HAZARD RANKING SYSTEM (HRS) DOCUMENTATION RECORD COVER SHEET

Name of Site: Galey and Lord Plant

EPA ID No.: SCD058189622

Contact Persons

Documentation Record:

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Pathways, Components, or Threats Not Scored

The ground water and air migration pathways, the drinking water threat of the surface water migration pathway, and the soil exposure and subsurface intrusion pathway were not scored as a part of this Hazard Ranking System (HRS) evaluation. These pathways were not included because a documented release to these media would not significantly affect the overall score and because the human food chain and environmental threats of the surface water migration pathway are sufficient to qualify the site for the National Priorities List (NPL). These pathways are of concern to the U.S. Environmental Protection Agency (EPA) and may be considered during future evaluation.

Ground Water Migration Pathway: The ground water migration pathway was not scored. Sampling results indicate that a release of volatile organic compounds, perfluorooctanoic acid, and perfluorooctanesulfonic acid has occurred to groundwater monitoring wells and, although it would not contribute significantly to the overall site score, the ground water migration pathway is of concern (Ref. 8, pp. 8, 18, 23). No municipal drinking water wells are within a 3-mile radius of the site (Ref. 8, p. 8). There are two public well systems located between three to four miles from the site. One is for a summer camp that serves approximately 100 people on and off while camping is ongoing. The other well is for a small rural system that uses four wells to serve 1,634 residents (Ref. 8, p. 8).

Air Migration Pathway: Evaluating and scoring this pathway would not affect the site score and decision whether to list this site on the NPL. No ambient air samples have been collected.

Drinking Water Threat of the Surface Water Migration Pathway: No drinking water intakes are within the 15-mile target distance limit (TDL) (Ref. 8, p. 9).

Soil Exposure and Subsurface Intrusion Pathway: Evaluating and scoring this pathway would not affect the site score and decision whether to list this site on the NPL. No resident population threat subject to actual contamination has been documented. No sub-slab soil gas or indoor air samples have been collected.

HAZARD RANKING SYSTEM (HRS) DOCUMENTATION RECORD

Name of Site:	Galey and Lord Plant
EPA Region:	4
Date Prepared:	September 2021
Street Address of Site*:	670 North Main Street
City, County, State, Zip:	Society Hill, Darlington County, South Carolina 29593
General Location in the State:	Northeastern portion of state
Topographic Map:	Society Hill, South Carolina 2017
Latitude:	34° 31' 53.50" North
Longitude:	79° 49' 59.85" West

The coordinates above for the Galey and Lord Plant were measured from sampling location GL-042-SD, within Source No. 1 (Ref. 5) (see Figure 3 of this HRS documentation record).

* The street address, coordinates, and contaminant locations presented in this HRS documentation record identify the general area where the site is located. They represent one or more locations EPA considers to be part of the site based on the screening information EPA used to evaluate the site for NPL listing. EPA lists national priorities among the known "releases or threatened releases" of hazardous substances; thus, the focus is on the release, not precisely delineated boundaries. A site is defined as where a hazardous substance has been "deposited, stored, disposed, or placed, or has otherwise come to be located." Generally, HRS scoring and the subsequent listing of a release merely represent the initial determination that a certain area may need to be addressed under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Accordingly, EPA contemplates that the preliminary description of facility boundaries at the time of scoring will be refined as more information is developed about where the contamination is located.

Pathway	**Pathway Score**
Ground Water[1] Migration	Not Scored
Surface Water Migration	100.00
Soil Exposure and Subsurface Intrusion	Not Scored
Air Migration	Not Scored
HRS SITE SCORE	**50.00**

[1] "Ground water" and "groundwater" are synonymous; the spelling is different due to "ground water" being codified as part of the HRS, while "groundwater" is the modern spelling.

WORKSHEET FOR COMPUTING HRS SITE SCORE

	S Pathway	S^2 Pathway
Ground Water Migration Pathway Score (S_{gw})	NS	NS
Surface Water Migration Pathway Score (S_{sw})	100.00	10,000.00
Soil Exposure and Subsurface Intrusion Pathway Score (S_{sessi})	NS	NS
Air Migration Pathway Score (S_a)	NS	NS
$S_{gw}^2 + S_{sw}^2 + S_{sessi}^2 + S_a^2$		10,000.00
$(S_{gw}^2 + S_{sw}^2 + S_{sessi}^2 + S_a^2) / 4$		2,500.00
$\sqrt{(S_{gw}^2 + S_{sw}^2 + S_{sessi}^2 + S_a^2) / 4}$		**50.00**

Note:

NS Not scored

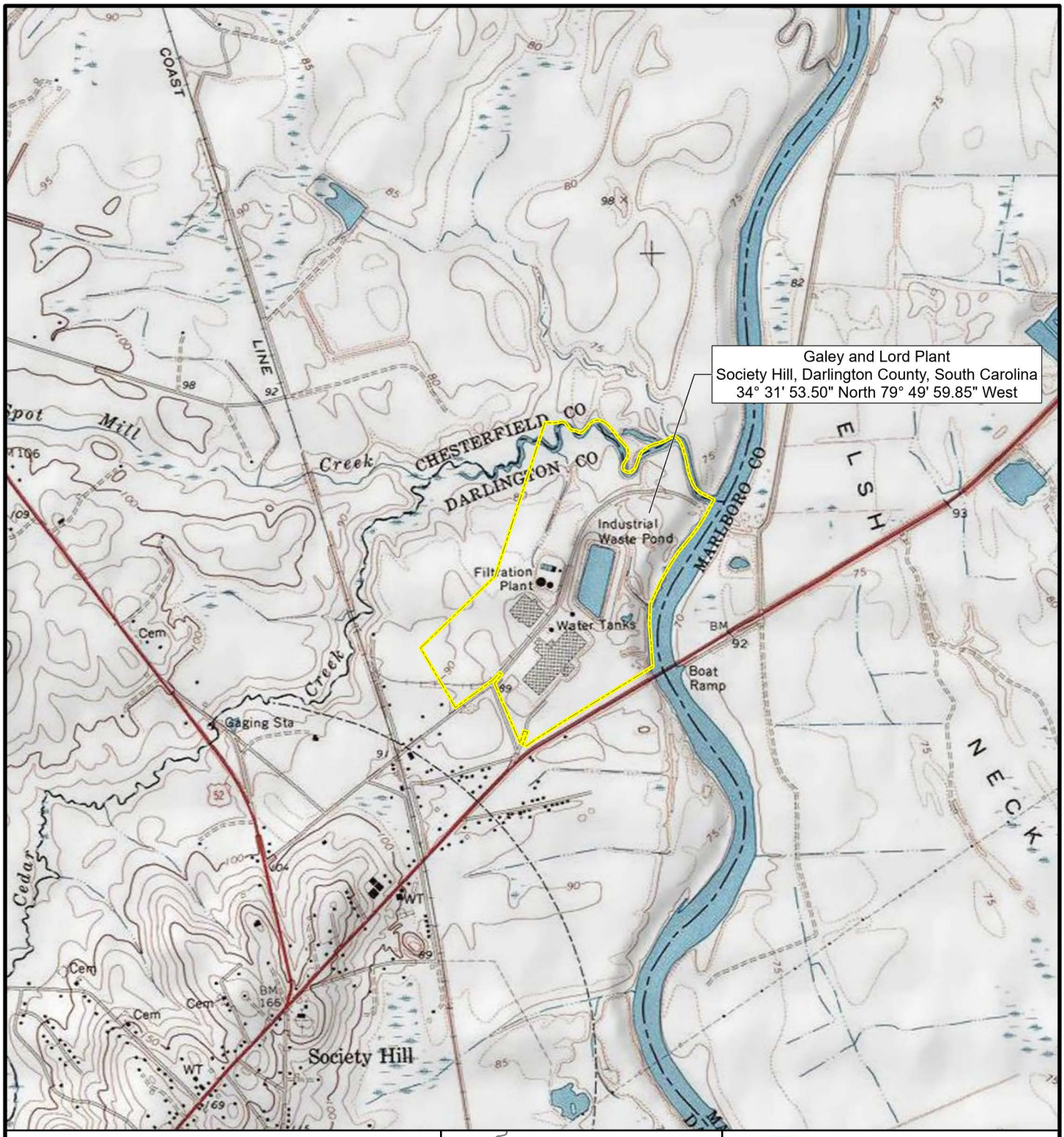
Table 4-1 – Surface Water Overland/Flood Migration Component Scoresheet			
Factor Categories and Factors	**Maximum Value**	**Value Assigned**	
Drinking Water Threat			
Likelihood of Release:			
1. Observed Release	550	550	550
2. Potential to Release by Overland Flow:			
2a. Containment	10	NS	
2b. Runoff	25	NS	
2c. Distance to Surface Water	25	NS	
2d. Potential to Release by Overland Flow [lines 2a(2b + 2c)]	500	NS	
3. Potential to Release by Flood:			
3a. Containment (Flood)	10	NS	
3b. Flood Frequency	50	NS	
3c. Potential to Release by Flood (lines 3a x 3b)	500	NS	
4. Potential to Release (lines 2d + 3c, subject to a maximum of 500)	500	NS	
5. Likelihood of Release (higher of lines 1 and 4)	550		550
Waste Characteristics:			
6. Toxicity/Persistence	(a)	NS	
7. Hazardous Waste Quantity	(a)	NS	
8. Waste Characteristics	100		NS
Targets:			
9. Nearest Intake	50	NS	
10. Population:			
10a. Level I Concentrations	(b)	NS	
10b. Level II Concentrations	(b)	NS	
10c. Potential Contamination	(b)	NS	
10d. Population (lines 10a + 10b + 10c)	(b)	NS	
11. Resources	5	NS	
12. Targets (lines 9 + 10d + 11)	(b)		NS
Drinking Water Threat Score:			
13. Drinking Water Threat Score [(lines 5x8x12)/82,500, subject to a maximum of 100]	100		NS
Human Food Chain Threat			
Likelihood of Release:			
14. Likelihood of Release (same value as line 5)	550		550
Waste Characteristics:			
15. Toxicity/Persistence/Bioaccumulation	(a)	500,000,000	
16. Hazardous Waste Quantity	(a)	10,000	
17. Waste Characteristics	1,000		1,000
Targets:			
18. Food Chain Individual	50	20	

