 km^2 (2,519 mi^2) and contains 21 watersheds with geographic regions that extend from the Blue Ridge Province to the Piedmont Province. The watershed that has the most influence on stage levels for the Congaree River is the Saluda River watershed. The Saluda River watershed is located in Lexington and Richland counties and consists primarily of the Saluda River and its tributaries from the Lake Murray Dam to its confluence with the Broad River. The watershed occupies 26,521 ha (65,535 ac) of the Piedmont and Sandhill regions of SC.

Surface runoff at the CFFF site flows into Mill Creek and ultimately into the Congaree River.

For stream gauging stations, rating tables giving the discharge for any stage are prepared from stage-discharge relation curves. The accuracy of stream flow data depends primarily on (1) the stability of the stage-discharge relation or, if the control is unstable, the frequency of discharge measurements and (2) the accuracy of observations of stage, measurements of discharge, and interpretations of records.

The gauging station at Columbia (station number 02168500) is located 2.25 km (1.4 mi) downstream of the confluence of the Saluda and Broad rivers. This gauging station has a drainage area of 20,231 km^2 (7,850 mi^2) and has systematic stream flow records from 1892 to present. Table 3.4-2 gives recent data for the Congaree River from the Columbia gauging station. *(Note: SC experienced a severe, multi-year drought from June 1998 to August 2002. Thus, the average stream flows for these years are lower than normally expected.)* Table 3.4-3 lists significant floods that have affected the area of central SC.

Table 3.4-2 Stream Flow Rates for the Congaree River

Year	Average Discharge (cfs)	Average Stage (ft)
1998	5,423.52	4.01
1999	4,736.25	3.71
2000	4,520.83	3.63
2001	3,473.28	3.87
2002	4,805.91	5.82
2003	12,342.65	6.32
2004	6,990.93	4.53
2005	8,317.56	5.27
2006	5,031.82	3.84
2007	4,613.48	3.47
2008	2,875.79	3.01
2009	7,921.48	4.52
2010	6,713.39	4.25
2011	3,383.17	3.25
2012	3,414.64	3.31
2013	10,310.24	5.56
2014	7,089.87	4.54
2015	10,363.14	5.33
2016	6,047.14	4.17
2017	5,029.71	4.06

Source: Westinghouse, 2012a 2019d

Table 3.4-3 Significant Flood Events

Date	Area Affected	Recurrence Interval (yr)	Remarks
August 1908	Statewide	2 to >50	Most extensive flood in state; rainfall of 12 in. in 24 hr
August 1928	Statewide	2 to >50	Bridges destroyed, roads and railways impassable
August 1940	Statewide	2 to >100	About 34 deaths and $10 million in damage
September 1945	Statewide	2 to >100	One death and $6-7 million in damages
September 1959	Eastern, southern and central SC	10 to 20	Hurricane Gracie; 6 to 8 in. of rainfall; seven deaths and $20 million in damages
October 1990	Central SC	Unknown	Tropical storms Klaus and Marco; five deaths and 80 bridge failures
October 2015	Coastal and central South Carolina	500 to 1000	Heavy rainfall occurred as a result of an upper atmospheric low-pressure system that funneled tropical moisture from Hurricane Joaquin; 17 fatalities, 410 roads or bridges closed, $300 million in damages.

Source: Westinghouse 2019d

The CFFF site lies within the flood basin of the Congaree River. High water on the Congaree River usually occurs in late winter and early spring, but flooding is possible any time of the year. Flooding occurs as the water level in the river rises above the flood stage and creeks and gullies begin to flow backward into the floodplain. Flood stage for the Congaree River at the Carolina Eastman gauging station, located in close proximity to the CFFF, is 35 m (115.0 ft) (above MSL). The CFFF site elevation ranges from 34 to 35 m (112 - 115 ft) (above MSL) on the southwest portion of the site, around Mill Creek and Sunset Lake, to 41 to 44 m (136 - 144 ft) (above MSL) on the northeast portion of the site, around the main manufacturing building. The main manufacturing building's floor sits at 43 m (142 ft) (above MSL). Impacts of flooding at the Carolina Eastman gauging station have been documented for the following water levels (see Table 3.4-4):

Table 3.4-4 Flood Potential of Various Water Levels

Water Level	Flood Potential
35.0 m (115 ft)	Low lying and flood prone areas become flooded. The Congaree National Park begins to flood.
36.7 m (119 ft)	Extensive flooding occurs in the Congaree National Park. Farmland downstream from Columbia becomes flooded.
37.4 m (123 ft)	Lowlands and swampland around the Carolina Eastman Chemical Plant become flooded.
37.8 m (124 ft)	Farmland along the Congaree River from Columbia to St. Matthews becomes flooded. Extensive flooding occurs on the Carolina Eastman facility.
38.1 m (125 ft)	Extensive flooding occurs downstream from the Carolina Eastman Chemical Plant.
38.4 m (126 ft)	Extensive swampland around St. Matthews becomes flooded.

Source: Westinghouse 2019d

Table 3.4-5 shows the crest history that has been documented for the Congaree River at the Carolina-Eastman gauging station.

Table 3.4-5 Recorded Crest History for the Congaree River

Date	Water Level (ft above MSL)
12/18/1972	124.00
04/03/1973	125.40
03/16/1975	126.00
10/12/1976	126.95
01/28/1978	124.20
02/27/1979	126.90
02/06/1998	124.40
05/25/2003	124.00
09/11/2004	124.60
03/04/2007	124.00
10/04/2015	123.30

Source: Westinghouse 2019d

Estimates of flood discharge range from 269,000 to 319,000 cfs. The base flood discharge is 269,000 cfs when applying a historical adjustment to the 1908, 1928, and 1930 floods and 280,000 cfs when only the 1908 flood is adjusted for historical information. Using the entire record, station skew and adjusting the 1908 flood for historical information results in a base flood discharge of 319,000 cfs.

One of the major issues in the determination of base flood discharge for the Congaree River is the degree of regulation afforded by Lake Murray. Peak flows from 1892 to 1929 are unregulated and those from 1930 to present have some unknown degree of regulation. Theoretically, the upper and lower bounds of the base flood discharge along the Congaree River would vary with the degree of regulation. The lower bound corresponds to the condition where Lake Murray prevents upstream floodwater from entering the Congaree River, and the upper bound indicates when Lake Murray does not attenuate any of the floodwater entering the Congaree River. However, water in Lake Murray is used for hydropower generation, and there is no dedicated flood storage. Operation of Lake Murray changed in about 1956. The median lake level ranged from 101 to 107 m (333 to 351) ft between 1931 and 1955 and from 107 to 109 m (350 to 358 ft) between 1956 and 1999. The higher reservoir levels after 1955 suggest that Lake Murray has a lower potential for attenuating flood discharges. Alternative independent analyses using gauging-station data upstream and downstream of the dam indicate that the Saluda River base-flood discharge could be reduced by as much as 50 percent by Lake Murray. Since the Saluda River represents 30 percent of the Congaree River watershed, the degree of regulation of the base-flood discharge for the Congaree River has been estimated as approximately 15 percent.

3.4.3 Water Quality

Investigative activities between 1980 and 2018 at the Westinghouse site have detected groundwater contaminated with nitrate, fluoride, gross alpha/uranium and gross beta/technetium-99 (Tc-99) and volatile organics from spills, leaks, and unknown sources. The facility was in a groundwater remediation phase from 1998-2011 for volatile organic compounds (VOCs). Surface waters affected by the groundwater contamination are Sunset Lake and the unnamed tributaries and wetlands draining into Mill Creek. In late 2015, SCDHEC indicated to CFFF that sites managed under the Bureau of Land and Waste Management (a division of SCDHEC) were going to be required to enter in to a VCC. CFFF entered into VCC-16-4948-RP with SCDHEC on August 23, 2016 and managed VOC contamination through the VCC until it was replaced with the CA in 2019. See Section 4.4 for additional details.

The information given in this section below was taken from a study of ground water and surface water quality conducted by SCDHEC (SCDHEC 2019). Water quality is characterized by measuring concentration and mass transport of a wide range of dissolved and suspended constituents, including nutrients, major bios, dissolved and sediment-bound heavy metals, common pesticides, and inorganic and organic forms of carbon. Water quality problems include fecal coliform bacteria contamination, low dissolved oxygen concentrations, high suspended-solid levels, and elevated nutrient levels. Runoff from urban areas can transport trace elements and synthetic organic compounds that can seriously affect the quality of water and wildlife habitats in the receiving streams. Enrichment by nitrogen and phosphorus causes algae in lakes and rivers to increase dramatically, which reduces the concentrations of dissolved oxygen and adversely affects fish and other aquatic biota. Pesticides and nutrients can contaminate both surface and groundwater. Sedimentation impairs municipal, industrial, and recreational water use; destroys aquatic habitat; and adversely impacts desired aquatic organisms. Sediment erosion due to past and present land use increases turbidity, which in turn increases the cost of treatment for public consumption and industrial use, deposits silt in reservoirs, covers fish spawning beds, and causes aesthetic problems. Examples of nonpoint sources of pollution include agricultural runoff, urban runoff, construction, mining, and silviculture.

There are fifteen SCDHEC monitoring stations along this section of the Congaree River. At special study sites *S-956, S-957, S-958, S-959, S-960, S-961*, S-965, and S-967 the aquatic life use data is limited to copper data. Based on that data, all the above sites except S-967 meet the criteria for copper and support the standards. Special study site *S-967* does not meet those copper standards. Only fecal coliform was sampled at special study sites *CSB-001R, CSB-001L, S-955, S-994, S-995,* and *S-996.* At CSB-001R and CSB-001L (stationed along the right and left banks of the headwaters of the Congaree River), recreational uses are partially supported due to fecal coliform bacteria excursions; however, significant decreasing trends in fecal coliform bacteria concentration suggest improving conditions for this parameter. All the remaining downstream special study sites fully support recreational uses. At the farthest downstream site *(C-074)*, aquatic life uses are fully supported; however, there is a significant increasing trend in five-day biochemical oxygen demand and a decreasing trend in dissolved oxygen concentration. Recreational uses are partially supported at this site due to fecal coliform bacteria excursions.

Mill Creek is a blackwater system, characterized by naturally low pH conditions. Although pH excursions occurred, they were typical of values seen in blackwater systems and were considered natural, not standards violations. Significant decreasing trends in total phosphorus concentration and increasing trends in dissolved oxygen concentration suggest improving conditions for these parameters. Recreational uses are partially supported due to fecal coliform bacteria excursions; however, a significant decreasing trend in fecal coliform bacteria concentration suggests improving conditions for this parameter.

3.4.4 Water Use

More than 95 percent of the water needs in SC are supplied by surface waters. The SC Water Resources Commission reported a state water use of 206 mgd (million gal per day) of ground water and 5,570 mgd of surface water in 1980. The total gross water withdrawal of 5,780 mgd represented a 96 percent increase from the previous decade. About 7.6 percent of this water was consumed and not returned to available supplies. Gross water use is projected to increase by 48 percent to 8,550 mgd by the year 2020, with 484 mgd projected to correspond to groundwater and 8,060 mgd to surface water.

Major industrial water users in the Congaree watershed include DAK Americas, Nephron Pharmaceuticals, Devro, and CFFF.

The major public uses correspond to water supplies, recreation, and waste disposal. Major municipal water users in the Congaree watershed include the City of Columbia Metro Plant, the City of Cayce Main Plant, and the East Richland County Public Service District Gills Creek Plant (Westinghouse 2019d).

3.5 Ecological Resources

This section describes the Ecological resources in the vicinity of CFFF, which include terrestrial (Section 3.5.1), aquatic (Section 3.5.2) and threatened and endangered species (Section 3.5.3). A list of flora and fauna observed on and near the CFFF observed during a 1974 site survey is found in Appendix C, Table C-1 (Westinghouse 1975).

3.5.1 Terrestrial

The Richland County area is located within the Southeastern Mixed Forest ecoregion, dominated by oak-hickory forests with the understory communities consisting of small tree species such as *dogwood (Cornus* spp.*),* red bud (*Cercis canandensis*), cedar (*Juniperus* spp.), and American holly *(Ilex opaca).* Common shrub species found within the understory include common poison ivy (*Toxicodendron radicans*) (Westinghouse 1975).

The undeveloped portions of the CFFF property are composed of open field dominated by grasses, forbs, and succesional hardwood forests. Climax woodland areas are located along Mill Creek and east of the property boundary.

Located approximately 8 km (5 mi) southeast of CFFF is the Congaree National Park. Initially designated as the Congaree Swamp National Monument in 1976, the U.S. National Park Service designated the 9,000-ha (22,200-ac) area as a national park in 2003. The park is widely acknowledged to be one of the best examples of Southern bottomland hardwood ecosystem remaining in the world. Its wetlands provide a habitat for a diverse population of flora and fauna. The park is designated as an International Biosphere, a Globally Important Bird Area, and a National Natural Landmark (Westinghouse 2004). According to the National Park Service (2006), there are approximately 294 species known or likely to occur within the park, including more than 34 mammal species, 32 reptile species, 29 amphibian species, 109 invertebrate species, and approximately 90 bird species. The Congaree National Park contains approximately 90 tree species with many holding state record sizes.

3.5.2 Aquatic

There are approximately 40 species of fish that are known or likely to live within the Congaree River System. The southern portion of CFFF lies within the flood plain of Mill Creek, a tributary to the Congaree River. Fish common to the area include largemouth bass, bluegill, catfish, and shiners.

3.5.3 Threatened and Endangered Species

Four federal-listed plant species have the potential to be found within Richland County: the endangered Smooth cornflower (*Echinacea laevigata),* the endangered Roughleaved Loosestrife (*Lysimachia asperulifolia*), the endangered Canby's Dropwort (*Oxypolis canbyi*), and the endangered Michaux's Sumac (*Rhus muchauxii*). In addition, two federal-listed animal species have the potential to be found within Richland County, the endangered Shortnose Sturgeon (*Acipenser brevirostrum*) and the endangered Red-cockaded Woodpecker (*Picoides borealis*). A listing of State and Federal rare, threatened, and endangered species found in Richland County is included in Appendix C, Table C-12 (SC-DNR, 2019).

3.6 Meteorology, Climatology, and Air Quality

This section describes the regional climatology (Section 3.6.1), site meteorological conditions (Section 3.6.2) and baseline air quality conditions (Section 3.6.3). The regional climatology and the local time-varying meteorological conditions determine the atmospheric transport and diffusion processes at and near the site.

3.6.1 Climatology

The climatology of the Richland County area was characterized based on data collected by the National Weather Service (NWS) station at the Columbia Metropolitan Airport, located about 19 km (12 miles) west-northwest of the site. Richland County experiences four distinct seasons due to its mid-latitude location area and resulting solar radiation effects. The weather in the region provides a temperate climate, with high relative humidity, moderate rainfall, moderate winds, and normal diurnal temperature changes. Temperatures are moderate throughout the year, averaging in the 18^{o} C (65^{o} F). Winters are mild, with cold waves rarely accompanied by temperatures of -18°C (0°F) or below. Freezing temperatures (0°C [32°F]) or less occur on an average of 77 days per year, generally during the months of November through March. Rainfall is moderate throughout the year as are winds. Storms bring severe weather in the form of lightning, hail, and tornadoes.

An overall summary of the climatology data for Richland County is presented in Table 3.6-1 (SC-DNR 2019b). Temperature, precipitation, relative humidity, wind, and the frequency of certain climatology events are reported. Details are discussed below.

Table 3.6-1 Richland County Climatology Summary

30 Year Climate Normals	**1981-2010**		USC Columbia	
Annual Average Maximum Temperature		78.0 ºF		
Annual Average Mean Temperature		66.7 ºF		
Annual Average Minimum Temperature		55.5 ºF		
Temperature	**1954-2016**			
Highest Maximum	June 29, 2012	113ºF		
Lowest Minimum	January 16, 1994	-5 ºF		
Precipitation	**1954-2016**			
Annual Average Rainfall		47.75 in	USC Columbia	
Highest Daily Rainfall	October 4,2015	8.35 in	Columbia Owens Airport	
Wettest Year	1959	74.49 in	USC Columbia	
Driest Year	1933	27.14 in	Columbia	
Highest Daily Snowfall	1973	12.50 in	USC Columbia	
Severe Weather Events		**Events**	**Injuries**	**Deaths**
Tornados	1950-2016	31	20	1
Thunderstorm Winds[1]	1955-2016	427	--	--
Hail[2]	1955-2016	109	--	--
Flood	1993-2016	137	--	--
Snow and Ice	1993-2016	13	--	--

1 Thunderstorm winds exceeding 50 knots (58 mph)
2 Hail diameter = 1 in. or greate
Source: SC-DNR 2019b

3.6.1.1 Winds

The Appalachian Mountains have an influence on wind in the Columbia area, which changes seasonally. Winds are predominantly from the southwest, but are also prevalent from the northeast in autumn and to a lesser extent in the winter. Wind speeds for all months generally range between 9.6 and 16 km/hr (6 and 10 mi per hr [mph]), averaging 11 km/hr (7 mph). Directions change with the season as listed below:

- Spring: Southwest
- Summer: South and Southwest
- Autumn: Northeast
- Winter: Northeast and Southwest

The NCDC database for wind events exceeding 50 kts for Richland County identifies 267 total events between January 1, 1950, and December 31, 2018 (NCDC 2019). During that time one death and six injuries were recorded. Only 11 of the recorded high wind events had wind gusts greater than 70 kts; the highest recorded wind gusts were 103 kts.

3.6.1.2 Precipitation

Precipitation occurs in the Richland County area in the form of rain, snow, and sleet with occasional instances of hail. Normal monthly precipitation ranges from a low of 7.3 cm (2.88 in.) in November to a high of 14.1 cm (5.54 in) in July. Normal annual precipitation is 123 cm (48.27) in. Table 3.6-2 shows the normal precipitation for each month based on data recorded between 1971 and 2000 at the Columbia Metropolitan Airport.

Probable maximum 5-th percentile precipitation is 157 cm (61.69 in.) annually. On a monthly basis, the greatest probable maximum expected quantity of rain is 44.3 cm (17.46 in.) occurring in the month of July. Table 3.6-3 shows probable maximum precipitation for each month.

Table 3.6-2 Normal Precipitation Amounts by Month for Richland County

Normal Precipitation (cm [in.])												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
11.8	9.75	11.7	7.37	8.05	12.7	14.1	13.7	10.0	7.34	7.31	8.59	122.6
(4.66)	(3.84)	(4.59)	(2.90)	(3.17)	(4.99)	(5.54)	(5.41)	(3.94)	(2.89)	(2.88)	(3.38)	(48.3)

Source: Westinghouse 2019d

Table 3.6-3 Maximum Precipitation Amounts by Month for Richland County

Maximum Precipitation (5-th percentile, cm [in.])											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
23.5	20.6	27.7	17.4	20.0	37.6	44.4	30.0	20.0	29.6	15.9	21.7
(9.26)	(8.10)	(10.9)	(6.85)	(7.88)	(14.8)	(17.5)	(11.8)	(7.86)	(11.7)	(6.26)	(8.54)

Source: Westinghouse 2019d

Although rain dominates the precipitation type and amount, Richland County does experience winter precipitation in the form of snow, sleet and freezing rain during the months between November and March, and there have been rare instances of snow in April. Measurable snowfall occurs one to three times during the winter, but seldom do accumulations remain on the ground very long. The average annual snowfall for Richland County totals 3 cm (1.2 in.). The maximum 24-hr snowfall recorded for the county between the years 1948 and 2002 was 41 cm (16 in.), occurring on February 9 and 10, 1973. Over all of South Carolina, the record total snowfall for any month was 86 cm (34 in.), recorded in Pickens County. Table 3.6-4 shows state snowfall statistics on a monthly basis.

Table 3.6-4 Number of Snowfall Days for South Carolina (by Month)

Number of Days with Snowfall Exceeding Threshold													
Threshold	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
> 0.25 cm (0.1 in.)	4.4	4.8	2.4	0.4	0	0	0	0	0	0	1.8	3.3	17.1
> 2.54 cm (1.0 in)	2.1	2.0	1.0	0.2	0	0	0	0	0	0	0.7	1.4	7.4

Source: Westinghouse 2019d

Flood of 2015

A historic flooding event occurred in October 2015. Columbia received 8.19 inches of rain in a 12 hour period, and a total of 12.4 inches over 4 days. 11.5 inches corresponds to a 500 year recurrence for the Columbia area. 13.3 inches corresponds to a 1000 year recurrence. The Congaree River crested at 123.3 feet (above MSL) in the vicinity of the CFFF. CFFF experienced flooding of low lying areas. The main manufacturing building was not impacted by flood waters. CFFF was closed for 3 days because of loss of city water supply and roads to the plant being closed. There were no safety issues at the plant because of the flooding (Westinghouse 2019d).

As a result of the flood, two process lagoons overfilled beyond containment during the early morning of 10/3/15. The Sanitary lagoon overflowed out of the chlorine contact chamber and flowed into the adjacent North and South lagoons. The West 2 lagoon was measured at approximately 15" beyond the liner onto the surrounding ground, but remained within the berm. An emergency discharge to the river was initiated on 10/3/15, per procedure which allowed the levels to be decreased at a faster rate. In-process sampling for Fluoride, Ammonia, pH, Total Suspended Solids (TSS), and activity was conducted during the flood period for the following lagoons: North, South, West 1, West 2 and Weir Box. Only one elevated reading for TSS was recorded on October 4th from the Round Tank Weir Box. Activity samples that were taken yielded less than detectable in some areas and the remaining resulted in maximum measurements of 10-07 and 10-08 µCi/ml, values consistent with background activity levels. There is no long term impact associated with the flooding that occurred in October 2015 (Westinghouse 2019d).

There are two dams on the rivers feeding the Congaree River, upstream of the CFFF. These dams are (1) the Lake Murray Dam on the Saluda River, confining the 50,000-acre Lake Murray, and (2) the Parr Shoals Dam on the Broad River, confining the 4,400-acre Parr Reservoir. Based on an evaluation by SCE&G, total failure of the Lake Murray Dam could result in a peak flood level of about 154 ft (above MSL) at the CFFF site; overtopping failure of the dam could result in a peak flood level of 169 ft (above MSL). Failure of the Lake Murray Dam would result in substantial flooding of the Columbia area and of the CFFF site. Figure 4.4 shows the areas that could be flooded should the Lake Murray Dam fail. Because of the vulnerability of the Lake Murray Dam (which is an earthen dam) to earthquake-induced failure, SCE&G has built a secondary containment dam. The secondary containment dam is designed to withstand an earthquake the size of the Charleston earthquake of 1886 which measured a maximum Moment Magnitude (Mw) of 7.56. Therefore, it is highly unlikely that the Lake Murray Dam system will fail, resulting in flooding of the CFFF (Westinghouse 2019d).

The SCE&G study revealed that failure of the Parr Shoals Dam would result in a peak flood level of 129 ft (above MSL) at the CFFF site. Failure of the Parr Shoals Dam could impact the low-lying, undeveloped areas of the CFFF site, but would not have any impact on the main manufacturing facilities (Westinghouse 2019d).

The SCE&G study did not evaluate simultaneous failure of both the Lake Murray Dam and the Parr Shoals Dam. Failure of the Lake Murray Dam by itself or simultaneous failure of both dams would result in complete flooding of the CFFF site, with the floor of the main manufacturing building under at least 12 ft of water. A flood this size would potentially result in release of uranium to the environment, and possibly a nuclear criticality accident. Failure of the Lake Murray Dam requires widespread evacuation in Richland County (Westinghouse 2019d). It is highly unlikely that a simultaneous failure of both the Lake Murray Dam and the Parr Shoals Dam would occur resulting in flooding of the CFFF and surrounding community.

3.6.1.3 Severe Weather

Severe weather occurs in SC occasionally in the form of violent thunderstorms, common in the summer months. The summer weather is dominated by a maritime tropical air mass known as the Bermuda high that brings warm moist air inland from the ocean. As the air comes inland, it rises, forming thunderstorms that bring precipitation, high winds, hail, and lightning. Tornadoes have occurred in the area, but are relatively rare. Although hurricanes are common in the Atlantic Ocean and coastal regions of the state, it is rare for a hurricane to maintain hurricane-force winds inland.

<u>Thunderstorms</u>

Thunderstorms occur an average of 53 days per year, 60 percent of those occurring in the summer months of June, July, and August. Damaging hail is infrequent, and thus is not a significant damaging factor. The NCDC database for hail of at least 1 in. in diameter identifies 112 events between January 1, 1950, and December 31, 2018 (NCDC 2019). No injuries or deaths were shown to have resulted from hail. Lightning events during thunderstorms have resulted in three injuries and no deaths during the period measured between 1994 and 2006. Damaging lightning events consisted of fifteen recorded occurrences between January 1, 1950, and December 31, 2018. Thunderstorms with high winds can also result in damage. Thunderstorms with high wind events consisted of 310 recorded occurrences between January 1, 1950, and December 31, 2015 resulting in two deaths and seven injuries. Only 9 of the recorded high wind events had wind gusts greater than 70 kts; the highest recorded wind gusts were 103 kts.

Tornadoes

Tornadoes averaged 1.8 per year in SC during the 68-year period from 1950 to 2018 (NCDC 2019). They occur between February and September, peaking during May and August. The NCDC database for tornadoes in the Richland County area showed that a total of 36 have been recorded between January 1, 1950, and December 31, 2018 resulting in 20 injuries and one death. Tornadoes with a rating on the Fujita Tornado Damage Scale between F2 and F5 are considered "strong violent" (Lott, et al., 2000). An increase in the Fujita Tornado Damage Scale number represents an increase in tornado severity. Of the 36 recorded tornadoes, 14 had a rating of F0 (40-72 mph winds), 11 were F1 (73-112 mph), and 7 were F2 (113-157 mph). In addition, 2 of the tornadoes were classified as EF0 (65-85 mph) and 2 as EF1 (86-110 mph), as rated by the Enhanced Fujita (EF) scale.

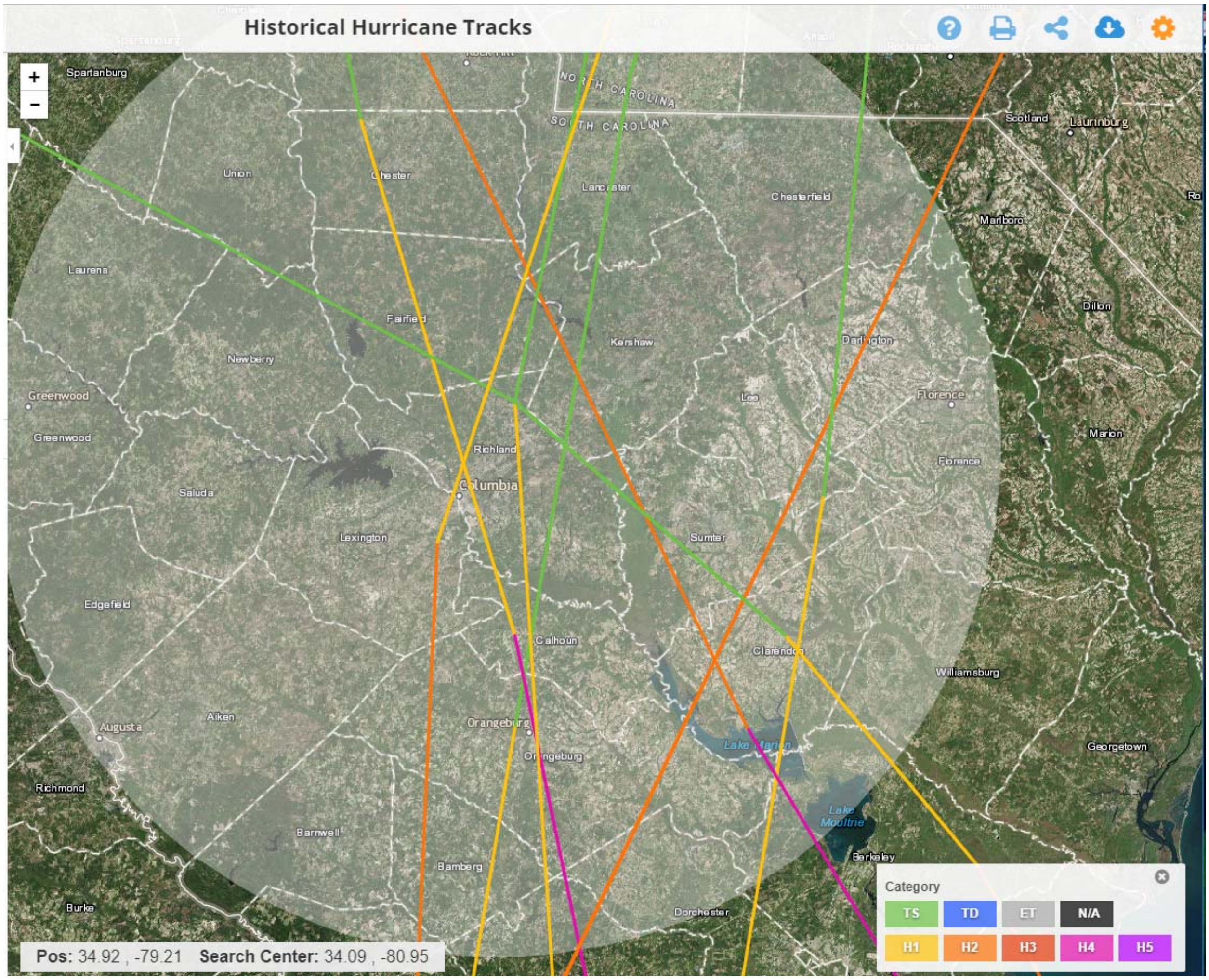
Hurricanes

Hurricanes impact the state of South Carolina at a rate of approximately one every 2 years. Most affect only the coastal areas. Those that do come inland decrease in intensity by the time they reach the Columbia area, becoming tropical storms. In the period, 1851-2016, only 38 tropical cyclones have made landfall on the South Carolina coast (24 hurricanes, 9 tropical/sub-tropical storms, 5 tropical depressions). Of these, ten were of Category 2 to Category 4 intensity. Since 1900, no Category 5 hurricanes have hit South Carolina. There have been three Category 4 hurricanes (Hazel, 1954, Gracie, 1959, and Hugo, 1989). From 1990 to 2016, South Carolina has only had five weak tropical cyclone landfalls along the coast: Tropical Storm Kyle (35 kts) in 2002, Hurricane Gaston (65 kts) and Hurricane Charley (70 kts) in 2004, Tropical Storm Ana (40 kts) in 2015, and Tropical Depression Bonnie (30 kts) in 2016. During September 1999 Hurricane Floyd, a very large storm, came very close to the South Carolina coast, then made landfall near Cape Fear, North Carolina. Hurricane Floyd triggered mandatory coastal evacuations along the South Carolina coast. Heavy rain of more than 15 inches fell in parts of Horry County, S.C., causing major flooding along the Waccamaw River in and around the city of Conway for a month (SC-DNR 2019c). Maps showing hurricane paths for central South Carolina show that three tropical storms and a two category 1 hurricanes have passed through Richland County since 1930 (see Figure 3.6-1).

3.6.2 Meteorology and Atmospheric Dispersion

Annual and seasonal summaries of the joint frequency distribution for wind speed, wind direction and atmosphere stability were obtained from onsite meteorological data (August 1, 1972, through July 31, 1973) (Westinghouse 1975, Westinghouse 1983). The data indicate that stable conditions exist 47 percent of the time, neutral conditions occur about 43 percent of the time, and unstable atmospheric conditions prevail about 10 percent of the time. The seasonal distribution of the various stability classes indicates that the greatest number of hours of unstable conditions (310 hr) and slightly stable conditions (412 hr) occurs in the spring; in winter, the most hours (1047) of neutral conditions occur; and, in summer, the most hours (984) of stable conditions occur.