Table 4-1 –Surface Water Overland/Flood Migration Component Scoresheet (Continued)			
Factor Categories and Factors	**Maximum Value**	**Value Assigned**	
19. Population			
19a. Level I Concentrations	(b)	NS	
19b. Level II Concentrations	(b)	NS	
19c. Potential Human Food Chain Contamination	(b)	0.0003	
19d. Population (lines 19a + 19b + 19c)	(b)	0.0003	
20. Targets (lines 18 + 19d)	(b)		20.0003
Human Food Chain Threat Score:			
21. Human Food Chain Threat Score [(lines 14x17x20)/82,500, subject to maximum of 100]	100		100
Environmental Threat			
Likelihood of Release:			
22. Likelihood of Release (same value as line 5)	550		550
Waste Characteristics:			
23. Ecosystem Toxicity/Persistence/Bioaccumulation	(a)	500,000,000	
24. Hazardous Waste Quantity	(a)	10,000	
25. Waste Characteristics	1,000		1,000
Targets:			
26. Sensitive Environments			
26a. Level I Concentrations	(b)	NS	
26b. Level II Concentrations	(b)	50	
26c. Potential Contamination	(b)	NS	
26d. Sensitive Environments (lines 26a + 26b + 26c)	(b)	50	
27. Targets (value from line 26d)	(b)		50
Environmental Threat Score:			
28. Environmental Threat Score [(lines 22x25x27)/82,500 subject to a maximum of 60]	60		60
Surface Water Overland/Flood Migration Component Score for a Watershed			
29. Watershed Score[c] (lines 13+21+28, subject to a maximum of 100)	100		100.00
Surface Water Overland/Flood Migration Component Score			
30. Component Score (S_{sw})[c] (highest score from line 29 for all watersheds evaluated; subject to a maximum of 100)	100		100.00

Notes:

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] Do not round to nearest integer

NS Not scored



Legend

Approximate Property Boundary

N
W E
S

0 1,000 2,000

Feet

Map Source:
USGS 7.5 Minute Topographic Quadrangle Maps:
Society Hill, SC 1971
Darlington County Parcel Viewer, Darlington County Planning/GIS Mapping
Refs. 5; 18

United States Environmental Protection Agency
Region 4

FIGURE 1

Property Location

TO Name: Galey and Lord Plant
TO No.: 68HE420F0028

City:	County:	State:
Society Hill	Darlington	South Carolina

TETRA TECH

Date: 12/31/2020
Analyst: greg.docekal

Spot Mill Creek
Cedar Creek
Great Pee Dee River
Low Impact Dam and Pumping Station
Filter Building
Softener Building
Aeration Basin
Equalization Basin
Plant II
Boiler House
Plant I
NPDES Outfall 001
Stormwater Outfall
Kolbs Tomb Rd
Highway 15-401 W
N Main St

Legend

- Parshall Flume
- Outfall
- Perennial Stream with Flow Direction
- Approximate Property Boundary
- Aeration Tank
- Basin
- Building
- Clarifier
- Coal Pile
- Coal Pile Runoff
- Digester
- Equalization Tank
- Sand Drying Bed (Abandoned)
- Sludge Storage Basin
- Water Sludge Pond

NPDES National Pollutant Discharge Elimination System

N
W E
S

0 250 500
Feet

Map Source:
The source of this image is ESRI, used by EPA with ESRI's permission.
Darlington County Parcel Viewer, Darlington County Planning/GIS Mapping
Refs. 18; 19; 20, p. 40

United States Environmental Protection Agency Region 4

FIGURE 2

Facility Layout

TO Name: Galey and Lord Plant

TO No.: 68HE420F0028

City:	**County:**	**State:**
Society Hill	Darlington	South Carolina

TETRA TECH

Date: 6/28/2021

Analyst: greg.docekal

Spot Mill Creek
Cedar Creek
Great Pee Dee River
Low Impact Dam and Pumping Station
GL-042-WW
GL-042-SD
GL-092-SD
E192904-08
Sludge Storage Basin
GL-041-WW
GL-041-SD
GL-091-SD
E192904-7
GL-046-SD
GL-040-WW
GL-040-SD
GL-069-SD
GL-045-WW
Digester
GL-039-WW
GL-039-SD
GL-047-SD
Sludge Storage Basin
NPDES Outfall 001
Aeration Basin
GL-048-SD
Equalization Basin
GL-053-SD
GL-051-SD
GL-049-WW
GL-050-WW
GL-052-SD
Stormwater Outfall
Kolbs Tomb Rd
Highway 15-401 W
N Main St

Legend

- Parshall Flume
- Outfall
- Sludge
- Wastewater
- Sludge and Wastewater
- Perennial Stream with Flow Direction
- Approximate Property Boundary
- Property Feature

Source Property Feature

- Source No. 1
- Source No. 2

GL - Galey and Lord

NPDES - National Pollutant Discharge Elimination System

SD - Sludge

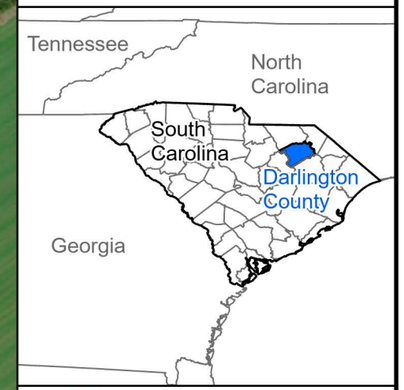
WW - Wastewater

0 250 500
Feet

N
W E
S

Note:
Sample identification numbers GL-041-SD and GL-042-SD were used for source samples collected from the same locations in 2018 and 2019. Therefore, laboratory sample identification numbers are presented for samples collected in 2019.

Map Source:
The source of this image is ESRI, used by EPA with ESRI's permission.
Darlington County Parcel Viewer, Darlington County Planning/GIS Mapping
Refs. 8, p. 17; 13, pp. 14, 15; 18; 19; 20, p. 40
See Tables 1, 2, and 4 of this HRS documentation record.



United States
Environmental Protection Agency
Region 4

FIGURE 3

Source Sampling Locations

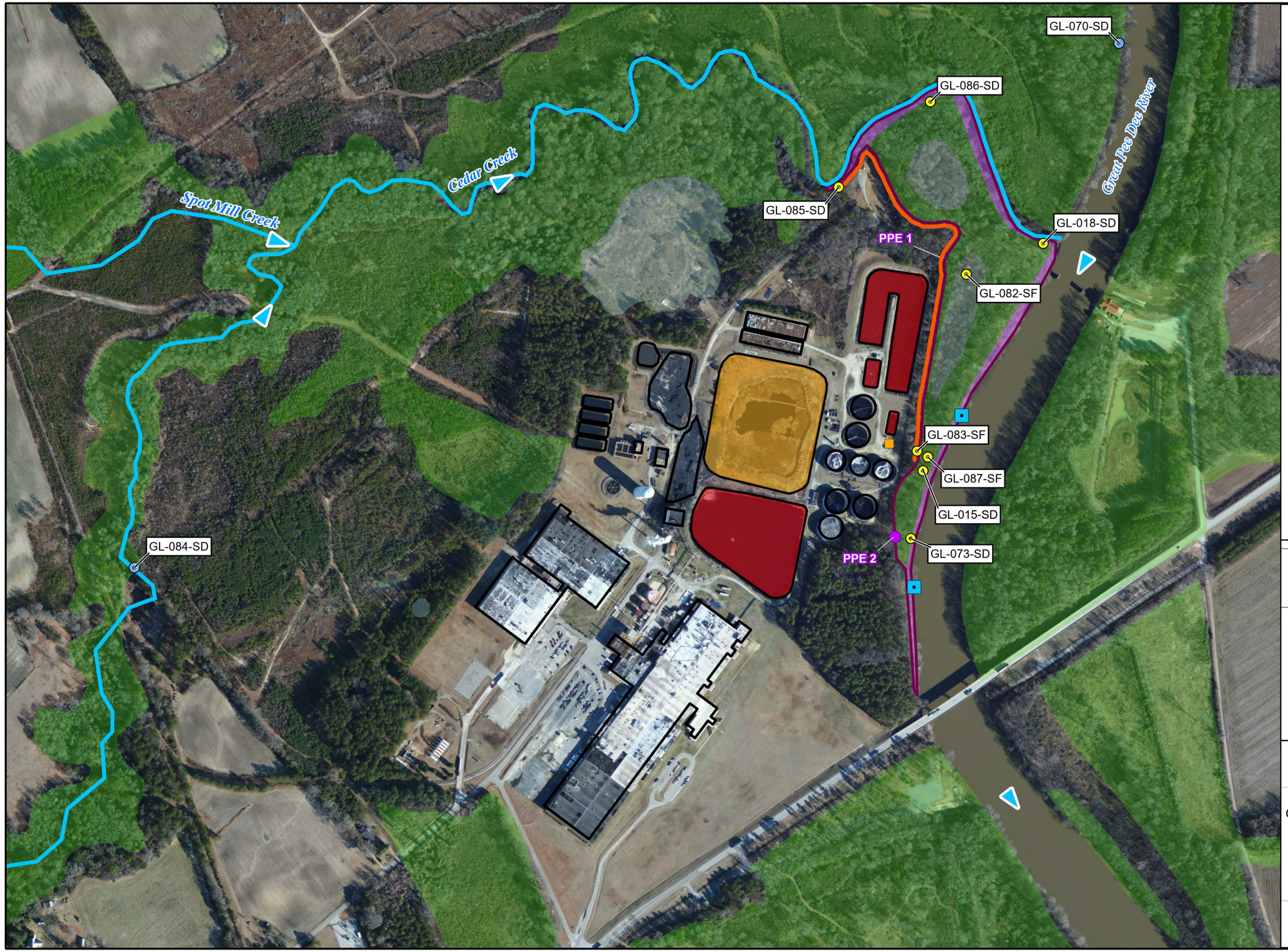
TO Name: Galey and Lord Plant

TO No.: 68HE420F0028

City: Society Hill
County: Darlington
State: South Carolina

TETRA TECH

Date: 6/29/2021
Analyst: greg.docekal



Legend

- Sediment Sample Location
- Background Sample Location
- Parshall Flume
- NPDES/Stormwater Outfall
- PPE 2
- PPE 1
- Perennial Stream with Flow Direction
- Palustrine Emergent Wetland
- Palustrine Forested/Shrub Wetland
- Riverine Emergent Wetland
- Observed Wetland Boundary
- Property Feature

Source Property Feature

- Source No. 1
- Source No. 2

GL - Galey and Lord

NPDES - National Pollutant Discharge Elimination System

SD - Sediment

PPE - Probable Point of Entry

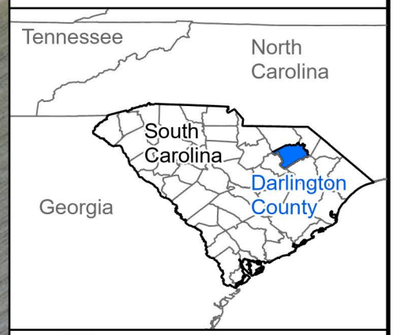
0 250 500

Feet

N W E S

Notes:
Level II contamination between sample locations GL-85-SD and GL-073-SD.