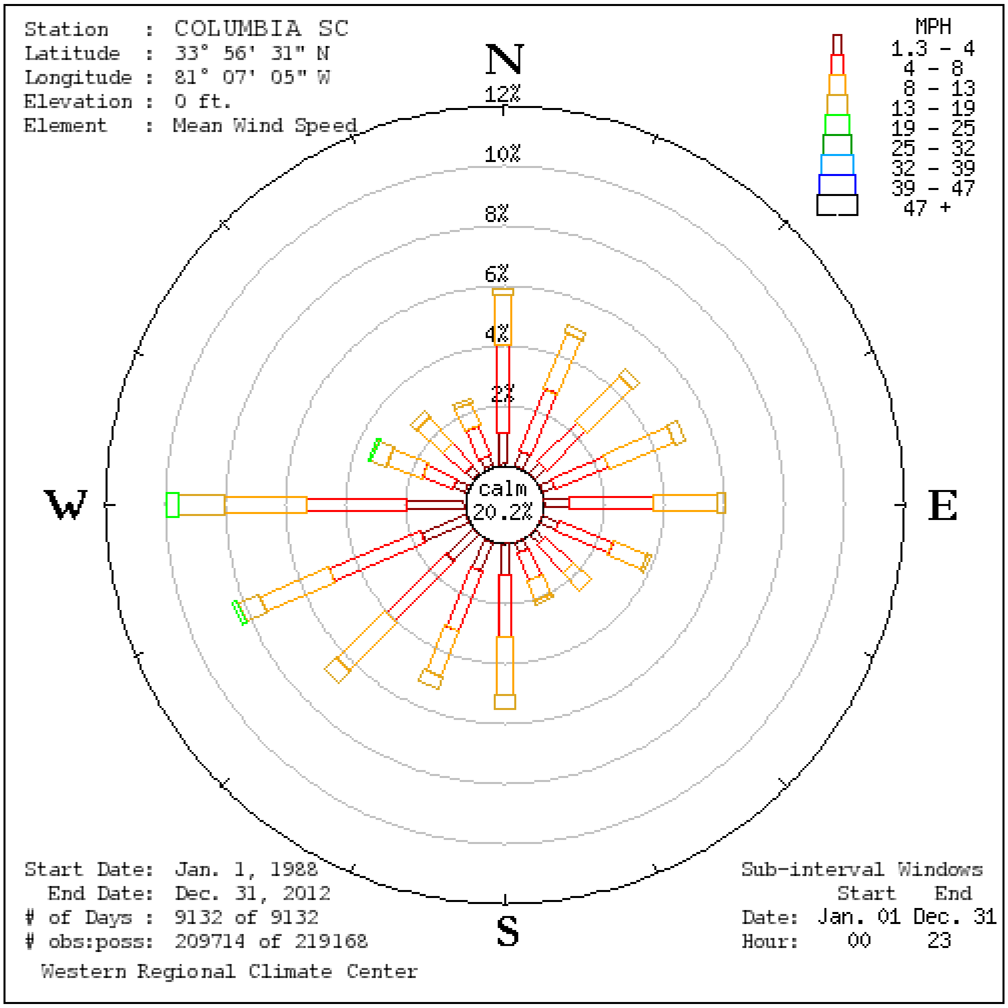
A wind rose for the Columbia Metropolitan Airport for the period 1988 through 1992 is presented in Figure 3.6-2. A previous comparison of the annual wind rose for the site (August 1, 1972, to July 31, 1973), and the wind rose for the Columbia Metropolitan Airport (1948-1981) showed they were in reasonably good agreement. Estimates of atmospheric dispersion factors (X/Q) on an annual basis at downwind distances up to 80 km (50 miles) in 16 compass directions at the 15-m (50-ft) level are provided in Table 3.6-5. These factors were calculated using the Gaussian plume model and diffusion coefficients for Pasquill-type turbulence. Because the CFFF effluent discharge points are generally lower than 2.5 times the height of adjacent solid structures, the discharge was conservatively assumed to occur at ground level, with credit for building wake effects. Using these assumptions, the annual average *X*/Q at the nearest residence (1000 m [3300 ft] northeast) is 7.67×10^{-6} s/m^3 and, at the nearest site boundary (550 m [1800 ft] north-northwest), is 1.54×10^{-5} s/m^3. (Westinghouse 1975, NUREG-1118)



Source: NCDC 2019

Figure 3.6-1 Map of Hurricane Paths for Central South Carolina

COLUMBIA SC



Source: NCDC 2019

Figure 3.6-2 Annual Wind Rose for Columbia, SC (1988 to 2012)

Table 3.6-5 Annual Average Atmospheric Dispersion Factors (χ/Q) by Distance and Direction from CFFF

Direction	χ/Q (s/m^3) at the Indicated Downwind Distance (km [mi])					
	0.8 (0.5)	1.6 (1.0)	3.2 (2.0)	4.8 (3.0)	6.4 (4.0)	8.0 (5.0)
N	$6.93x10^{-6}$	$2.12x10^{-6}$	$7.04x10^{-7}$	$3.80x10^{-7}$	$2.47x10^{-7}$	$1.78x10^{-7}$
NNE	$7.49x10^{-6}$	$2.28x10^{-6}$	$7.59x10^{-7}$	$4.10x10^{-7}$	$2.67x10^{-7}$	$1.93x10^{-7}$
NE	$1.13x10^{-5}$	$3.45x10^{-6}$	$1.15x10^{-6}$	$6.26x10^{-7}$	$4.09x10^{-7}$	$2.96x10^{-7}$
ENE	$8.81x10^{-6}$	$2.70x10^{-6}$	$9.01x10^{-7}$	$4.89x10^{-7}$	$3.19x10^{-7}$	$2.31x10^{-7}$
E	$1.23x10^{-5}$	$3.79x10^{-6}$	$1.27x10^{-6}$	$6.92x10^{-7}$	$4.52x10^{-7}$	$3.27x10^{-7}$
ESE	$9.62x10^{-6}$	$2.95x10^{-6}$	$9.88x10^{-7}$	$5.36x10^{-7}$	$3.50x10^{-7}$	$2.53x10^{-7}$
SE	$7.25x10^{-6}$	$2.23x10^{-6}$	$7.45x10^{-7}$	$4.04x10^{-7}$	$2.63x10^{-7}$	$1.90x10^{-7}$
SSE	$6.41x10^{-6}$	$1.97x10^{-6}$	$6.61x10^{-7}$	$3.59x10^{-7}$	$2.34x10^{-7}$	$1.69x10^{-7}$
S	$5.84x10^{-6}$	$1.79x10^{-6}$	$6.02x10^{-7}$	$3.27x10^{-7}$	$2.14x10^{-7}$	$1.55x10^{-7}$
SSW	$7.50x10^{-6}$	$2.30x10^{-6}$	$7.71x10^{-7}$	$4.18x10^{-7}$	$2.73x10^{-7}$	$1.97x10^{-7}$
SW	$1.04x10^{-5}$	$3.20x10^{-6}$	$1.07x10^{-6}$	$5.83x10^{-7}$	$3.81x10^{-7}$	$2.75x10^{-7}$
WSW	$1.10x10^{-5}$	$3.37x10^{-6}$	$1.14x10^{-6}$	$4.19x10^{-7}$	$4.06x10^{-7}$	$2.94x10^{-7}$
W	$1.26x10^{-5}$	$3.87x10^{-6}$	$1.30x10^{-6}$	$7.11x10^{-7}$	$4.66x10^{-7}$	$3.39x10^{-7}$
WNW	$1.02x10^{-5}$	$3.13x10^{-6}$	$1.05x10^{-6}$	$5.75x10^{-7}$	$3.77x10^{-7}$	$2.74x10^{-7}$
NW	$9.59x10^{-6}$	$2.95x10^{-6}$	$9.89x10^{-7}$	$5.37x10^{-7}$	$3.50x10^{-7}$	$2.53x10^{-7}$
NNW	$7.85x10^{-6}$	$2.41x10^{-6}$	$8.08x10^{-7}$	$4.37x10^{-7}$	$2.85x10^{-7}$	$2.05x10^{-7}$

Direction	χ/Q (s/m^3) at the Indicated Downwind Distance (km [mi])				
	16 (10)	32 (20)	48 (30)	64 (40)	80 (50)
N	$6.71x10^{-8}$	$2.71x10^{-8}$	$1.61x10^{-3}$	$1.12x10^{-8}$	$8.45x10^{-9}$
NNE	$7.29x10^{-8}$	$2.96x10^{-8}$	$1.77x10^{-3}$	$1.23x10^{-8}$	$9.32x10^{-9}$
NE	$1.13x10^{-7}$	$4.60x10^{-8}$	$2.76x10^{-3}$	$1.92x10^{-8}$	$1.45x10^{-7}$
ENE	$8.76x10^{-8}$	$3.53x10^{-8}$	$2.09x10^{-3}$	$1.45x10^{-8}$	$1.09x10^{-7}$
E	$1.25x10^{-7}$	$5.15x10^{-8}$	$3.11x10^{-3}$	$2.17x10^{-8}$	$1.65x10^{-7}$
ESE	$9.65x10^{-8}$	$3.93x10^{-8}$	$2.36x10^{-3}$	$1.64x10^{-8}$	$1.24x10^{-7}$
SE	$7.22x10^{-8}$	$2.92x10^{-8}$	$1.75x10^{-3}$	$1.21x10^{-8}$	$9.15x10^{-9}$
SSE	$6.43x10^{-8}$	$2.62x10^{-8}$	$1.57x10^{-3}$	$1.09x10^{-8}$	$8.26x10^{-9}$
S	$5.90x10^{-8}$	$2.41x10^{-8}$	$1.45x10^{-3}$	$1.01x10^{-8}$	$7.66x10^{-9}$
SSW	$7.50x10^{-8}$	$3.06x10^{-8}$	$1.83x10^{-3}$	$1.28x10^{-8}$	$9.65x10^{-9}$
SW	$1.05x10^{-7}$	$4.29x10^{-8}$	$2.58x10^{-3}$	$1.80x10^{-8}$	$1.36x10^{-8}$
WSW	$1.13x10^{-7}$	$4.69x10^{-8}$	$2.84x10^{-3}$	$1.99x10^{-8}$	$1.51x10^{-8}$
W	$1.30x10^{-7}$	$5.40x10^{-8}$	$3.27x10^{-3}$	$2.29x10^{-8}$	$1.74x10^{-8}$
WNW	$1.06x10^{-7}$	$4.36x10^{-8}$	$2.63x10^{-3}$	$1.84x10^{-8}$	$1.39x10^{-8}$
NW	$9.63x10^{-8}$	$3.92x10^{-8}$	$2.35x10^{-3}$	$1.64x10^{-8}$	$1.24x10^{-8}$
NNW	$7.74x10^{-8}$	$3.13x10^{-8}$	$1.87x10^{-3}$	$1.30x10^{-8}$	$9.77x10^{-9}$

Source: NUREG-1118

3.6.3 Air Quality

Air quality at CFFF is regulated for non-radiological and radiological emissions. Applicable Federal air pollution control regulations include 40 CFR Part 50, National Primary and Secondary Ambient Air Quality Standards; 40 CFR Part 61, National Emission Standards for Hazardous Air Pollutants; and 10 CFR Part 20, Standards for Protection Against Radiation. Non-radiological emissions at CFFF are regulated by SCDHEC.

The term "ambient air quality" refers to the atmospheric concentration of a specific compound (amount of pollutants in a specified volume of air) actually experienced at a particular geographic location that may be some distance from the source of the relevant pollutant emissions. Ambient air quality data generally are reported as a mass per unit volume (such as micrograms per cubic meter of air [$\mu g/m^3$]) or as a volume fraction (e.g., parts per million [ppm] by volume).

Air pollutants are often characterized as being "primary" or "secondary" pollutants. Primary pollutants are those emitted directly into the atmosphere (such as carbon monoxide, sulfur dioxide, lead, and particulates). Secondary pollutants are those formed through chemical reactions in the atmosphere (such as ozone and nitrogen dioxide). Atmospheric chemical reactions usually involve primary pollutants, normal constituents of the atmosphere, and other secondary pollutants. Meteorological conditions such as temperature, humidity, and the intensity of ultraviolet light can also play an important role in atmospheric chemistry.

3.6.3.1 National Ambient Air Quality Standards

Under the federal Clean Air Act, the U.S. Environmental Protection Agency (EPA) established National Ambient Air Quality Standards (NAAQS), which define the acceptable levels for six pollutants: nitrogen oxides, ozone, sulfur oxides, carbon monoxide, lead, and total suspended particles. Compliance is attained when pollutant concentration levels are lower than the established NAAQS standards. The pollutant concentration levels in Richland County are lower than the established NAAQS standards for all pollutants.

Compliance with the NAAQS in metropolitan areas is typically related to local area meteorology, transportation, and major permitted dischargers (such as coal burning) that affect the primary pollutants. The federal Clean Air Act requires the EPA to classify areas using these three designations:

- Attainment, which means the area meets the standards;
- Nonattainment, which means the area doesn't meet the standards; and
- Unclassifiable, which means there isn't enough data to classify the area under the new or revised standard.

EPA has designated all of South Carolina in attainment for all criteria air pollutants. There is a section of Rock Hill/eastern York County south of Charlotte that was designated in "non-attainment" for the 2008 8-hour ozone standard. On September 30, 2016, as required by the Clean Air Act, SCDHEC submitted a recommendation of "attainment" for every area in the state, including Rock Hill and the eastern, urbanized part of York County. SCDHEC is now awaiting EPA's response to this recommendation (SCDHEC 2019a).

The CFFF is located in rural southeast Richland County on the southeast edge of the Columbia Metropolitan Statistical Area (MSA) (Westinghouse 2006c). All three SCDHEC monitoring sites within the MSA are classified as "Attaining" (SCDHEC 2019a). The CFFF is located proximal to

SCDHEC Congaree Bluff sampling site. Westinghouse does not conduct on-site monitoring for ambient air quality. Compliance with air regulations is demonstrated by issuance of SCDHEC air permit and emissions modeling.

3.6.3.2 National Emissions Standards for Hazardous Air Pollutants

The National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulates hazardous chemicals, which are usually associated with particular industrial sources or activities (NRC 2007a). Non-radiological emissions at CFFF are regulated by SCDHEC under permit number 1900-0050-R1 (effective March 5, 2008). The CFFF permit addresses NAAQS pollutants, nitric acid, and opacity. The permit does not require monitoring. Instead, operating permit limits are based on process throughputs at rated capacities as outlined by SCDHEC in South Carolina Air Quality Control Regulation 61-62. Emission rates are calculated based on these throughputs. Details concerning the baseline CFFF non-radiological gaseous emissions are presented in Section 3.11.

Exposure calculations from the CFFF radiological gaseous emissions for baseline conditions are presented in Section 3.11.

3.7 Noise

Noise from the CFFF is not detectable at the site boundary (Westinghouse 2006c; NRC 2007a). The distance from the facility to the site boundary (0.5 km [0.3 mi]) helps mitigate offsite noise impacts.

3.8 Historic and Cultural Resources

The CFFF site is located near the Congaree River basin. Prehistoric inhabitants and historic Native American groups utilized the Congaree River region's diverse plant and animal resources. The Congaree Native Americans were a small tribe that farmed and built houses along the banks of the Congaree River next to other small Native American groups. Eventually the few remaining Congaree were assimilated into the Catawba Indian tribe.

The National Register of Historic Places lists 11 prehistoric and historic sites located within an 8-km [5-mi] radius of the CFFF site (NRC 2007a). None of these sites is located on the CFFF property. Six prehistoric mound sites are located on bluffs along the Congaree River in the Congaree Swamp National Park, and nine historic sites are located near the town of Hopkins, South Carolina (Westinghouse 2019d):

- Barber House – 19th century dwelling in Hopkins, SC
- Big Lake Creek Cattle Mound – 18th century feature in Hopkins, SC
- Brady's Cattle Mound – 18th century feature in Hopkins, SC
- Bridge Abutments – feature in Hopkins, SC
- Cattle Mound #6 – 18th century feature in Hopkins, SC
- Cook's Lake Cattle Mound – 18th century feature in Hopkins, SC
- Cooner's Cattle Mound – 18th century feature in Hopkins, SC
- Dead River Cattle Mound – 18th century feature in Hopkins, SC
- Dead River Dike – 18th century feature in Hopkins, SC

The South Carolina Department of Archives and History considers five other sites, located within 8 km (5 mi) of the CFFF, to have historical significance (Westinghouse 2004):

- Raiford's Mill Creek (Mill Creek)
- Cabin Branch (John Hopkins, Jr. Plantation House)—circa 1786 dwelling
- Clayton House—1887 dwelling
- Chappell Cabin Branch (Hicks Plantation House and Garden)—1781 dwelling
- Hopkins Overseers' Dwellings—19th century dwelling

During a land sale and right of way issuance to South Carolina Electric and Gas, an onsite cemetery, known as the Denley Cemetery, was rediscovered by Westinghouse employees in 2003 on Westinghouse property 304 m (1,000 ft) southwest of the CFFF. The area, approximately 80 x 160 ft was fenced off. Shrubs were removed, and existing stones were maintained. The restoration was done by Westinghouse staff. The cemetery, which operated from about 1890 to 1940, is located on property that was once part of the Denley plantation. It contains over 100 grave sites of African-Americans (Westinghouse 2006b, 2008a).

3.9 Visual/Scenic Resources

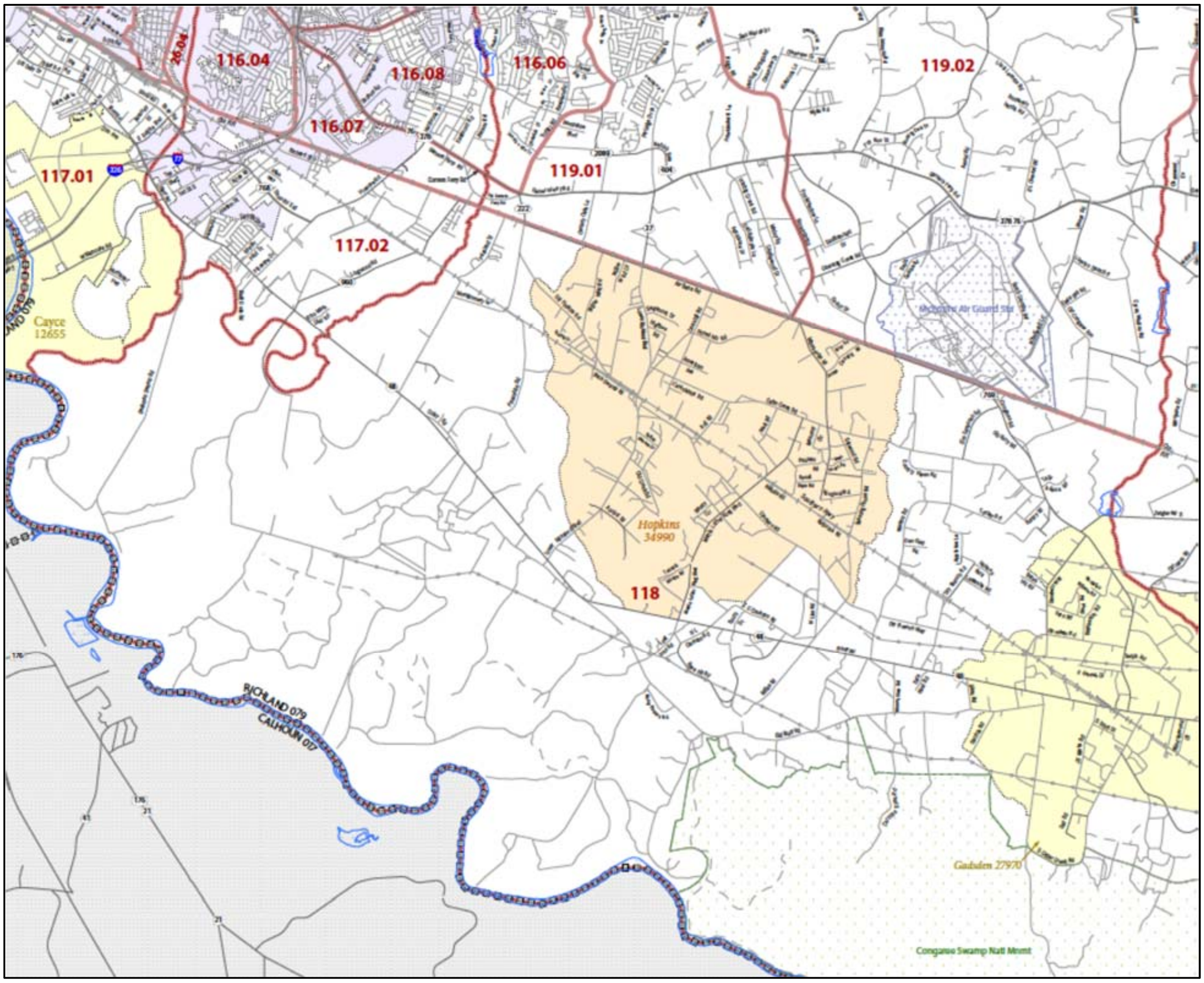
The CFFF is an industrial complex located in a semi-rural area that is surrounded in part by forested lands. There are no nearby natural or man-made features that are considered distinct visual or scenic resources, such as views of mountains, surface water features, or monuments. An aerial view of the CFFF was shown previously in Figure 2.1-4.

3.10 Socioeconomics

The CFFF is located in Richland County, within Census Tract 118 (Hopkins), and approximately 13 km (8 mi) southeast of the city limits of Columbia, which is the nearest population center (see Figure 3.10-1; USCB 2012a). Lexington County is west of Richland County; both counties are included in the Columbia, SC, Metropolitan Statistical Area. Tables 3.10-1 and 3.10-2 present general demographic and economic data, respectively, from the 2010 Census for the State of SC, Richland County, Lexington County, and Census Tract 118.

The 2010 U.S. census shows a total population of 646,895 for the Columbia metropolitan area, which includes Richland and Lexington counties. The major population is concentrated in the city of Columbia. Richland County had a population of 384,504. Lexington County to the west, which includes West Columbia, had a population of 262,391.

The data from the 2010 Census indicate that Richland County Census Tract 118, in which the CFFF is located, has a relatively higher percentage of minorities compared to Richland County in its entirety and the State; in addition, the residents of Census Tract 118 tend to have lower incomes, with a greater percent of families in poverty, compared to Richland County in its entirety and the State. The population density in census tract 118 (which has an area of 119 square miles) is low, less than 100 people per square mile.



Source: USCB, 2012a.

Figure 3.10-1 U.S. Census Bureau Census Tracks

Table 3.10-1 Census 2010 General Demographics for the State of South Carolina, Richland County, Lexington County, and Richland County Census Tract 118 (Hopkins)[1]

Population Type	State of South Carolina	Richland County	Lexington County	Census Tract 118
Total Population	4,625,364	384,504	262,391	6,424
Male	2,250,101 (48.6%)	187,330 (48.7%)	128,134 (48.8%)	3,001 (46.7%)
Female	2,375,263 (51.4%)	197,174 (51.3%)	134,257 (51.2%)	3,423 (53.3%)
Race				
White	3,060,000 (66.2%)	181,974 (47.3%)	208,023 (79.3%)	810 (12,6%)
Black or African American	1,290,684 (27.9%)	176,538 (45.9%)	37,522 (14.3%)	5,463 (85.0%)
Native American Indian and Alaska Native	19,524 (0.4%)	1,230 (0.3%)	1,134 (0.4%)	12 (0.2%)
Asian	59,051 (1.3%)	8,548 (2.2%)	3,729 (1.4%)	7 (0.1%)
Native Hawaiian and Other Pacific Islander	2,706 (0.06%)	425 (0.1%)	130 (0.05%)	2 (0.03%)
Two or more races	116,170 (2.5%)	15,789 (4.1%)	11,853 (4.5%)	140 (2.2%)
Hispanic or Latino (of any race)	235,682 (5.1%)_	18,637 (4,8%)	14,529 (5.5%)	144 (2.2%)
Number of Housing Units	2,137,683	161,725	113,957	2,610

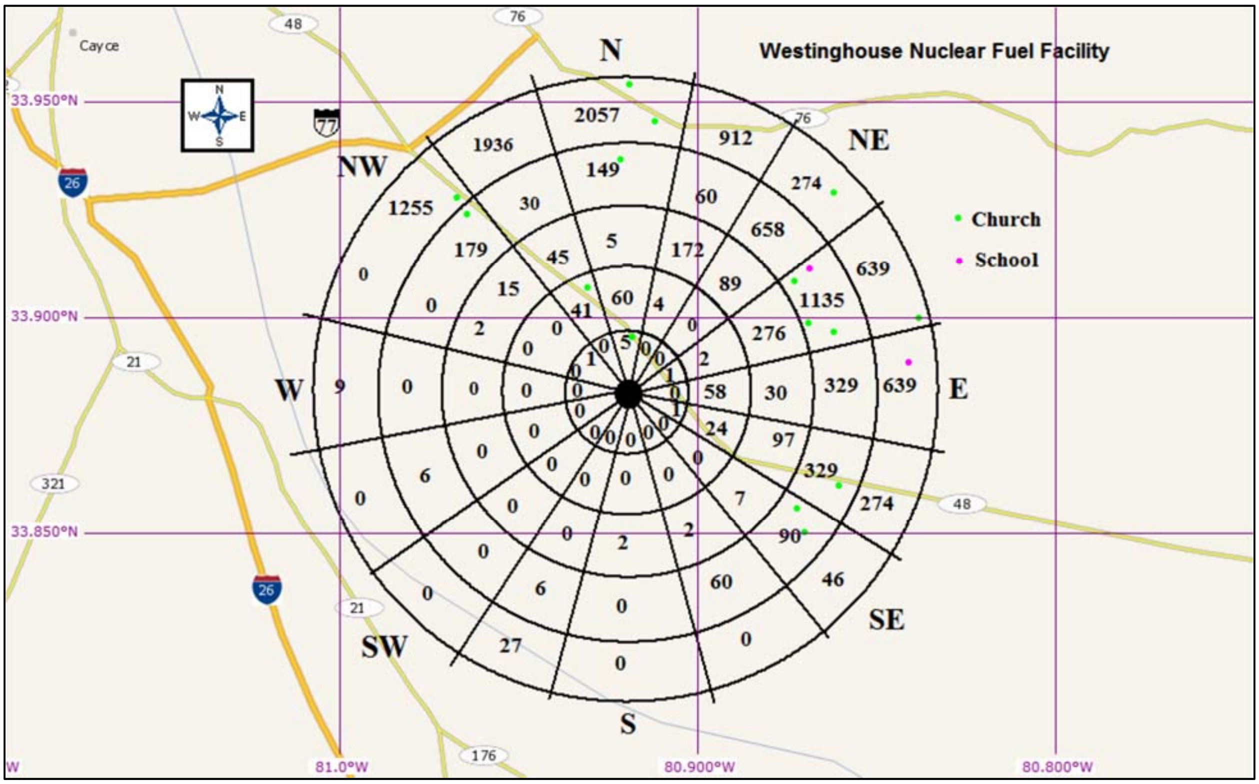
[1] USCB 2012b

Table 3.10-2 Economic Data for the State of South Carolina, Richland County, Lexington County, and Richland County Census Tract 118 (Hopkins)

	State of South Carolina[1]	Richland County[1]	Lexington County[1]	Census Tract 118[2]
Civilian Labor Force	2,241,485	194,673	141,973	3,267
Civilian Labor Force Unemployment Rate	7.8%	11.3%	11.0%	11.5%
2010 Per Capita Income	$22,128	$24,037	$25,932	$17,602
2010 Families in Poverty	162,935 (13.8%)	8,586 (10.1%)	6,777 (9.7%)	337 (20.4%)

[1] USCB 2012c
[2] USCB 2012d

A population wheel out to 8 km (5 mi) is presented in Figure 3.10-2 based on the 2010 census. The population within a 1.6-, 4.8-, 8.0- km (1-, 3-, and 5-mi) radius of the CFFF site is given in Table 3.10-3. Within a 8-km (5-mi) radius of the CFFF site, the population has been estimated to be 8.668. The population density in the area near the CFFF site is low, less than 39/km^2 (100/mi^2) (Westinghouse, 2012). People living near the CFFF site primarily live northeast along the Bluff Road and Atlas Road areas, and southeast in the Hopkins area



Note: Each concentric ring represents an additional one mile radius from the CFFF. Numbers in each quadrant represent the estimated population in that area and geographical direction based on the 2010 census.

Source: Westinghouse 2019d

Figure 3.10-2 Estimated Population Distribution within 5 Mile Radius of CFFF

Table 3.10-3 Estimated Population Near the CFFF Site

Demographic	1-Mile Radius	3-Mile Radius	5-Mile Radius
Population	8	1,327	8,668
Number of Housing Units	3	~379	~2,579
Density (people/mi^2)	1.9	~46.9	~110.3

Source:. Westinghouse 2019d.

Total Westinghouse employment at the CFFF is about 1,250 employees (Westinghouse 2019a) working over 3 shifts. Plant employment represented 0.6 percent of 2010 Richland County total civilian employment (194,673), which was not a significant fraction of the employment of Richland County.

3.11 Public and Occupational Health

The continued handling of materials and conduct of operations at the CFFF pose potential impacts to public and occupational health. For normal operations, the potential impacts are related to the release of low levels of toxic or radioactive materials to the environment over extended periods of time. For accident conditions, the hazard may involve releasing higher concentrations of materials over relatively short periods of time.

3.11.1 Background Radiation Characteristics

For a U.S. resident, the average total effective dose equivalent from natural background radiation sources is approximately 310 mrem/yr but varies by location and elevation (NRC 2007a and NCRP 2009). The source of this dose includes cosmic radiation, terrestrial radionuclides in the earth, radionuclides emanating from the earth into the air, and radionuclides that exist naturally in the body. In addition, the average American receives 310 mrem/yr from man-made sources, including medical diagnostic tests and consumer products (NCRP 2009). Because of its low elevation, relatively low radon levels, and relatively low concentration of radionuclides in the earth, the natural background radiation level in the vicinity of the CFFF site is 117 mrem/yr (Westinghouse 2004).

3.11.2 Public Health and Safety

Potential public health impacts could occur if large amounts of contaminants discharged from the CFFF enter the environment and are transported from the site through the air, surface water, or groundwater. The potential contaminants include uranium, technetium-99, ammonia, fluoride, and VOCs. An effluent monitoring program is in place at the facility to ensure that potential discharges to the environment are within federal and state regulations and are maintained ALARA.

Radioactive uranium may be transported through the environment in a variety of ways and the public may be exposed from both internal and external pathways. Potential releases to the air may cause internal exposures directly through inhalation or indirectly through ingestion of crops and animal products that come in contact with radioactive material in the air. External exposures can occur directly from the radioactive plume or from particles from the plume deposited on the ground and other surfaces. Potential liquid releases to surface water or groundwater might lead to internal exposures through drinking water or eating irrigated crops. External and/or internal exposures may also occur from recreational activities, including boating and swimming in affected surface waters.

Calculated radiological doses to the public from CFFF operations are primarily from air emissions. CFFF stack emissions could result in a total effective dose of less than 0.16 mrem/yr to a hypothetical exposed individual living at the site boundary (Westinghouse 2019b). This is approximately 1.6 percent of the (10 mrem) annual constraint for air emissions imposed by 10 CFR 20.1101.Additionally, the annual total effective dose from liquid effluents is only 8.7E-5 mrem (Westinghouse 2019b).

Radiological emissions are regulated by NRC under 10 CFR Part 20 and by the EPA under 40 CFR Part 61. Westinghouse monitors radiological gaseous discharges from 47 stacks and calculates an offsite dose from the combined emissions. Each stack is continuously (24/7/365) sampled. The sample media is changed daily and analyzed for gross alpha activity. The sample results are used to calculate the concentration of U-234, U-235, and U-238 that is discharged at the stack. Those concentrations are used as input into the COMPLY code that was developed by the EPA and NRC to calculate the dose to a member of the public at the site boundary. Note that Tc-99 is not included in this calculation because it is left behind in the UF_6 cylinder during vaporization. Tc-99 is present in liquid effluent from the cylinder recertification process where the heels (and Tc-99) are removed. Stack samples have been analyzed in the past to verify the absence of Tc-99.

Representative samples of the site's liquid discharge is collected daily according to an established site procedure. The daily samples are combined to make a monthly composite and sent to a third party laboratory for isotopic uranium and Tc-99 analysis. The sample results are used in conjunction with the equations and assumptions from Regulatory Guide 1.109 to calculate a dose to the public via the following pathways: potable water, aquatic foods, and shoreline deposition. The source term consists of U-234, U-235, U-238, and Tc-99. The primary dose contributor is U-234.

As part of the environmental monitoring program, Westinghouse also monitors for the presence of radioactive material in ambient air at four onsite locations. The detailed features of the radiological monitoring program were established in 1975 based on: the background alpha, beta, and uranium concentration levels; discussions with radiation monitoring subject matter experts from both government and private industry; monitoring programs established for similar facilities; and probable exposure pathways for uranium movement through the environment.

As part of the 2007 SNM-1107 license renewal process, NRC performed a safety review of CFFF that includes a detailed radiation safety analyses (NRC 2007b).

3.11.3 Occupational Health and Safety

Risks to occupational health and safety include exposure to industrial hazards, hazardous materials, and radioactive materials. Industrial hazards for CFFF are typical for similar industrial facilities and include exposure to chemicals and accidents ranging from minor cuts to industrial machinery accidents (NRC 2007b). No deaths have occurred at the CFFF site since operations began in 1969. For 2017 and 2018, the CFFF Occupational Safety and Health Administration (OSHA) Total Recordable Incident Rates were 0.83 and 2.10, respectively. The incident rate accounts for both the number of OSHA recordable injuries and illnesses and the total number of man-hours worked. The incident rate is used for measuring and comparing work injuries, illnesses, and accidents within and between industries. The average incident rate for manufacturing facilities like Westinghouse is 2.0 (DOL, 2012).

The CFFF workers are exposed to non-radiological materials that could pose a potential hazard through chronic exposure or improper handling. The CFFF operations use a variety of hazardous and toxic chemicals including ammonia, nitric acid, nitrate, and hydrofluoric acid. Other hazardous materials include degreasing solvents, miscellaneous lubricating and cutting oils, and spent plating solutions. The CFFF Chemical Safety Program is designed to assure that all current and proposed chemical-use hazards are evaluated, and appropriate measures are taken to assure safe operations.

Workers are monitored for radiation exposure to ensure occupational doses are maintained ALARA. For the 5-year period from 2014 to 2018, the average annual total effective dose received by an occupational worker ranged between 0.098 rem and 0.143 rem (Westinghouse 2018 and 2014m). These doses are less than 10 percent of the 5 rem annual occupational dose limit imposed by 10 CFR 20.1201. During that same time period, no individual radiation worker had an annual total effective dose above this limit.