Map Source:
The source of this map is ESRI, used by the EPA with ESRI's permission.
Darlington County Parcel Viewer, Darlington County Planning/GIS Mapping
U.S. Fish and Wildlife, National Wetland Inventory, 2020.
Refs. 13, pp. 15, 18; 18; 19; 20, p. 40; 52; 91, pp. 10, 15; 92
See Tables 7 through 10 of this HRS documentation record.



United States Environmental Protection Agency Region 4

FIGURE 4

Observed Release Sampling Locations and Probable Points of Entry

TO Name: Galey and Lord Plant

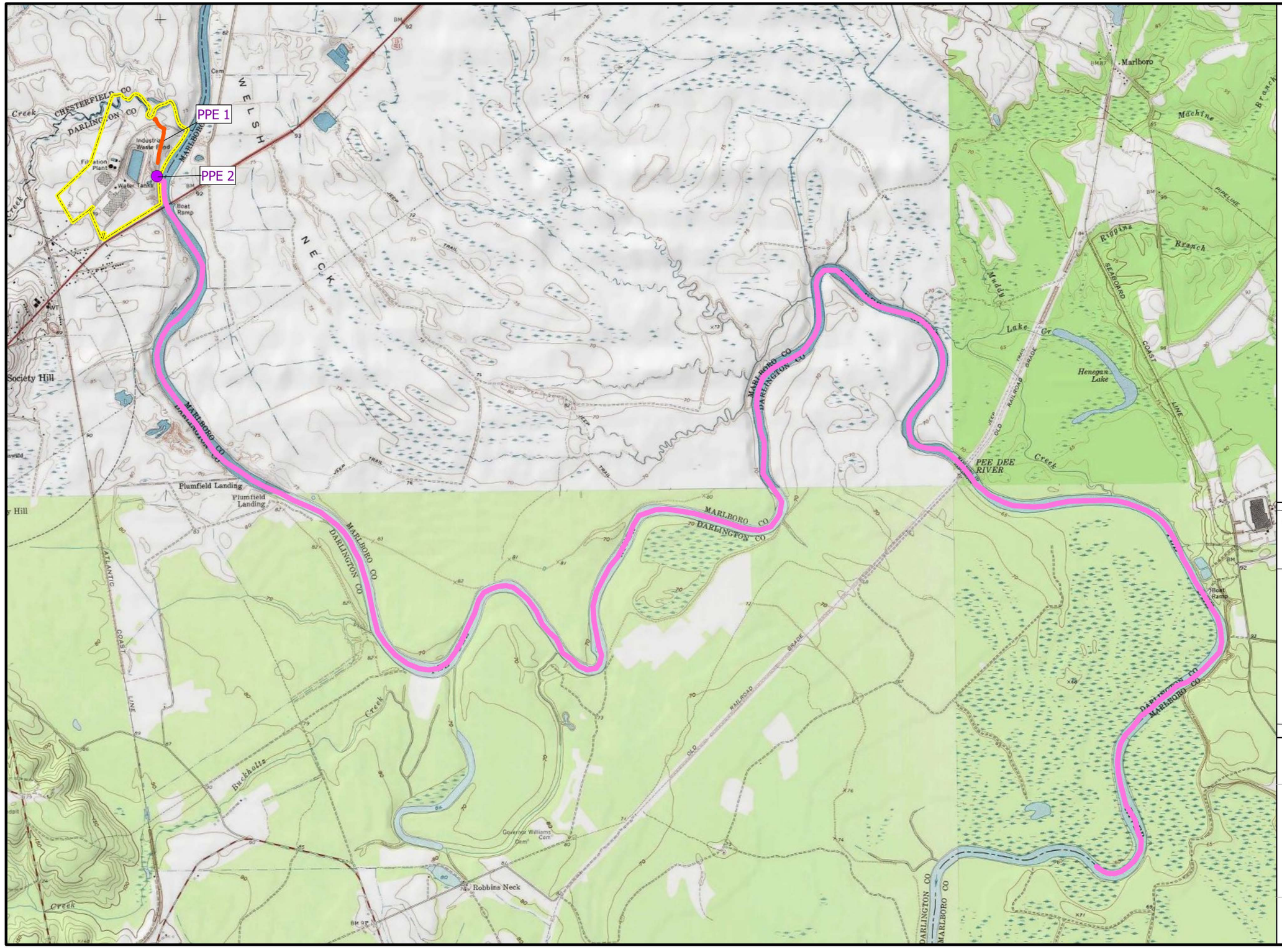
TO No.: 68HE420F0028

City:	County:	State:
Society Hill	Darlington	South Carolina

TETRA TECH

Date: 6/28/2021

Analyst: greg.docekal



Legend

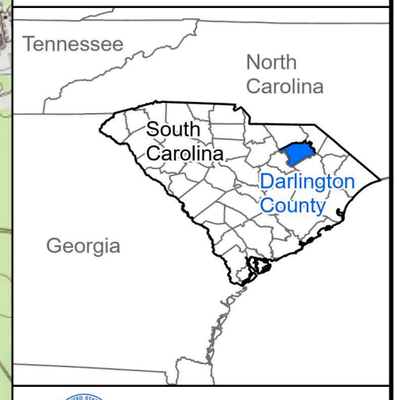
- Approximate Property Boundary
- 15-miles Surface Water Migration Pathway
- PPE 1
- PPE 2

PPE - Probable Point of Entry

N
W E
S

0 1,500 3,000
Feet

Map Source:
USGS 7.5 Minute Topographic Quadrangle Maps: Bennettsville South, SC 1972; Drake, SC 1972; Mont Clare, SC 1963; Society Hill, SC 1971; Darlington County Parcel Viewer, Darlington County Planning/GIS Mapping
Refs. 18; 19



United States Environmental Protection Agency Region 4

FIGURE 5

15-Miles Surface Water Migration

TO Name: Galey and Lord Plant

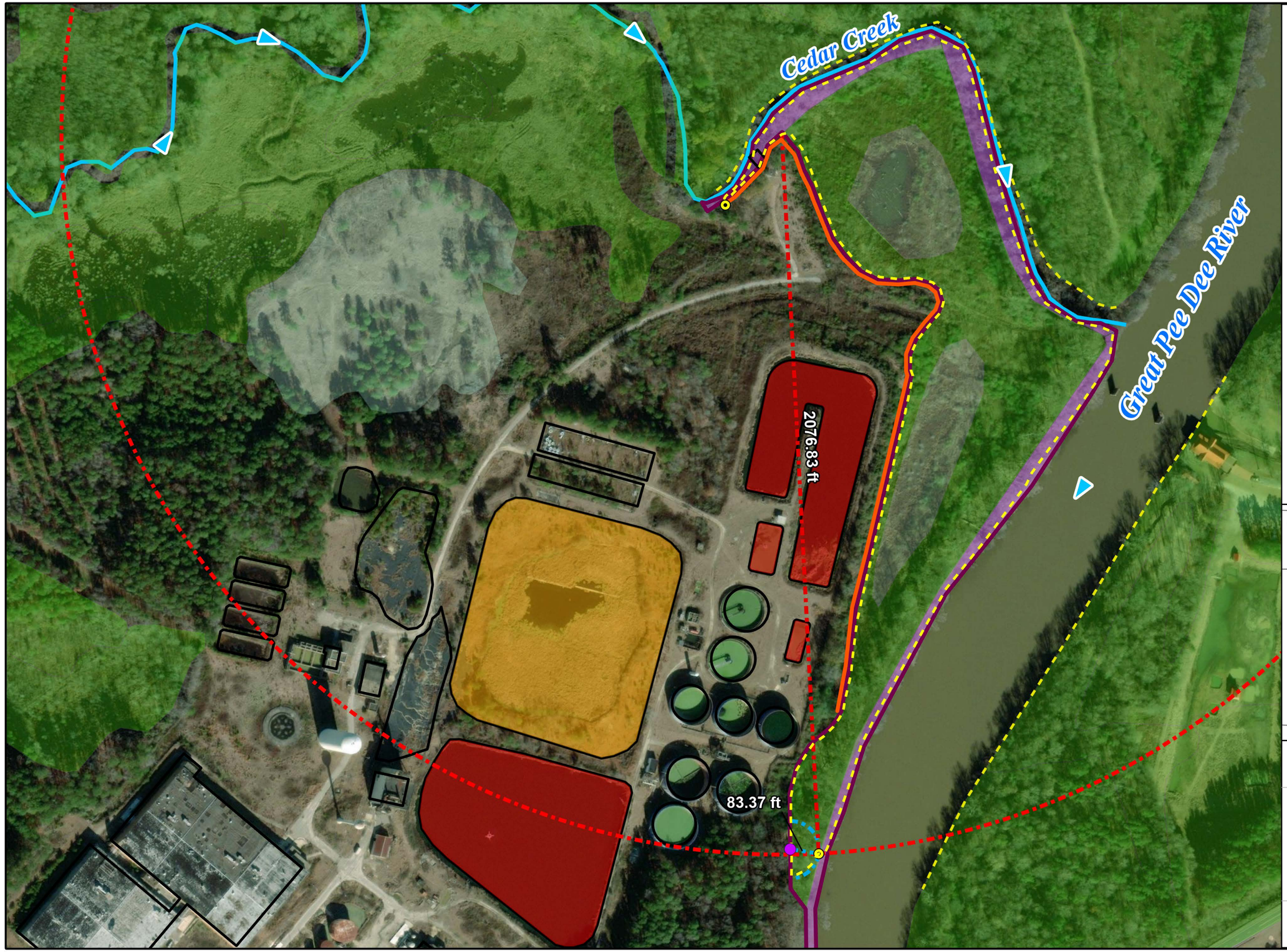
TO No.: 68HE420F0028

City:	**County:**	**State:**
Society Hill	Darlington	South Carolina

TETRA TECH

Date: 6/28/2021

Analyst: greg.docekal



Legend

- Most upstream/downstream sample location
- PPE 1
- PPE 2
- Radius of Arc #1
- Arc #1
- Radius of Arc #2
- Arc #2
- Palustrine Emergent Wetland
- Palustrine Forested/Shrub Wetland
- Riverine Emergent Wetland
- Observed Wetland Boundary
- Wetland Perimeter/Frontage
- Property Feature

Source Property Feature

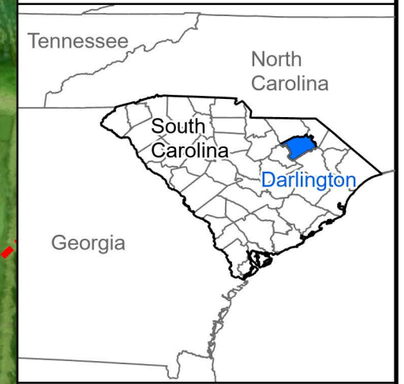
- Source No. 1
- Source No. 2
- Perennial Stream with Flow Direction

ft - Feet

N
W E
S

0 250 500
Feet

Map Source:
The source of this map is ESRI, used by the EPA with ESRI's permission.
U.S. Fish and Wildlife, National Wetland Inventory, 2020.
Refs. 13, pp. 15; 19; 20, p. 40; 52; 91, pp. 10, 15; 92



United States Environmental Protection Agency Region 4

FIGURE 6
Wetland Length Subject to Actual Contamination at Level II Concentrations

TO Name: Galey and Lord Facility
TO No.: 68HE420F0028
City: Society Hill **County:** Darlington **State:** South Carolina

TETRA TECH

Date: 7/9/2021
Analyst: greg.docekal

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SITE DESCRIPTION

For HRS scoring purposes, the Galey and Lord Plant is the result of a release of perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), arsenic, cadmium, chromium, copper, lead, manganese, and mercury from wastewater treatment plant (WWTP) basins (Source Nos. 1 and 2) and an associated observed release to palustrine forested, palustrine emergent, and riverine emergent wetlands that receive runoff from the former Galey and Lord facility (see Sections 2.2.1, Source Nos. 1 and 2; and Figures 1 through 4 of this HRS documentation record). Palustrine forested, palustrine emergent, and riverine emergent wetlands contain the same hazardous substances at concentrations greater than background levels, indicating that a release of hazardous substances has occurred to the surface water migration pathway, as documented in Section 4.0 of this HRS documentation record. The Great Pee Dee River, which receives runoff from the former Galey and Lord facility, is fished for human consumption (Refs. 7; 16, pp. 1, 2; 19). Surface water bodies along the surface water migration pathway and wetlands likely became contaminated as a result of direct discharge of effluent to and flooding of Cedar Creek and the Great Pee Dee River, and surface water runoff from the Galey and Lord facility (Ref. 16, p. 1).

The geographic coordinates of the Galey and Lord site, as measured from Source No. 1 sample GL-042-SD collected during the July 2019 South Carolina Department of Health and Environmental Control (SCDHEC) expanded site inspection (ESI) update, are 34° 31' 53.50" north and 79° 49' 59.85" west (Refs. 5; 13, pp. 13, 17, 27). The EPA identification number, as recorded in the Superfund Enterprise Management System (SEMS), is SCD058189622 (Ref. 3). Land uses surrounding the Galey and Lord facility are predominantly undeveloped wooded and agriculture, with few residential properties (Refs. 5; 17, p. 1) (see Figure 2 of this HRS documentation record). The former Galey and Lord facility is bordered to the north by Cedar Creek, to the east by the Great Pee Dee River, to the south by North Main Street and undeveloped land beyond, and to the west by undeveloped land and residential properties (see Figure 2 of this HRS documentation record).

The Galey and Lord facility occupies about 234.73 acres of land and operated between 1966 and 2016. The facility was owned/operated by and associated with six textile manufacturing companies (Ref. 30, pp. 5, 13, 14, 15, 16, 19, 22). The Galey and Lord facility was built in 1965 by Burlington Industries Klopman Mills Division (Klopman), and production began in 1966 (Ref. 30, p. 19). In 1971, Klopman merged into Burlington Industries, Inc. (Burlington) (Ref. 25, pp. 1 to 4). In 1988, Burlington conveyed the facility to G&L Industries, Inc., by deed. In 2004, G&L Industries, Inc. conveyed the facility to G&L Industries, LLC by Special Warranty Deed. G&L Industries, LLC is the current owner of the property (Ref. 30, p. 16). Taxes on the facility have not been paid since 2017 (Refs. 30, pp. 10, 16; 90).

OPERATIONAL HISTORY

Galey and Lord is a former textile dyeing and finishing facility consisting of two main manufacturing buildings (Society Hill [Plant I] and Specialty Finishing Plant [Plant II]), a water filter plant, a coal boiler house, a WWTP, and several chemical storage areas (Refs. 17, pp. 1, 3, 14, 20; 18; 21, p. 1; 24, pp. 2, 3; 27, p. 4). The WWTP consisted of three 2-million-gallon (MG) equalization tanks, three 2.56-MG aeration tanks, a 17,200-gallon flash mix tank, a 107,700-gallon flocculation tank, two 850,000-gallon clarifiers, a 1-MG (0.2-acre) digester/thickener, 20-MG equalization basin (6.32-acres), 30-MG (9.65-acres) aeration basin, 12 former sand drying beds, a 15-MG (4.48-acres) sludge storage basin, 0.5-MG (0.2-acre) sludge storage basin, and an effluent flow measurement and sampler (Refs. 14, pp. 8, 10, 28, 29; 15, pp. 11, 12, 14, 15, 16, 17, 18; 19; 23, pp. 10, 11; 24, p. 3) (see Figure 2 of this HRS documentation record).

Additionally, a filter building, softener building, coal pile runoff, coal pile, water sludge ponds, 1.5 acre landfill, chromic acid pit, boiler house, and numerous above ground storage tanks (AST) are present on the property (Refs. 15, pp. 11, 12, 14, 15, 16; 19; 24, p. 3; 36, p. 3; 37, p. 10; 66, pp. 1, 2, 3; 71, p. 2). The facility closed in 2016 and most machinery and equipment were removed from the property. Drums, totes, and laboratory chemicals were removed during the 2019 EPA time-critical removal action. As of January

2021, all other features are present (Ref. 16, p. 2). The 2019 EPA time-critical removal action is discussed in the Site Description, Previous Investigations section of the HRS documentation record).

It should be noted that the volumes of the WWTP basins are not consistent in historical references. The volumes listed in this HRS documentation record are for informational purposes only and were obtained from References 14, 15, and 23. The areas of the WWTP basins were obtained from Reference 19. The WWTP basins (equalization, aeration, digestor, and sludge storage) are referred to as ponds and lagoons in reference documents; however, the term "basin" is used in this HRS documentation record (Refs. 8, pp. 4, 6; 20, p. 40; 23, pp. 2, 11). During operations, the 30-MG (9.65-acres) aeration basin was divided into two sections by a synthetic fiber curtain: 15-MG aeration basin and 15-MG sludge storage pond (Ref. 14, p. 10). For consistency and clarity in the HRS documentation record, the entire 30-MG (9.65 acre) basin is referred to as the aeration basin. Reference documents refer to the 4.48-acre sludge storage basin as a polishing pond or holding pond, the 0.2-acre sludge storage basin as a second polishing pond and a former chlorine contact chamber/mixed chlorine contact basin (Refs. 14, pp. 10, 28, 29; 15, p. 17; 64, p. 89). This HRS documentation record refers to these basins by their acreages.

Galey and Lord dyed and finished cotton and synthetic fabrics from 1966 to 2016 (Refs. 21, p. 1; 27, p. 4; 30, pp. 19, 22). Plant I consisted of a conventional woven textile dyeing and finishing operation, fabric mechanical treatment, and plant utilities (Ref. 27, p. 4). The plant produced about 80 percent polyester, cotton, and cotton/polyester blends. The remaining 20 percent was a mixture of polyester, cotton, wool, rayon, and nylon materials (Ref. 27, p. 4). Operations included preparation, pressure beck dyeing, thermosol dyeing, finishing, and surface treatment (Ref. 27, pp. 4 through 7). Plant II was a specialty plant that housed a screen-printing operation. Woven fabrics were rotary screen printed, and the dyes were set in steam-heated ovens (Ref. 27, p. 7). In 1995, all manufacturing operations ceased at the specialty plant (Plant II) (Ref. 29). Subsequently, Plant II was used as an expansion building and contained several pieces of equipment, including tenter frames and a bleach range (Ref. 31, p. 2). Plant I ceased operations in 2016 (Ref. 30, pp. 20, 22).

Fabrics received from weaving mills were undyed (greige fabric) and possibly contained surface agents or coatings that interfered with the color and blocked adsorption of dyes or finish agents. Several processes were applied to prepare the fabric for dyeing and finishing processes, including bleaching, washing, mercerizing, heat setting, and chemical application (Refs. 27, pp. 5, 6, 7; 28, p. 13).