3.12 Waste Management

This section summarizes air, liquid and solid effluents from CFFF operations.

3.12.1 Gaseous Effluents

Gaseous effluents are normally treated by HEPA filters, scrubbers, or both prior to discharge through stacks in accordance with 40 CFR Parts 50 and 61, and 10 CFR Part 20. The CFFF is classified as a minor-source operator, and SCDHEC does not require Westinghouse to directly monitor for non-radiological pollutants. Instead, Westinghouse provides modeled emissions rates that the Department of Environmental Health and Control uses to determine compliance. Table 3.12-1 contains the modeled emission rates for various CFFF non-radiological gaseous pollutants. Emission rates are calculated based on process throughputs expressed in hours of operation. Typically, SCDHEC performs compliance calculations for minor-source operators when permits are renewed or facilities are new or undergo major changes. Table 3.12-2 contains the modeled concentrations for various CFFF non-radiological gaseous pollutants. All pollutant concentrations were below regulatory limits. The only pollutant with concentrations greater than 18 percent of the limit was sulfur dioxide. The sulfur dioxide concentration ranged between 25 and 68 percent of the limit depending on the averaging time used for the calculation. Exposure calculations from the CFFF radiological gaseous emissions are presented in Section 3.11.

3.12.2 Liquid Effluents

Liquid effluents are treated and discharged into the Congaree River in accordance with the NPDES permit and 10 CFR Part 20 requirements. For radiological parameters, there have been no results since the last license renewal that challenge dose to public 10 CFR Part 20 requirements.

On a typical day, CFFF discharges 100,000 gal of liquid effluent into the Congaree River. Non-radiological parameters analyzed for NPDES compliance include pH, fluoride, ammonia, dissolved oxygen, biochemical oxygen demand, ultimate oxygen demand, total suspended solids, phosphorus, e.coli, total residual chlorine (TRC), and uranium. There are no NPDES permit limits for fluoride and nitrate.

From 2000 to 2005, the only parameter to exceed NPDES limits was biochemical oxygen demand (Westinghouse 2004, Westinghouse 2006a). During that time, the daily maximum threshold was exceeded three times and the monthly average threshold was exceeded four times. The largest of these temporary exceedances occurred on September 19, 2002, when the biochemical oxygen demand was nearly twice the daily maximum threshold (Westinghouse 2004).

From 2005-2014, NPDES permit limits were exceeded for BOD, TSS, DO, pH, TRC, and fecal coliform. Over the 9-year period BOD exceeded the allowable daily maximum 3 times, with the highest being 72.62 lb/d versus a limit of 60 lb/d. The monthly average for BOD has been exceeded once since 2006 at 48.65 lb/d versus an allowable 30 lb/day. BOD was not sampled one week in September of 2013, which also resulted in a permit violation with SCDHEC. TSS exceeded the daily maximum twice and monthly average once with the highest measurement of 93.16 lb/d versus the permit limit of 64 lb/d in April of 2010. Dissolved oxygen has been below the permitted limit once by 0.02 mg/l, which occurred in 2012. Values for pH were not in compliance twice, once in November of 2012 when the maximum of 9.0 was exceeded with 9.24 and then again in January 2014 for 4 days when frozen vacuum breaks caused line siphoning. Another equipment failure caused a violation of TRC in February 2014 where the site discharged effluent measuring 1.38 mg/l TRC versus the allowable 1.0 mg/l. In August of 2015 the daily max for BOD was measured at 98.27 lb/day, exceeding the permitted limit of 60 lb/day. The most recent violations resulted from sanitary package plant upsets where the daily maximum for fecal coliform was exceeded a combined seven times in October 2014, June 2016, and September 2016 with the highest value recorded at >2419.6 versus the permitted limit of 400. After an extensive investigation into these events, including the consultation of an outside vendor, the site initiated administrative controls on chlorine addition and applied for an NPDES permit modification. The modification was approved and implemented in May 2017, replacing fecal coliform monitoring requirements with the new state standard of e. coli. A TRC exceedance of 1.01 mg/l was recorded on 1/23/19 versus the maximum of 1.0 mg/l. No NPDES exceedances were recorded for calendar years 2017 and 2018. Exposure calculations from the CFFF radiological liquid effluents are presented in Section 3.11. Storm water runoff is regulated by SCDHEC under a general NPDES permit for Storm Water Discharges Associated with Industrial Activity (General Permit Number SCR000000). The general permit does not include construction activities. A copy of the general permit can be found on the SCDHEC website. There is no specific permit for CFFF. Most industrial users in the state of SC operate under the general permit. As required by this permit, Westinghouse developed a Storm Water Pollution Prevention Plan.

Table 3.12-1 Modeled Emission Rates for CFFF Non-radiological Gaseous Pollutants

Facility Wide Emissions	
Pollutant	Uncontrolled Emissions (TPY)
PM	5.74
PM_{10}	5.39
$PM_{2.5}$	5.39
SO_2	3.04
NO_x	28.47
CO	16.01
VOC	4.11
Nitric Acid (HNO3) [TAP]	0.77

Source: SCDHEC 2018
Note: This is the most current information that is available, as newer emissions modeling has not been conducted. The air permit is currently being processed under timely renewal.

Table 3.12-2 Maximum Modeled Concentrations for CFFF Non-radiological Gaseous Pollutants

Pollutant	Averaging Time	Maximum Modeled Concentration (μg/m^3)	Standard (μg/m^3)
SO_2	3 hours	724.93	1,300
	24 hours	245.55	365
	Annual	20.082	80
PM_{10}	24 hours	18.04	150
NO_2	Annual	18.06	100
CO	1 hour	202.28	40,000
	8 hours	151.85	10,000
Nitric Acid	--	0.5	125

Source: NRC 2007a.
Note: This data is valid for current operations (2018), as no changes have occurred that would alter the modeled concentrations and no newer emissions modeling data has been conducted.

3.12.3 Solid and Hazardous Waste and LLRW

The CFFF operations produce low-level radioactive solid waste. As described in Section 1.3.2 and Section 2.1.4, the material is either decontaminated for free release or reuse, or shipped offsite for disposal. It is typical for the volume of the shipment to vary, depending on the fullness of the sealand container. From 1996 to 2003, the annual amount of low-level radioactive waste shipped offsite varied between 79 m^3 (2,790 ft^3) and 5,132 m^3 (181,235 ft^3) (Westinghouse 2004). From 2010-2018, the amount of low-level radioactive waste shipped offsite annually has generally decreased over time, ranging from 12,000 ft^3 to 38,000 ft^3. The cumulative maximum shipped off-site from 2008-2018 was 38,000 ft^3, occurring in 2018. In part, shipment volumes were higher in 2018 because of the soil remediation work performed as a result of the Hydrofluoric Spiking Station #2 event, as described in Section 4.4.1.3 of this report.

As mentioned in Section 2.1.4, the site generates various non-uranium bearing hazardous wastes. The CFFF hazardous waste generation rate from 2013 to 2018 was approximately 92,360kg (204,000 lb) annually.

Nonhazardous waste is generated from routine office and industrial activities (including calcium fluoride) and is recycled or disposed of at an offsite state-permitted landfill. The annual CFFF generation rate for nonhazardous waste in 2018 was 8,120 MT, of which >97% was recycled.

No waste is disposed of onsite.

4.0 ENVIRONMENTAL IMPACTS

This section describes the impacts for each resource described in Section 3.0, *Description of the Affected Environment*. These impacts (e.g., direct, indirect, and cumulative) consider normal operational events as well as reasonably foreseeable accidents (e.g., credible consequence events for 10 CFR 70 licensees). As noted in Section 1.2, the No-Action Alternative is the only alternative considered in this ER besides the proposed action, and for which environmental impacts are described. The No-Action Alternative is defined as continued CFFF operations for the remainder of the existing 20-year license (expires 2027), without any significant changes in the existing facility.

4.1 Land Use Impacts

4.1.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing facilities would be constructed within the CAA. Land uses at the CFFF plant site (see Section 3.1) would not change significantly, because no new buildings or major external modifications would be built as a result of operating under the current license.

4.1.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action of a 40-year license renewal, manufacturing capacity would remain the same as the current capability. As a result, no new manufacturing facilities would be necessary within the CAA.

Land uses mentioned in Section 3.1 of this report would not change significantly as a result of a 40 year renewal because no new buildings or major external modifications would be made.

4.1.3 Mitigation

None required for either alternative.

4.2 Transportation Impacts

4.2.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing facilities would be constructed within the CAA and capacity would remain the same; therefore, no changes would occur in operations that would affect transportation. CFFF committed to transitioning from the traditional MCC containers for shipment of fuel to the newer Traveller containers by 2022. Fuel assembly packages must have an approved Certificate of Compliance from the NRC or an approved Competent Authority Certification from the DOT. They are designed to withstand worst case accident conditions. The transportation packages are also manufactured, maintained and modified under an NRC approved quality assurance program. Although the change in packaging results in 2 less assemblies per vehicle, the change is a positive safety improvement that has no significant negative impact. There is no significant impact to the public or environment for changes in the design of packaging used for shipping fuel assemblies.

Current transportation quantities and frequency of incoming and outgoing materials from CFFF operations are identified in Appendix B, Table B-2. As noted in Table B-2, the total shipments of chemicals and radioactive materials to or from the site under the No-Action alternative would be an estimated 1342 shipments of all types per year. Since each shipment involves entry to and departure from the site, the total shipment-related traffic on local roads would be 7.4 vehicles per day (i.e., = [2 x 1342]/365).

The employment level at the CFFF under the No-Action alternative would be approximately 1,250 employees. Assuming that a given worker works five days per week and 50 weeks per year, then the annual average daily work force is 859 (i.e., = [50/52] x [5/7] x 1250). Assuming one worker per vehicle (maximum traffic estimate), then the total number of worker vehicles on local roads would be 1,718 per day (i.e., = 2 x859).

The primary highway supporting traffic into and out of the site is SC 48. The South Carolina Department of Transportation (SC-DOT) provides annual average daily traffic (AADT) counts by highway and highway segment. The AADT count during 2017 for the portion of SC 48 between Secondary State Highways S-87 and S 734 (along which is the site) was 4,300 vehicles per day. Based on the information presented above, CFFF-related traffic of all types (worker and shipments) during operation under the No-Action alternative would comprise an estimated 40 percent (i.e., 100 x [7.4 +1,718] / 4,300) of the local traffic on SC 48 near the site on a daily basis, dominated by worker traffic.

The CFFF has been in operation since 1968 with current facility-related traffic levels indicated above. For this reason, no significant impacts to transportation are anticipated under the No-Action alternative.

4.2.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action of a 40-year license renewal, manufacturing capacity would remain the same as the current manufacturing capacity and therefore would have no additional impact to the environment versus the No-Action Alternative. The change in shipping containers has little to no impact but is applicable to both the No-Action and Proposed Action Alternative since the MCC containers are already being phased out and the Travellers are already being introduced.

4.2.3 Mitigation

Transportation activities are a vital aspect of manufacturing that cannot be avoided; however negative impacts can be minimized by following established regulations. All shipments of nuclear materials, chemicals and wastes would be carried out in conformance with NRC, DOT, and SC requirements, including truck placarding to identify contents, and manifests. Trucks used for transport would be of the design and size deemed appropriate by the applicable regulations, and subject to the necessary inspections and maintenance to ensure safe transport. Site access roads and loading areas would be paved, minimizing the potential for fugitive dust generation by truck traffic. These mitigation methods would apply to both alternatives, regardless of the one approved by the NRC.

4.3 Geology and Soils Impacts

4.3.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing facilities would be constructed within the CAA; therefore site geology and soils would not be significantly impacted.

The original manufacturing building, designed to comply with the Southern Standard Building Code, 1965 Edition, was designed to meet Seismic Zone 1 criteria. Two other building additions constructed in 1978 and 1986, were designed to comply with the Southern Standard Building Code, 1976 and 1986 Editions, respectively.

In 2013, Nuclear Safety Associates, Inc. performed a seismic evaluation of the main manufacturing buildings and selected equipment (Refs. 4.17 and 4.18). The facility was evaluated to current requirements as if it were being designed today, and it was assumed *a priori* that the facility would not meet all of the current requirements. The intent of the evaluation was to determine what parts of the facility met the current requirements, and for the parts of the facility that did not meet the current requirements, to identify their stress state and also to assess whether these members can still perform their original intended function.

The primary conclusions are that the main manufacturing buildings (consisting of the original 1968 main buildings, the 1978 expansion buildings, and the 1986 addition buildings) are stable. The seismic induced stress state within the building members is generally within code allowable limits with very few members exceeding these limits.

The majority of the process equipment evaluated was determined to survive the earthquake. The process equipment which was determined to fail (collapse and/or rupture) upon the occurrence of an earthquake that either contain SNM, chemicals co-located with SNM or could adversely impact either of these, are the ADU vaporization system, Q-Tanks, SOLX columns, UN bulk storage tanks, assembly area wash pits, hydrogen tank, and fire water supply system. The release of hazardous materials can also occur because of: ruptured piping or process vessel overflow. The failures of indoor equipment resulting from the earthquake would not be harmful to human health or the environment from a criticality standpoint because IROFS are established that result in distributing the leaked materials in such a manner that the geometry would be favorable, and a criticality would not occur. For the UN Bulk storage tanks, IROFS are established for a diked area to provide secondary containment and Site Emergency Procedures require closing the storm drain isolation valves to contain any leaked UN within the plant boundaries. Leaks to the soil or groundwater as a result of a natural phenomenon event would be entered into CAP and evaluated for action against the site's Remediation Process. A leak or failure in the outdoor fire water system would not be detrimental to the environment, as it contains water. Similarly, hydrogen, although flammable, is a naturally occurring element that can return to the environment with little or no adverse effects. Site Emergency Procedures require isolation of the Hydrogen system in the event of an earthquake.

Seismic upgrades have been incorporated for the conversion area vaporizers and final assembly wash pits. Emergency response procedures include facility evacuation after a seismic event. Potential criticality scenarios have been evaluated and are summarized in ISA 2, 3, 16, and 17. Bounding non criticality seismic accident sequences have been evaluated and are detailed in ISA 2 and ISA 3. IROFS are established to ensure 10CFR70 performance requirements are satisfied.

In 2018 as part of the Hydrofluoric Spiking Station #2 repair, a previously undocumented modification to the original 1968 main building Truckwell #3, located between Column Lines 1 & 2, and A & C, was investigated, documented and evaluated to determine the seismic qualification per CCF structural requirements. The design evaluation of the CFFF Truckwell #3 Concrete Structural Slab and Steel Beam Support provides qualification for the existing concrete structural slab and steel beam framing system.

4.3.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action of a 40-year license renewal, manufacturing capacity would remain the same as the current manufacturing capacity. As a result, no new manufacturing facilities would be necessary within the CAA.

4.3.3 Mitigation

None required for either alternative.

4.4 Water Resources Impacts

4.4.1 No-Action Alternative

The liquid effluents associated with CFFF operations under the No-Action alternative have been described in Section 2.1.4. Potential surface water impacts associated with operations at the CFFF site include some degradation of water quality in the Congaree River because of effluent discharges. This potential impact is minimized by Westinghouse's compliance with the discharge limits outlined in its NPDES permit. Current effluent quality characteristics are well within the permit limitations (NRC 2007a). It is not expected that liquid effluent discharges would result in the deterioration of recreational uses of water bodies. The discharge volume is miniscule compared to the flow rate and volume of the river. The temperature of the discharge is close to ambient, and solids contents are sufficiently low to preclude collection of sediments under the NPDES monitoring program. Sediment in the Congaree River near the site's NPDES outfall is sampled annually for uranium and Tc-99 as part of the site's SNM-1107 license with the NRC.

Environmental investigations have been performed at CFFF over the last 40 years and have included assessments of groundwater, surface water, soil, and sediment. Contaminants of potential concern (COPC) have been identified as fluoride, nitrate, gross alpha / uranium, gross beta / Tc-99 and the VOCs PCE, TCE, cis-1,2-DCE, and VC. Investigative activities have identified the WWTP, manufacturing operations within the building, contaminated wastewater system piping, and the Former Oil House as the potential sources of the contamination. Potential groundwater impacts include the degradation of groundwater quality because of process or raw material leaks or spills into the soil.

On February 26th of 2019, CFFF entered into a Consent Agreement (CA) with SCDHEC, which like the VCC follows the CERCLA process. The CA will address all contaminants of potential concern including fluoride, nitrate, gross alpha, gross beta, uranium, Tc-99 and VOCs.

Routine environmental monitoring data has been input into a Conceptual Site Model (CSM). The CSM provides an understanding of how a contaminant release may be observed and measured currently in the site environment, and identifies the fate and transport of the contaminant in the future. The model incorporates what is known about the site's hydrogeology, existing and past site activities that may have resulted in contaminant releases to the environment, the locations of those releases, the contaminants of concern, their fate and transport within the environment, and the receptors of those contaminants. Based upon current and historical operations, the facility has established defined Operable Units (OU) such as the manufacturing building, western storage area (location of the underground CWW line), and WWTP lagoons. Each OU will have specified groundwater monitoring wells associated with it to provide early leak detection or early indication of contaminant migration.

To minimize future impacts, CFFF has developed a Remediation Process to establish programmatic controls and a repeatable process for how CFFF responds in the future. The purpose of the remediation process is to prevent migration of licensed material and/or contamination off-site and to minimize the impacts to future decommissioning. In the event of a release, whether recent or newly detected, this remediation process will be followed to determine the appropriate steps. The process outlines the key components in decision making for either remediating the release or documenting the decision not to remediate. In each instance, the process involves updating and analyzing the data in the Conceptual Site Model (CSM), including the migration pathways and potentially affected receptors. This process also guides the evaluation and documentation of the decommissioning impacts resulting from the remediation actions or the absence thereof.

The process assures CFFF actions are protective of human health and the environment, meet regulatory requirements and prevent off-site migration of contamination.

The primary Westinghouse CFFF approach to minimizing potential environmental impacts to water resources is through the following measures:

- Prevention through implementation of the CFFF Chemical Safety Program which employs robust process control and best management practices for material handling;
- Safe and proper management of liquid effluents leading to and from the six wastewater treatment process lagoons;
- Implementation of the environmental monitoring program as described in Section 6.0 of this document;
- Assessment of elevated concentrations of liquid effluent constituents in surface waters and groundwater; and
- Mitigation through training and rapid response to any spills.

Liquid effluent monitoring requirements at the CFFF are in accordance with both the NPDES permit requirements and NRC part 20 requirements, as described in Section 6.0 of this document.

The groundwater is confined in a shallow geologic unit that has little or no potential of being an underground source of drinking water and discharges or will discharge to surface water.

Since the last Environmental Report in 2007, there have been three environmental events at the site and one natural phenomenon.

4.4.1.1 Past Events: 2014 Cylinder Recertification Transfer Line

In January 2014, a leak was detected on the transfer line from cylinder recertification tank (T-1405) to the Waterglass processing tank (T-1160A). In immediate response to the leak, absorbent pads were positioned to reduce further liquid migration into the soil. The estimated volume of uranium contaminated process solution spilled was 20-25 gallons. Soil sampling was initiated in the affected area prior to soil remediation, with measured results equaling 26.3 ppmU. In response to the results, approximately 1,033 ft^3 of contaminated soil was removed from the affected area and transported off-site for disposal as LLRW. Additionally, a leak check was performed on the repaired transfer line prior to its return to service.

4.4.1.2 Past Events: October 2015 Flood

A historic flooding event occurred in October 2015. Columbia received 8.19 inches of rain in a 12 hour period, and a total of 12.4 inches over 4 days. 11.5 inches and 13.3 inches of rain in 24 hours correspond to a 500 year and 1000 year recurrence for the Columbia area, respectively. The Congaree River crested at 123.3 feet (above MSL) in the vicinity of the CFFF. CFFF experienced flooding of low lying areas. The main manufacturing building was not impacted by flood waters but two lagoons did overflow as stated in Section 3.6.1.2. No long term impacts resulted from the lagoon overflows, as they were minor. There was also no long term impact to groundwater wells within the existing monitoring well network and the water table on the bluff, as the majority of the rainfall left the site via overland flow in the property's network of stormwater ditches.

4.4.1.3 Past Events: Hydrofluoric Spiking Station #2 Leak (HFSS2)

<u>Background</u>
The HFSS2 operation is contained within a concrete secondary containment system lined with an impermeable membrane. Spiking Station operators, as part of normal operations, conduct routine visual inspections for leaks. Additionally, the integrity of the secondary containment is leak tested annually by filling it with water and monitoring for leaks. The annual leak test conducted on HFSS2 in March 2018 did not indicate the presence of a leak in the containment. On June 16, 2018, during a routine shift inspection, an operator noticed a small patch of leaked solution (uranyl nitrate and hydrofluoric acid) outside the secondary containment area, which was cleaned up. The unit was immediately shutdown for further investigation. On June 26, 2018, the Spiking Station equipment was removed to allow for inspection of the membrane and the concrete floor beneath the membrane. The inspection of the secondary containment concrete floor identified a small crack. Soil samples taken directly beneath the area in question were found to be impacted by the leak.

<u>Initial Investigation</u>
CFFF sampled and found no impacts in the closest downgradient monitoring well (W-28), approximately 188 feet from the leak. Quarterly monitoring of this well was initiated. CFFF also contracted AECOM to develop a sampling plan and conduct a subsurface investigation of the HFSS2 in August 2018. A HF Spiking Station #2 Assessment Report was prepared by AECOM and submitted to SCDHEC with copy to the NRC on November 30, 2018 (Westinghouse 2018a). During the period August 20 – 22, 2018, AECOM obtained hand auger samples at 12 locations within the secondary containment area to a depth of approximately 6 feet below concrete surface (bcs) or auger refusal. The floor of the building that includes the Spiking Station is approximately 4 feet above natural grade. Soil samples were collected at 2 foot intervals. Samples were analyzed for fluoride, uranium, Tc-99 and pH. Sample analysis indicated the presence of fluoride and U at various depths as well as low pH (<5 standard units).

Subsequent Investigation

On September 6, 7, and 12, 2018, AECOM collected samples to a depth of 12 feet bcs at five locations that had not encountered auger refusal and one location where concrete was able to be removed. SCDHEC also requested three additional borings located outside of the HFSS2 footprint. In addition to the analytes sampled in the initial investigation, nitrate was also analyzed during this subsequent investigation at the request of SCDHEC. Analysis of the soil samples did not identify impact from the release at depths below 9 feet bcs within the boundaries of the HFSS2 footprint, with the exception of soil samples from borehole HF-B1. At this location, U and nitrate were detected at a depth up to the 11-12 foot bcs interval. Samples collected from the three locations external to the HFSS2 footprint also indicated the presence of analytes at various depths.

Remedial Activities

CFFF contracted Leidos to develop a Technical Basis Document to determine target cleanup levels using computer software, RESRAD-ONSITE Version 7.2. Additionally, Leidos evaluated NRC decommissioning guidance, which provides remediation levels for exposure to industrial workers. The identified practical depth of impact based on these levels varies from approximately 9 feet to 12 feet bcs. This allows for removal of soil to concentrations well below the target cleanup level, eliminates risk to employees and minimizes the risk of potential future migration to groundwater. Therefore, CFFF elected to remediate soils to the practical excavation depth, in order to ensure the groundwater table was not negatively affected by the remediation process itself. Remedial activities were initiated in October 2018 and completed in February 2019. Fill material was installed in March 2019.

Conclusions and Further Environmental Evaluation

Based on the data provided in the HF Spiking Station #2 Assessment Report and the Technical Basis Document, CFFF concluded the following:

- Some of the soil below the concrete floor within the HFSS2 area is impacted with fluoride, nitrate, and U, and has localized areas of low pH (<5 standard units).
- U below the concrete floor exists outside of the HFSS2 footprint, in HF-B15, but does not appear to be associated with the HFSS2 release. These results are likely due to past impacts and will be addressed with the Conceptual Site Model (CSM).

Based on these conclusions, CFFF has implemented or is in the process of completing the following additional activities:

- The impacted soil below the HFSS2 was removed down to 9 feet in a 13 ft x 17 ft area and confirmatory sampling was conducted for uranium, fluoride, nitrate and pH. Along the exterior wall and eastern side of the excavation, additional soil was removed down to 10 feet. In a localized section of the southwest corner, soil was removed down to 11 feet, which was the deepest practical depth for excavation without intercepting the groundwater table. Additional confirmatory samples were collected, with uranium concentrations reported from less than 12 ug/g in four locations and up to 2,740 ug/g in the SW corner. All of the results were below the technical basis document criteria requiring immediate remediation.
- Fill material was added to the excavated area beginning on March 13, 2019
- Impacted soil is being disposed of at an approved facility. Copies of the waste disposal manifests will be sent to SCDHEC.
- AECOM developed a CSM on behalf of CFFF to assist the site in development of the RI work plan. Actions in the RI work plan including the installation of additional building perimeter wells will strengthen the site's monitoring program. The CSM, additionally

proposed perimeter wells, and existing groundwater monitoring network formulate a robust groundwater monitoring and release detection program for potential impacts from past or future manufacturing operations for the life of the plant.

4.4.1.4 Past Events: Contaminated Wastewater Line Breaches

Background

The CWW line was installed as part of the 1978 expansion to the west side of the manufacturing building. The CWW line receives wastewater streams that contain contaminants. The various input lines, some of which run underground and external to the building, are routed to a single external line and sump for collection and on-site treatment. The primary source streams are the shower/sink water from the operators' locker rooms, the respirator cleaning facility, and the uranium hexafluoride vaporization steam condensate/trench, overflow of the 8A scrubber and various laboratories sinks and floor drains.

<u>2008 CWW Breach:</u>
In 2008, CFFF maintenance personnel inspected an underground external section of CWW line and noted a breach at a connection point near Dock 3. During repair of this breach, samples of water from the CWW line and soil near the breach were collected and analyzed for radionuclides. Results of the samples collected at the source identified radionuclides in the CWW and subsurface soils.

In response to the breach, the external section of the CWW line along the western side of the plant was replaced. Soil which could not be placed back into the excavation along with concrete removed to perform the repair was sampled for U and shipped off-site for disposal at a properly licensed facility.

<u>2011 CWW Breach:</u>
In 2011, CFFF personnel discovered breaches at two locations in the CWW line underneath the building floor. Three soil samples and one process wastewater sample were collected at one of the breaches. The second breach location could not be sampled due to access issues related to plant infrastructure. Analysis of these samples identified radionuclides in both soil and the wastewater at the source of the breach. As a result, the affected buried piping under the facility floor was abandoned in place and replaced with above ground PVC piping. No remediation of the soil below the manufacturing floor was performed.

2018 Environmental Assessments
In early 2018, CFFF personnel reviewed the data available for both the 2008 and 2011 leaks and determined that additional assessment and characterization was needed. CFFF requested its environmental consultant, AECOM, further assess soil and groundwater quality near the external CWW line. The assessment activities summarized below are detailed in the AECOM report submitted to SCDHEC (AECOM 2019).

At first, Direct Push Technology (DPT) was used to collect groundwater samples at nine sampling locations. This method of sample collection resulted in highly turbid samples that were not representative of groundwater. The anomalous results were discussed with SCDHEC, and it was determined that the installation of Temporary Monitoring Wells (TMW) was necessary to obtain representative groundwater samples for the assessment.

AECOM collected nine soil borings and installed nine temporary monitoring wells to collect soil and groundwater samples along the exterior western wall of the plant near the CWW line. All soil sample results for residual U were well below the target cleanup levels as discussed below and in the associated *Technical Basis Document* dated November 30, 2018 prepared by Leidos. Groundwater samples taken at the source of potential impact were collected from these wells and analyzed for all potential contaminants associated with the site. While there are no drinking water wells onsite, sample results were compared to drinking water standards which establish Maximum Contaminant Levels (MCL). A MCL is the maximum concentration of a substance that is allowed in public drinking water systems**.**

Groundwater samples from temporary wells TMW-5 (renamed W-55) and TMW-6 (renamed W-56) were detected at concentrations of 142.57 µg/L and 156.87 µg/L, respectively, exceeding the uranium MCL of 30µg/L. W-55 and W-56 are located near Dock 3 approximately 30 feet west of the building, and are screened more shallow within the surficial aquifer than already existing wells, W-37, W-38, and W-45. In addition, nitrate and vinyl chloride were identified to be above MCLs in two wells and one well, respectively. Nitrate samples from temporary wells TMW-8 (renamed W-58) and TMW-9 (renamed W-59) were detected at concentrations of 17 mg/L and 26 mg/L, respectively, exceeding the drinking water standard nitrate MCL of 10 mg/L, and vinyl chloride was detected above its MCL in groundwater from temporary well TMW-3 (renamed W-53) at 2.1 µg/L versus an MCL of 2.0 µg/L. A detailed discussion of groundwater results (including nitrate concentrations) was provided to SCDHEC in the required annual groundwater monitoring report submitted on September 28, 2018. The report provided data for the past five years (2013-2018) that indicate nitrate and other constituents have remained stable and are located within the CFFF property boundary.

CFFF also obtained groundwater samples from monitoring wells W-37, W-38 and W-45 that are in the vicinity of the CWW to assess whether or not groundwater within these wells had been impacted by uranium since the previous sampling event. These wells, which are screened 5-10 feet lower in the surficial aquifer than wells W-55 and W-56, were below the uranium MCL.

In 2018, CFFF also completed an assessment of CWW line piping integrity external to the building and found the system to be intact with no concerns noted.

Technical Basis for Pre-Decommissioning Target Clean-up Levels

CFFF requested that Leidos establish pre-decommissioning target clean-up levels, for use during facility operations, for total uranium in soil adjacent to the external CWW line and soil under the building floor. The evaluation from the Leidos' *Technical Basis Document* (TBD) dated November 30, 2018 is summarized below.

Target clean-up levels for total Uranium in soil, specific to the conditions at the CWW line, have been calculated using computer software, RESRAD-ONSITE Version 7.2 (See Table 4.4-1 CWW Exposure Scenarios listed below). Dose based target levels were based on a maximum 15 mrem/year and the risk-based target levels were based on the lifetime cancer risk of 1 in 1,000,000 and 1 in 10,000 (1E-6 and 1E-4). These results were used to make decisions regarding radionuclide contamination in soil that would be protective in their current location and configuration.

Reasonable exposure scenarios include an industrial worker that performs their duties in the vicinity of the CWW line, either within the manufacturing building on the floor or above the external line at ground surface. The other scenario evaluated was the utility worker that performs their duties at the CWW line area outside the manufacturing building and who comes into contact with the impacted soil during subsurface activities, which are assumed to occur over a 2 week time period. With proper monitoring and inspection, these risks can be mitigated and impacts to groundwater minimized or eliminated.

Table 4.4-1 CWW Exposure Scenarios

CWW Line Scenario	Dose –Based Target Level (15mRem/yr)	Risk-Based Target Level[3] ($CR=10^{-6}$)	Risk-Based Target Level[3] ($CR=10^{-4}$)	Maximum Detected Soil Levels
CWW Line Outside the Building – Industrial Worker[1]	32,758 ppm	60.1 ppm	6,013 ppm	54 ppm
CWW Line Outside the Building – Utility Worker[2]	7,894 ppm	33.3 ppm	3,330 ppm	54 ppm
CWW Line Inside the Building – Industrial Worker	107,142 ppm	262.5 ppm	26,250 ppm	136 ppm

[1]Industrial Worker Scenario assumes the cover material remains in place and provides a barrier between the worker and the residual U in soil.
[2]Utility Worker Scenario assumes the cover material has been removed and the worker is exposed to the residual U in soil.
[3]US Environmental Protection Agency Target Levels developed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) also known as the Superfund Act.

For the CWW area, the utility worker scenario, where the cover material would be removed to repair or replace the line, soils above the 33.3 ppm of total U would be removed before the line is repaired or replaced to protect the utility worker. As shown in the table above, the maximum detected concentration of 54 ppm total U found in the soil outside of the building is below the upper limit of the CERCLA target risk range of 6,013 ppm (1x10-4 or 1 in 10,000 increased cancer risk) and, therefore, does not require immediate removal as long as adequate cover material remains in place. Adequate cover materials (e.g., concrete, asphalt, soil) protect the Industrial Worker from being exposed to total U concentrations above the CERCLA target risk range of 33.3 ppm (1x10-6 or 1 in 1,000,000 increased cancer risk). If sub-surface repair work within the impacted area of the external CWW line location is required, the need to remove impacted material will be evaluated at that time.

Conclusions and Further Environmental Evaluation

- Subsurface soils do not require immediate removal based on existing data and as discussed in the TBD.
- Two of the nine temporary wells sampled, (W-55 and W-56) exceeded the groundwater MCL for uranium. The groundwater nitrate MCL was also exceeded in two temporary wells (W-58 and W-59), and the vinyl chloride MCL was slightly exceeded in one temporary well (W-53). The nine wells are located immediately adjacent (approximately 30 feet) to the western side of the manufacturing plant.
- The existing groundwater monitoring well network continues to indicate no offsite impact.