Bleaching involved saturation of cloth with a chemical solution; steaming of saturated cloth to enhance chemical processes; washing of cloth to remove applied chemicals, soil, etc.; and drying of cloth. These processes were repeated several times on several bleach ranges with different chemical applicators (Ref. 28, p. 13). Mercerizing involved saturation of fabric with caustic solutions to swell fibers and render the fabric more receptive to dyeing (Ref. 28, p. 13). Heat setting proceeded by application of heat to greige fabric to stabilize width and size of the fabric to ensure that fabric dimensions would not be affected by additional processing and heating in other process equipment (Ref. 28, p. 14). The fabric was then pre-treated with chemical solutions to remove additional substances and to aid in further preparation processes (Ref. 28, p. 14).

The dyeing department consisted of several continuous dye ranges used to apply dye solutions to fabric, set/cure dyes, and wash and dry dyed fabric (Ref. 28, p. 14). Galey and Lord utilized pressure beck dyeing and thermosol dyeing (Ref. 27, pp. 4, 5). Pressure beck dyeing included operation of several high-pressure dye becks—batch dyeing vessels in which dyes impregnated fabric by application of pressure and elevated temperature (Ref. 27, pp. 4, 5). A chemical swelling agent (solvent) called a dye carrier was also used to accelerate dyeing of polyester fibers. Typical carriers were biphenyl, methyl naphthalene, orthophenyl phenol, and trichlorobenzene (Ref. 27, p. 5). Thermosol dyeing involved vapor phase transfer of dyes into either manmade or natural fibers. Each thermosol dyeing line was configured to conduct continuous dyeing of both polyester and cotton fibers and to remove excess dyes by washing (Ref. 27, p. 5).

After dyeing, the fabric was coated/reacted with a number of chemical agents (finishing solutions) to provide desired physical properties. The chemical agents were applied on finishing lines that included a padding station drying oven (tenter) (Ref. 27, p. 6). Surface finishing of fabric, including sueding and shearing, resulted in desired finished fabric textures (Ref. 28, p. 16).

In 1973, Burlington Industries, Inc. submitted several permit applications to SCDHEC (formerly South Carolina Pollution Control Authority, Division of Air Pollution Control) for multiple pieces of equipment in Plant II (Ref. 33, pp. 1 through 38; 34). The permit applications included brief descriptions of processing equipment, raw materials, products, and gaseous materials admitted to the atmosphere (Ref. 33, pp. 1 to 4, 7 to 9, 11 to 13, 15 to 17, 20 to 22, 25 to 27, 30 to 32, 34 to 38). Raw materials listed for the tenter frame permit applications included water and oil repellants. The definition of water and oil repellents specified in the permit applications included aqueous emulsions of fluorochemical or silicone polymers (Ref. 33, pp. 1 to 4, 7 to 9, 11 to 13). Fluorochemical polymer was listed as a raw material for the #6 and #7 Tenter Frames (Ref. 33, pp. 7, 8, 11, 12). It should be noted that the terms "fluorocarbons," "fluoropolymers," and "fluorochemicals" are used interchangeably, and each referred to a polymeric material coating containing at least one fluorinated segment (Ref. 83, p. 11).

Wastewater Treatment Operations

Wastewater is the textile industry's largest waste stream (Ref. 61, p. 40). Large-volume wastes include washwater from preparation and continuous dyeing, alkaline waste from preparation, and batch dye waste containing large amounts of salt, acid, or alkali (Ref. 61, p. 40). For example, in beck dyeing, 40 to 50 pounds of water is consumed per pound of fabric. At least 98 percent of this water is wastewater that must be processed before it is returned to the process stream. In continuous dyeing, 20 to 25 pounds of water is consumed per pound of fabric, of which only 4 percent is evaporated, and the remaining 96 percent added to waste effluents (Ref. 60, p. 26).

When Plant I opened in 1966, waste treatment occurred in a single 30-MG oxidation pond that discharged to the Great Pee Dee River (Ref. 23, p. 2). Between 1973 and 1974, the WWTP was modified to an activated sludge treatment facility, and the first National Pollutant Discharge Elimination System (NPDES) permit was obtained (Refs. 23, p. 2; 30, p. 19). The following is a summary of the WWTP process:

1. Equalization basin – reception of wastewater from Plant I, Plant II, sanitary wastewater, steam plant condensate, and boiler blowdown (Refs. 14, pp. 7, 8, 10). Equalization of wastewater organic concentration levels and adjustment of pH, if required (Ref. 14, p. 23).
2. Aeration basin (two sections, divided by a wooden partition) – mixture of wastewater with air and loading of sludge with bacteria (Refs. 14, pp. 7, 24, 25, 26; 62, p. 4).
3. Clarifiers – reception of mixed liquor suspended solids (MLSS) (biodegradable and nonbiodegradable organic matter, and inert material) from the aeration basin; separation of MLSS from treated wastewater (Refs. 14, p. 7; 15, pp. 20, 62).
4. Aeration basin (first section) – reception of return sludge from the clarifier (Ref. 14, p. 7).
5. Digester (Thickener) – stabilization and thickening of waste sludge from the clarifier prior to disposal; pumping of thickened sludge to sand drying beds, temporary contact belt filter press, or sludge storage basin where the sludge is further thickened (Refs. 14, pp. 8, 9, 10; 15, p. 62; 32, p. 2). Reference 14 refers to the digester as a concrete thickener basin. Reference 14 incorrectly states that the digester is a concrete basin (Refs. 15, p. 62; 32, p. 2).
6. Sludge storage basin – separation of thickened sludge from the aeration basins by a synthetic fabric curtain (Ref. 14, pp. 7, 9).
7. Polishing pond – reception of effluent from the clarifiers, mostly composed of accumulated settled solids (Ref. 14, pp. 9, 26).

8. Second polishing pond (originally designed as a chlorine contact basin) – reception of effluent from the polishing pond (Ref. 14, pp. 9, 10, 29).
9. Parshall flume – measurement and recording of effluent flow (Ref. 14, p. 9).
10. NPDES Outfall 001 – discharge of final effluent (Ref. 14, p. 9).

Between 1988 and 1993, compliance with NPDES discharge limits was difficult due to the strain placed on the WWTP caused by an increase in cotton production and sulfur dye use (Ref. 23, p. 2). Therefore, the WWTP was modified—construction began in 1993 and was completed in June 1994 (Ref. 23, pp. 2, 8, 11). A simplified summary of the modified WWTP process is as follows:

1. Equalization basin – reception of industrial process wastewater, blowdown, filter backwash, and coal pile runoff (Refs. 15, pp. 9, 11, 39, 40).
2. Equalization tanks – mixture and equalization of wastewater prior to aeration (Ref. 15, pp. 12, 42).
3. Splitter – splitting effluent and return of sludge to three aeration tanks (Ref. 23, p. 10).
4. Aeration tanks – activation of sludge containment and aeration (Ref. 23, p. 10).
5. Chemical mixing chamber (flash mix tanker) – addition of polymer and any other chemicals to the wastewater to enhance treatment (Refs. 15, p. 15; 23, p. 10; 30, p. 34).
6. Flocculation tank – allowance of full reaction of chemicals added in the mixing chamber (Refs. 15, p. 16; 23, p. 10).
7. Clarifiers – allowance of biological material to be wasted or recycled (Refs. 15, p. 16; 23, p. 10). Wasted sludge transferred to the aeration tanks or digestor as waste-activated sludge (Ref. 15, p. 16, 20, 61). Activated sludge returned to the aeration tanks and resuspended during aeration to maintain a continuous population of microbes for additional treatment (Ref. 15, p. 20).
8. Digester – stabilization and thickening of waste prior to disposal (Refs. 15, p. 62; 23, p. 11).
9. Sludge storage basin (former polishing pond) – collection and decanting of sludge (Refs. 14, p. 10; 19; 23, p. 11).
10. Land application – digestion of sludge that underwent disposal via land application (Ref. 15, p. 65). In 2013, 325 dry tons of sludge was generated (Ref. 64, p. 89).
11. Second sludge storage basin (previously second polishing pond/former chlorine contact basin) – reception of clarifier effluent (Refs. 14, pp. 8, 9, 10, 11; 15, p. 59).
12. Parshall flume system – measurement of effluent flow and collection of samples near NPDES Outfall 001 (Refs. 14, pp. 9, 10; 15, p. 65).
13. NPDES Outfall 001 – discharge of effluent to the Great Pee Dee River (Refs. 14, pp. 9, 10; 15, p. 9; 64, p. 90).

With implementation of the aeration tank system process, the aeration basin was no longer used (Ref. 23, p. 6). In May 1999, Galey and Lord submitted a modification request for its Sludge Lagoon Closure Plan which included the closure of the Sludge Storage basin (Ref. 39, pp. i, 4). The initial closure plan, approved in January 1998, included removal and application of the sludge to various land areas over a 3-year period (Ref. 39, pp. i, 4). Once empty, the basin would be covered with vegetation. The modification included addition of coal boiler ash (fly ash and bottom ash) to the sludge lagoon over about 9 years until the basin would be full. Once full, a final cover of earthen materials would be installed (Ref. 39, pp. 4, 5, 14, 15). SCDHEC approved the modifications in June 1999 (Ref. 40). The aeration basin was classified as a Class I Industrial Solid Waste Landfill by SCDHEC (Ref. 72, p. 1). Addition of coal boiler ash continued until the facility closed in 2016 (Ref. 30, p. 20). Following closure of the facility, the WWTP was shut down but was not remediated or cleaned (Refs. 24, pp. 2, 3; 30, p. 22).

During operations, the capacity of the WWTP was approximately 3.5 million gallons per day (MGD) (Ref. 64, p. 89). Between 2012 and 2016, effluent flow at NPDES Outfall 001 ranged from 0.87 to 3.228 MGD, and discharge monitoring reports (DMR) indicated presence of cadmium (at 0.0003 milligrams per liter [mg/L]), chromium (up to 1.5 mg/L), copper (at 0.01 mg/L), and mercury (up to 0.000403 mg/L) (Ref. 64, pp. 33, 34, 35, 156).