Based on the above findings, CFFF has proposed the following:

- Develop and implement a conceptual site model to assist CFFF in developing and implementing monitoring and remediation strategies as needed for constituents of interest. CFFF anticipates this model will result in a proposed recommendation for SCDHEC approval to install a series of monitoring wells oriented east-west along the southern side of the manufacturing area similar to the ones installed north-south along the eastern side of the manufacturing area to act as detection monitoring wells. Collectively this well network will form a robust groundwater monitoring and release detection program for potential impacts from past or future manufacturing operations for the life of the plant.

- Perform additional groundwater assessment upgradient, downgradient and sidegradient of temporary wells W-55 and W-56 to further define the horizontal extent of the U identified in the immediate area of the CWW line. Other existing groundwater monitoring wells will be monitored to evaluate the extent of nitrate and vinyl chloride as part of the overall facility monitoring program.
- As part of the CA commitment, input the assessment results into the site's CSM as discussed in Section 4.4.1 and re-evaluate for future actions

Past events mentioned above have been accounted for in the site's newest revision of the DFP to be submitted in May 2019. Associated areas that were not fully remediated as a part of the site's immediate response to the event will be remediated at the facility's closure. The DFP ensures appropriate funds are available for the remediation work.

4.4.1.5 Groundwater and Surface Water Impacts

All 60 of the site's wells were sampled for all contaminants of concern beginning with the Oct/Nov 2018 sampling campaign. The additional sampling was conducted to obtain baseline data across the site for all COPCs.

In a September 2015 letter, SCDHEC indicated to CFFF that sites managed under the BLWM at SCDHEC were going to be required to enter in to a VCC. CFFF entered into VCC-16-4948-RP with SCDHEC on August 23, 2016 to address legacy VOC contamination at the site. On February 26th of 2019, CFFF entered into a Consent Agreement (CA) with SCDHEC, which like the VCC also follows the CERCLA process. As the scope and goals of the VCC are addressed in the broader CA, Westinghouse, after consultation with SCDHEC deemed it appropriate to terminate the VCC. The CA will address all contaminants of potential concern including fluoride, nitrate, gross alpha, gross beta, uranium, Tc-99 and VOCs. The sampling and monitoring requirements under the CA are defined in a Remedial Investigation (RI) work plan that will be submitted to and approved by SCDHEC and are primarily driven by a CSM. Groundwater wells at the site are routinely sampled, monitored and evaluated against water quality parameters, as described in Section 6.0 of this document to comply with the site's NPDES permit. Additional locations for groundwater, surface water, soil, and sediment investigation will be defined in the RI work plan, depending on the identified data gaps from the CSM. Increasing trends and new exceedances in groundwater COPCs by either NPDES or CA monitoring initiates an investigation and corrective action, which will include mitigation response as necessary per the site's Remediation Process. Additional details regarding groundwater and surface water impacts under the No-Action alternative are presented below, by contaminant of potential concern.

<u>Volatile Organic Compounds (VOCs)</u>:

A groundwater contamination event was noted at the site following an EPA site screening inspection at the facility in February 1989. Following this screening, an evaluation indicated that organic compounds were detected in the groundwater. Westinghouse confirmed in 1993 that chlorinated volatile organic compounds (VOCs, including PCE and PCE degradation products) were detected in the groundwater. Subsequently, Westinghouse performed a detailed site inspection assessment in 1994 documenting VOC contamination west southwest of the plant extending 300 m (1000 ft) from the old oil house to Sunset Lake. Historically, the perchloroethlyene contamination source was suspected to be poor management of drums and the temporary storage of leaking drums outside the oil house prior to passage of regulations requiring more prescriptive methods of handling hazardous materials and waste. Initially, wells were sampled and found to contain approximately 0-3000 µg/L VOCs (1995-98). Studies conducted on VOC contamination since the original assessment in 1994 appear to indicate sourcing near the West II Lagoon area instead of the previous oil house location. However, the West II lagoon and the WWT process itself is not a likely contributor. Additional future assessments will be conducted as part of the RI work plan.

After further evaluation and consultation with SCDHEC, Westinghouse voluntarily installed a groundwater remediation system consisting of air sparging and soil vapor extraction (AS/SVE) system in 1997 in downgradient areas of the VOC plume.

The primary VOCs at the site are perchloroethylene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE) and vinyl chloride (VC). TCE, cis-1,2-DCE and vinyl chloride are potential breakdown products of PCE. The objective of the AS/SVE approach was to contain the plume and prevent further migration. The AS/SVE system consisted of eleven AS well and 11 SVE wells in two transects. The AS wells were installed on top of the confining unit and SVE wells installed above the water table (AECOM 2017).

During investigations to detect groundwater contamination, multiple soil geoprobe penetrations were completed (Rust 1994-1995) in locations affected by past spills of chlorinated solvents. Soil samples were taken at depths from 0.9 to 3.4 m (3 to 11 ft). One sample was noted to contain Total VOC's equal to 4.5 mg/kg; and nineteen other samples indicated Total VOC's less than 0.3 mg/kg. No management program was necessary specifically to manage the soil. Programs were implemented to manage the groundwater in the shallow surficial aquifer beneath the soil.

The soil impacted by chlorinated solvent contamination would be leached by rainwater, the surface aquifer, and then be attenuated by reaction with soil bacteria. No requirements were established by SCDHEC to remove or remediate the soil at the low documented levels of contamination.

Operation of the AS/SVE system resulted in decreasing VOC concentrations in a number of monitoring wells. Wells W-15, W-16, W-26, and W-48, located along the escarpment, indicate a decreasing trend in contaminant concentration. Well W-48 indicated a dramatic change, where TCE, DCE, and VC concentrations no longer exceed MCLs and the PCE concentration decreased significantly between April 1995 and December 2008. This dramatic decrease was likely due to the proximity of well W-48 to the southern AS/SVE area. Wells located in the northern AS/SVE area also indicate decreasing concentration trends. Well W-41R indicated a dramatic change, which is likely due to the proximity of well W-41R to the northern AS/SVE area. The estimated total was reduced approximately 76 percent eleven years after the AS/SVE system was installed in 1997. Apparent mass reduction in the areas influenced by the AS/SVE system was 97 percent, in the southern AS/SVE area, and 44 percent in the northern AS/SVE area. Air sparging, biodegradation of the VOCs, and other natural attenuation mechanisms can be attributed for the mass removal in these areas. Use of the AS/SVE system was discontinued in December 2010, as agreed by SCDHEC (Westinghouse 2011b) when performance appeared to have reached a plateau phase with reduced efficiency and decreased ability to reduce contaminant concentrations.

Monitoring for VOCs continued in four groundwater monitoring wells after the discontinuance of the AS/SVE equipment but data sampling frequency prior to 2004 varied by well and parameter. VOC data collected from 2004 to present is maintained by the site in spreadsheets and databases. On September 15, 2015, SCDHEC issued a letter indicated that regulatory oversight of the VOC impact to groundwater would be managed by the State Remediation Section of the Bureau of Land and Waste Management (BLWM) at SCDHEC and that groundwater monitoring and reporting for the WWTP area would be managed by the Bureau of Water. In the letter, SCDHEC requested that a work plan be submitted to install three new monitoring wells in specific areas of the VOC impact. The letter also requested a second work plan for long-term groundwater monitoring. However in a subsequent letter from SCDHEC dated September 30, 2015, the BLWM recommended that field screening be conducted prior to well installation so that appropriate well locations and screening intervals would be selected. After the September 30, 2015 letter, SCDHEC indicated to CFFF that sites managed under the BLWM at SCDHEC were going to be required to enter in to a VCC. CFFF entered into VCC-16-4948-RP with SCDHEC on August 23, 2016.

As part of the VCC terms, CFFF submitted a work plan in October of 2016 developed by AECOM to delineate tasks associated with continued VOC investigation. The subsequent investigation and field work was performed in December 2016. The data from the field work was submitted to SCDHEC as part of the VCC's established quarterly reporting. Subsequent discussions with CFFF, AECOM personnel and SCDHEC staff in February 2017 determined that further groundwater screening for VOCs was necessary before permanent monitoring wells could be installed. The investigation was performed in October 2017 with the final report submitted to SCDHEC in December 2017. The report included recommendations for the installation of 10 permanent monitoring wells with five to be installed in the upper surficial aquifer and five in the lower surficial aquifer. The objective of the VOC investigation was to further delineate the horizontal and vertical extent of VOCs in the surficial aquifer. Field conditions only allowed for the installation of nine total wells; four wells were installed in the upper surficial aquifer (W-61, W-64, W-66, and W-67) and five wells in the lower surficial aquifer (W-60, W-62, W-63, W-65, and W-68).

In October/November 2018, CFFF voluntarily monitored all of site's existing 60 groundwater wells for VOCs and SVOCs. PCE was detected in groundwater samples from 22 of the 60 monitoring wells, with detections above the MCL in 15 of those wells. TCE was detected in groundwater samples from 13 of the 60 monitoring wells, with detections above the MCL in 7 of those wells.

VOCs detected during the October/November 2018 sampling event exceeding MCLs were primarily PCE and, to a lesser extent, TCE. One additional daughter product of PCE reductive dechlorination, cis-1,2 DCE, was detected in groundwater at the CFFF site at concentrations below the MCL. Trans-1,2-Dichloroethene and vinyl chloride were not detected in groundwater from the monitoring wells. The groundwater analytical results indicates that there are PCE and TCE groundwater plumes in the upper and lower portions of the surficial aquifer west of the plant building and in the upper surficial aquifer south of the plant building. The plumes in the western site area appear to emanate from the vicinity of west lagoon 2 and from a source(s) between the plant building and west lagoon 2. Results from the 1993 hydropunch groundwater investigation also indicated the highest total VOC concentrations were in the vicinity of west lagoon 2 with a plume apparently emanating from west lagoon 2 with detected concentrations of VOCs near the former oil house east of west lagoon 2 (Rust, 1994). The liner of west lagoon 2 was replaced in December 2008. Groundwater elevations in monitoring wells near west lagoon 2 are similar to groundwater elevations in nearby monitoring wells and therefore do not indicate that liquids from west lagoon 2 are currently leaking into the subsurface. Elevated PCE concentrations in the western plume extend from the upper surficial aquifer to the lower surficial aquifer. Although TCE concentrations in the western plume are above TCE's MCL in the upper and lower portions of the surficial aquifer, concentrations of TCE above its MCL occur primarily in the lower surficial aquifer. PCE was not detected in lower surficial monitoring well W-60 located between W-19B and west lagoon 2 but was in W-19B at a concentration of 120 ug/L, exceeding the MCL.

The southern VOC plume is located in the southern portion of the site near several out buildings and upgradient of the man-made "Gator" pond. Elevated PCE concentrations within this plume appear to be within the upper surficial aquifer only, based on previous conclusions (AECOM, 2017). The source area(s) for this plume is unknown, as there are no known processes in this area that currently use PCE or used PCE in the past. PCE concentrations in this plume are an order of magnitude lower than the PCE concentrations in the western plume and do not appear to point to any particular potential source area of the CFFF site.

On February 26th of 2019, CFFF entered into a Consent Agreement (CA) with SCDHEC, which like the VCC also follows the CERCLA process. As the scope and goals of the VCC are addressed in the broader CA, Westinghouse, after consultation with SCDHEC deemed it appropriate to terminate the VCC. The CA will address all contaminants of potential concern including fluoride, nitrate, uranium, Tc-99 and VOCs.

Fluoride:

Groundwater monitoring data since 2004 indicates that fluoride concentrations ranged from <0.50 milligrams per liter (mg/L) to 37.3 mg/L (W-30 in March 2010). The fluoride MCL (4 mg/L) has been exceeded in groundwater samples from 17 of the 60 wells including W-7, W-10, W-13, W-15, W-16, W-17, W-18R, W-22, W-24, W-27, W-28, W-29, W-30, W-32, W-37, W-38, and W-47 since 2004. W-24 and W-37 only had one isolated incident each of exceeding the MCL in June 2011 and September 2011, respectively. The source investigation performed by AECOM in the wastewater lagoon area in 2011 included groundwater sampling from 20 DPT borings. The samples were analyzed for fluoride and nitrate. A total of 40 DPT groundwater samples were collected from the 20 locations to determine the extent of fluoride and nitrate in the upper and lower portions of the shallow aquifer at the site. As part of the Remedial Investigation agreement between Westinghouse and SCDHEC, a total of 10 sediment samples coinciding with previous surface water sample locations were analyzed. As part of the RI, AECOM developed isoconcentration maps from select dates from December 2004 through October 2013 and from regular groundwater monitoring events in December 2004, December 2008 and October 2013.

AECOM noted in the Remedial Investigation Report from December 2013 that fluoride generally does not adsorb to soil or react with other compounds. Therefore, fluoride moves with groundwater flow (advection) and is present from the WWTP to downgradient wells near the pond and Sunset Lake. Since four of the WWT lagoons were relined in 2012, there has been an overall decrease in fluoride concentration in downgradient wells W-22 and W-18 and nearby well W-30. In addition the fluoride concentration in downgradient wells W-10 and W-15, although once above the MCL has decreased to below the MCL and remained there since 2013.

AECOM further elaborated that while COPCs have been detected in groundwater near surface water bodies, only fluoride has been detected in Sunset Lake at concentrations exceeding MCLs. December 2008 fluoride concentrations in surface water ranged from 0.5 mg/l (SW-6) to 12.1 mg/l (SW-1, Upper Sunset Lake and SW-9, Sunset Lake). Other surface water sampling locations SW-7, SW-8, and SW-10 exceeded the MCL of 4 mg/l measuring at

4.7 mg/l, 4.4 mg/l, and 10.3 mg/l, respectively. In 2008 fluoride, however was not detected above the MCL at the spillway, indicating that the fluoride MCL was exceeded only in a localized area near the location of the groundwater plumes. A mitigating circumstance for the "Gator" Pond is that it is a man-made impoundment with no outflow to the stream system and, therefore is not a natural surface water body. Fluoride concentrations at the "Exit" location of surface water sampling, which is where Mill Creek exits the site's property (See Figure 6.1-2) has been less than 0.5 mg/l since February 2012.

Additional analysis was performed in 2018 by Earthcon Consultants, Inc. who performed a Groundwater Plume Analytics™ study in addition to a Ricker Method® Well Sufficiency Analysis. The overall analysis was performed on data from 2004 to September 2018 for fluoride. There were apparent inflection points in the data, particularly in June 2011 for each COPC, which corresponded to the shutdown of the AS/SVE system. Thus plume stability trends were calculated from 2011 to 2018 for each COPC. For fluoride, Earthcon used Mann-Kendall to conclude with greater than 99% confidence that the fluoride plume is decreasing in area, mass, and concentration.

There is no indication from environmental sampling activities that fluoride has the potential to impact areas off-site. The CA and CSM will define the RI work plan actions and any subsequent required remedies through the site Remediation and CERCLA processes.

Nitrate:

Groundwater monitoring data from 2004-2018 indicates that nitrate concentrations ranged from <0.02 mg/L to 2,900 mg/L (W-30 in Dec 2011). The nitrate MCL (10 mg/L) has been exceeded in groundwater samples from 28 of the 60 wells including W-7, W-10, W-13, W-15, W-16, W-17, W-18R, W-22, W-23, W-26, W-28, W-29, W-30, W-32, W-33, W-38, W-39, W-41, W-43, W-44, W-47, W-48, W-58, W-59, W-64, W-66, W-67and RW-2 since 2004. W-16, W-23, W-42, and W-44 only had one isolated incident each of exceeding the MCL in July 2014, April 2011, December 2008, and June 2012, respectively. The source investigation performed by AECOM in the wastewater lagoon area in 2011 included groundwater sampling from 20 DPT borings. The samples were analyzed for fluoride and nitrate. A total of 40 DPT groundwater samples were collected from the 20 locations to determine the extent of fluoride and nitrate in the upper and lower portions of the shallow aquifer at the site. As part of the Remedial Investigation agreement between Westinghouse and SCDHEC, a total of 10 sediment samples coinciding with previous surface water sample locations were analyzed. As part of the RI, AECOM developed isoconcentration maps from select dates from December 2004 through October 2013 and from regular groundwater monitoring events in December 2004, December 2008 and October 2013.

AECOM noted in the Remedial Investigation Report from December 2013 that fluoride and nitrate are soluble in water. Nitrate moves with groundwater flow but can be depleted through the natural processes of nitrate reduction and denitrification. Denitrification occurs when nitrate is converted to nitrogen and nitrate concentrations measured in groundwater decrease. Nitrate reduction is the process of converting nitrate to nitrite to ammonia. Denitrification can also occur as groundwater discharges to surface water due to the presence of organic carbon.

The 2013 Remedial Investigation Report by AECOM concluded that the concentrations of nitrate exceeding the MCL are located from the vicinity of the WWTP to the area of the escarpment just north of Sunset Lake. Areas of elevated nitrate include the WWTP, the vicinity of the northern and southern equipment pads, and West Lagoon 2. Nitrate has generally increased in the area of the WWTP since 2008. As a result of the data collected during the borings, Westinghouse elected to reline four of the site's lagoons in January and February of 2012. W-29 and W-30 have had an overall decrease in their concentrations since four of the lagoons were relined, while downgradient wells W-26 and W-48 have decreased to below the MCL. Upgradient wells W-28, W-38, and W-43 have also been sampled and continue to result in concentrations below the MCL.

Additional analysis was performed in 2018 by Earthcon Consultants, Inc. who performed a Groundwater Plume Analytics™ study in addition to a Ricker Method® Well Sufficiency Analysis. The overall analysis was performed on data from 2004 to September 2018 for nitrate. There were apparent inflection points in the data, particularly in June 2011 for each COPC, which corresponded to the shutdown of the AS/SVE system. Thus plume stability trends were calculated from 2011 to 2018 for each COPC. For nitrate, Earthcon used Mann-Kendall to conclude with greater than 99% confidence that the plume area is decreasing and greater than 93% confidence that the plume mass was decreasing. There was not an identifiable trend for average concentration.

Ammonia:

An ammonia groundwater contamination event was noted in 1980 involving contamination south-southwest of the facility as a result of leaks at waste treatment and product storage. The effects of the ammonia contamination at the initial most elevated location appear to have been corrected from a concentration of 1000 mg/L to current levels of approximately 55 mg/L by remedial actions such as underground pipe relocation, lagoon relining, and attenuation of the source.

Groundwater monitoring data from 2004-2018 indicates that ammonia concentrations ranged from <0.1 mg/L to 157 mg/L (W-18 in January 2016) (see Section 6.1.4 for identification of well locations). Well 18 and Well 32 are located in the most concentrated portion of the nitrate plume. Natural denitrification of nitrate contamination is likely the cause of increased ammonia concentrations in these areas.

Ammonia concentrations fluctuate at wells showing ammonia detections across the site. This fluctuation in ammonia is expected because ammonia in the subsurface is thermodynamically unstable and would be oxidized to nitrate under the proper geochemical conditions. Nitrate is typically more thermodynamically stable than ammonia in groundwater.

Although the ammonia data fluctuated at each individual well because of its physicochemical characteristics in groundwater, it is apparent that the ammonia plume is stable with no evidence of expanding. Wells W-48 and W-26 upgradient from the Mill Creek did not indicate ammonia over the years and ammonia concentrations at wells W-10 and W-15 located upgradient from wells W-48 and W-26 are stable with no sign of increase in concentrations.

Additional analysis was performed in 2018 by Earthcon Consultants, Inc. who performed a Groundwater Plume Analytics™ study in addition to a Ricker Method® Well Sufficiency Analysis. The overall analysis was performed on data from 2004 to September 2018 for ammonia. There were apparent inflection points in the data, particularly in June 2011 for each COPC, which corresponded to the shutdown of the AS/SVE system. Thus plume stability trends were calculated from 2011 to 2018 for each COPC. For ammonia, Earthcon used Regression analysis to conclude with greater than 93% confidence that the plume area is decreasing. There were no identifiable trends for ammonia plume mass and average concentration.

Due to the little to no migration of the ammonia plume, the plume occurs and will only occur on the property with little to no possibility of groundwater withdrawals to create drawdown such that contaminants would flow off-site. In addition, ammonia is not considered dangerously toxic, mobile or persistent based on the historical site data and natural attenuation of ammonia is expected.

Radionuclides:

Historically, well water analysis was required as an NRC license commitment on ten surficial aquifer wells. Prior to 2018, gross alpha and gross beta were used as “indicator” tests to alert the site to the potential presence of source radionuclides uranium and Tc-99. The action levels were 15 pCi/L for isotopic uranium and 50 pCi/L for Tc-99 for gross alpha and gross beta samples, respectively. Beginning in Fall 2018, the site voluntarily added the requirement to speciate all groundwater samples for uranium by alpha spectroscopy (DOE EML HASL-300, Tc-02-RC Modified) and also ICP-MS (EPA Method 200.8), and Tc-99 by liquid scintillation (DOE EML HASL-300 regardless of the action level results. The intent of the focused sampling for uranium and Tc-99 is to analyze for COPCs that could actually be sourcing at CFFF, rather than reporting indicator values that could have other potential sources such as radon, natural uranium, and natural beta emitters reported with them, even at results below the action levels.

Radionuclides: Gross Alpha and Uranium

In looking at the plant’s history, gross alpha has exceeded the action level of 15 pCi/L (as identified in the SNM-1107 license) at least one time for 18 of the site’s existing 60 wells. The wells include: W-7, W-13, W-18R, W-22, W-23, W-28, W-30, W-32, W-33, W-39, W-41, W-43, W-44, W-45, WRW-2, W-55, W-56, and W-59. Of these detections above the action level, four wells (W-39, W-41, W-43, and W-44) can be eliminated from consideration, as the resultant contingent testing for uranium concentrations were all <2 pCi/L. Speciation above the action level of 15 pCi/L was not implemented prior to the second half of 2013. CFFF clarified this requirement in 2016 following in-person discussions with the third party analytical lab and analysis has been consistently performed since then. Of the remaining 14 wells exceeding the action level since 2013, 7 of them (W-13, W-22, W-23, W-28, W-32, W-33, RW-2) can be excluded from consideration, as the resultant isotopic U values do not exceed 15 pCi/L collectively. Speciated data available for Wells W-7 and W-18 since January 2017 indicates no exceedances of the MCL for uranium. The remaining 5 wells (W-30, W-45, W-55, W-56, and W-59) have exceeded the gross alpha action level and past CFFF operations and maintenance activities associated with the CWW line appear to be the source term. These exceedances are discussed in detail in section 4.4.1.4.

For the Oct/Nov 2018 sampling campaign, the action level contingent testing was only triggered in 4 of the 60 wells (W-30, W-55, W-56 and W-59); however CFFF elected to speciate U for all groundwater samples, regardless of whether the contingent testing was triggered. Exceedances of the drinking water MCL for uranium as measured by the EPA approved ICP-MS method occurred in W-55, W-56, and W-59 during the Oct/Nov sampling campaign. The MCL exceedances ranged from 31.1 – 187 µg/L versus the 30 µg/L MCL. Wells W-55, W-56, and W-59 are shallow wells screened in the upper surficial aquifer and situated in a line of perimeter wells located along the western edge of the building.

Existing groundwater monitoring data indicates that uranium contamination above the MCL is localized to the area immediately adjacent to the CWW. The CA and CSM will define the RI work plan actions and any subsequent required remedies through the site Remediation and CERCLA processes. The lack of contaminant detections in downgradient wells W-20 and W-25 coupled with the years of surface water data collected for the site demonstrate that there is no immediate off-site environmental impact.

Radionuclides: Gross Beta and Tc-99

An investigation in 1998 following the overflow of hydrostatic water supply tank, T-1405 identified three NRC well sampling sites that exceeded the 50 pCi/L Gross Beta action level (Well 17, Well 32, and Well 13). The hydrostatic water supply tank (T-1405) in the cylinder recertification building overflowed as a result of operator error when the employee opened the manual fill valve and left the area before turning the valve off. When the tank overflowed on the floor, some water spilled outside the building and onto the grass. As a result, some grass was excavated and an active engineered interlock was installed on top of the tank along with an alarm to minimize the potential for this type of overflow to reocccur. The corrective actions were implemented and appeared to be effective in eliminating and mitigating the source of elevated beta activity.

In 2010, two identified NRC sampling well sites exceeded the 50 pCi/L Gross Beta action level (Westinghouse 2011b). Four other wells (W10, W15, W18, W22,) which were not on the NRC sampling list at the time, also exceeded the 50 pCi/l Gross Beta limit. This elevated Gross Beta content was identified and confirmed as technicium-99 (Tc-99). The investigation evaluated potential causes from lagoon leaks, K-40 natural contamination, sampling errors, the cylinder recertification building, and adjacent surface water contamination from the concrete pad. The cylinder recertification building liquid from the hydrostatic test process appeared to have the highest potential of being a major contributor since this liquid (from remnants of activity in the cleaned cylinders) could contain elevated uranium daughter beta, Tc-99 beta, and low alpha concentrations. Further sampling and investigation of Tc-99 in groundwater was initiated in 2011 with the addition of the four abovementioned wells.

Historically, gross beta has exceeded the action level of 50 pCi/L (as identified in the SNM-1107 license) for 20 of the site's existing 60 wells. The wells include: W-6, W-7, W-10, W-11, W-13, W-15, W-16, W-17, W-18R, W-22, W-28, W-29, W-30, W-32, W-47, WRW-2, W-55, W-56, W-64, and W-67.

For the Oct/Nov 2018 sampling campaign, the action level contingent testing was only triggered in 14 of the 60 wells (W-6, W-7, W-10, W-11, W-13, W-15, W-17, W-18R, W-32, W-47, W-55, W-56, W-64, and W-67); however CFFF elected to sample for Tc-99 in all groundwater samples, regardless of whether the contingent testing was triggered.

The site-wide re-baseline campaign in Oct/Nov 2018 initiated testing in several wells that were not routinely monitored as part of sites current NPDES or NRC SNM-1107 commitments. The drinking water MCL for Tc-99 (900 pCi/L) was exceeded in two of those wells: once in W-6 (2,370 pCi/L in Jan 2019) and two times in W-11. The first suspected exceedance for W-11 came after the Oct/Nov sampling campaign. The result of 3,570 pCi/L was reported to the site after which time well redevelopment and resampling ensued to obtain a confirmatory sample. The confirmatory sample collected on Dec 5, 2018 confirmed the exceedance with a reported value of 3,640 pCi/L for Tc-99. The second exceedance of the MCL for Tc-99 in W-11 occurred during the January 2019 sampling campaign when the result was reported at 4,200 pCi/L. Wells W-6 and W-22 are a well pair situated on the southwest corner of the east lagoon. Wells W-11 and W-32 are also a well pair located south of the main plant building and on the edge of the bluff.

The lack of contaminant detections in downgradient wells W-20 and W-25 coupled with the years of surface water data collected for the site demonstrate that there is no immediate off-site environmental impact.

There is no estimation for the total quantity of Tc-99 that has leached into the groundwater; however the results to date have been input into the CSM. The CSM provides an understanding of how a contaminant release may be observed and measured currently in the site environment, and identifies the ultimate fate of the contaminant in the future. The model incorporates what is known about the site's hydrogeology, existing and past site activities that may have resulted in contaminant releases to the environment, the locations of those releases, the contaminants of concern, their fate and transport within the environment, and the receptors of those contaminants. Based upon current and historical operations, the facility has established defined Operable Units (OU) such as the manufacturing building and WWTP lagoons. Each OU will have specified groundwater monitoring wells associated with it to provide early leak detection or early indication of contaminant migration. The RI work plan due to SCDHEC on April 26, 2019 will also include a section devoted to the continued investigation of Tc-99 sources and eventual remediation, if feasible and necessary.

Issues identified through the environmental monitoring program, including the CSM and OU monitoring, are entered into the CAP program Assessment of the data follows the site's Remediation Process.

<u>Overall Groundwater and Surface Water Impacts</u>:

Numerous investigations by various engineering firms since 1980 led to the following conclusions regarding the site. The WWTP, building manufacturing operations, previous spills and leaks, and the former oil house are the likely source areas for COPCs fluoride, nitrate, uranium, Tc-99 and VOCs. While COPCs have been detected in groundwater near surface water bodies, only fluoride has been detected in Sunset Lake at concentrations exceeding MCLs. However, fluoride was not detected above the MCL at the spillway in 2008, indicating that the fluoride MCL was exceeded only in a localized area near the location of the groundwater plumes.

Surface water exits the site through a ditch and culvert system that discharges to Mill Creek. Mill Creek meanders through the wooded lands behind the CFFF property boundary until it ultimately discharges into the Congaree River. As described in Section 6.0 of this report, surface water samples are collected from six locations on the property and from four locations on the Congaree River. Figure 6.1-2 illustrates the on-site surface water sampling locations.

Surface water samples have been collected monthly since 2010 from six locations along the primary surface water flow path exiting the plant site. All six locations are monitored for uranium, Tc-99, and fluoride. In review of historical data, one sample collected in March 2015 resulted in alpha and beta measured values exceeding the action limits of 50 pCi/L and 300 pCi/L, respectively. However, much lower concentrations were detected in all upstream samples collected at the same time, and all samples collected prior to and after the March 2015 sample were much lower. These observations indicate that the analysis of this single sample was anomalous. Fluoride concentrations at the "Exit" location of surface water sampling, which is where Mill Creek exits the site's property (See Figure 6.1-2) has been less than 0.5 mg/l since February 2012. The drinking water MCL for fluoride is 4 mg/L. Therefore, there is no evidence of off-site impact from fluoride.

Since the AS/SVE system was shutdown at the end of 2010, the VOC concentrations have remained stable or decreased in the four wells that have been consistently sampled and monitored (AECOM 2013). Additional investigation is needed through the CSM and RI work plan to implement data-based decisions for future actions involving VOCs.

Based on the information presented above, the groundwater impacts of the No-Action alternative are not significant. The groundwater is confined in a shallow geologic unit that has little or no potential of being an underground source of drinking water and discharges or will discharge to surface water. Any plumes detected are confined to the property, with little to no possibility of groundwater withdrawals to create drawdown such that contaminants would flow off-site. The lack of contaminant detections in downgradient wells W-20 and W-25 coupled with the years of surface water data collected for the site demonstrate that there is no immediate off-site environmental impact.

4.4.2 Proposed Action Alternative—40 Year License Renewal

As stated in the groundwater impacts for the No-Action Alternative, any contamination that might be detected by periodic monitoring would be confined to the property, with little or no possibility of groundwater withdrawals to create drawdown for flow off-site. The lack of contaminant detections in downgradient wells W-20 and W-25 coupled with the years of surface water data collected for the site demonstrate that there is no immediate off-site environmental impact. CFFF's commitment to the implementation and maintenance of a CSM coupled with the Remediation Process will ensure COPCs do not migrate off-site during the proposed action alternative. Because of this, impacts on groundwater as a result of the proposed 40-year license renewal are not significant.

4.4.3 Mitigation

The primary Westinghouse approach for impact avoidance to water resources would be through:

- Prevention through implementation of the CFFF Chemical Safety Program which employs robust process control and best management practices for material handling;
- Safe and proper management of liquid effluents leading to and from the six wastewater treatment process lagoons;
- Implementation of the environmental monitoring program as described in Section 6.0 of this document;
- Assessment of elevated concentrations of liquid effluent constituents in surface waters and groundwater; and
- Mitigation through training and rapid response to any spills.

These mitigation methods would apply to both alternatives, regardless of the one approved by the NRC.

Westinghouse voluntarily subscribed to groundwater remediation through the installation and continuous operation of the AS/SVE system for VOC removal from 1997 through 2010. The process effectively operated to remove VOC's and perchloroethylene (PCE) contamination in the shallow surficial aquifer identified west southwest of the target area CFFF continued to monitor, study, and assess the impacts by VOCs since the discontinuance of the AS/SVE system.

Continued investigation and monitoring after 2007 indicated that that nitrate and fluoride concentrations in groundwater remain at levels exceeding the MCLs in the vicinity of well W-30 in the wastewater treatment area. In 2010 Westinghouse undertook a source investigation in the vicinity of the wastewater treatment area consisting of direct push borings to collect groundwater samples for analysis of fluoride and nitrate concentrations (AECOM 2011). Groundwater borings in May 2011 indicated the North and South Lagoons to be source of nitrate contamination. The wastewater lagoons were also a suspected source of fluoride contamination in the groundwater. Liquid waste from the conversion area is high in fluorides and is sent to URRS for treatment. The fluorides in the liquid waste are converted to calcium fluoride with the addition of lime. As a result of the boring data, Westinghouse relined four of the site lagoons in January to February 2012 in order to minimize future impacts.

Following identification of Tc-99 in the groundwater and liquid effluents in 2010, monitoring of Tc-99 continued and is included in the annual ALARA report with other radiological analysis

On February 26th of 2019, CFFF entered into a Consent Agreement (CA) with SCDHEC, which like the VCC also follows the CERCLA process. The CA will address all contaminants of potential concern including fluoride, nitrate, uranium, Tc-99 and VOCs. Groundwater around the CFFF is routinely monitored and evaluated, as described in Section 6.0.The sampling and monitoring requirements under the CA are defined in a RI work plan that will be submitted to DHEC by April 28th, 2019 and must be subsequently approved by SCDHEC prior to the start of work. Groundwater wells at the site are routinely sampled, monitored and evaluated against water quality parameters, as described in Section 6.0 of this document to comply with the site's NPDES permit. Additional locations for groundwater, surface water, soil, and sediment investigation will be defined in the RI work plan. Increasing trends and new exceedances in groundwater contamination COPCs by either NPDES or CA monitoring initiates an investigation and corrective action, which as appropriate includes mitigation response as necessary per the site's Remediation Process.