A 2016 permit application for Sludge Disposal Report C noted that 325 dry tons of sludge had been generated in 2013, 6,000,000 gallons of sludge was stockpiled, and 325 dry tons (in 2013) and 3,997,500 gallons of liquid sludge had been transported off property (Refs. 64, pp. 44, 73, 87, 88, 89; 69, pp. 4, 12). Sludge samples collected from the sludge storage pond and analyzed for metals as part of the NPDES permit requirements contained arsenic (up to 11 milligrams per kilogram [mg/kg]), cadmium (at 1.0 mg/kg), copper (up to 230 mg/kg), lead (up to 34 mg/kg), and mercury (up to 1.4 mg/kg), among other metals (Refs. 63, pp. 8 to 16; 65, p. 27).

Land application of industrial sludge was first documented in a modification of the 1990 NPDES permit, dated November 6, 1992, and was approved for approximately 565 acres of various agricultural sites in Darlington County (Ref. 68, pp. 1, 21). Between 1993 and 2013, about 9,875 acres (304 separate agricultural fields) received sludge. Approximately 45,424 dry tons of treated sludge was applied at various volumes depending on and in accordance with NPDES permit requirements (Ref. 69, p. 4).

Hazardous Substances Associated with Operations

Operations at Galey and Lord included dyeing and finishing cotton and synthetic blend fabrics (Ref. 28, p. 4). Metals, including arsenic, cadmium, chromium, copper, lead, and mercury are widely used for production of color pigments of textile dyes (Refs. 41, pp. 22, 23; 42, p. 664; 43, p. 217). Manganese in textile wastewater is due to impurities present in chemicals used in various steps (Ref. 74, p. 142). Chromium is used as a mordant to form a dye complex that fixes the fiber and dye together (Ref. 41, p. 22). Finishing chemicals used at Galey and Lord included fluorochemical polymers and fluorochemical co-polymers, which were used as water and oil repellants (Refs. 27, p. 6; 33, pp. 1, 2, 4, 7, 8, 11, 12).

Fluorochemicals are a class of synthetically produced organic chemicals that contain a perfluoroalkyl residue in which all the hydrogen atoms have been replaced by fluorine atoms (Ref. 77, p. 2). Fluorochemicals are the most popular repellent finishes because they repel water and oil-water-borne stains, are very efficient and require little add-on, and are particularly durable during laundering and dry cleaning (Ref. 26, p. 506). Fluorochemicals are typically provided to the textile industry as a concentrate to be subsequently diluted to a specific concentration and then applied to the fabric. The treating solution containing the diluted fluorochemical may include additives such as surfactants, wetting aids, solvents, cross-linkers, etc. Application of the treating solution to the fabric proceeds by padding (dipping) the fabric into the treating solution, spraying the fabric with the treating solution, or foaming the fabric with the treating solution (Ref. 78, pp. 3, 4). Perfluoroalkyl substances (PFAS) —a group of fluorinated, organic, man-made compounds that include PFOA and PFOS—are used to make fluoropolymer coatings and products that resist heat, oil, stains, grease, and water. During formation of fluorochemicals via electrofluorination and telomerisation, a small amount of PFOA and PFOS is produced (Refs. 73; 75, pp. ES-1, 1-1; 76, pp. ES-1, 1-1; 77, pp. 2, 4).

PREVIOUS INVESTIGATIONS

Multiple investigations have been conducted at Galey and Lord. The paragraphs that follow include information most relevant to the scoring in this HRS documentation record.

In 2018, SCDHEC conducted an ESI. Soil, wastewater, and sludge samples were collected within potential source areas; groundwater samples were collected from permanent and temporary monitoring wells; and surface water and sediment samples were collected from Cedar Creek and the Great Pee Dee River (Ref. 8, pp. 7, 8, 17 to 20). Potential source areas sampled included WWTP basins and tanks, sludge

drying beds, coal runoff pond, coal pile, water sludge ponds, former landfill, possible former landfill, dump areas, and a suspected spray field (Refs. 8, pp. 17, 20; 9, pp. 2, 3, 16, 17, 18; 19; 66; 67). All samples were analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), polychlorinated biphenyls (PCB), and metals. Wastewater and surface water samples were analyzed for PFAS (Ref. 8, pp. 30, 32, 77, 79, 151, 153, 192, 194, 275, 277, 309, 311, 381, 386, 387, 632, 636, 637).

Wastewater samples collected from the WWTP basins contained PFOA (up to 7,500 nanograms per liter [ng/L]), PFOS (up to 8,300 ng/L), arsenic (up to 59 micrograms per liter [µg/L]), cadmium (up to 15 µg/L), chromium (at 860 µg/L), copper (at 4,700 µg/L), lead (up to 600 µg/L), mercury (at 150 µg/L), and manganese (up to 4,000 µg/L) (Ref. 8, pp. 17, 21). Sludge samples collected from the WWTP basins contained arsenic (up to 110 mg/kg), cadmium (up to 0.59 mg/kg), chromium (up to 21 mg/kg), copper (up to 160 mg/kg), lead (up to 13 mg/kg), and manganese (up to 160 mg/kg) (Ref. 8, pp. 17, 22). Samples collected from the remaining source areas contained PFOA, PFOS, PCB-1254, PCB-1260, VOCs, SVOCs, and metals (Ref. 8, pp. 17, 20, 21, 22, 26, 27). Surface water and sediment samples were collected from Cedar Creek and the Great Pee Dee River. One surface water sample collected from the Great Pee Dee River contained PFOS (at 210 ng/L), and one sediment sample contained trichloroethene (TCE) (at 21 micrograms per kilogram [µg/kg]). Sediment samples collected from Cedar Creek contained elevated concentrations of arsenic, chromium, copper, and manganese (Ref. 8, pp. 19, 24, 25).

During the 2018 SCDHEC ESI investigation, PFAS analysis by the EPA Region IV Laboratory was limited to water media (Ref. 13, p. 3). Between the 2018 and 2019 investigations, EPA Region 4 Laboratory Services and Applied Sciences Division (LSASD) Laboratory Services Branch (LSB) developed a PFAS method for soil/sediment analysis (ASBPROC-800PFAS) (Ref. 13, pp. 3, 20, 107, 109). In July 2019, SCDHEC collected samples from (1) sludge storage basin, (2) Parshall flume, (3) WWTP stormwater discharge, (4) suspected spray field, (5) wetlands below WWTP, (6) Cedar Creek, and (7) Great Pee Dee River (Ref. 13, pp. 3, 14, 15, 16, 18 to 22). All samples were analyzed for PFAS and metals. Samples collected from the WWTP (sludge storage basin, Parshall flume, and stormwater discharge) contained PFOA (up to 25,000 nanograms per kilogram [ng/kg]), PFAS (up to 84,000 ng/kg), arsenic (up to 25 mg/kg), cadmium (up to 5.4 mg/kg), chromium (up to 84 mg/kg), copper (up to 640 mg/kg), lead (up to 91 mg/kg), and manganese (up to 130 mg/kg) (Ref. 13, pp. 14, 17, 18). Sediment samples collected from Cedar Creek contained PFOS (up to 9,200 ng/kg), arsenic (up to 1.3 mg/kg), chromium (up to 22 mg/kg), copper (up to 28 mg/kg), lead (up to 15 mg/kg), and manganese (up to 620 mg/kg). Sediment samples collected from the Great Pee Dee River contained PFOA (up to 7,500 ng/kg) and PFOS (up to 6,500 ng/kg) (Ref. 13, pp. 15, 19, 20). Soil samples collected from wetlands below the WWTP contained PFOA (up to 53,000 J [estimated] ng/kg) and PFOS (up to 2,600,000 ng/kg) (Ref. 13, pp. 16, 22). Samples collected from the suspected spray field did not contain hazardous substances at concentrations significantly above background levels (Ref. 13, pp. 16, 21, 22).

In February 2019, EPA conducted a removal site evaluation (RSE). During the RSE, EPA observed multiple containers (drums, totes, ASTs, spilled elemental mercury, a leaking ammonia AST, and a breach in secondary containment of four large hydroxide ASTs). In March 2019, EPA was notified of a release from an ammonia hydroxide tank and a possible oil discharge from the flooded oil and grease storage room. Subsequently, EPA initiated an emergency response (Ref. 71, p. 1) during which EPA conducted an initial inspection, evaluated the stability of various abandoned chemical containers, sampled exterior ASTs, performed hazard categorization and water quality monitoring, and collected soil samples (Ref. 71, p. 2). In May 2019, EPA performed a time-critical removal. A total of 2,400 containers were bulked and transported off property for disposal. Waste streams generated during removal activities included neutral liquid and solid, acid liquid and solid, base liquid and solid, sulfide liquid, flammable liquid and solid, oxidizer liquid and solid, chloroform, dry liquid, and dry solid/sludge (Ref. 71, pp. 3, 4). About 100,000 gallons of liquid flammables, neutral, corrosive, and oxidizer waste; 53,000 pounds of solid flammable, neutral, corrosive, and oxidizer waste; and 17 separate hazardous materials cubic yard boxes of solid dyes were sent off property for disposal (Ref. 71, p. 4). The removal action did not include removal of any sources evaluated in this HRS documentation record (Ref. 71, pp. 2, 7) (see Section 2.2.1, Source Characterization, Source Nos. 1 and 2 of this HRS documentation record).

It should be noted that samples collected at the Galey and Lord facility contained VOCs, SVOCs, and PCBs in addition to PFAS and metals. PFAS and metals are directly linked to textile dyeing and finishing processes, including fabric preparation, fabric dyeing, and fabric finishing, and are prevalent throughout the WWTP basins, as well as along the surface water migration pathway (see Section 2.2.1 Source Identification and Section 4.1.2.1.1 Surface Water Migration Pathway Observed Release of this HRS documentation record). Therefore, only PFAS and metals are evaluated in this HRS documentation record.