4.5 Ecological Resources Impacts

4.5.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing facilities would be constructed. No effects would occur on ecological resources.

4.5.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action of a 40-year license renewal, no new manufacturing facilities would be constructed within the CAA; therefore ecological resources would not be significantly impacted.

4.5.3 Mitigation

The primary Westinghouse approach to minimizing potential environmental impacts for avoidance to ecological resources would be through:

Prevention through implementation of the CFFF Chemical Safety Program which employs robust process control and best management practices for material handling;

- Safe and proper management of liquid effluents leading to and from the six wastewater treatment process lagoons;
- Implementation of the environmental monitoring program as described in Section 6.0 of this document;
- Assessment of elevated concentrations of liquid effluent constituents in surface waters and groundwater; and
- Mitigation through training and rapid response to any spills;
- CSM and Remediation Process

These mitigation methods would apply to both alternatives, regardless of the one approved by the NRC. Additionally, the CFFF has voluntarily partnered with the South Carolina Department of Natural Resources (SCDNR) as a Wildlife and Industry Together (W.A.I.T.) site. Members of the CFFF W.A.I.T. Team establish conservation, biodiversity, and education goals that are implemented to maintain and improve wildlife health on the site and certification with SCDNR.

4.6 Air Quality Impacts

4.6.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing activities would be constructed within the CAA. No changes to air quality in the vicinity of the CFFF would result. Gaseous effluents under the No-Action alternative have been described in Section 2.1.4 and Section 2.2.

Agricultural use of nearby land could potentially be affected by fluoride and ammonia emissions on crops, pasture grasses, and cattle. However, analysis of past projected fluoride emissions indicates that there will be no significant or observable impacts (NUREG-1118).

Although ammonia is a plant nutrient and is used in fertilizers, a very high atmospheric concentration of ammonia can adversely affect vegetation. Ammonia emissions from the plant should not present a hazard to domestic or wild animals or to public health. For significant impacts to occur on domestic animals and on land uses involving these animals, concentrations of ammonia would have to be much higher than the suggested guidelines for the protection of human health. Because the predicted ammonia concentrations at and beyond the nearest site boundary are below applicable criteria, no impact should occur (NUREG-1118).

4.6.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action of a 40-year license renewal, no new manufacturing facilities would be constructed within the CAA; therefore air quality would not be significantly impacted as compared to the no-action alternative. In addition, impacts on air quality as a result of increasing the ^{235}U possession limit and calcium fluoride release limit are not significant.

4.6.3 Mitigation

Control of gaseous effluents is described in Section 2.1.4. Gaseous effluents are normally treated by HEPA filters, scrubbers, or both prior to discharge through stacks in accordance with 40 CFR 50 and 61, and 10 CFR 20. This treatment serves as impact avoidance and also impact minimization. The impacts to air are further reduced by maintenance and improvement projects to stacks and scrubbers. For example, CFFF made some piping configuration changes to scrubber S-1008 in December 2014, which led to ammonia emissions from that unit being decreased by half. The NESHAPs regulates airborne discharges of hazardous materials. Non-radiological emissions at CFFF are regulated by SCDHEC under permit number 1900-0050-R1 (effective March 5, 2008).The CFFF permit addresses NAAQS pollutants, nitric acid, and opacity. The permit does not require monitoring. Instead, operating permit limits are based on process throughputs at rated capacities as outlined by SCDHEC in SC Air Quality Control Regulation 61-62.

Radiological emissions are regulated by NRC under 10 CFR Part 20 and by the U.S. Environmental Protection Agency under 40 CFR Part 61. Westinghouse monitors radiological gasous discharges from 47 stacks and calculates an offsite dose from the combined emissions. As part of the environmental monitoring program, Westinghouse also monitors for the presence of radioactive material in ambient air at four onsite locations.

4.7 Noise Impacts

The CFFF currently generates levels of noise commensurate with a large manufacturing facility. As noted in Section 3.7, noise from the CFFF is not detectable at the site boundary (Westinghouse 2006c).

4.7.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing activities would be constructed within the CAA. Ambient noise levels associated with existing manufacturing activities would remain relatively the same, and no impacts are anticipated.

4.7.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action of a 40 year license renewal, no new manufacturing activities would be constructed within the CAA. Ambient noise levels associated with existing manufacturing activities would remain relatively the same, and no impacts are anticipated.

4.7.3 Mitigation

None required for either alternative.

4.8 Historic and Cultural Resources Impacts

The nearest historic and cultural resource, the Denley Cemetery, is located on the site, as described in Section 3.8. The cemetery is maintained in good condition and fenced.

4.8.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing activities would be constructed within the CAA. No changes would occur to historic or cultural resources.

4.8.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action, no new manufacturing activities would be constructed within the CAA. No changes would occur to historic or cultural resources.

4.8.3 Mitigation

None required for either alternative.

4.9 Visual/Scenic Resources Impacts

4.9.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing activities would be constructed within the CAA. No changes would occur to nearby visual/scenic resources.

4.9.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action, no new manufacturing activities would be constructed within the CAA. No changes would occur nearby visual/scenic resources.

4.9.3 Mitigation

None required for either alternative.

4.10 Socioeconomic Impacts

4.10.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing activities would be constructed within the CAA. There would be no changes to the regional economy and population, and no socioeconomic changes would occur.

The CFFF provides significant local employment, provides tax revenues, is partnered with local schools (i.e., Mill Creek Elementary), is active in the community, is a major supporter of the United Way, as well as provides training and support to local emergency response organizations.

The number of persons expected to be employed by Westinghouse is not expected to increase significantly over current employment levels. In the long term, the CFFF operations would continue to have a beneficial socioeconomic impact on the nearby community.

4.10.2 Proposed Action Alternative—40 Year License Renewal

Under the Proposed Action, no new manufacturing activities would be constructed within the CAA. There would be no changes to the regional economy and population, and no socioeconomic changes would occur.

The CFFF provides significant local employment, provides tax revenues, is partnered with local schools (i.e., Mill Creek Elementary), is active in the community, is a major supporter of the United Way, as well as provides training and support to local emergency response organizations.

The number of persons expected to be employed by Westinghouse is not expected to increase significantly over current employment levels. However, an approved license extension could offer economic stability to the local and state economy as well as Westinghouse employees for an additional 40 years. In the long term, the CFFF operations would continue to have a beneficial socioeconomic impact on the nearby community.

4.10.3 Mitigation

None required for either alternative.

4.11 Environmental Justice

The evaluation of environmental justice impacts is predicated on the identification of high and adverse impacts in surrounding areas, followed by a determination if those impacts would affect minority and low-income populations disproportionately. Previous analyses of impacts from operating the CFFF facility do not indicate high and adverse impacts for any of surrounding areas. It must be noted, however, that the CFFF exists in a section of Richland County (Census Tract 118) that has higher levels of minority and/or low-income populations compared with Richland County as a whole, and SC. Therefore, the nearest human receptors (other than occupational exposures) of any radiological or non-radiological impacts resulting from operational or accidental discharges from CFFF operations would likely be to minority and/or low-income populations.

4.11.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing activities would be constructed within the CAA. There would be no changes to the regional economy and population. No socioeconomic-related changes would occur, and there would be no changes to existing environmental conditions. Therefore, the No-Action alternative would not result in any environmental justice impacts.

4.11.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action, no new manufacturing activities would be constructed within the CAA. There would be no changes to the regional economy and population. No socioeconomic-related changes would occur, and there would be no changes to existing environmental conditions. Therefore, the proposed action would not result in any environmental justice impacts.

4.11.3 Mitigation

Mitigation measures to minimize radiological and non-radiological emissions including monitoring are expected to result in emissions from the CFFF that are "As Low As Reasonably Achievable" (ALARA). No additional mitigation measures are required to protect against environmental justice impacts.

4.12 Public and Occupational Health Impacts

A Preliminary Human Health Risk Assessment (HHRA) previously was performed at the CFFF in 2014 as part of a Preliminary Baseline Risk Assessment (BRA), which included both HHRA and Ecological Risk Assessment (ERA) components. The 2014 Preliminary HHRA was based on data collected at the site between 2008 and 2013. This Preliminary HHRA was updated (AECOM 2019b) based on recent data collected in 2018 to review potential migration pathways for contamination, exposure routes and potential receptors and to inform the Remedial Investigation being performed by Westinghouse as part of the February 26, 2019 Consent Agreement with DHEC. The updated report includes the initial steps of the HHRA process, consisting of an evaluation of the exposure setting, development of a preliminary conceptual site model, and conservative screenings of recent data collected at the site. The results of the Preliminary HHRA will be used, in consultation with DHEC to determine if additional data need to be collected and/or additional steps in the HHRA process need to be performed. As additional site-specific information is gathered, the HHRA will continue to be updated in order to define or modify risks and hazards, and to calculate the most accurate pathways that may lead to potential exposure.

4.12.1 No-Action Alternative

Under the No-Action alternative, no new manufacturing activities would be constructed within the CAA. There would be no changes to environmental conditions at the CFFF that have potential public and/or occupational health hazards.

4.12.1.1 Non-radiological Impacts

For the workforce, industrial accidents can occur, as is the case in all work environments. A total of 5,147 workers died from a work-related injury in the U.S. in 2017, down slightly from the 2016 total of 5,190. About 2.8 million nonfatal workplace injuries and illnesses were reported by private industry employers in 2017, occurring at a rate of 2.8 cases per 100 full-time workers. Both the number of injuries and illnesses and the rate of these cases declined from 2016. The Occupational Safety and Health Act of 1970 provides OSHA the authority to prescribe and enforce standards and regulations affecting the occupational safety and health of private- sector employees. The CFFF operates in compliance with OSHA regulations, and has an aggressive worker safety management program in place. There has never been a death at the CFFF. CFFF statistics at the end of 2017 and 2018 yielded an Industrial Safety Accident Rate (ISAR) of 0.31 for 3 cases and 0.70 for 7 cases, respectively. Although all work activities are conducted in as safe a manner as possible, there is a chance that workers could be accidentally killed or injured under the No-Action alternative, unrelated to any radiation or chemical exposures.

4.12.1.2 Radiological Impacts

4.12.1.2.1 Pathway Assessment

Potential health impacts to members of the general public could occur if material released from the CFFF entered the environment and was transported from the site through the air, surface water, or groundwater. Off-site releases of uranium, because of the low specific activity of uranium, are expected to be small based on current and historical sampling data.

4.12.1.2.2 Public and Occupational Exposure

Calculated radiological doses to the public from the CFFF operations are primarily from the air emissions. Over 99 percent of the offsite dose originates from the airborne pathway (Westinghouse, 2012). CFFF stack emissions would result in a total effective dose of less than 0.16 mrem to a hypothetical exposed individual living at the site boundary (Westinghouse 2013). This dose is less than the ALARA goal in NRC Regulatory Guide 8.37 and SCDHEC Licensing Guide, "ALARA Levels for Effluents from Materials Facilities" (10 mrem/year); less than the "dose constraint" level in 10 CFR 20.1101(d), and less than the investigation level in Westinghouse procedures of 1 mrem/yr. Air emissions from the CFFF are routinely monitored, the results are trended, and corrective actions are taken if necessary to ensure that emissions remain ALARA.

Radiological Exposures to the public from CFFF operations are primarily via air emissions results of which are described above. Based on using the TEDE compliance option, the contribution of dose from the liquid discharges will be negligible at the present liquid discharge levels (less than approximately 0.0002 mrem/year). Control of liquid discharges is based on adherence with ALARA principles and compliance with Westinghouse Procedures and NRC Regulatory Guide 8.37. Note that the liquid effluent dose is not the major pathway in individual off-site dose calculations. Approximately 99 percent of the off-site dose originates from the airborne pathway.

4.12.1.3 Potential Impacts of Accidents

In accordance with 10 CFR Part 70, Subpart H, Westinghouse performed an Integrated Safety Analysis (ISA) (Westinghouse 2012a). An ISA is defined in 10 CFR 70.4 as “a systematic analysis to identify facility and external hazards and their potential for initiating accident sequences, the potential accident sequences, their likelihood and consequences, and the items relied on for safety.” Items relied on for safety are structures, systems, equipment, components, and activities of personnel that prevent potential accidents that could exceed the performance requirements in 10 CFR 70.61.

Accidents that could occur at the CFFF under the No-Action alternative are both radiological and non-radiological in nature. The fabrication of fuel for nuclear reactors involves the chemical processing of low-enriched uranium. Significant radioactive materials present at the fuel fabrication facility, Uranyl Nitrate stored in external tanks, are the UO_2 pellets for fuel rod fabrication and the UF_6 stored in cylinders. The 4.5 to 5 percent enriched uranium that is used has a low specific activity of 2.4 pCi/g. Thus, with the exception of a criticality accident and the potential rupture of UN storage tanks or UF_6 cylinders, the environmental impacts which would result from postulated accidents at CFFF would be similar to the impacts of a manufacturing plant in which nonradioactive chemicals are stored.

The hazards posed by these materials are evaluated in the ISA for the associated systems or process operations. The bounding maximum consequence basis accidents for the CFFF are:

- Liquid System Criticality
- Dry System Criticality
- Soluble Uranium Release
- Insoluble Uranium Release
- Aqueous Ammonia Release
- Hydrofluoric Acid Release
- Nitric Acid Release
- Chlorine Release
- Hydrogen Explosion
- Fuel Oil Fire
- Natural Phenomena Hazards

The NRC prepared a Safety Evaluation Report (SER) regarding the CFFF to evaluate the potential adverse impacts of continued operation of the facility to the worker and public health and safety, under both normal operating and accident conditions (NRC 2007b). The review also considered physical protection of SNM, material control and accounting of SNM, and the management organization, administrative programs, and financial qualification proved to ensure the safe design and operation of the facility. The NRC staff concluded in the SER that “the licensee’s [Westinghouse] descriptions, specifications, and analyses provide an adequate basis for the safety and safeguards of facility operations, and that continued operation of the facility does not pose an undue risk to worker and public health and safety.”

Use of anhydrous ammonia at CFFF was eliminated in August 2011, and replaced by aqueous ammonium hydroxide (Westinghouse 2019). This resulted in a reduction in chemical hazard risk.

For the purpose of the ER, additional information regarding potential accidents is provided in the remainder of this section. A spectrum of possible accidents related to the operation of CFFF and their potential consequences are presented in Table 4.12-1 (NUREG-1118, Westinghouse 2019d). Accident severity is classified into three categories. Category 1 accidents are those most likely to occur during normal plant operations, and have the least environmental impacts of the three. Category 2 events, which would occur infrequently during the plant's operating life, could release concentrations of radiological and non-radiological pollutants to the onsite (and possibly offsite) environment that would exceed normal effluent releases and could cause significant impacts, if not controlled or mitigated. Category 3 accidents are those not expected to occur during the life of the plant but which could result in significant releases of radioactive or toxic pollutants to the onsite and offsite environment. Westinghouse (1975, 1983 and 2019) has analyzed the radiological and non-radiological consequences of several accident scenarios, both inside the manufacturing plant and outside the plant (e.g., storage areas, lagoons, etc.).

Table 4.12-1 Potential CFFF Accidents

Area and Material Involved	Typical Accidents	Severity Class	Release(s) of Concern
Tank farm Ammonium hydroxide Sodium hydroxide Nitric acid	Pipeline or tank leak; rupture, spills, fire	1, 2	Ammonia Nitrate Caustic and acid solutions
Lagoons Ammonium nitrate Calcium fluoride Uranium	Leak, massive dike/liner failure, flooding	1, 2	Ammonia Nitrate Fluoride Uranium
Outside-storage/inside-vaporization area Uranium hexafluoride (solid, liquid, vapor) Uranyl nitrate	Ruptured cylinder, vapor release Ruptured tank	1, 2 3	Uranium, hydrogen fluoride Uranium Nitrate
Chemical and manufacturing areas Uranium Uranium dioxide Ammonium diuranate Hydrogen fluoride Hydrogen	Pipeline or container rupture, spills, explosions, fires, filter failure criticality Explosion	1, 2, 3 3	Uranium Ammonia Fluoride Uranium
Transportation	Container rupture, spills	1, 2	Uranium Miscellaneous chemicals

Source: NUREG-1118

4.12.1.3.1 Radiological Accidents

Although several minor accidents are likely to happen during the life of the plant (e.g., a small leak in a pipeline or a small spill), most will not result in a significant release of uranium to the environment. Therefore, the accident analysis in support of this assessment is limited to the consideration of severe, low-probability accidents that could potentially result in the release of large quantities of radioactivity, a UN release, a UF_6 release or a criticality accident. The radiological consequences of a major fire and a transportation accident are also evaluated. The dose estimates presented below are based on information presented in Westinghouse 1975, 1983, 2019d and NUREG-1118.

<u>UN Release</u>
A spill from a ruptured full UN tank would contain approximately 7800 gallons of uranyl nitrate at an assumed concentration of 6g U235/l or approximately 120 gU/l at an enrichment of 5.0% U-235. Further assuming that approximately 75% of the material would be precipitated out or adsorbed by the soil, and approximately 25 % of the uranium was solubilized and transported to the storm drain and Sunset Lake with a volume of approximately 43 million gallons.

The resultant release to Sunset Lake would be estimated to be 3 Ci of material and a resultant concentration of 1.85 E-05 uCi/ml in Sunset Lake. An individual would have to drink approximately 5 liters of lake water to get an uptake of 30 mg U. Since Sunset Lake is not a potable water source and is totally enclosed on Westinghouse property, it is not reasonable to expect that an off duty employee or a member of the public would reach this exposure threshold. Nor would it be possible for a worker or member of the public to get a 25 Rem dose as a result of a loss of a UN tank.

Unmitigated circumstances in this instance constitutes the assumptions both of failure of the tank wall potentially contributing to the rupture, and the absence of the dike which encloses the UN bulk storage tank array. Under these circumstances, it can be shown that the concentration of radioactivity potentially released to the site ground water is in excess of 5000 times the 10CFR20 Appendix B Table 2 limiting effluent concentration in water for U-234, U-235, and U-238, viz., 3×10^{-7} μCi/ml. This constitutes an intermediate consequence event as defined in 10CFR 70.61.

A solution containing 6g U235/l or approximately 120 gU/l at an enrichment of 5.0% U-235 would contain the following activity concentrations [μCi/ml]:

Table 4.12-2 UN Typical Isotopic

Isotope	[μCi/ml]	5000 X 10CFR 20 limit [μCi/ml]
U-234	3.3e-1	1.5e-3
U-235	1.3e-2	1.5e-3
U-236	2e-4	1.5e-3
U-238	4e-2	1.5e-3

Three of the isotopic concentrations listed are in excess of 5000 times the corresponding 10CFR20 Appendix B Table 2 limiting effluent concentration in water. Although it is doubtful that material would be available to the groundwater, a conservative approach has been taken and an assumption has been made to address the worst case situation by declaring Items Relied on for Safety (IROFS) for the system. The tanks are surrounded by a dike designed to capture the release from a ruptured tank. There is a shutoff valve designated the "C" valve which emergency procedures require be closed in the event of a spill that will prevent flow into Sunset Lake.

UF_6 Release

Shipping cylinders of UF_6 (2.27 MT [2.5 tons]) are stored inside the manufacturing building or in a secured outdoor area. The UF_6 is a solid at ambient temperatures (sublimes at 56° C [132°F]) and is only heated and vaporized inside the CFFF Chemical Area. Therefore, the possibility of an outdoor release of liquid UF_6 is extremely remote. If a cylinder of solid UF_6 were to fail outside, for any reason, the UF_6 would vaporize very slowly. Because UF_6 reacts with atmospheric moisture to form uranyl fluoride (UO_2F_2), which is a nonvolatile solid, such a leak would tend to be self-sealing. Therefore, the quantity of material released from such an accident involving a cylinder of solid UF_6 would not contribute significantly to the plant's normal emissions, and the potential offsite consequences would not be a concern.

Although highly unlikely, an accident resulting in a massive outdoor release of UF_6 was postulated as the maximum credible UF_6 accident (NUREG-1118) . Such an accident would involve a fire in the UF_6 outside storage area when a truck crashes there and ruptures two of the UF_6 cylinders. A fire results when the truck's fuel tank is ruptured by the crash. The resulting release of UF_6 is estimated to be about 1260 kg (2,778 lb) over a one-hour period, assuming no remedial action is taken. This equates to a total release of 860 kg (1,896 lb) of low-enriched (<5 wt-% ^{235}U) uranium.

The UF_6 gas volatilized by the fire would react with water vapor in the air to form hydrogen fluoride (HF) gas, and uranyl fluoride (UO_2F_2) particulates. The resultant cloud would rise at least 30 m (100 ft) above the site, primarily driven by the thermal expansion of heated air and combustion products from the burning truck fuel (NUREG-1118). The accident is assumed to occur under adverse meteorological conditions including an F type of atmospheric stability and a light wind blowing at 1 m/s. With a ground-level release and a dilution effect caused by building wake turbulence, the X/Q at the nearest residence (1000 m to the northeast) is 2.33×10^{-4} s/m^3. Under these atmospheric conditions, UO_2F_2 and HF could move downwind in a narrow, unwavering plume. The plume would be a dense white cloud which would be highly visible at the nearest residence during the day. The average concentration of uranium and HF as the plume passes through this location would be about 60 mg/m^3 and 20 mg/m^3, respectively.

HF is a corrosive vapor, and exposure to concentrations of 25 mg/m^3 for several minutes is known to cause respiratory discomfort (NAS, 1971). Brief exposure to 40 mg/m^3 of HF is dangerous to life; exposure to 100 mg/m^3 of HF for 1 minute is considered epidemiologically significant (Sunshine, 1972). Therefore, the calculated HF concentration at the nearest residence may cause some respiratory discomfort (prompting a person to flee), but would not be life-threatening.

If an adult at the nearest residence stood in the plume and endured this discomfort for an entire hour, there would be an intake of soluble uranium of approximately 50 mg. The chemical toxicity of this intake would likely cause kidney injury (Eve, 1964) but would be well below the potentially fatal uranium intake of 160 mg (Luessenhop, 1958). The radiation dose associated with this intake would be insignificant.

Criticality Accident (Westinghouse 2019d)

A criticality accident at a low enriched uranium fuel processing plant is considered to be a highly unlikely event owing to the double contingency principle invoked in criticality safety. The Westinghouse Integrated Safety Analysis addresses the potential for inadvertent criticality accidents in the major uranium processing areas. Controls are established as Items Relied On For Safety to ensure that any such accident sequence will be highly unlikely to occur. Nonetheless, this analysis estimates the offsite consequences of an inadvertent criticality at the Columbia Fuel Fabrication Facility, this analysis is consistent with the Nuclear Regulatory Commission's Regulatory Guide 3.34.

The Integrated Safety Analysis (Westinghouse 2019d) describes the following characteristics of and assumptions for a criticality accident at the CFFF:

- 10^{19} fissions are produced in a series of pulses within a supercritical liquid system over an 8-hour period.
- Volatile fission products are released and radioactive decay begins.
- 25 percent of the halogens and 100 percent of the noble gases are released from the

manufacturing building.
- Atmospheric conditions feature F-type atmospheric stability, wind speed at 1 m/s, and building wake effect.

For the worst case analysis, Reg. Guide 3.34 suggests using an F-stability class and 1 m/s wind speed. Alternatively, the Environmental Protection Agency's (EPA) Risk Management Plan (RMP) guidance suggests a wind speed of 1.5 m/s for this case. The RMP methodology also suggests using D-stability class and 3 m/s for a more realistic scenario, which results in more dilution in a given distance. For radiological releases, one is interested in the distance at which representative individual dose equivalent equals 5 rem TEDE. Total Effective Dose Equivalent TEDE is the summation of contributions from prompt gamma, prompt neutron, and plume radiation doses. From the plume, there is an external whole body dose contribution from gamma rays, and internal dose contributions from inhalation of radioactive particles. Prompt gamma and prompt neutron dose are calculated by equations presented in Reg. Guide 3.34.

Table 4.12-3 summarizes the lengths of the radiological hazard zones for various meteorological and criticality conditions.

Table 4.12-3: Summary of Hazard Zone Distances

Type of Criticality	Atmospheric Stability Class	Wind Speed (m/s)	Distance to 5rem TEDE Boundary (m)	Distance to 100mrem TEDE Boundary (m)
Liquid	F	1	744	6180
Liquid	F	1.5	681	5890
Liquid	D	3	346	2420

The liquid criticality is assumed to occur in the uranyl nitrate tanks just outside the south wall of the plant. For such a postulated accident, dose estimates were determined at the nearest site boundary and at each of four environmental samplers on site. Table 4.12-4 lists the distances from each criticality accident to the receptor points while Table 4.12-5 lists the dose estimates for the various accident conditions at these receptors.

Table 4.12-4: Distances to Various Receptors

Type of Criticality	Site Boundary Distance (m)	Sampler #1 Distance (m)	Sampler #2 Distance (m)	Sampler #3 Distance (m)	Sampler #4 Distance (m)
Liquid	629	1015	729	415	622

Table 4.12-5: Dose Estimates at Various Receptors

Type of Criticality	Atmos. Stability	Wind Speed (m/s)	Site Boundary Dose (rem)	Sampler #1 Dose (rem)	Sampler #2 Dose (rem)	Sampler #3 Dose (rem)	Sampler #4 Dose (rem)
Liquid	F	1	6.91	3.21	5.49	12.7	7.03
Liquid	F	1.5	5.65	2.62	4.49	10.2	5.75
Liquid	D	3	1.49	0.577	1.11	3.44	1.53

The analysis estimates above demonstrate that the offsite consequences (at the site boundary) from this accident would be well within 10 CFR Part 70 regulatory limits for a highly unlikely accident of 25 Rem.

Transportation Accidents

Transportation of special nuclear materials is strictly regulated by the DOT (NRC, 1977a and 10 CFR 50 and 71), and package design and specifications must be approved by the NRC. Containers must be designed to withstand hypothetical accident conditions applied sequentially in an order specified in the regulations to determine the cumulative effect on the container being tested. Criteria include free drops, punctures, thermal stress, and water immersion tests. These tests, which are more severe than any expected transportation accidents, make the probability of release of contents or accidental criticality very small. In addition, to ensure that all packages are properly prepared for shipment, the applicant must establish, maintain, and execute a quality assurance program (10 CFR 71) that satisfies applicable criteria (10 CFR 50). The special nuclear materials are transported in dedicated vehicles specifically designed for the purpose of assuring nuclear safety and material accountability and security.

The environmental effects of transportation accidents involving properly packaged radioactive materials have been analyzed and documented (NRC, 1975 and 1977b). These analyses show that the radiological risk from transportation accidents involving radioactive materials does not contribute appreciably to the accident consequences.

Major Fire (Westinghouse 2019d)

The bounding fire evaluated in the facility Integrated Safety Analysis in the Conversion Enclosure Containment ventilation system could result in a release of insoluble uranium to the environment. Depending on the fraction of total available uranium released, the heat of combustion, and the meteorological conditions at time of the release, this material might cause some adverse effect on site personnel and the public. The maximum total available licensed material has been determined to be 10 kg of uranium on the filters and 10 kg of uranium in the plenum.

This postulated Plant Ventilation System fire is assumed to release insoluble uranium to the atmosphere. This radioactive cloud or plume spreads and mixes with the air as the prevailing wind moves it in a given direction. Hence, the concentration of plume contaminants decreases with distance from the source. A Gaussian plume dispersion model was used to calculate radioactive plume concentrations downstream from the source.

For the worst case analysis, F-stability class and 1m/s wind speed are assumed. Alternatively, the Environmental Protection Agency's (EPA) Risk Management Plan (RMP) guidance suggests a wind speed of 1.5m/s for this case. The RMP methodology also suggests using D-stability class and 3m/s for a more realistic scenario, which results in more dilution in a given distance.

A worst case roof filter fire could result in the release of 20 kg of insoluble uranium. After dilution due to plume transport, the internal dose to the lung of downwind individuals is determined using the equation described in the previous section. The radiological consequence information (rem) is provided in Table 4.12-6. The acute dose to a worker is assumed to be less than 25 rem CEDE, based on an assumption that most of a roof release would go over the workers' heads and/or they would be protected by being in a building until they are evacuated to a safe, upwind location.

Table 4.12-6: Insoluble Uranium Release Radiological Consequences

Atmospheric Stability Class	Wind Speed (m/s)	Distance to 5rem CEDE Boundary (m)	Distance to 100mrem CEDE Boundary (m)	Site Boundary Dose (rem)
F	1	140	7590	2.36
F	1.5	<50	5510	1.58
D	3	<50	1230	0.308

The results demonstrate that this bounding fire scenario is well below the 10 CFR 70 threshold of 5 Rem for an intermediate or high consequence event to the public.

Underground Transmission Pipelines

Two companies operate transmission pipelines in the Columbia area: Dixie Pipeline of Atlanta, Georgia, which operates propane transmission pipelines and Dominion Carolina Gas Transmission (formerly South Carolina Pipeline Corporation), which operates natural gas transmission pipelines. The propane transmission pipeline owned and operated by Dixie Pipeline runs north of Columbia near I-20 in an east-west direction and is not near the CFFF site. A natural gas transmission pipeline, owned and operated by Dominion Carolina Gas Transmission, runs just north of the CFFF site along the high power electric line right of way and is approximately 2,800 ft north of the main manufacturing building (Westinghouse 2019d). Westinghouse contracted ABS Consulting to perform an analysis of a potential pipeline rupture. The scope of this study was to evaluate the dispersion of natural gas from a postulated pipeline rupture, perform explosion calculations, plot pressure contours and estimate damage to the Westinghouse Main Building.

This analysis predicts that the Main Building would receive Low Damage due to the postulated scenario. The low blast loads are below the level at which window breakage would be expected, so it would be likely that the Main Building would not have any observable damage. Based upon this conclusion, no release is anticipated to occur (Westinghouse 2019d).

4.12.1.3.2 Non-radiological Accidents

Environmental impacts that may occur at a low-level-enrichment nuclear fuel fabrication plant would most likely result from possible accidents associated with potentially harmful chemicals rather than from radioactive materials. Thus, the CFFF under the No-Action alternative can be considered in the same class as any other manufacturing plant where significant quantities of nonradioactive chemicals are processed. A summary of the location and quantity of chemicals stored onsite is included in Appendix B, Table B-1.

Category 1. Category 1 accidents within the manufacturing building in the chemical processing area would be typified by minor liquid spills (i.e., 40 L [10 gal] or less) of acids, ammonium diuranate, uranyl nitrate, and oil. Operators can quickly detect these spills and take corrective action (such as isolation of the leaking section). The spilled liquids would be quickly cleaned up and transferred to appropriate waste containers or, if appropriate, returned to the process for recovery. No floor drains are present in the chemical processing area of the main plant building; therefore, there would be no release to the environment through either airborne or liquid pathways.

Category 1 accidents external to the manufacturing building that are likely to happen during the life of the plant include minor process-equipment leaks or small spills (200 L [50 gal] or less). A leak of this type would be located rapidly by operators, and corrective action would be implemented. Another Category 1 accident could result from the release of chemicals by a leak in the liner of a waste-holding lagoon. Such a release would contaminate underlying soil and groundwater. The contaminated groundwater would discharge into Sunset Lake and the small onsite pond. Depending on the magnitude of the release and the contaminants present, concentrations could rise to levels that are hazardous to aquatic life.

Category 2. Category 2 accidents occurring in the chemical storage areas outside the manufacturing building could result in complete or partial emptying of a bulk chemical storage tank. Such a release is considered very unlikely because storage vessels are designed using good engineering practices and are filled according to safe operating procedures. To experience a rupture or failure, some unforeseen catastrophic disaster would have to occur, or all current safety systems would have to deteriorate simultaneously. Nevertheless, the most conceivable release scenarios involve 1) exposure of the storage vessels to an intense, prolonged fire with subsequent release of vapors through pressure relief valves and 2) tank rupture caused by a projectile from an adjacent explosion.

In 1975, protective dikes that could contain approximately 136,000 L (36,000 gal) of a liquid release in the event of complete tank failure were placed around the chemical tank farm. The dikes were further upgraded in 1982 to assure that leaks do not reach the groundwater. Any overflow would run through the storm drainage ditch to Upper Sunset Lake, where it would mix and flow into Lower Sunset Lake via a causeway. Lower Sunset Lake drains into Mill Creek, which eventually enters the Congaree River via a meandering route of about 11 km (7 miles). In the event of a major spill, the upper lake can be closed off at the causeway and then diluted by increasing the diverted flow of incoming Mill Creek water. The continuous chemical monitoring and prompt dilution of these waters can prevent significant liquid releases to the offsite environment.

Airborne concentrations of vapors in the release area could be excessive, but after dispersion in the atmosphere, concentrations at the site boundary would not likely require isolation of offsite areas or temporary evacuation of residents. Some of the potential vapors, such as ammonia and hydrogen fluoride, have pungent suffocating odors which would force people away and aid in limiting offsite exposures.

Category 3. These accidents are catastrophic in magnitude and are not expected in the plant's lifetime. All are extremely unlikely; they would involve either container rupture, failure, explosion, fire, natural disaster, or an extremely improbable criticality-type accident. The potential consequences of such accidents have been discussed previously.

4.12.2 Proposed Action Alternative—40 Year License Renewal

Under the Proposed Action, no new manufacturing activities would be constructed within the CAA. Because the 40-year renewal is an extension of time of the existing permit, the radiological, non-radiological, and accident impacts all addressed in the No-Action Alternative apply to the

Proposed Action as well. Consequently, there would be no changes to environmental conditions at the CFFF that have potential public and/or occupational health hazards.

4.12.3 Mitigation

Under both the No-Action alternative and the Proposed Alternative, management and regulatory controls such as the Consent Agreement, CFFF ALARA program, NPDES program, air permit, etc. minimize the impact of public and occupational health effects. Under both alternatives, additional programs would be in place to limit gaseous, liquid and solid waste effluents to below applicable regulatory limits. The environmental monitoring program as part of the consent agreement and described in Section 6.0 would be continued to ensure concentrations of hazardous materials in the environment remain below acceptable levels to protect public and occupational health. Should abnormal increases in any concentrations be detected, the conditions contributing to such increases would be evaluated and the appropriate mitigation measures taken.

4.13 Waste Management Impacts

4.13.1 No-Action Alternative

Under the No-action alternative, no new manufacturing activities would be constructed within the CAA. There would be no changes to levels of wastes generated at the CFFF and, therefore, no effects on waste management at the CFFF.

4.13.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action, no new manufacturing activities would be constructed within the CAA. There would be no changes to levels of wastes generated at the CFFF and, therefore, no effects on waste management at the CFFF.

4.13.3 Mitigation

Waste management under the both alternatives would be in accordance with applicable state and Federal regulations. Since no new facilities will be constructed, no significant change in waste generation is expected. For nonradioactive materials and where feasible, waste generation is avoided by internal reuse and recycling such as pallet reuse. Where waste generation can not be avoided, impacts are minimized by establishing external recycling partnerships such as those for reusing pallets “as-is” and also for recycling low density plastic films so that waste generation impacts can be reduced. These same principles are employed with the radioactive materials. The CFFF generates both combustible and non-combustible materials during the manufacture of nuclear fuel. Uranium containing combustible materials are incinerated on site and the ash and clinker residue is leached (chemically reacted with nitric acid) to remove uranium in the form of uranyl nitrate. This material is not considered a waste since the uranyl nitrate is recycled / reused by the facility. Combustible materials are packaged in compatible containers, assayed for grams ^{235}U, and stored to await incineration. Alternately, CFFF may ship uranium containing combustible materials or ash to other licensed facilities for processing to recover the usable uranium. The non-combustible wastes are either prepared for burial or decontaminated for reuse, recycle, or release from the plant. Wastes consigned to disposal are shipped to a licensed disposal facility. Shipments are made in compliance with all applicable NRC, DOT, EPA and State regulations; and, in conformance to disposal site criteria. Figure 2.1-7 shows the process flow for the handling of solid contaminated wastes, including LLRW.

Hazardous wastes such as degreasing solvents, lubricating and cutting oils, and spent plating solutions are generated at CFFF. These wastes are regulated under 40 CFR Part 261, Identification and Listing of Hazardous Waste; 40 CFR Part 262, Standards Applicable to Generators of Hazardous Waste; and South Carolina Hazardous Waste Regulations R61-79.261. Hazardous Waste Generation Reports are provided quarterly and the waste is disposed of offsite through permitted contractors.

4.14 Impacts by Forest Management and access to private properties behind the CFFF site.

4.14.1 No-Action Alternative

Forest management activities have an overall positive impact on the site. Logging is an important part of sustainable forestry and ecosystem management. The increases in transportation on SC-48 is one of the few negative impacts that results from logging activities along with additional carbon emissions. The transportation, however is negligible compared to the 1250 employees already commuting to the site daily. Forest management has been practiced on the Westinghouse site for decades and prior to the construction of the nuclear facility. Forest management activities are independent of the manufacturing operations and therefore have no impact on the no action alternative.

4.14.2 Proposed Action Alternative—40 Year License Renewal

Under the proposed action, forest management is independent of the manufacturing operations and therefore has no impact on the forty year license renewal.

4.14.3 Mitigation

None required for either alternative.

5.0 MITIGATION MEASURES

This section summarizes mitigation measures under the No-Action Alternative and Proposed Alternative identified in Section 4.0, *Environmental Impacts*.

5.1 Land Use Mitigation Measures

None required for either alternative.

5.2 Transportation Mitigation Measures

Transportation activities are a vital aspect of manufacturing that cannot be avoided; however negative impacts can be minimized by following established regulations. All shipments of nuclear materials, chemicals and wastes would be carried out in conformance with NRC, DOT, and SC requirements. Trucks used for transport would be of the design and size deemed appropriate by the applicable regulations, and subject to the necessary inspections and maintenance to ensure safe transport. Site access roads and loading areas would be paved, minimizing the potential for fugitive dust generation by truck traffic. . These mitigation methods would apply to both alternatives, regardless of the one approved by the NRC.

5.3 Geology and Soils Mitigation Measures

None required for either alternative.

5.4 Water Resources Mitigation Measures

Environmental investigations have been performed at CFFF over the last 40 years and have included assessments of groundwater, surface water, soil, and sediment. COPCs have been identified as fluoride, nitrate, gross alpha, gross beta, uranium, Tc-99 and the VOCs PCE, TCE, cis-1,2-DCE, and VC. Investigative activities have identified the WWTP, manufacturing operations within the building, contaminated wastewater system piping, and the Former Oil House as potential sources of the contamination. Potential groundwater impacts include the degradation of groundwater quality because of process or raw material leaks or spills into the soil.

The primary Westinghouse CFFF approach to minimizing potential environmental impacts to water resources is through the following measures:

- Prevention through implementation of the CFFF Chemical Safety Program which employs robust process control and best management practices for material handling;
- Safe and proper management of liquid effluents leading to and from the six wastewater treatment process lagoons;
- Implementation of the environmental monitoring program as described in Section 6.0 of this document;
- Assessment of elevated concentrations of liquid effluent constituents in surface waters and groundwater; and
- Mitigation through training and rapid response to any spills;
- CSM and Remediation Process.

Liquid effluent monitoring requirements at the CFFF are in accordance with both the NPDES permit requirements and NRC part 20 requirements, as described in Section 6.0 of this document.

Numerous investigations by various engineering firms since 1980 led to the following conclusions regarding the site. The WWTP, building manufacturing operations, previous spills and leaks, and the former oil house are the likely source areas for COPCs fluoride, nitrate gross alpha, gross beta, uranium, Tc-99 and VOCs. While COPCs have been detected in groundwater near surface water bodies, only fluoride has been detected in Sunset Lake at concentrations exceeding MCLs. However, fluoride was not detected above the MCL at the spillway in 2008, indicating that the fluoride MCL was exceeded only in a localized area near the location of the groundwater plumes. Fluoride concentrations at the "Exit" location of surface water sampling, which is where Mill Creek exits the site's property (See Figure 6.1-2) has been less than 0.5 mg/l since February 2012.

Since the AS/SVE system was shutdown at the end of 2010, the VOC concentrations have remained stable or decreased in the wells that have been consistently sampled and monitored. Additional investigation is needed through the CSM and RI work plan to implement data-based decisions for future actions involving VOCs.

Based on the information presented above, the groundwater impacts of the No-Action alternative are not significant. The groundwater is confined in a shallow geologic unit that has little or no potential of being an underground source of drinking water and discharges or will discharge to surface water. Any plumes detected are confined to the property, with little to no possibility of groundwater withdrawals to create drawdown such that contaminants would flow off-site. The lack of contaminant detections in downgradient wells W-20 and W-25 coupled with the years of surface water data collected for the site demonstrate that there is no immediate off-site environmental impact.

There is no indication from environmental sampling activities that COPCs have the potential to impact areas off-site. The CA and CSM will define the RI work plan actions and any subsequent required remedies through the site Remediation and CERCLA processes.

5.5 Ecological Resources Mitigation Measures

The environmental monitoring program described in Section 6.0 is designed to identify any unexpected buildup of radioactive and chemical concentrations in environmental media. Additionally, the CFFF has voluntarily partnered with the South Carolina Department of Natural Resources (SCDNR) as a Wildlife and Industry Together (W.A.I.T.) site. Members of the CFFF W.A.I.T. Team establish conservation, biodiversity, and education goals that are implemented to maintain and improve wildlife health on the site and certification with SCDNR.

5.6 Air Quality Mitigation Measures

Control of gaseous effluents is described in Section 2.1.4. Gaseous effluents are normally treated by HEPA filters, scrubbers, or both prior to discharge through stacks in accordance with 40 CFR 50 and 61, and 10 CFR 20. This treatment serves as impact avoidance and also impact minimization (Westinghouse 2006c). The impacts to air are further reduced by maintenance and improvement projects to stacks and scrubbers. For example, CFFF made some piping configuration changes to scrubber S-1008 in December 2014, which led to ammonia emissions from that unit being decreased by half. The NESHAPs regulates airborne discharges of hazardous materials. Non-radiological emissions at CFFF are regulated by SCDHEC under permit number 1900-0050-R1 (effective March 5, 2008). The CFFF permit addresses NAAQS pollutants, nitric acid, and opacity. The permit does not require monitoring. Instead, operating permit limits are based on process throughputs at rated capacities as outlined by SCDHEC in South Carolina Air Quality Control Regulation 61-62.

Radiological emissions are regulated by NRC under 10 CFR Part 20 and by the EPA under 40 CFR Part 61. Westinghouse monitors radiological airborne discharges from 47 stacks and calculates an offsite dose from the combined emissions. As part of the environmental monitoring program, Westinghouse also monitors for the presence of radioactive material in ambient air at four onsite locations.

5.7 Noise Mitigation Measures

None required for either alternative.

5.8 Historic and Cultural Resources Mitigation Measures

None required for either alternative.

5.9 Visual/Scenic Resources Mitigation Measures

None required for either alternative.

5.10 Socioeconomic Mitigation Measures

None required for either alternative.

5.11 Environmental Justice Mitigation Measures

None required for either alternative.

5.12 Public and Occupational Health Mitigation Measures

Under both the No-Action Alternative and the Proposed Action Alternative, management measures and regulatory controls such as the CFFF ALARA program, NPDES permit, air permit, etc. minimize the impact of public and occupational health effects. Under both alternatives, additional programs would be in place to limit airborne, liquid and solid waste effluents to be below applicable regulatory limits. The environmental monitoring program described in Section 6.0 would be continued to ensure concentrations hazardous materials in the environment remain below acceptable levels to protect public and occupational health. Should abnormal increases in any concentrations be detected, then the conditions contributing to such increases would be evaluated and the appropriate mitigation measures taken.

5.13 Waste Management Mitigation Measures

Waste management under both the No-Action alternative and the Proposed Action would be conducted in accordance with applicable SC and Federal regulations. Since no new facilities will be constructed, no significant change is waste generation is expected. For nonradioactive materials and where feasible, waste generation is avoided by internal reuse and recycling such as pallet reuse. Where waste generation can not be avoided, impacts are minimized by establishing external recycling partnerships such as those for reusing pallets "as-is" and also for recycling low density plastic films so that waste generation impacts can be reduced. These same principles are employed with the radioactive materials. The CFFF generates both combustible and non-combustible materials during the manufacture of nuclear fuel. Uranium containing combustible materials are incinerated on site and the ash and clinker residue is leached (chemically reacted with nitric acid) to remove uranium in the form of uranyl nitrate. This material is not considered a waste since the uranyl nitrate is recycled / reused by the facility. The non-combustible wastes are either prepared for burial or decontaminated for reuse, recycle, or release from the plant. Wastes consigned to disposal are shipped to a licensed disposal facility. Shipments are made in compliance with all applicable NRC, DOT, EPA and SC regulations; and, in conformance to disposal site criteria. Figure 2.1-7 (page 1) shows the process flow for the handling of solid contaminated wastes, including LLRW.

5.14 Mitigation Measures for Forest Management and access to private properties behind the CFFF site

None required for either alternative.

5.15 Increases in Possession Limit Mitigation Measures

None required for either alternative.

6.0 ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

This section describes the environmental measurement and monitoring programs as they apply to the No-Action alternative and the Proposed Action.

Under the No-Action alternative, Westinghouse would continue to monitor CFFF effluents and the environment in and around the site, to evaluate potential health and environmental impacts from its effluents, and to monitor compliance with applicable regulations. Samples are collected from the air, surface water, groundwater, sediment, soil, vegetation, and fish. Collection frequency and action levels differ for the various sample types. Responses to results that exceed action levels include resampling, investigation, corrective action, and notification of the responsible regulatory agency if required.

Section 6.1 describes the radiological monitoring program. Section 6.2 describes the physicochemical monitoring program for non-radiological gaseous and liquid effluents.

6.1 Radiological Monitoring

The CFFF maintains an Environmental Protection Program for the site. A primary purpose of the Environmental Protection Program is to ensure that exposure of the public and the environment to hazardous materials used in facility operations is kept As Low As Reasonably Achievable (ALARA). The 2018 ALARA goals for gaseous and liquid effluents were as follows:

- Annual Average Concentration of Radiological Material in Gaseous Effluents = 6.0E-13 µCi/mL;
- Annual Average Concentration of Radiological Material in Liquid Effluents = 2.0E-7 µCi/mL; and
- Dose To Members Of The Public (Gaseous And Liquid Effluents) = 1 mrem/year.

The CFFF prepared an Environmental Evaluation Report, dated March 1975, that has been updated in revisions dated April 1983, April 1990 and December 2004, December 2014, March 2018, and March 2019. The March 2019 revision consolidates and supercedes the information from the December 2014 and March 2018 submittals. Annual reviews of Environmental Protection Program data are documented in the ALARA Reports to the NRC.

6.1.1 Gaseous Effluent Control

For operations with the potential to exhaust radioactive materials to unrestricted areas, representative stack sampling is performed to determine the adequacy of air effluent controls. Such sampling is performed during production operations involving licensed materials and the results are used to demonstrate compliance with applicable regulatory limits. Sampling and monitoring methods and frequencies (i.e., continuous sampling, periodic sampling or periodic administrative reviews for release points where material has little potential to be released) are determined in accordance with regulatory guidance.

ALARA goals and investigation limits are established based on guidance provided in Reg. Guide 8.37, Revision 0 (July 1993). If the investigation level is exceeded, corrective actions are taken to reduce emissions, as appropriate. If radioactivity in gaseous effluents results in a TEDE in excess of 10 mrem/yr to a member of the public in an unrestricted area, a report is submitted to NRC

Staff within 30-days upon discovery. This report is prepared in accordance with 10CFR20.2203(b) and is submitted to NRC Headquarters with a copy to NRC Region II.

If measurement results indicate the TEDE (due to liquid and gaseous effluents) to any member of the public in a calendar year could exceed a limit of 100 millirem, immediate steps are taken to reduce emissions to levels that will bring the TEDE back below the limit.

6.1.2 Liquid Effluent Control

Liquid waste treatment facilities, with sufficient capacity and capability to enable retention, treatment, sampling, analysis, and discharge of liquid wastes in accordance with applicable regulations, are provided and maintained in proper operating condition.

Control of radioactivity in the process liquid waste stream is achieved by operation of two treatment systems in series:

- A continuous in-line gamma spectroscopy monitor and quarantine tank filtration system within the chemical controlled area of the main plant building; and,

- Wastewater Treatment Facility (for removing uranium to ALARA levels) that is external to the building.

The first system is installed following quarantine tanks, diversion tanks, and filtration operations. This system assures that the process liquid waste stream, being transferred from the internal chemical controlled area to the external treatment area, meets the discharge limit in approved operating procedures. This limit is nominally less than 24 parts per million. When the liquid has successfully passed the scan for discharge from the first system, it is transferred from the in-plant final pump-out tank to the second system for further uranium removal.

The second system assures that uranium in the discharge is removed to a nominal limit of less than 0.2 parts per million uranium.

Goals and investigation limits are established based on guidance provided in Reg. Guide 8.37, Revision 0, to assure that liquid effluents are ALARA. If the investigation level is exceeded, corrective actions are taken to reduce radioactive effluent, as appropriate. If measurement results indicate the TEDE (due to liquid and gaseous effluents) to any member of the public in a calendar year could exceed a limit of 100 mrem, immediate steps are taken to reduce radioactive effluent to levels that will bring the TEDE back below the limit.

Miscellaneous liquid wastes are filtered and sampled on a batch basis to assure uranium is effectively removed to levels that will enable conformance to ALARA goals.

Quiescent settling in the North, South, East, and West Lagoons further reduce uranium levels in liquid wastes prior to final discharge to the Congaree River. A continuous, proportional sample of the liquid effluent discharged to Congaree River is collected. A 30-day composite of this sample is analyzed for recording the isotopic uranium and Tc-99 content of the final discharge.

If the CFFF's National Pollutant Discharge Elimination System (NPDES) Permit is renewed, revised or revoked, NRC Headquarters and Region II Staff are promptly notified. The CFFF will also notify NRC within 30 days of any NPDES Notice of Violation.

6.1.3 Solid Waste Disposal

Solid waste disposal preparation facilities, with sufficient capacity and capability to enable processing, packaging, and transfer of solid wastes to licensed treatment or disposal sites, in accordance with applicable regulations, are provided and maintained in proper operating condition.

6.1.4 Environmental Sampling and Monitoring

The CFFF environmental monitoring program includes the sampling criteria presented in Table 6.1-1. Action levels for sample results are established by approved procedures. (Note: For wells found not to contain water at the time of sampling, an evaluation is performed by the Environmental Protection Function to determine if alternate well data can be used to represent the dry well; or, if a new well must be installed.) Typical program analytical sensitivities are as presented in Table 6.1-2. Locations of air, vegetation and soil monitoring stations, surface water sampling locations, and locations of monitoring wells are as presented in Figures 6.1-1, 6.1-2, and 6.1-3, respectively.

Table 6.1-1 Environmental Sampling Criteria

TYPE OF SAMPLE	LOCATIONS	ANALYSES[1]	MINIMUM SAMPLING FREQUENCY
Air Particulates	Four	Alpha	Continuous (Collection Weekly)
Surface Water	Six	Uranium; Tc-99	Quarterly
Well Water[2]	Forty	Uranium; Tc-99	Semi-Annually
River Water	Four	Uranium; Tc-99	Quarterly
Sediment	Three	Uranium; Tc-99	Annually
Soil	Five	Uranium; Tc-99	Annually
Vegetation	Four	Uranium; Tc-99; Fluoride	Annually
Fish	One	Uranium; Tc-99	Annually

[1]If new surface water or well water results were to exceed federal or state regulatory limits, a CAP shall be entered to document the action(s) taken in response to the elevated analysis results.

Surface water exits the site through a ditch and culvert system that discharges to Mill Creek. Mill Creek meanders through the wooded lands behind the CFFF property boundary until it ultimately discharges into the Congaree River. Surface water samples are collected from six locations on the property and from four locations on the Congaree River as specified by the SNM-1107 license:

Surface Water Sampling Locations

- Entrance – Sample obtained from entrance side of flood gate valve that controls flow from Mill Creek Swamp into Upper Sunset Lake. GPS Coordinates: N-33˚52’59.72 W-80˚55’56.32
- Exit – Sample obtained from exit side of flood gate valve that controls flow from Sunset Lake Swamp into the canal. GPS Coordinates: N-33˚52’16.94 W-80˚55’28.52

- Pond (Gator) – Sample obtained from surface of pond. GPS Coordinates: N-33˚52'47.54 W-80˚55'17.46
- Spillway – Sample obtained from between Lower Sunset Lake and Sunset Lake Swamp. GPS Coordinates: N-33˚52'34.72 W-80˚55'14.5
- Causeway – Sample obtained from concrete flume connecting Upper and Lower Sunset Lakes. GPS Coordinates: N-33˚52'43.55 W-80˚55'24.
- Roadway – Sample is obtained from Plant side of roadway, where Control Valve A/B stream and Control Valve D/E stream connect. This is before the stream flows into Control Valve C. GPS Coordinates: N-33˚52'52.88 W-80˚55'20.68

A fish sample is taken annually from the Congaree River. Sediment samples are taken annually from the Gator Pond and Sunset Lake as well as near the Congaree River diffuser discharge point.

Congaree River Sampling Locations

- Blossom Street Bridge (above the site's NPDES discharge);
- 500 yards above the NPDES discharge;
- 500 yards below the NPDES discharge; and
- Mill Creek (where Mill Creek converges with the Congaree).

All of these locations are monitored for uranium and Tc-99 at least four times a year. An image of the on-site surface water sampling locations in relationship to the site is depicted in Figure 6.1-2.

These sampling criteria, sensitivities, and/or locations can be changed without prior NRC Staff approval provided:

(a) A documented evaluation by the Environmental Protection Function demonstrates that the changes do not decrease the overall effectiveness of the environmental monitoring program;,

(b) The changes are submitted to NRC Staff as part of the subsequent updates of this License Application to enable opportunity to inspect the evaluation.

Issues identified through the environmental monitoring program are entered into the CAP.

Table 6.1-2 Typical Environmental Program Radiological Analytical Sensitivities

TYPE OF SAMPLE	ANALYSES[1]	TYPICAL SAMPLE QUANTITY	NOMINAL MINIMUM DETECTION LEVEL
Air Particulates	Alpha	571 Cubic Meters	6.0E-14 µCi/ml
Surface Water	Uranium	1 Liter	0.5 pCi/l
	Tc-99	1 Liter	50 pCi/l
Well Water	Uranium	1 Liter	0.5 pCi/l
	Tc-99	1 Liter	50 pCi/l
River Water	Uranium	1 Liter	0.5 pCi/g
	Tc-99	1 Liter	50 pCi/l
Sediment	Uranium	100 Grams	0.5 pCi/g
	Tc-99	100 Grams	50 pCi/g
Soil	Uranium	100 Grams	0.5 pCi/g
	Tc-99	100 Grams	50 pCi/g
Vegetation	Fluoride	100 Grams	Variable (based on dilution level)
	Uranium	100 Grams	0.5 pCi/g
	Tc-99	100 Grams	50 pCi/g
Fish	Uranium	1 Kilogram	0.5 pCi/g
	Tc-99	100 Grams	50 pCi/g

Source: Westinghouse 2019e

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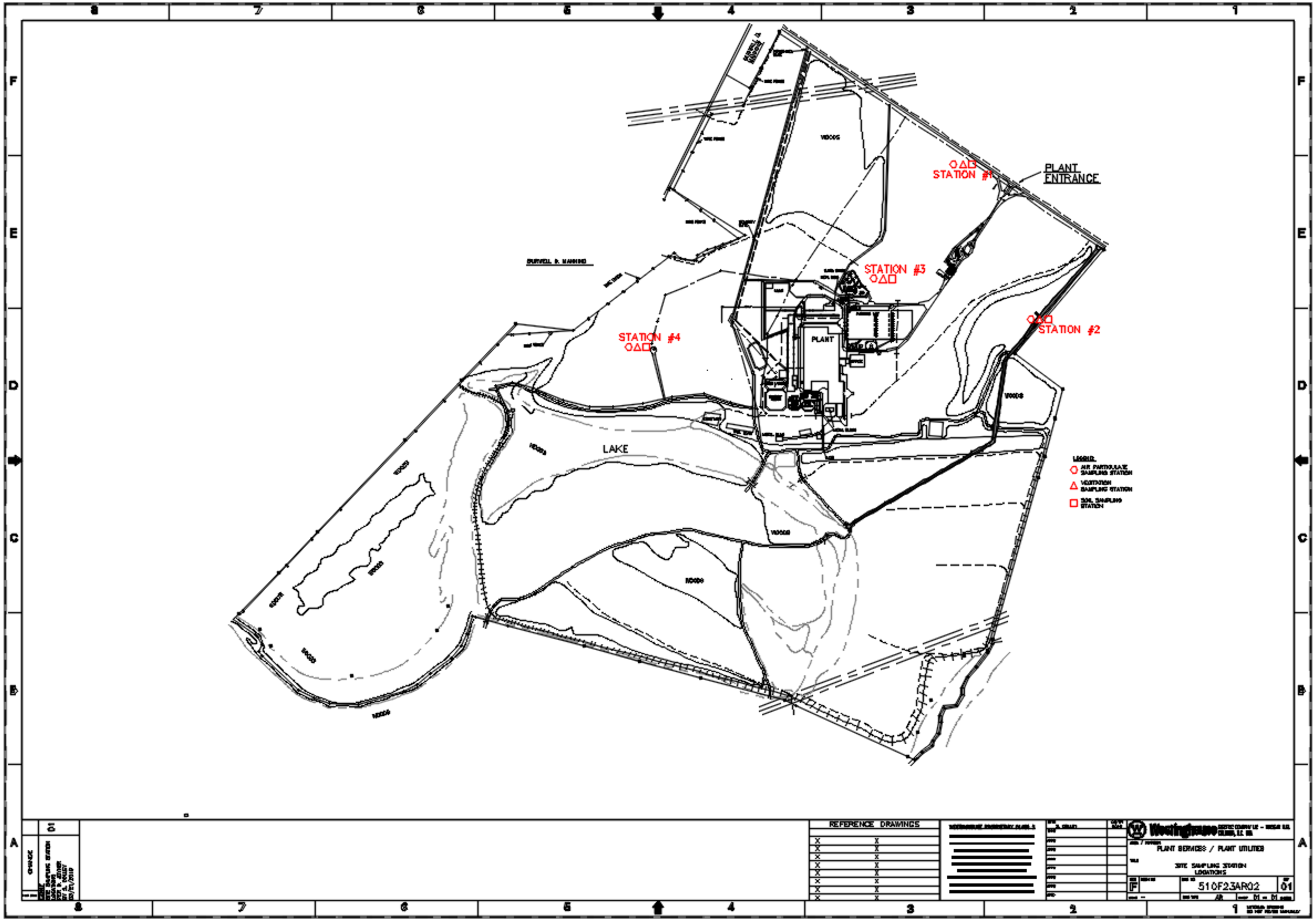

Figure 6.1-1 Locations of Air, Vegetation and Soil Monitoring Stations

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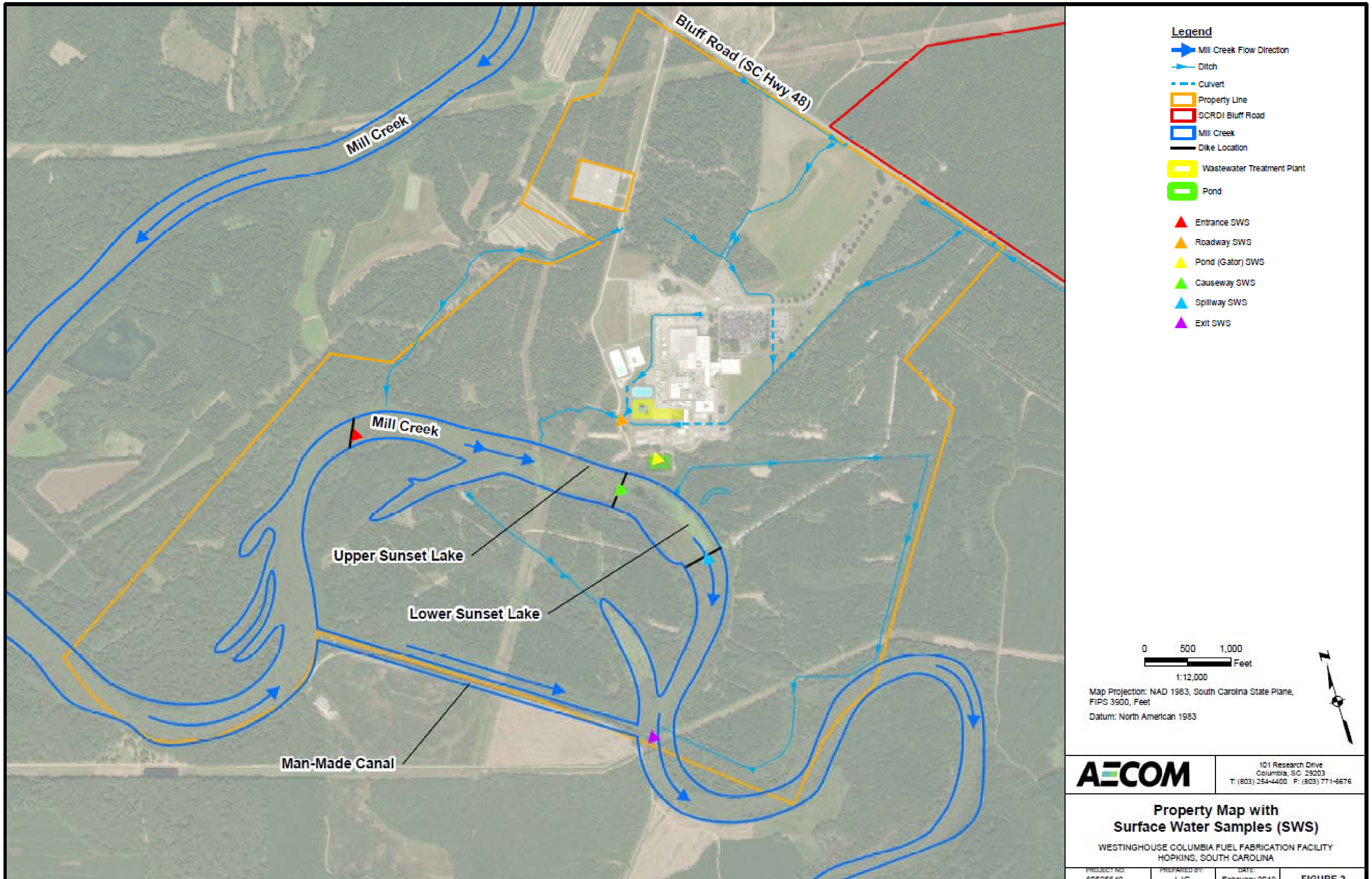

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Figure 6.1-2 Surface Water Sampling Locations

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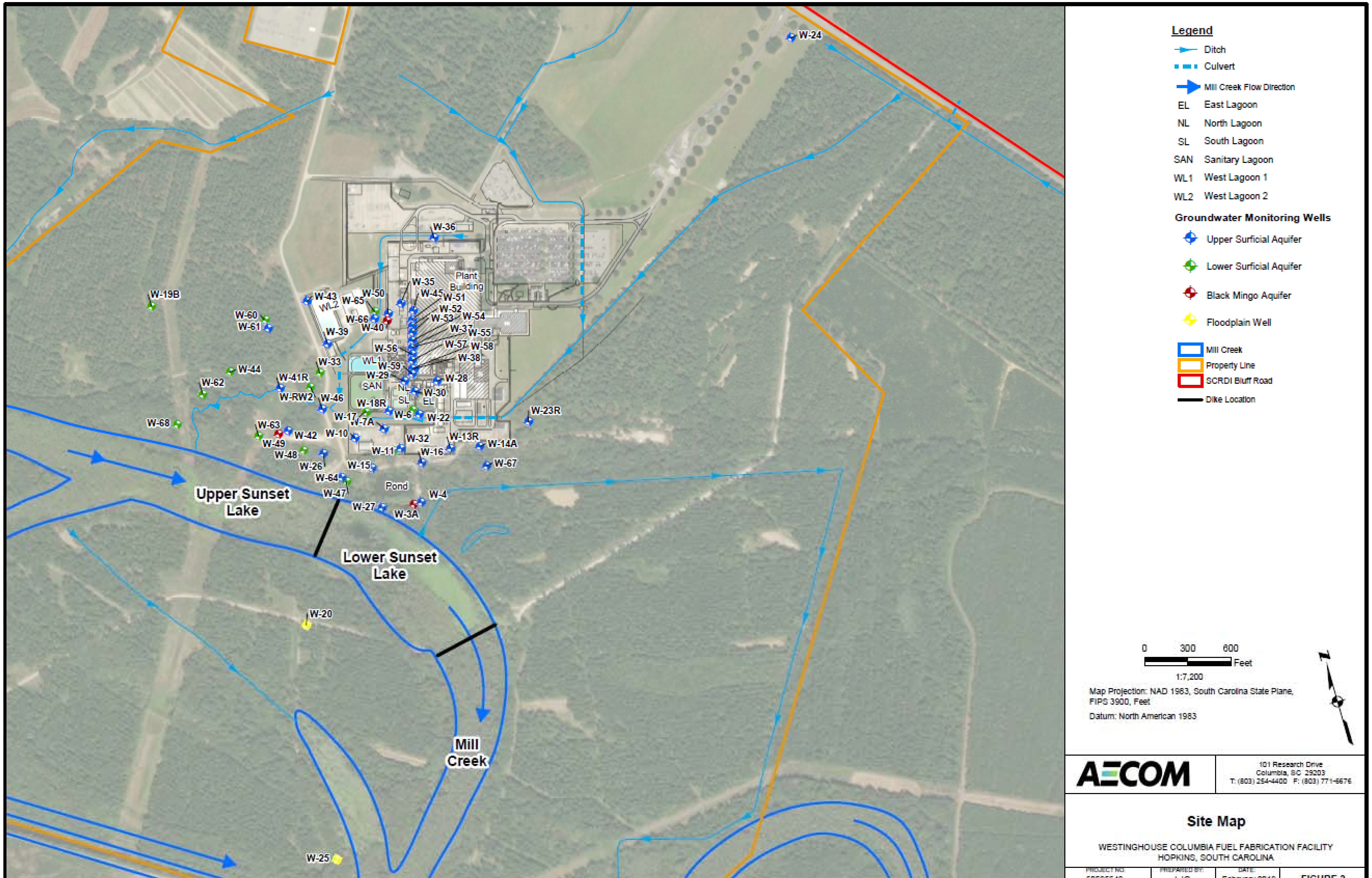

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Figure 6.1-3 Locations of Monitoring Wells

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6.2 Physiochemical Monitoring

In addition to the environmental monitoring Westinghouse conducts as part of radiological monitoring, Westinghouse also conducts non-radiological monitoring related to gaseous and liquid effluents as presented below.