Additional Information – Land Application of Sludge

Land application of industrial sludge was first documented in a modification of the 1990 NPDES permit dated November 6, 1992 and was approved for approximately 565 acres of various agricultural sites in Darlington County (Ref. 68, pp. 1, 21). Between 1993 and 2013, about 9,875 acres (304 separate agricultural fields) received sludge. Approximately 45,424 dry tons of treated sludge was applied at various volumes depending on and in accordance with NPDES permit requirements (Ref. 69, p. 4).

The 2019 SCDHEC sampling investigation included agricultural fields that received the highest reported volumes of sludge. Additionally, these fields include drinking water wells, and surface water bodies are either on or immediately adjacent to the fields (Ref. 69, pp. 4, 12). Samples of soil (surface and subsurface), surface water, sediment, and groundwater (residential and monitoring wells) were collected within each field (designated A, B, and C) and/or adjacent parcel (Ref. 69, pp. 4, 9, 18 to 27). Soil samples contained PFOA up to 10,000 ng/kg and PFOS up to 21,000 ng/kg; groundwater samples contained PFOA up to 8,100 ng/L and PFOS up to 150 ng/L; surface water samples contained PFOA up to 13,000 ng/L and PFOS up to 810 ng/L; and sediment samples contained PFOA up to 170,000 J ng/kg and PFOS up to 11,000 J ng/kg (Ref. 69, pp. 28 to 32, 515 to 618). Of the 11 residential wells sampled, six wells contained PFOA and/or PFOS above the EPA Health Advisory (HA) of 70 ng/L (Ref. 69, pp. 30, 65; 87, p. 2).

On July 8, 2020, at the request of SCDHEC, the EPA Region 4 Emergency Response, Removal, Prevention & Preparation Branch (ERRPPB) initiated a time-critical removal action (Ref. 93, p. 1). The time-critical removal action addressed five of the six private wells identified during the SCDHEC 2019 SI containing PFOA/ PFOS at concentrations above the HA. The removal action consisted of the installation of five granulated activated carbon (GAC) filtration systems with protective shed enclosures. One residential property installed a filter system without EPA assistance and/or oversight (Ref. 93, p. 1).

Based on the results of the 2019 SI, SCDHEC initiated a second SI using a phased sampling approach focusing on private drinking water wells near agricultural fields that received sludge from the Galey and Lord facility (Ref. 93, p. 1). On February 10, 2020, SCDHEC submitted a Quality Assurance Project Plan (QAPP) to EPA for additional sampling activities. The QAPP suggested sampling of up to 100 potable wells in areas near agricultural fields that had received sludge from the Galey and Lord facility (Ref. 70, pp. 1, 4). EPA approved the QAPP on February 19, 2020 (Ref. 70, p. 1).

As of April 2021, 90 private drinking water wells have been sampled. Of the 90 wells sampled, 19 contained PFOA/PFOS at concentrations above the HA. Remediation activities have been and will be conducted for these private drinking water wells and include (1) referred to EPA Region 4 ERRPPB, (2) connection to municipal water (if possible), and (3) private installation of filtration systems (without EPA assistance and/or oversight) (Ref. 93, p. 1). EPA installed GAC filtration systems at five properties, discussed above; additional systems were scheduled to be installed at nine properties by the end of April 2021. EPA will conduct a one-year quality assurance surveillance of the GACs, and a one-year technical/operational support for the GACs. Additional sampling under the SCDHEC SI was scheduled for June 2021. Private drinking water wells containing PFOA/PFOS at concentrations above the HA (if any), will be referred to the EPA Region 4 ERRPPB (Ref. 93, p.1).

2.2 SOURCE CHARACTERIZATION

2.2.1 SOURCE IDENTIFICATION

Number of source: 1

Name of source: WWTP basins (equalization, digester, and sludge storage basins)

Source Type: Surface impoundments

Description and Location of Source (with reference to a map):

Source No. 1 consists of the equalization, digester, and two sludge storage basins (discussed below as the 4.48-acre and 0.2-acre basins) containing wastes resulting from facility operations as documented by detections of hazardous substances in 17 samples collected in June 2018 and July 2019 (see Figures 2 and 3 and Tables 1 and 2 of this HRS documentation record). The basins are the same source type (surface impoundment), affect similar targets (human food chain and sensitive environments, see Section 4.1.4.3), contain the same constituents of concern (PFOA, PFOS, metals), and all were designed to hold and treat waste effluent from the WWTP.

Equalization basin waste is grey, thick clay-like material with black grit throughout and with a chemical odor. Waste contained in the 4.48-acres sludge storage basin is black and grey, fine grainy material. Digester waste is similar to waste contained in the 4.48-acres sludge storage basin but emits a hydrogen sulfide odor. Waste contained in the 0.2-acre sludge storage basin is black and gritty with a soft texture and chemical odor (Ref. 16, p. 1). Waste in each of these basins contains hazardous substances throughout their entire extent and the waste is homogenous (Ref. 16, p. 1). The equalization basin, digester, and two sludge storage basins (4.48-acre and 0.2-acre) are not lined (Refs. 8, p. 6; 16, p. 1; 22, p. 19). Waste sludge samples are consistent with waste but referred to as sediment samples in the September 2018 ESI (Ref. 8, pp. 79, 153). However, as shown above, these samples are waste and will be referred to as waste in this HRS documentation record (Ref. 16, p. 1).

The WWTP treated industrial wastewater from textile manufacturing operations (Ref. 15, p. 10). Simplified diagrams of the WWTP process before and after modifications appear in Reference 14, page 10 and Reference 64, page 93. The diagrams show an integrated system for the treatment of wastewater. The equalization, digester, and two sludge storage basins (4.48-acre and 0.2-acre) each received the same wastewater at different stages of treatment (Refs. 14, pp. 8, 10; 64, p. 93). Samples collected from the equalization basin, digester, and sludge storage basins (0.2-acre and 4.48-acre) contain the same hazardous substances as documented by samples listed in Tables 1 and 2 of this HRS documentation record.

Operations at Galey and Lord included dyeing and finishing cotton and synthetic blend fabrics (Ref. 28, p. 4). Metals, including arsenic, cadmium, chromium, copper, and lead are widely used for production of color pigments of textile dyes (Refs. 41, pp. 22, 23; 42, p. 664). Manganese in textile wastewater is due to impurities present in chemicals used in various steps (Ref. 74, p. 142). Chromium is used as a mordant to form a dye complex that fixes the fiber and dye together (Ref. 41, p. 22). Fluorochemical polymers and fluorochemical co-polymers were used in the finishing process as water and oil repellants (Refs. 27, p. 6; 33, pp. 1, 2, 4, 7, 8, 11, 12).

Samples collected to characterize Source No. 1 in 2018 and 2019 contained PFOA, PFOS, arsenic, cadmium, chromium, copper, lead, and manganese (see Tables 1 and 2 of this HRS documentation record).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

SCDHEC 2018 ESI

Source No. 1 samples listed in Table 1 of this HRS documentation record were collected during the June 2018 ESI (Ref. 8, pp. 7, 8). The samples contained equalization, digester, and sludge storage basins wastewater and waste sludge resulting from facility operations (Ref. 16, p. 1). The wastewater samples were collected from the surface of the basin. The waste sludge samples were collected within the top 0 to 6 inches of sludge. All samples were collected in accordance with the EPA-approved QAPP, dated May 21, 2018; the EPA Region 4 LSASD (previously Science and Ecosystem Support Division [SESD]) Field Branches Quality System and Technical Procedures (FBQST) for Wastewater Sampling, SESDPROC-306-R4, dated February 13, 2017; Sediment Sampling, SESDPROC-200-R3, dated August 21, 2014 (Refs. 10; 16, p. 1; 45; 46).

The samples were analyzed for PFAS and total metals by the EPA Region 4 LSASD Analytical Support Branch (ASB) via Methods ASBPROC-800 PFAS (Water), ASBPROC-800 PFAS (Waste), and EPA Methods 6010 and 200.8 (total metals) (Ref. 8, pp. 30, 52, 54, 56, 58, 62, 64, 89, 90, 91, 92, 104, 105, 106, 108, 110, 169, 171, 173, 175). The data were verified in accordance with the EPA Region 4 ASB Laboratory Operations Quality Assurance Manual (LOQAM) (Refs. 8, pp. 30, 77, 151; 47; 48). Minimum reporting limits (MRL) are listed on the analytical data sheets in Reference 8. Each MRL is sample-specific and corresponds to the lowest quantitative point on the calibration curve; it is adjusted for the amount of sample prepared and any dilutions performed, as well as for percent moisture (Ref. 49). MRLs are equivalent to sample quantitation limits (SQL) as defined in Section 1.1, Definitions, of the HRS (Refs. 1, Section 1.1; 49).

Logbook notes are in Reference 9. Chain-of-custody records are in Reference 50. Locations of the samples listed in Table 1 are in Reference 8, p. 17 (also see Figure 3 of this HRS documentation record). Specific page numbers in chain-of-custody records and logbook notes are listed in Table 1. Samples GL-039-SD, GL-040-SD, GL-041-SD, GL-042-SD, GL-050-WW, GL-051-SD, and GL-052-SD are mislabeled in logbook notes. The correct sample identifications are provided in chain-of-custody records (Refs. 9, pp. 39, 40, 46, 47, 57; 16, p. 2; 50, pp. 1, 4, 5).