6.2.1 Air Quality

SCDHEC Bureau of Air Quality issued the CFFF an Air Permit in May 2003 documenting that the facility was not regulated as a “major” or “significant minor” emitter. Westinghouse is required to comply with the emission limitations in Section II of the permit. Westinghouse is not required to monitor air emissions for any of the six primary criteria air pollutants (ozone, particulates, carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead).

6.2.2 Liquid Effluents

The CFFF is regulated by SCDHEC with an NPDES general permit for storm water discharges associated with industrial activity. Westinghouse has implemented an approved Storm Water Pollution Prevention Plan to assure regulatory requirements are met. No process wastes are discharged to storm drains (i.e., only non-process surface water runoff).

Westinghouse performs, as a minimum, monthly grab sample checks at the composite "Road Storm Drain (001)" location adjacent to the "C" control valve. This sampling includes chemical monitoring for pH, fluoride, and ammonia. Radiological monitoring is also performed on monthly composites.

The liquid effluent is tested with the required frequencies to demonstrate continuous compliance for the following parameters: pH, fluoride, ammonia, dissolved oxygen, BOD_5, total suspended solids, phosphorus, fecal coliform, and chlorine.

6.3 Ecological Monitoring

As noted previously in Tables 6.1-1 and 6.1-2, sediment, soil, vegetation, and fish samples are collected annually and undergo radiological analyses. Vegetation samples are also analyzed for fluoride levels.

6.4 Laboratory Analysis

CFFF's Chemical Laboratory, which conducts analysis of some effluent environmental samples, is certified by SCDHEC under certificate number 40561001. Certification lasts for three years, includes periodic inspections by SCDHEC, and includes independent annual proficiency testing for each parameter listed on the certification.

Samples not able to be analyzed by the site’s Chemical Laboratory are sent to off-site state certified laboratories. In addition to chain of custody documents, purchase orders and client profiles establish the type of sampling required including action levels, notifications, and EPA/Department of Energy (DOE) approved methods.

6.5 Conceptual Site Model

Environmental monitoring data is input into a Conceptual Site Model (CSM) on a periodic frequency. The CSM provides an understanding of how a contaminant release may be observed and measured currently in the site environment, and identifies the fate and transport of the contaminant in the future. The model incorporates what is known about the site's hydrogeology, existing and past site activities that may have resulted in contaminant releases to the environment, the locations of those releases, the contaminants of concern, their fate and transport within the environment, and the receptors of those contaminants.

Based upon current and historical operations, the facility has established defined Operable Units (OU) such as the manufacturing building and WWTP lagoons. Each OU will have specified groundwater monitoring wells associated with it to provide early leak detection or early indication of contaminant migration.

Issues identified through the environmental monitoring program, including the CSM and OU monitoring, are entered into CAP. Assessment of the data follows the site's Remediation Process.

7.0 COST BENEFIT ANALYSIS

This section describes the cost-benefits aspects of the No-Action alternative and the Proposed Action based on information originally developed by Westinghouse in prior environmental studies of the CFFF (Westinghouse 1975). Section 7.1 summarizes the benefits and Section 7.2 summarizes the costs.

7.1 Summary of Benefits

The objectives and need for continued and expanded operation of the CFFF have been described in Sections 1.1 and 1.2. The primary and secondary benefits are summarized in Table 7.1-1. The primary benefits of this operation, applicable to both the No-Action alternative and the Proposed Action, consist of the uranium fuel fabrication contributions to the total benefits of nuclear power production in the US.

To attain these primary benefits, the operation of CFFF also produces other benefits which are designated secondary benefits. These secondary benefits are incidental to the achievement of the stated objectives and do not constitute justification for further operation of CFFF in their own right. The secondary benefits are, however, of vital importance to the individuals and communities which constitute the local socioeconomic environment.

Table 7.1-1 Summary of Benefits of the CFFF

Benefit	No-Action Alternative
Primary Benefits	
Annual fuel production, MTU/yr	1,600
Value of annual fuel production, 10^6 dollars/yr	
Generation capacity of annual fuel production, 10^9 KW-hr/yr	1,125
Secondary Benefits	
Employment Estimates	
Total jobs (Operation)	1,250
Increase in number of jobs	
Work force influx	
Annual Revenues, 10^6 dollars/yr	
Personal income (wages and salaries)	
Increase in personal income	
Tax revenues – local	
- state	
Purchase of local goods and services	
Construction revenues for expansion	
Local materials and equipment	
Labor	

7.2 Summary of Costs

The continued operation of the CFFF under the No-Action alternative to meet the anticipated demand for fabricated uranium fuel assemblies will provide the benefits described in the previous section. A number of costs, however, are generated in order to meet that objective. These potential costs include the burden placed on the natural environment in the vicinity of the plant, social and economic effects on the community, and internal costs to Westinghouse for facility construction and operation. The internal costs would be accounted for and compensated for through the fuel price structure. From the broader perspective of a social benefit-cost analysis, it is the external costs in the forms of burdens on the natural, social and economic environment would need to be considered. A summary of the environmental and socioeconomic costs resulting from the continued and expanded operation of CFFF is presented in Table 7.2-1.

Table 7.2-1 Summary of Costs of CFFF

Benefit	No-Action Alternative
Environmental Costs	(see Table 2.4-1)
Construction Costs	
Socioeconomic Costs	
Effect on housing locally	Negligible
Increased in school enrollment	Negligible
Impact on school system	Negligible
Effect on traffic congestion	Negligible

7.3 Balance of Benefits and Costs

In the preceding sections, the benefits and costs expected to result from the continued and expanded operation of CFFF have been summarized. To integrate these many factors and balance the benefits versus costs, a range of measures on different bases need to be taken into account. The primary benefits resulting from fabrication of uranium fuel assemblies will accrue to the nuclear power generating industry and through those power plants to the power consuming public. An important consideration in this regard would be the decrease use of foreign oil and the decrease in emissions of greenhouse gases. The secondary benefits of employment, income generation and taxes are of importance, not only to the nation, but also to the local and regional communities. Throughout this ER (e.g., Sections 2.0, 4.0 and 8.0) it has been demonstrated that the potential environmental impacts of both the No-Action alternative and the Proposed Action would be small from an overall viewpoint. In areas where there is potential for environmental impacts (e.g., groundwater contamination), the plans for mitigation (see Section 5.0) and the environmental monitoring program (see Section 6.0) would adequately address these areas to ensure potential impacts would be minimized.

8.0 TECHNICAL ISSUES REGARDING LICENSE EXTENSION

This section describes technical issues regarding the extension of Westinghouse's SNM-1107 license from a 20- to a 40-year period. This section builds on the background information regarding environmental, licensing and permitting issues outlined in Section 2.0. Section 3.1 outlines considerations regarding a license extension. Section 3.2 summarizes the approach taken in developing justification for a license extension. Section 3.3 describes Westinghouse's proactive approach in addressing issues that could arise during the extension period.

8.1 Environmental, Licensing and Permitting Issues

There are a number of intertwined environmental, licensing and permitting issues affecting future CFFF operations and a potential 40-year license extension. The supporting ER addresses some, but not all of these issues. Some of the issues of interest regarding a 40-year license extension include the following:

- Potential future modifications to CFFF. Such modifications would need to be addressed on a case-by-case basis in terms of a license amendment or 10 CFR 70.72.

- Potential increase in groundwater contamination.

    - Groundwater borings in May 2011 indicated the North and South Lagoons to be source of nitrate contamination. The wastewater lagoons were also a suspected source of fluoride contamination in the groundwater. Liquid waste from the conversion area is high in fluorides and is sent to URRS for treatment. The fluorides in the liquid waste are converted to calcium fluoride with the addition of lime. As a result of the boring data, Westinghouse relined four of the site lagoons in January to February 2012. The most recent data for nitrate, fluoride, and ammonia indicate a general decreasing trend. Since the AS/SVE system was shutdown at the end of 2010, the VOC concentrations have remained stable or decreased in the wells that have been consistently sampled and monitored.

    - In 2010, gross beta concentrations in two groundwater sampling wells exceeded action levels prompting additional investigation. The source was traced to technicium-99 (Tc-99), originating from UF_6 cylinder recertification. Sampling of Tc-99 in groundwater and liquid effluents was initiated in 2011.

    - Exceedances of the drinking water MCL for uranium as measured by the EPA approved ICP-MS method occurred in W-55, W-56, and W-59 during the Oct/Nov sampling campaign.

    - The site-wide re-baseline campaign in Oct/Nov 2018 initiated testing in several wells that were not routinely monitored as part of sites current NPDES or NRC SNM-1107 commitments. The drinking water MCL for Tc-99 (900 pCi/L) was exceeded in two of those wells.

  The RI work plan (as part of the CA) will drive evaluation of additional environmental impacts through the site's CSM. Where necessary and feasible and as approved by SCDHEC, remedial action will be initiated according to the site's Remediation Process.

- Buildup of uranium in the environment. Control of emissions and a comprehensive environmental monitoring program are designed to minimize this potential.

- Potential for accidents leading to releases of radioactive and chemical materials at CFFF resulting from operations and during transportation of materials to and from the facility in support of operations. The potential for such accidents is minimized through the ALARA program, environmental and radiation monitoring, a radiation safety program, a chemical safety program, an environmental protection program. NRC-approved Site Emergency and Physical Protection Plans further minimizes the potential for such accidents and the severity of such accidents should they occur. Use of anhydrous ammonia at CFFF was eliminated in August 2011, and replaced by aqueous ammonium hydroxide (Westinghouse 2019d). This resulted in a reduction in chemical hazard risk.

- The air quality in the region could be affected by future growth. The U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for criteria air pollutants. EPA has designated all of South Carolina in attainment for all criteria air pollutants and the remainder of the state is unclassifiable/attainment" (EPA 2012, SCDHEC 2019a). Future changes in the NAAQS could affect the region's attainment status.

- Population growth, increased development and increased traffic in the CFFF site vicinity. Environmental impacts of CFFF operations are small, as confirmed by Westinghouse and NRC evaluations as part of the license renewal process. Future growth in the site vicinity is unlikely to affect those conclusions.

- Adequate planning and funding need to be in place for the eventual decommissioning of CFFF. The CFFF Decommissioning Funding Plan (DFP) is updated and validated once every three years in accordance with 10 CFR 70.25(e) regarding the decommissioning cost estimate and technical approach (SNS, 2012). It was determined that the CFFF decommissioning activities are consistent with industry standards and that no unusual circumstances will be encountered.

In order for Westinghouse to obtain a 40-year license extension as per the NRC Staff Requirements Memorandum, Westinghouse has submitted a license renewal application for a license extension to a 40 year period as per the NRC guidance. Based on NRC general requirements for license applications and license renewal applications (10 CFR 70) and NEPA requirements, such an application would be accompanied by an ER. The ER supporting this report is designed for that purpose. In accordance with NEPA, the NRC in turn would need to follow the NEPA process by notifying the public through the Federal Register and preparing an EA or EIS. Due to past NRC NEPA-related documents prepared regarding the CFFF, an EA would likely be appropriate.

In considering a 40-year extension in accordance with SECY-06-0186, NRC will be reviewing its Fuel Cycle Facility inspection program to ensure that inspectors are appropriately focused on the licensees' existing programs that address material degradation and aging issues, such as the chemical process safety, corrosion prevention, and environmental qualification programs. This includes the need to address material degradation and aging issues as they might relate to 10 CFR 70, Subpart H and the NRC's licensing and inspection programs. The NRC is developing an appropriate process for completing its review of ISA updates to facilitate effective risk-informed inspection and validation of licensee programs.

The CFFF has been in operation from 1969 to the present, or 50 years. As noted in Section 2.2, the ER indicates that no significant environmental impacts, including cumulative effects, have been identified for the areas within the affected environments as a result of past or present operations. CFFF is in compliance with relevant environmental standards and regulations, as well as NRC regulations related to radiation dose to the public and facility workers. The CFFF has been safely operated since 1969 and no major events have occurred in the interim which would reverse this characterization. Extending CFFF operations into the future for an additional 40 years would be expected to result in similar conclusions.

The global energy crisis supports a potential future growth in commercial nuclear power. Westinghouse supports the nuclear industry at CFFF by manufacturing low-enriched uranium fuel for light-water commercial nuclear reactors. With consideration to future demand for global energy, Westinghouse believes that continued operation the CFFF is vital to meet this demand.

Further justification for a license extension include the following:

- Giving Westinghouse, financial sources, and Westinghouse customers assurance of a stable licensed process for a reasonable period of time in support of long-term U.S., global and nuclear industry goals regarding commercial nuclear power

- Reducing CFFF operating costs, and leveling the competitive “playing field,” by allowing Westinghouse to amortize costs and spread decommissioning funding over a longer period of time

8.2 CFFF Operational Issues

Another aspect of justifying a 40-year license extension would be on material degradation and aging issues associated with CFFF facilities. From a broader perspective, these issues in turn lead to environmental and safety issues that could potentially develop over a 40-year facility life period. Westinghouse will demonstrate to the NRC that CFFF operations over such a period will be accomplished in an environmentally sound and safe manner. For this reason, Westinghouse will take a proactive approach to these issues with emphasis on the following areas:

- Degradation and aging
- Cumulative environmental impacts
- Nuclear safety
- Hazardous material safety
- Emergency planning
- Occupational safety
- Community relations
- Sustainability
- Decontamination and decommissioning
- Lessons learned from events at CFFF and other fuel fabrication facilities.

Examples of this proactive approach applied to the areas identified above are outlined in Table 8.1-1.

8.3 Proactive Westinghouse Approaches to Issues

An overriding consideration in a license extension to 40 years, is how Westinghouse will handle changes and potential technical problems arising as part of CFFF operation. In addition to programs identified previously (e.g., ALARA program; environmental and effluent monitoring program, a radiation safety program; a chemical safety program, Site Emergency Plan and Physical Protection Plan), Westinghouse management at CFFF already has in place established programs and procedures to address these issues, which include:

- Environmental, Safety and Health Policy
- Quality Assurance / Management Measures
- Continuous Improvement
- Configuration Control
- Problem Identification and Corrective Action
- CSM / Remediation Process

Table 8.1-1 Potential Areas Affecting a 40-year License Extension

Issue	Description	Example Action Plan
Degradation and aging	Potential degradation of equipment, piping, pond liners, drums, and other aspects of CFFF operations could result in conditions potentially affecting environmental or safety aspects.	Implement a plan to identify all aspects of the facility and its operations subject to long-term degradation and aging in a manner that could result in undesirable environmental and/or safety related conditions.
Cumulative environmental impacts	Cumulative environmental impacts developing over time could include buildup of radioactive and non-radioactive hazardous materials in environmental media (air, vegetation, groundwater, surface water, soil and sediment) on site and in the site vicinity.	Continue to track and identify potential environmental inventories of released radioactive and non-radioactive hazardous materials in environmental media.
Nuclear safety	Facility operational conditions developing over time could increase the likelihood of an unplanned nuclear critically. Degradation of storage cylinders, drums, tanks and piping could lead to unexpected releases.	Continue to support a robust nuclear criticality safety program based on NRC regulations and national consensus standards. Review procedures for inspection of cylinders, drums, tanks and piping. Develop replacement criteria based on time in service and usage for selected facility components.
Hazardous material safety	Hazardous material safety related handling, storage, and potential accidents. Degradation of storage cylinders, drums, tanks and piping could lead to unexpected releases.	Review procedures for inspection of cylinders, drums, tanks and piping. Develop replacement criteria based on time in service and usage for selected facility components. Continue to support a Mechanical Integrity Program applied to Risk Management Program (RMP) covered systems.
Physical security	Facility security threats, including sabotage, terrorism (domestic and international), and workplace violence	Periodically update the Physical Protection Plan and Physical Security features beyond that normally required of a Category III Nuclear Facility. This will ensure its adequacy with regard to the range of potential facility security threats and the related changing domestic and international environment.
Emergency planning	Emergency response planning for accidental releases of radioactive and non-radioactive hazardous material to the environment.	Review emergency planning and preparedness with continued focus on improvement and exercises beyond that normally required.
Occupational safety	Worker exposure and potential health effects will continue to be an area of interest over the license extension period.	Enhance the CFFF occupational exposure and monitoring program to include consideration of issues encountered at similar facilities.

Table 8.1-1 Potential Areas Affecting a 40-year License Extension (continued)

Issue	Description	Example Action Plan
Community relations	There will be a need for continued attention to community relations with regard to persons living in the vicinity of the site and potential impact of facility operations. Population growth in Richland County will increase the potential for perceived offsite impacts.	Maintain community relations to focus on how to increase positive benefits of CFFF to the local community. This includes partnerships with local schools, Wildlife and Industry Together (WAIT) certification by the South Carolina Wildlife Federation (SCWF), and support for local and national charities.
Sustainability	A focus on sustainability and going “green” would be an important aspect of an extended CFFF operating life. Recovering, recycling and reuse of natural resources and other materials would be a key environmental initiative.	Continued development and implementation of the Sustainability Plan for future CFFF operations with milestones implementing related actions in this regard.
Decontamination and Decommissioning	The state of the facility, the site and its environs will affect the nature and extent of decontamination and decommissioning required at the end of facility life. Adverse conditions affecting closure build-up over time.	Review facility operations and potential cumulative buildup of radioactive and non-radioactive hazardous materials over time with a view to facilitate decontamination and decommissioning. Update the Closure Plan to reflect the license extension periodically as required by the regulations.
Lessons learned	Lessons learned from events at CFFF and other fuel fabrication facilities can help improve future operations and prevent similar occurrences.	Maintain a process that updates Lessons Learned and provides a feedback into facility operations and procedures. Westinghouse currently utilizes the Corrective Action System for Lessons Learned.

8.3.1 Westinghouse EHS and Sustainability Policy (September 2017)

- Westinghouse will design, source, produce, market and deliver our products and services in a safe, environmentally sound and socially responsible manner.
- We will conduct our operations in a manner that meets the needs of Westinghouse and its stakeholders today, while protecting and sustaining the human and natural resources that will be needed in the future.
- Westinghouse considers Environment, Health and Safety (EHS) and Sustainability to be key management responsibilities, as well as the responsibility of every employee, essential to our success.

Westinghouse is committed to:

- Providing safe and engaging work places for our employees, and protecting the safety of the communities in which Westinghouse operates.
- Protecting the environment by minimizing the raw materials and energy usage while reducing waste, preventing pollution, and re-using and recycling materials and resources to the extent that is economically and technically feasible.
- Achieving compliance, at a minimum, with all applicable EHS legal requirements, and any other requirements to which the company subscribes.
- Continually improving EHS management systems and performance
- Recognizing the special characteristics and unique hazards of nuclear technology and activities involving nuclear materials and demonstrating the traits of a healthy nuclear safety culture.
- Effectively managing EHS risks and ensuring the integration of EHS considerations into business decisions, including management of change.
- Providing qualified and adequate resources to implement EHS requirements, and to maintain and improve EHS and Sustainability performance.
- Communicating our EHS and Sustainability activities and performance with integrity and transparency.

8.3.2 Quality Assurance / Management Measures

The scope of the EH&S Policy includes applicable management measures to ensure reliability of controls (engineered and administrative), instrumented systems and computer programs affecting the quality of CFFF design, construction and operations important to safety, safeguards, and protection of the environment as defined by the EH&S function. The scope includes program administration and EH&S vendor services. As committed to in the License Application, the management measures define the basic requirements applicable to such items and services that serve to protect workers, the public, and the environment. These management measures apply to design, maintenance, procedures, training and qualification, human performance, quality assurance, audits and records requirements that ensure compliance with all applicable regulations related to safety, safeguards, and protection of the environment in accordance with the NRC license for CFFF.

8.3.3 Continuous Improvement

Westinghouse implements a Continuous Improvement Program at CFFF. This includes assignment of a full-time manager for this purpose. This program is inherent at all levels of CFFF operations, starting with each individual employee, and applied to 1) each step the operation, 2) the management process, and 3) all other programs in effect (e.g., environmental, safety, and health; management measures; and nuclear safety). Potential improvements are identified, evaluated and implemented if deemed appropriate.

As part of the Continuous Improvement Program, Westinghouse received International Standards Organization (ISO) 14001 certification for CFFF in November 2010 (ISO Certificate Number: UQA 0102162/D). The ISO 14000 family includes most notably the ISO 14001 standard, which represents the core set of standards used by organizations for designing and implementing an effective environmental management system. It serves as a framework to assist organizations in developing their own environmental management system, and can be integrated with other management functions in meeting their environmental and economic goals.

8.3.4 Configuration Control

Westinghouse has formal procedures regarding Configuration Control (Westinghouse, 2009b and 2009c). The procedures establish requirements for 1) implementing of proposed changes to all plant manufacturing and inspection systems, facilities, and utilities, and 2) identifying documentation requirements for maintaining records of current conditions. The procedures define the review and approval process necessary to make sure that systems continue to meet their specification requirements for manufacturing and inspection functions in a manner which is safe. They are intended to ensure compliance with all applicable regulations, and appropriately incorporates ALARA considerations in accordance with the NRC license for CFFF.

Configuration Control applies plant-wide to: 1) all areas of manufacturing and inspection, ancillary support facilities and systems, and utilities; and 2) when the equipment or system is to be connected to any existing approved process, or is to independently produce usable product. It provides for review and approval by the appropriate parties of any work changing the configuration of manufacturing or inspection systems and their ancillary facilities, including potential safety significant software changes. Appropriate specifications defining manufacturing and inspection systems are required to be updated to reflect the current conditions.

All Safety Significant Control changes involving “Items Relied on for Safety” (IROFS) require an independent design verification. New or modified systems may require development of a Process Hazard Analysis, Criticality Safety Evaluation, Fire Hazards Analysis, or ISA documentation.

In accordance with NRC regulation 10 CFR 70.72 regarding “Facility changes and change process”, the licensee may make changes to the site, structures, processes, systems, equipment, components, computer programs, and activities of personnel, without prior NRC approval, if the change:

- Does not create new types of accident sequences that, unless mitigated or prevented, would exceed the performance requirements of 10CFR70.61 and that have not been previously described in the integrated safety analysis summary;
- Does not use new processes, technologies or control systems for which the licensee has no prior experience;

- Does not remove, without at least an equivalent replacement or the safety function, an item relied on for safety that is listed in the integrated safety analysis summary;
- Does not alter any item relied on for safety, listed in the integrated safety analysis summary, that is the sole item preventing or mitigating an accident sequence that exceeds the performance requirements of 10CFR70.61; and
- Is not otherwise prohibited by this regulation, license condition, or order.

The NRC requires that Westinghouse submit to NRC annually within 30 days after the calendar year, a report reflecting Configuration Control changes that did not require NRC preapproval.

8.3.5 Problem Identification and Corrective Action

The Corrective Action Program (CAP) establishes requirements and responsibilities for identifying, documenting and resolving issues that require corrective or preventive action (Westinghouse, 2009a).

Conditions adverse to the safety and security are identified, documented, analyzed, and corrected in accordance with established procedures. For significant conditions adverse to quality, these procedures provide for identification; assignment of responsibility for corrective action; documentation of the cause and corrective action taken; implementation, evaluation, and verification of corrective action to prevent recurrence; and reporting to the appropriate levels of management.

9.0 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Under the No-Action alternative, the continued operation of the CFFF would not result in significant environmental consequences in the short- or long-term. The facility already exists, and no substantial changes to the facility or its operation are associated with the recent license renewal. The environmental consequences of the Proposed Action can be considered a continuation of existing impacts and were, therefore, evaluated based on known impacts from past and ongoing operations.

- CFFF is not proposing changes in authorized operations or any new construction of land disturbance within the CAA; therefore no impacts on land use, historic or cultural resources, visual resources, or socioeconomics are expected.

- Impacts on ecological resources, air quality, public and occupational health, transportation, and waste management from continued operation of the site would be similar to those occurring now and are not expected to be significant. For example, gaseous emissions and liquid effluents would continue to be within regulatory limits for non-radiological and radiological components. Public and occupation radiological dose exposures would be below 10 CFR Part 20 regulatory limits. Existing groundwater contamination onsite has not migrated into the deeper Black Mingo aquifer and there is no evidence of offsite impacts.

The environmental consequences resulting from continued CFFF operations under the No-Action Alternative are not expected to significantly affect the quality of the human environment. No environmental consequences leading to an environmental justice impact are anticipated. None of the environmental consequences is expected to contribute negatively to the long-term productivity of the region in terms of economics, demographics, natural resources, etc. CFFF will continue to meet all of its local, State, and Federal requirements including its NPDES, air permit, and consent agreement obligations with SCDHEC.

A commitment of a resource is considered *irreversible* when the primary or secondary impacts from its use limit the future options for its use. An *irretrievable* commitment refers to the use or consumption of a resource that is neither renewable nor recoverable for later use by future generations. The major irreversible and irretrievable commitments of natural and man-made resources under the No-Action Alternative would be related to continued CFFF operation.

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Westinghouse 2019f. Westinghouse Electric Company, “Tier II Report” for calendar year 2018 data, (February 28, 2019).

Westinghouse 2019g. Westinghouse Electric Company," Westinghouse CFFF Licenses, Permits and Certificates Tracking Sheet" (March 25, 2019).

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APPENDIX A

Existing CFFF Permits, Licenses and Certifications

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Table A-1 CFFF Permits, Licenses and Certifications

Document Type	Document Number	Compliance Agency	Location
City of Columbia Cross Connection Control Program - Potable Water Backflow Prevention Device Field Test - Serial Number 521396	521396	City of Columbia	Columbia
City of Columbia Cross Connection Control Program - Potable Water Backflow Prevention Device Field Test - Serial Number 521397	521397	City of Columbia	Columbia
City of Columbia Cross Connection Control Program - Potable Water Backflow Prevention Device Field Test - Serial Number 210488	210488	City of Columbia	Columbia
City of Columbia Cross Connection Control Program - Potable Water Backflow Prevention Device Field Test - Serial Number 288425	288425	City of Columbia	Columbia
City of Columbia Cross Connection Control Program - Potable Water Backflow Prevention Device Field Test - Serial Number 179875	179875	City of Columbia	Columbia
City of Columbia Cross Connection Control Program - Potable Water Backflow Prevention Device Field Test - Serial Number 259011	259011	City of Columbia	Columbia
City of Columbia Cross Connection Control Program - Potable Water Backflow Prevention Device Field Test - Serial Number 230950	230950	City of Columbia	Columbia
Boiler #3: Powermaster Boiler No. NB 28830, Capacity 5,900 LBS/HR, MFG. 1974	N/A	CNA Risk Control Inspection Company	Columbia

Table A-1 CFFF Permits, Licenses and Certifications (continued)

Document Type	Document Number	Compliance Agency	Location
Radio Station Authorization – FCC Registration Number 8378788	8378788	Federal Communications Commission (FCC)	Columbia
ISO 9001:2015 Certificate of Approval	10063292	Burea Veritas	Columbia
EPA ID NO. SCD047559331	SCD047559331	N/A	Columbia
Pressure Vessels in test loops	N/A	N/A	Columbia
Design Information Questionaire, SNM-1107, Docket 1151	1151	U.S. Nuclear Regulatory Commission (NRC)	Columbia
Fundamental Nuclear Material Control Plan, SNM-1107 Docket 1151	1151	NRC	Columbia
License SNM-1107 Docket 1151	1151	NRC	Columbia
Physical Security Plan, SNM-1107, Docket 1151	1151	NRC	Columbia
SNM-1107 Docket 1151 - Authorizations and Exemptions - Calcium Fluoride Disposal	1151	NRC	Columbia
Transitional Facility Attachment, SNM-1107, Docket 1151	1151	NRC	Columbia
Cafeteria Business and Professional License	2018-45633-44675	Richland County, South Carolina	Columbia
Columbia Plant Business and Professional License	2018-21040-20192	Richland County, South Carolina	Columbia
Hazardous Materials Registration Certificate	10353	Richland County, South Carolina	Columbia
CLIA Laboratory Certification Program	42D0867917	South Carolina Department of Health and Environmental Control (SCDHEC)	Columbia

Table A-1 CFFF Permits, Licenses and Certifications (continued)

Document Type	Document Number	Compliance Agency	Location
Environmental Laboratory Certification Program	40561001	SCDHEC	Columbia
Infectious Waste Generator Registration	SC40-0332G	SCDHEC	Columbia
National Pollutant Discharge Elimination System (NPDES) Permit	SC0001848	SCDHEC	Columbia
NPDES General Permit for Storm Water Discharges	SCR000000	SCDHEC	Columbia
Office of Environmental Quality Control Bureau of Air Quality Operating Permit	1900-0050-R1	SCDHEC	Columbia
Radioactive Material License	094	SCDHEC	Columbia
South Carolina Radioactive Waste Transport Permit	0046-39-06-X	SCDHEC	Columbia
South Carolina Registration for radiation producing machines and other sources of ionizing radiation	40-0846	SCDHEC	Columbia
Elevator Permit 40-0006	40-0006	South Carolina Department of Labor, Licensing and Regulation (SC-DLLR)	Columbia
Elevator Permit 40-0008	40-0008	SC-DLLR	Columbia
Elevator Permit 40-1368	40-1368	SC-DLLR	Columbia
Cafeteria Retail License	040022689	State of South Carolina Department of Revenue	Columbia
Tennessee Radioactive Waste License-for-Delivery (Columbia Site Usage)	T-SC004-L19	State of Tennessee Department of Environmental and Conservation Division of Radiological Health	Columbia
Generator Site Access Permit (Columbia Site Usage)	0207001421	Utah Department of Environmental Control	Columbia
Miscellaneous Columbia Support Documents			
Waste Control Specialists	CN 600616890	Texas Commission on Environmental Quality	Andrews, TX

Source: Westinghouse 2019g

Table A-2 Stakeholder List for Environmental Report

Agency	Point of Contact	Area of Interest
Federal Agencies		
U.S. Department of Energy National Nuclear Security Administration 1000 Independence Ave., SW Washington, DC 20585	Hitesh Nigam, NEPA Compliance Officer	Nonproliferation issues
U.S. Department of Energy Savannah River Site Savannah River Operations Office Office of External Affairs P.O. Box A Aiken, SC 29802		Emergency response coordination
U.S. Department of Homeland Security Federal Emergency Management Agency R4 3003 Chamblee Tucker Road Atlanta, GA 30341	Dr. William R. Straw, Regional Environmental Officer	Facility security/terrorism
U.S. Department of the Interior U.S. Fish and Wildlife Service Ecological Services, Region 4 1875 Century Blvd., NE Suite 200 Atlanta, GA 30345-3319	Ms. Cynthia Bohn	Compliance with Endangered Species Act
Native American Tribes		
American Indian Center of South Carolina 655 St. Andrews Road, #111 Columbia, SC 29210	Judy M. Orr-Rabon, Chairman	External relations with Tribal organizations in/near Richland County
Catawba Indian Tribe P.O. Box 188 Catawba, SC 29704	Chief Gilbert Blue	External relations with Tribal organizations in/near Richland County

Table A-2 Stakeholder List for Environmental Report (continued)

Agency	Point of Contact	Area of Interest
Native American Tribes (continued)		
Catawba Indian Nation P.O. Box 188 Catawba, SC 29704	Vice Chief Buck George	External relations with Tribal organizations in/near Richland County
Catawba Indian Nation Catawba Cultural Preservation Project Tribal Historic Preservation Office P.O. Box 750 Rock Hill, SC 29731	Dr. Wenonah G. Haire	Compliance with National Historic Preservation Act and Native American Graves Protection and Repatriation Act
Midlands Intertribal Indian Center P.O. Box 7512 Columbia, SC 29202	Terence Little Water	External relations with Tribal organizations in/near Richland County
SC Indian Affairs Commission 15 Old Clayton Court Columbia, SC 29205	Terence Lily Little Water, Executive Director	External relations with Tribal organizations in/near Richland County
State Agencies		
SC Department of Health and Environmental Control Bureau of Land and Waste Management 2600 Bull Street Columbia, SC 29201		Protection of public health—agency has oversight over nuclear facilities
SC Governor's Nuclear Advisory Council South Carolina Energy Office 1201 Main Street Suite 430 Columbia, SC 29201		External relations with State of South Carolina governmental energy oversight organizations

Table A-2 Stakeholder List for Environmental Report (continued)

Agency	Point of Contact	Purpose of Consultation
State Agencies (continued)		
SC Institute of Archaeology and Anthropology 1321 Pendleton Street USC Anthropology Columbia, SC 29208-0001		Compliance with National Historic Preservation Act
SC State Historic Preservation Office Department of Archives and History 8301 Parklane Road Columbia, SC 29223-4905	Rodger E. Stroup	Compliance with National Historic Preservation Act
SC State Energy Office Suite 820 1201 Main Street Columbia, SC 29201-1200	Mitch Perkins	External relations with State of South Carolina governmental energy oversight organizations

Table A-3 Other Potential Stakeholders

Federal Agencies
U.S. Department of the Interior Atlanta Regional Office 75 Spring Street, SW, Suite 1144 Atlanta, GA 30303
U.S. Department of the Interior U.S. Geological Survey 720 Gracern Road, Suite 129 Columbia, SC 29210-7658
U.S. Department of the Interior Bureau of Indian Affairs, Eastern Regional Office 711 Stewarts Ferry Pike Nashville, TN 37214-2751
U.S. Department of the Interior National Park Service Congaree National Park 100 National Park Road Hopkins, SC 29061
U.S. Department of the Interior National Park Service, SE Regional Office Atlanta Federal Center, 1924 Building – 100 Alabama Street SW Atlanta, GA 30303
U.S. Department of Transportation Office of Transportation Policy 1200 New Jersey Avenue, SE Washington, DC 20590-0001
Federal Energy Regulatory Commission 888 First Street, NE, Room 6A-01, PJ-1 Washington, DC 20426
Federal Energy Regulatory Commission Atlanta Regional Office 3125 Presidential Pkwy., Suite 300 Atlanta, GA 30340-3700
International Trade Commission 500 East E Street SW, Room 511-K Washington, DC 20436

Tribal Organizations (historically in/near Richland County)
Eastern Cherokee, Southern Iroquois, and United Tribes of South Carolina P.O. Box 7062 Columbia SC 29202
Eastern Shawnee Tribe of Oklahoma P.O. Box 350 Seneca, MO 64865
Eastern Band of Cherokee Cultural Resource Development P.O. Box 455 Cherokee, NC 28719
Seminole Nation of Oklahoma P.O. Box 1498 Wewoka, OK 74884
State Agencies
SC State Clearinghouse/SC NEPA Point of Contact Office of State Budget 1201 Main Street, Suite 870 Columbia, SC 29201
SC Department of Parks, Recreation and Tourism Suite 110 Columbia SC 29201
SC Department of Health and Environmental Control Water Pollution Control 2600 Bull Street Columbia, SC 29201
SC Department of Natural Resources Land, Water, and Conservation Division 1201 Main Street Columbia, SC 29202
SC Council for Economic Development P.O. Box 927 Columbia, SC 29223-4905

Table A-3 Other Potential Stakeholders (continued)

Economic Development/Corporate Organizations
Columbia, SC, Office of Economic Development 1201 Main Street Suite 250 Columbia, SC 29201
Central SC Alliance 120a Main Street Suite 100 Columbia, SC 29201
Duke Energy P.O. Box 1090 Charlotte, NC 28201-1090
South Carolina E&G Columbia, SC 29218
Progress Energy P.O. Box 1551 Raleigh, NC 27602-1551

Advocacy Organizations (active in nuclear issues in South Carolina
The Carolina Peace Resource Center P.O. Box 7933 Columbia, SC 29202
Friends of the Earth 1717 Massachusetts Ave., NW Suite 600 Washington, DC 20036
Environmentalists, Inc. 1339 Sinkler Road Columbia, SC 29206-4551
Nuclear Watch South P.O. Box 8574 Atlanta, GA 31106
Women's Action for New Direction Atlanta Chapter 250 Georgia Ave., SE Suite 202 Atlanta, GA 30312
Catawba Riverkeeper 2295 Stearns Road Edgemoor, SC 29712

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APPENDIX B

Site Hazardous Chemicals and Transportation Aspects

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Table B-1 Listing of Hazardous and Extremely Hazardous Chemicals[1]

	CHEMICAL	UN / NA[2] Number	CAS[3]	Quantity (lbs)		Extremely Hazardous?
				Maximum	Typical	
1	Chlorine	UN1007	7782-50-5	750	450	Y
2	Hydrogen Fluoride	UN1790	7664-39-3	80,698	32,279	Y
3	Nitric Acid	UN2031	7697-37-2	175,140	87,570	Y
4	Sulfur Dioxide	UN1079	7446-09-5	600	450	Y
5	Sulfuric Acid	UN1830	7664-93-9	18,300	18,300	Y
6	#2 Fuel Oil	NA1993	68476-30-2	511,000	153,300	N
7	Ammonium Hydroxide	NA2672	1336-21-6	2,027,970	983,941	N
8	Calcium Hydroxide	--	1305-62-0	92,260	73,808	N
9	Calcium Oxide	UN1910	1305-78-8	140,000	70,000	N
10	Liquid Argon	UN1951	7440-37-1	70,312	23,080	N
11	Liquid Hydrogen	UN1966	1333-74-0	10,400	10,400	N
12	Liquid Nitrogen	UN1977	7727-37-9	183,733	34,772	N
13	Oxygen	UN1072	7782-44-7	1,000	1,000	N
14	Sodium Hydroxide	UN1824	1310-73-2	213,640	149,548	N
15	Sodium Silicate	UN1719	1344-09-8	58,000	5,800	N
16	Uranium Hexafluoride	UN2927	7783-81-5	1,736,855	inventory	N
17	URANIUM OXIDE (U3O8)	UN2918	1344-59-8	19,142	inventory	N
18	URANIUM OXIDE (UO2)	UN2918	1344-57-6	1,206,114	inventory	N
19	Uranyl Nitrate	UN2980	36478-76-9	450,630	225,315	N

Table B-1 Listing of Hazardous and Extremely Hazardous Chemicals (continued)

Additional Bulk Chemicals On-Site but < 10,000 lb Threshold						
	CHEMICAL	UN / NA[2] Number	CAS[3]	Quantity (lbs)		Extremely Hazardous?
				Maximum	Typical	
20	Acetone	UN1090	67-64-1	2,901		N
21	Ammonium Fluoride	UN2505	12125-01-8	1,078		N
22	Beryllium Compounds		7440-41-7	988		N
23	Erbium Oxide		12061-16-4	4,410	2,205	N
24	Freon 11, CFC-11		75-69-4	5,361		N
25	Freon, CFC-12		75-71-8	5,084		N
26	Gasoline	UN1203	86290-81-5	6,092	1,218	N
27	Helium	UN1046	7440-59-7	1,980		not listed
28	Hydrochloric Acid	UN1789	7647-01-0	2,167		N
29	Kerosene	UN1223	64742-81-0 or 8008-20-6	2,203		N
30	Nickel Chloride		7718-54-9	1,629		N
31	Nickel Hydroxide		12054-48-7	4,433		N
32	Nickel Sulfate		7786-81-4	2,169		N
33	Perchlorethylene	UN1897	127-18-4	5,144		N
34	Tributyl Phosphate		126-73-8	1,786		not listed
35	Uranyl Nitrate Crystals	UN2981	10102-06-4	N/A	N/A	N

1 Basis – 10,000 lbs Hazardous Substances and 500 lbs Extremely Hazardous Substances
2 UN / NA – United Nations / North American numbers for hazardous materials
3 CAS – Chemical Abstract Service number for hazardous materials
4 Use of anhydrous ammonia at CFFF was eliminated in August 2011, and replaced by aqueous ammonium hydroxide (Westinghouse 2019d and 2012e).

Source: Westinghouse 2014 g

Table B-2 Transportation of Radioactive Materials and Chemicals

Material	No-Action Alternative	
	Shipments/yr	Quantity per Shipment
Chemicals, L		
Ammonium hydroxide	8	20 tons
Fuel oil	10	1,000 gal
Kerosene	3	140 gal
Hydrofluoric acid	10	20 tons
Sodium Hydroxide	73	24 tons
Nitric acid	55	4,000 gal
Calcium hydroxide	51	25 tons
Sodium silicate	4	21 tons
Hydrogen	47	8.0×10^5 scf
Nitrogen	278	1.0×10^6 scf
Argon	52	2.5×10^5 scf
Helium	47	9.7×10^4 scf
Radioactive materials, kg		
Uranium hexafluoride	240	7,500 kg
Uranyl Nitrate	147	850 kg-U
Fuel rod assemblies	295	10
Solid waste, m^3		
Low-level radioactive waste	18	1,200 ft^3
Non-radioactive waste	4	2,500 lb
Total Shipments/yr (all types)	1,342	-

[1] scf – standard cubic feet
Source: Westinghouse 2014k

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APPENDIX C

Ecological Resources

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Table C-1 Plants Observed on the Site

Common Name	Scientific Name
Loblolly pine	*Pinus taeda*
Overcup oak	*Quercus lyrata*
Swamp chestnut oak	*Q. michauxii*
Southern red oak	*Q. falcata*
Cherrybark oak	*Q. falcata var. pagodaefolia*
Scarlet oak	*Q. coccinea*
Water oak	*Q. nigra*
White oak	*Q. alba*
Willow oak	*Q. phellos*
White ash	*Fraxinus americana*
Carolina ash	*F. caroliniana*
Shagbark hickory	*Carya ovata*
Mockernut hickory	*C. tomentosa*
Shellbark hickory	*C. laciniosa*
Bitternut hickory	*C. cordiformes*
Sweet gum	*Liquidambar styraciflua*
American elm	*Ulmus americana*
Winged elm	*U. alata*
Red maple	*Acer rubrum*
Yellow poplar	*Liriodendron tulipifera*
American beech	*Fagus grandifolia*
Black cherry	*Prunus serotina*
Water tupelo	*Nyssa aquatica*
Black locust	*Robinia pseudoacacia*
Redbud	*Cercis canadensis*
Poison ivy	*Rhus radicans*
Smooth sumac	*R. glabra*
Japanese honeysuckle	*Lonicera japonica*
Greenbrier	*Smilax bona-nox*
Trumpet vine	*Campsis radicans*
Virginia creeper	*Parthenocissus quinquefolia*
Common privet	*Ligustrum vulgare*
Cross vine	*Bignonia capreolata*
Blackberry	*Rubus sp*
Lead bush	*Amorpha fruticosa*
Wild onion	*Allium sp*
Smartweed	*Polygonum sp*
Broomsedge	*Andropogon virginicus*

Table C-1 Plants Observed on the Site (continued)

Common Name	Scientific Name
Great mullein	*Verbascum thapsus*
Sorrel	*Rumex hastatulus*
Sheep sorrel	*R. acetosella*
Queen Anne's lace	*Daucus carota*
Duckweed	*Spirodela sp*

Source: Westinghouse 1975

Table C-2 Avifauna Observed in Open Field Areas

Common Name	Scientific Name
Turkey vulture	*Cathartes aura*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*B. lineatus*
Bobwhite	*Colinus virginianus*
Killdeer	*Charadrius vociferus*
Mourning dove	*Zenaidura macroura*
Chimney swift	*Chaetura pelagica*
Tree sparrow	*Iridoprocne bicolor*
English sparrow	*Passer domesticus*
Bobolink	*Dolichonyx oryzivorus*
Eastern meadowlark	*Sturnella magna*
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
Savannah sparrow	*Passerculus sandwichensis*
Vesper sparrow	*Pooecetes gramineus*
Field sparrow	*Spizella pusilla*
Chipping sparrow	*S. passerina*
Song sparrow	*Melospiza melodia*

Source: Westinghouse 1975

Table C-3 Avifauna Observed in Swamp Edge Areas

Common Name	Scientific Name
Black duck	*Anas rubripes*
Wood duck	*Aix sponsa*
Marsh hawk	*Circus cyaneus*
Cattle egret	*Bubulcus ibis*
Great blue heron	*Ardea herodias*
Solitary sandpiper	*Trinqa solitaria*
Spotted sandpiper	*Actitis macularia*
Barred owl	*Strix varia*
Fish crow	*Corvus ossifragus*
Acadian flycatcher	*Empidonax virescens*
Carolina wren	*Thrvothorus ludovicianus*
Gray catbird	*Dumetella carolinensis*
White-eyed vireo	*Vireo griseus*
Red-eyed vireo	*V. olivaceus*
Prothonotary warbler	*Protonotaria citrea*
Northern parula warbler	*Parula americana*
American redstart	*Setophaga ruticilla*
Red-winged blackbird	*Agelaius phoeniceus*
American goldfinch	*Spinus tristis*
Song sparrow	*Melospiza melodia*

Source: Westinghouse 1975

Table C-4 Avifauna Observed Along Borders of Old Fields and Woodlots

Common Name	Scientific Name
Turkey vulture	*Cathartes aura*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*B. lineatus*
Common flicker	*Colaptes auratus*
Red-bellied woodpecker	*Centurus carolinus*
Hairy woodpecker	*Dendrocopus villosus*
Ruby-throated hummingbird	*Archilochus colubris*
Eastern kingbird	*Tyrannus tyrannus*
Great crested flycatcher	*Myiarchus crinitus*
Acadian flycatcher	*Empidonax virescens*
Blue jay	*Cyanocitta cristata*
Fish crow	*Corvus ossifragus*
Tufted titmouse	*Parus bicolor*
White-breasted nuthatch	*Sitta carolinensis*
Carolina wren	*Thryothorus ludovicianus*
Mockingbird	*Mimus polyglottos*
Gray catbird	*Dumetella carolinensis*
Robin	*Turdus migratorius*
Wood thrush	*Hylocichla mustelina*
Blue-gray gnatcatcher	*Polioptila caerulea*
Ruby-crowned kinglet	*Regulus calendula*
Cedar waxwing	*Bombycilla cedrorum*
Loggerhead shrike	*Lanius ludovicianus*
Starling	*Sturnus vulgaris*
Solitary vireo	*Vireo solitarius*
White-eyed vireo	*V. griseus*
Worm-eating warbler	*Helmitheros vermivorous*
Northern parula warbler	*Parula americana*
Yellow-rumped warbler	*Dendroica coronata*
Black-throated green warbler	*D. virens*
Black-throated blue warbler	*D. caerulescens*
Prairie warbler	*D. discolor*
Yellowthroat	*Geothlypis trichas*
Yellow-breasted chat	*Icteria virens*
Summer tanager	*Piranga rubra*
Cardinal	*Richmondena cardinalis*
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Indigo bunting	*Passerina cyanea*

Table C-4 Avifauna Observed Along Borders of Old Fields and Woodlots (continued)

Common Name	Scientific Name
American goldfinch	*Spinus tristis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Savannah sparrow	*Passerculus sandwichensis*
Vesper sparrow	*Pooecetes gramineus*
Field sparrow	*Spizella pusilla*
White-throated sparrow	*Zonotrichia albicollis*
Song sparrow	*Melospiza meibdia*

Source: Westinghouse 1975

Table C-5 Avifauna Observed in all Areas on and Near the Plant Site

Common Name	Scientific Name
Black duck	*Anas rubripes*
Wood duck	*Aix sponsa*
Turkey vulture	*Cathartes aura*
Marsh hawk	*Circus cyaneus*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*B. lineatus*
Bobwhite	*Colinus virginianus*
Cattle egret	*Bubulcus ibis*
Great blue heron	*Ardea herodias*
Killdeer	*Charadrius vociferus*
Solitary sandpiper	*Tringa solitaria*
Spotted sandpiper	*Actitis macularia*
Mourning dove	*Zenaidura macroura*
Barred owl	*Strix varia*
Chimney swift	*Chaetura pelagica*
Ruby-throated hummingbird	*Archilochus colubris*
Common flicker	*Colaptes auratus*
Red-bellied woodpecker	*Centurus carolinus*
Hairy woodpecker	*Dendrocopus villosus*
Eastern kingbird	*Tyrannus tyrannus*
Great crested flycatcher	*Myiarcus crinitus*
Acadian flycatcher	*Empidonax virescens*
Tree swallow	*Iridoprocne bicolor*
Blue jay	*Cyanocitta cristata*
Fish crow	*Corvus ossifragus*
Tufted titmouse	*Parus bicolor*
White-breasted nuthatch	*Sitta carolinensis*
Carolina wren	*Thryothorus ludovicianus*
Mockingbird	*Minus polyglottos*
Gray catbird	*Dumetella carolinensis*
Robin	*Turdus miqratorius*
Wood thrush	*Hylocichla mustelina*
Blue gray gnatcatcher	*Polioptila caerulea*
Ruby-crowned kinglet	*Regulus calendula*
Cedar waxwing	*Bombycilla cedrorum*
Loggerhead shrike	*Lanius ludovicianus*
Starling	*Sturnus vulgaris*
Solitary vireo	*Vireo solitarius*

Table C-5 Avifauna Observed in all Areas on and Near the Plant Site (continued)

Common Name	Scientific Name
White-eyed vireo	*V. griseus*
Pronthonotary warbler	*Protonotaria citrea*
Worm-eating warbler	*Helmitheros vermivorus*
Parula warbler	*Parula americana*
Northern yellow-rumped warbler	*Dendroica coronata*
Black-throated green warbler	*D. virens*
Black-throated blue warbler	*D. caerulescens*
Prairie warbler	*Dendroica discolor*
Yellowthroat	*Geothlypis trichas*
Yellow-breasted chat	*Icteria virens*
American redstart	*Setophaqa ruticilla*
English sparrow	*Passer domesticus*
Bobolink	*Dolichonyx oryzivorus*
Eastern meadowlark	*Sturnelia magna*
Red-winged blackbird	*Agelaius phoeniceus*
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
Summer tanager	*Piranga rubra*
Cardinal	*Richmondena cardinalis*
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Indigo bunting	*Passerina cyanea*
American goldfinch	*Spinus tristis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Savannah sparrow	*Passerculus sandwichensis*
Vesper sparrow	*Pooecetes gramineus*
Chipping sparrow	*Spizella passerina*
Field sparrow	*S. pusilla*
White-throated sparrow	*Zonotrichia albicolis*
Song sparrow	*Melospiza melodia*

Source: Westinghouse 1975

Table C-6 Mammals of the Plant Site and Adjacent Areas

Common Name	Scientific Name
Opossum[1]	*Didelphis marsupialis*
Shorttail shrew	*Blarina brevicauda*
Least shrew	*Cryptotis parva*
Eastern mole	*Scalopus aquaticus*
Little brown myotis	*Myotis lucifugus*
Raccoon[1]	*Procyon lotor*
River otter[1]	*Lutra canadensis*
Striped skunk	*Mephitis mephitis*
Red fox	*Vulpes fulva*
Gray fox[1]	*Urocyon cinereoargenteus*
Bobcat[1]	*Lynx rufus*
Woodchuck	*Marmota monax*
Eastern chipmunk	*Tamias striatus*
Eastern gray squirrel[1]	*Sciurus carolinensis*
Red squirrel[1]	*Tamiasciurus hudsonicus*
White-footed mouse[1]	*Peromyscus leucopus*
Golden mouse[1]	*Peromyscus nuttalli*
Meadow vole	*Microtus pennsylvanicus*
Muskrat	*Ondatra zibethica*
Meadow jumping mouse	*Zapus hudsonius*
Eastern cottontail[1]	*Sylvilagus floridanus*
Wild boar	*Sus scrofa*
Eastern whitetail deer[1]	*Odocoileus virginianus*

[1] Mammals observed on site and adjacent areas during 1974 survey.

Source: Westinghouse 1975

Table C-7 Mammals Common to Shore-Line Areas

Common Name	Scientific Name
Opossum	*Didelphis marsupialis*
Shorttail shrew	*Blarina brevicauda*
Least shrew	*Cryptotis parva*
Little brown myotis	*Myotis lucifugus*
Raccoon	*Procyon lotor*
River otter	*Lutra canadensis*
Striped skunk	*Mephites mephites*
Red fox	*Vulpes fulva*
Gray fox	*Urocyon cinereoargenteus*
Bobcat	*Lynx rufus*
Eastern chipmunk	*Tamias striatus*
White-footed mouse	*Peromyscus leucopus*
Muskrat	*Ondatra zibethica*
Eastern whitetail deer	*Odocoileus virginianus*

Source: Westinghouse 1975

Table C-8 Mammals Common to Edge Areas of Old Fields and Woodlots

Common Name	Scientific Name
Opossum	*Dideiphis marsupialis*
Shorttail shrew	*Blarina brevicauda*
Raccoon	*Procyon lotor*
Red fox	*Vulpes fulva*
Gray fox	*Urocyon cinereoargenteus*
Eastern chipmunk	*Tamias striatus*
Eastern gray squirrel	*Sciurus carolinensis*
Red squirrel	*Tamiasciurus hudsonicus*
White-footed mouse	*Peromyscus leucopus*
Eastern cottontail	*Sylvilagus floridanus*
Eastern whitetail deer	*Odocoileus virginianus*

Source: Westinghouse 1975

Table C-9 Mammals Common to Grassy Areas and Open Fields

Common Name	Scientific Name
Opossum	*Didelphis marsupialis*
Least shrew	*Cryptotis parva*
Eastern mole	*Scalopus aquaticus*
Striped skunk	*Mephites mephites*
Woodchuck	*Marmota monax*
Meadow vole	*Microtus pennsylvanicus*
Meadow jumping mouse	*Zapus hudsonius*

Source: Westinghouse 1975

Table C-10 Herpetofauna Observed on the Site and Adjoining Areas

Common Name	Scientific Name
Amphibians	
Green frog	*Rana clamitans melanota*
Bullfrog	*R. catesbeiana*
Southern leopard frog	*R. pipiens sphenocephala*
Southern cricket frog	*Acris gryllus gryllus*
American toad	*Bufo americanus*
Reptiles	
Snapping turtle	*Chelydra serpentina*
Yellow-bellied turtle	*Pseudemys scripta scripta*
Eastern mud turtle	*Kinosternon subrubrum subrubrum*
Eastern painted turtle	*Chrysemys picta picta*
Eastern box turtle	*Terrapene carolina carolina*
Five-lined skink	*Eumeces fasciatus*
Banded water snake	*Natrix sipedon fasciata*
Red-bellied water snake	*N. erythrogaster erythrogaster*
Black rat snake	*Elaphe obsoleta obsoleta*
Eastern king snake	*Lampropeltis getulus*
Canebrake rattlesnake	*Crotalus horridus atricaudatus*

Source: Westinghouse 1975

Table C-11 Threatened or Endangered Species in South Carolina, Possibly Occurring on the Site Area

Common Name	Scientific Name
Eastern brown pelican	*Pelicanus occidentalis*
Southern bald eagle	*Haliaeetus leucocephalus leucocephalus*
American peregrine falcon	*Falco peregrinus aratum*
Red-cockaded woodpecker	*Dendrocopus borealis*
Bachman's warbler	*Vermivora bachmanii*
Eastern cougar	*Felis concolor*
American alligator	*Alligator mississippiensis*

Source: Westinghouse 1975

Table C-12 South Carolina Rare, Threatened and Endangered Animal Species in Inventory, Species Found in Richland County Data last Updated March 2019

Scientific Name	Common Name	Federal Status	State Status	Global Rank	State Rank
Acipenser brevirostrum	Shortnose Sturgeon	LE: Endangered	SE: Endangered	G3	S3
Alligator mississippiensis	American Alligator	LT: Threatened	ST: Threatened	G5	S5
Alosa aestivalis	Blueback Herring	ARS*: Risk, priority	--	G3G4	S5
Cambarus spicatus	Broad River Spiny Crayfish	ARS*: Risk, priority	--	G3	S3
Condylura cristata	Star-nosed Mole	--	--	G5	S3?
Corynorhinus rafinesquii	Rafinesque's Big-eared Bat	--	SE: Endangered	G3G4	S2
Danaus plexippus	Monarch Butterfly	ARS*: Risk, Priority	--	G4	SNR
Elimia catenaria	Gravel Elimia	--	--	G4	SNR
Etheostoma collis	Carolina Darter	--	--	G3	SNR
Eurycea chamberlaini	Chamberlain's Dwarf Salamander	ARS*: Risk, priority	--	G4	SNR
Fundulus diaphanus	Banded Killifish	--	--	G5	S1
Haliaeetus leucocephalus	Bald Eagle	--	ST: Threatened	G5	S2
Heterodon simus	Southern Hognose Snake	ARS*: Risk, priority	ST: Threatened	G2	SNR
Hyla andersonii	Pine Barrens Treefrog	--	ST: Threatened	G4	S2S3
Moxostoma robustum	Robust Redhorse	ARS*: Risk, priority	--	G1	SNR
Mycteria americana	Wood Stork	LT: Threatened	SE: Endangered	G4	S1S2
Notropis chiliticus	Redlip Shiner	--	--	G4	S1?
Perimyotis subflavus	Tricolored Bat	ARS*: Risk, priority	--	G2G3	S1S2
Picoides borealis	Red-cockaded Woodpecker	LE: Endangered	SE: Endangered	G3	S2
Pyganodon cataracta	Eastern Floater	--	--	G5	SNR
Rhinichthys obtusus	Blacknose Dace	--	--	G5	S1
Sciurus niger	Southern Fox Squirrel	--	--	G5	S3S4
Spilogale putorius	Eastern Spotted Skunk	--	--	G4	S3
Strophitus undulatus	Creeper	--	--	G5	S2

Sylvilagus aquaticus	**Swamp Rabbit**	**--**	**--**	**G5**	**S2?**
Tyto alba	**Barn-owl**	**--**	**--**	**G5**	**S4**
Ursus americanus	**Black Bear**	**--**	**--**	**G5**	**S5**
Villosa delumbis	**Eastern Creekshell**	**--**	**--**	**G4**	**S4**

Source: SC-DNR 2019

Table C-12 South Carolina Rare, Threatened and Endangered Plant Species in Inventory, Species Found in Richland County Data last Updated March 2019 (continued)

Scientific Name	Common Name	Federal Status	State Status	Global Rank	State Rank
Agalinis tenella	Pennell's False Foxglove	--	--	G4Q	SNR
Andropogon gyrans var. stenophyllus	Elliott's Bluestem	--	--	G5T4	S1
Aristida condensata	Piedmont Three-awned Grass	--	--	G4?	S2
Astragalus michauxii	Sandhills Milkvetch	--	--	G3	S3
Balduina atropurpurea	Purple Balduina	ARS*: Risk, priority	--	G2	S1
Botrychium lunarioides	Winter Grape-fern	--	--	G4?	S1
Calamovilfa brevipilis	Pine-barrens Reed-grass	--	--	G4	S1
Carex cherokeensis	Cherokee Sedge	--	--	G4G5	S2
Carex collinsii	Collins' Sedge	--	--	G4	S2
Carex crus-corvi	Ravenfoot Sedge	--	--	G5	S2
Carex elliottii	Elliott's Sedge	--	--	G4?	S1
Carex socialis	Social Sedge	--	--	G4	S1
Cayaponia quinqueloba	Cayaponia	--	--	G4	S1?
Collinsonia serotina	Southern Horse-balm	--	--	G3G4	S1
Collinsonia verticillata	Whorled Horse-balm	--	--	G3G4	S3
Coreopsis gladiata	Southeastern Tickseed	--	--	G4G5	SNR
Dryopteris carthusiana	Spinulose Shield Fern	--	--	G5	S1
Echinacea laevigata	Smooth Coneflower	LE: Endangered	--	G2G3	S3
Eleocharis robbinsii	Robbins Spikerush	--	--	G4G5	S2
Hymenocallis coronaria	Shoals Spider-lily	--	--	G3?	S2
Hypericum nitidum	Carolina St. John's-wort	--	--	G4	S1

Ilex amelanchier	Sarvis Holly	--	--	G4	S3
Ipomopsis rubra	Red Standing-cypress	--	--	G4G5	S2
Juncus abortivus	Pinebarren Rush	--	--	G4G5	S2
Lechea torreyi	Piedmont Pinweed	--	--	G4	SNR
Liatris microcephala	Small-head Gayfeather	--	--	G3G4	S1
Lilium pyrophilum	Sandhills Lily	--	--	G2	S1
Lindera subcoriacea	Bog Spicebush	ARS*: Risk, priority	--	G3	S3
Lobelia sp. 1	Lobelia	--	--	G3	SNR
Ludwigia spathulata	Spatulate Seedbox	--	--	G2	S2
Lycopus cokeri	Carolina Bugleweed	--	--	G3	S2
Lysimachia asperulifolia	Rough-leaved Loosestrife	LE: Endangered	--	G3	S1
Macbridea caroliniana	Carolina Bird-in-a-nest	ARS*: Risk, priority	--	G2G3	S3
Magnolia macrophylla	Bigleaf Magnolia	--	--	G5	S1
Magnolia pyramidata	Pyramid Magnolia	--	--	G4	S1
Myriophyllum laxum	Piedmont Water-milfoil	--	--	G3	S2
Nestronia umbellula	Nestronia	--	--	G4	S3
Ophioglossum vulgatum	Adder's-tongue	--	--	G5	S2
Oxypolis canbyi	Canby's Dropwort	LE: Endangered	--	G2	S2
Paspalum bifidum	Bead-grass	--	--	G5	S2
Pityopsis pinifolia	Pine-leaved Golden Aster	--	--	G4	S2
Platanthera lacera	Green-fringe Orchis	--	--	G5	S2
Potamogeton confervoides	Algae-like Pondweed	--	--	G4	S1
Prunus alabamensis	Alabama Black Cherry	--	--	G4	S1
Psilotum nudum	Whisk Fern	--	--	G5	S1
Pteroglossaspis ecristata	Crestless Plume Orchid	--	--	G2G3	S2
Quercus oglethorpensis	Oglethorpe's Oak	--	--	G3	S3

Rhexia aristosa	Awned Meadowbeauty	--	--	G3G4	S3
Rhododendron eastmanii	May White	--	--	G2	S2
Rhus michauxii	Michaux's Sumac	LE: Endangered	--	G2G3	SX
Rhynchospora inundata	Drowned Hornedrush	--	--	G4?	S2?
Rhynchospora macra	Beak Rush	--	--	G3	S1
Rhynchospora oligantha	Few-flowered Beaked-rush	--	--	G4	S2
Rhynchospora pallida	Pale Beakrush	--	--	G3	S1
Rhynchospora stenophylla	Chapman Beakrush	--	--	G4	S2
Sarracenia rubra	Sweet Pitcher-plant	--	--	G4	S3S4
Scirpus etuberculatus	Canby Bulrush	--	--	G3G4	SNR
Symphyotrichum elliotii	Elliott's Aster	--	--	G4	S3
Symphyotrichum georgianum	Georgia Aster	ARS*: Risk, priority	--	G3	SNR
Tofieldia glabra	White False-asphodel	--	--	G4	S1S2
Trepocarpus aethusae	Aethusa-like Trepocarpus	--	--	G4G5	S1
Tridens chapmanii	Chapman's Redtop	--	--	G5T3	S1
Trillium oostingii	Wateree Trillium	--	--	G1	S1
Urtica chamaedryoides	Weak Nettle	--	--	G4G5	S2
Vaccinium crassifolium ssp. sempervirens	Rayner's Blueberry	--	--	G4G5T1	S1
Warea cuneifolia	Nuttall Warea	--	--	G4	S1

Source: SC Department of Natural Resources Web site (**SC-DNR 2019)**

Key:

<u>**GRANK** - the Nature Conservancy rating of degree of endangerment world-wide:</u>

GX **Presumed Extinct (species)**— Not located despite intensive searches and virtually no likelihood of rediscovery.
Eliminated (ecological communities)—Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.

GH **Possibly Extinct (species)—** Missing; known from only historical occurrences but still some hope of rediscovery.
Presumed Eliminated— (Historic, ecological communities)-Presumed eliminated throughout its range, with no or virtually no likelihood that it will be rediscovered, but with the potential for restoration, for example, American Chestnut (Forest).

G1 Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.

G2 Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.

G3 Vulnerable—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

G4 Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

G5 Secure—Common; widespread and abundant.

<u>**SRANK** - the Nature Conservancy rating of degree of endangerment in South Carolina</u>

Status	Definition
NX SX	**Presumed Extirpated—Species or community is believed to be extirpated from the nation or state/province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.**
NH SH	**Possibly Extirpated (Historical)—Species or community occurred historically in the nation or state/province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become NH or SH without such a 20-40 year delay if the only known occurrences in a nation or state/province were destroyed or if it had been extensively and unsuccessfully looked for. The NH or SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.**
N1 S1	**Critically Imperiled—Critically imperiled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.**
N2 S2	**Imperiled—Imperiled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.**
N3 S3	**Vulnerable—Vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.**

Status	Definition
N4 S4	Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
N5 S5	Secure—Common, widespread, and abundant in the nation or state/province.
NNR SNR	Unranked—Nation or state/province conservation status not yet assessed.
NU SU	Unrankable—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
NNA SNA	Not Applicable —A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
N#N# S#S#	Range Rank —A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).
Not Provided	Species is known to occur in this nation or state/province. Contact the relevant natural heritage program for assigned conservation status.

STATUS - legal status

US Endangered Species Act (USESA) Designation

Rank	Meaning
LE: Endangered	A species "in danger of extinction throughout all or a significant portion of its range."
LT: Threatened	A species "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."
C: Candidate	A species under consideration for official listing for which there is sufficient information to support listing.
ARS*: At Risk Species, Priority	A species that either is a former Candidate Species or is an emerging conservation priority species.

State Protection Definitions

Rank	Meaning
SE: Endangered	Any species or subspecies of wildlife whose prospects of survival or recruitment within the State are in jeopardy or are likely within the foreseeable future to become so.
ST: Threatened	A species that is likely to become endangered and in need of management.