Table 1: Analytical Results from Source No. 1

Sample ID	Hazardous Substance	Hazardous Substance Concentration	MRL	References
Equalization Basin – Wastewater				
GL-049-WW	PFOA	3,100 ng/L	400 ng/L	8, pp. 17, 62; 50, p. 4
GL-049-WW	PFOS	330 ng/L	40 ng/L	8, pp. 17, 62; 50, p. 4
GL-049-WW	Arsenic	3.8 µg/L	1.0 µg/L	8, pp. 17, 104; 50, p. 4
GL-049-WW	Manganese	6.0 µg/L	5.0 µg/L	8, pp. 17, 104; 50, p. 4
GL-050-WW	PFOA	3,000 ng/L	390 ng/L	8, pp. 17, 64; 50, p. 4
GL-050-WW	PFOS	360 ng/L	39 ng/L	8, pp. 17, 64; 50, p. 4
GL-050-WW	Arsenic	3.6 µg/L	1.0 µg/L	8, pp. 17, 105; 50, p. 4
GL-050-WW	Manganese	6.3 µg/L	5.0 µg/L	8, pp. 17, 105; 50, p. 4
Equalization Basin – Waste Sludge				
GL-051-SD	Arsenic	0.58 mg/kg	0.20 mg/kg	8, pp. 17, 106; 50, p. 5
GL-051-SD	Chromium	7.7 mg/kg	0.49 mg/kg	8, pp. 17, 106; 50, p. 5
GL-051-SD	Copper	5.2 mg/kg	0.99 mg/kg	8, pp. 17, 106; 50, p. 5

Table 1: Analytical Results from Source No. 1				
Sample ID	**Hazardous Substance**	**Hazardous Substance Concentration**	**MRL**	**References**
GL-051-SD	Lead	5.9 mg/kg	0.20 mg/kg	8, pp. 17, 106; 50, p. 5
GL-051-SD	Manganese	20 mg/kg	0.49 mg/kg	8, pp. 17, 106; 50, p. 5
GL-052-SD	Chromium	7.7 mg/kg	0.50 mg/kg	8, pp. 17, 108; 50, p. 5
GL-052-SD	Copper	12 mg/kg	1.0 mg/kg	8, pp. 17, 108; 50, p. 5
GL-052-SD	Lead	4.1 mg/kg	0.20 mg/kg	8, pp. 17, 108; 50, p. 5
GL-052-SD	Manganese	25 mg/kg	0.50 mg/kg	8, pp. 17, 108; 50, p. 5
GL-053-SD	Arsenic	0.37 mg/kg	0.20 mg/kg	8, pp. 17, 110; 50, p. 5
GL-053-SD	Chromium	8.2 mg/kg	0.50 mg/kg	8, pp. 17, 110; 50, p. 5
GL-053-SD	Copper	10 mg/kg	0.99 mg/kg	8, pp. 17, 110; 50, p. 5
GL-053-SD	Lead	5.2 mg/kg	0.20 mg/kg	8, pp. 17, 110; 50, p. 5
GL-053-SD	Manganese	37 mg/kg	0.50 mg/kg	8, pp. 17, 110; 50, p. 5
Digester – Wastewater				
GL-040-WW	PFOA	2,400 ng/L	390 ng/L	8, pp. 17, 54; 9, p. 40; 50, p. 3
GL-040-WW	PFOS	730 ng/L	39 ng/L	8, pp. 17, 54; 9, p. 40; 50, p. 3
GL-040-WW	Manganese	180 µg/L	5.0 µg/L	8, pp. 17, 90; 9, p. 40; 50, p. 3
Digester – Waste Sludge				
GL-040-SD	Arsenic	0.89 mg/kg	0.20 mg/kg	8, pp. 17, 171; 9, p. 40; 50, p. 1
GL-040-SD	Cadmium	0.10 mg/kg	0.10 mg/kg	8, pp. 17, 171; 9, p. 40; 50, p. 1
GL-040-SD	Chromium	12 mg/kg	0.50 mg/kg	8, pp. 17, 171; 9, p. 40; 50, p. 1
GL-040-SD	Copper	8.7 mg/kg	1.0 mg/kg	8, pp. 17, 171; 9, p. 40; 50, p. 1
GL-040-SD	Lead	3.4 mg/kg	0.20 mg/kg	8, pp. 17, 171; 9, p. 40; 50, p. 1
GL-040-SD	Manganese	85 mg/kg	0.50 mg/kg	8, pp. 17, 171; 9, p. 40; 50, p. 1
4.48-Acre Sludge Storage Basin – Wastewater				
GL-041-WW	PFOA	7,500 ng/L	820 ng/L	8, pp. 17, 56; 9, p. 57; 50, p. 4
GL-041-WW	PFOS	2,100 ng/L	41 ng/L	8, pp. 17, 56; 9, p. 57; 50, p. 4
GL-041-WW	Manganese	95 µg/L	5.0 µg/L	8, pp. 17, 91; 9, p. 57; 50, p. 4
GL-042-WW	PFOA	7,100 ng/L	780 ng/L	8, pp. 17, 58; 9, p. 58; 50, p. 4
GL-042-WW	PFOS	1,900 ng/L	39 ng/L	8, pp. 17, 58; 9, p. 58; 50, p. 4
GL-042-WW	Arsenic	1.1 µg/L	1.0 µg/L	8, pp. 17, 92; 9, p. 58; 50, p. 4
GL-042-WW	Manganese	66 µg/L	5.0 µg/L	8, pp. 17, 92; 9, p. 58; 50, p. 4
4.48-Acre Sludge Storage Basin – Waste Sludge				
GL-041-SD	Arsenic	0.47 mg/kg	0.20 mg/kg	8, pp. 17, 173; 9, p. 57; 50, p. 1
GL-041-SD	Chromium	2.9 mg/kg	0.50 mg/kg	8, pp. 17, 173; 9, p. 57; 50, p. 1
GL-041-SD	Copper	1.9 mg/kg	0.99 mg/kg	8, pp. 17, 173; 9, p. 57; 50, p. 1
GL-041-SD	Lead	2.2 mg/kg	0.20 mg/kg	8, pp. 17, 173; 9, p. 57; 50, p. 1
GL-041-SD	Manganese	8.2 mg/kg	0.50 mg/kg	8, pp. 17, 173; 9, p. 57; 50, p. 1

Table 1: Analytical Results from Source No. 1				
Sample ID	**Hazardous Substance**	**Hazardous Substance Concentration**	**MRL**	**References**
GL-042-SD	Arsenic	0.53 mg/kg	0.20 mg/kg	8, pp. 17, 175; 9, p. 58; 50, p. 2
GL-042-SD	Chromium	4.7 mg/kg	0.49 mg/kg	8, pp. 17, 175; 9, p. 58; 50, p. 2
GL-042-SD	Copper	4.9 mg/kg	0.98 mg/kg	8, pp. 17, 175; 9, p. 58; 50, p. 2
GL-042-SD	Lead	2.3 mg/kg	0.20 mg/kg	8, pp. 17, 175; 9, p. 58; 50, p. 2
GL-042-SD	Manganese	6.0 mg/kg	0.49 mg/kg	8, pp. 17, 175; 9, p. 58; 50, p. 2
0.2-Acre Sludge Storage Basin – Wastewater				
GL-039-WW	PFOA	3,900 ng/L	970 ng/L	8, pp. 17, 52; 9, p. 39; 50, p. 3
GL-039-WW	PFOS	6,700 ng/L	970 ng/L	8, pp. 17, 52; 9, p. 39; 50, p. 3
GL-039-WW	Arsenic	59 µg/L	5.0 µg/L	8, pp. 17, 89; 9, p. 39; 50, p. 3
GL-039-WW	Cadmium	15 µg/L	2.5 µg/L	8, pp. 17, 89; 9, p. 39; 50, p. 3
GL-039-WW	Chromium	860 µg/L	50 µg/L	8, pp. 17, 89; 9, p. 39; 50, p. 3
GL-039-WW	Copper	4,700 µg/L	100 µg/L	8, pp. 17, 89; 9, p. 39; 50, p. 3
GL-039-WW	Lead	600 µg/L	5.0 µg/L	8, pp. 17, 89; 9, p. 39; 50, p. 3
GL-039-WW	Manganese	4,000 µg/L	50 µg/L	8, pp. 17, 89; 9, p. 39; 50, p. 3
0.2-Acre Sludge Storage Basin – Waste Sludge				
GL-039-SD	Arsenic	2.8 mg/kg	0.20 mg/kg	8, pp. 17, 169; 9, p. 39; 50, p. 1
GL-039-SD	Cadmium	0.37 mg/kg	0.10 mg/kg	8, pp. 17, 169; 9, p. 39; 50, p. 1
GL-039-SD	Chromium	21 mg/kg	2.5 mg/kg	8, pp. 17, 169; 9, p. 39; 50, p. 1
GL-039-SD	Copper	130 mg/kg	5.0 mg/kg	8, pp. 17, 169; 9, p. 39; 50, p. 1
GL-039-SD	Lead	13 mg/kg	0.20 mg/kg	8, pp. 17, 169; 9, p. 39; 50, p. 1
GL-039-SD	Manganese	41 mg/kg	2.5 mg/kg	8, pp. 17, 169; 9, p. 39; 50, p. 1

Notes:

GL	Galey and Lord	ng/L	Nanograms per liter
ID	Identification	PFOA	Perfluorooctanoic acid
µg/L	Micrograms per liter	PFOS	Perfluorooctanesulfonic acid
MRL	Minimum reporting limit	SD	Sediment
mg/kg	Milligrams per kilogram		

SCDHEC 2019 ESI Update

Source No. 1 samples listed in Table 2 of this HRS documentation record were collected during the July 2019 ESI Update (Ref. 13, p. 6). The samples consisted of waste sludge in the 4.48-acre sludge storage basin resulting from facility operations (Refs. 11, pp. 25, 26; 16, p. 1) (see Figure 3 of this HRS documentation record). The waste sludge samples were collected within 0 to 6 and 12 to 18 inches below the sludge surface (Ref. 16, p. 1). All samples were collected in accordance with the approved QAPP, dated June 21, 2019, and the EPA Region 4 LSASD FBQST for Sediment Sampling, SESDPROC-200-R3, dated August 21, 2014 (Refs. 12; 16, p. 1; 46).

The samples were analyzed for PFAS and total metals by the EPA Region 4 LSASD LSB via methods ASBPROC-800 PFAS, and EPA Methods 6010 and 200.8 (total metals) (Ref. 13, pp. 39, 41, 81, 83, 121, 123). The data were verified in accordance with the EPA Region 4 LSB LOQAM (Refs. 13, pp. 25, 107; 47; 48). MRLs are listed on the analytical data sheets in Reference 13. Each MRL is sample-specific and corresponds to the lowest quantitative point on the calibration curve; it is adjusted for the amount of sample prepared and any dilutions performed, as well as for percent moisture. MRLs are equivalent to SQLs as defined in Section 1.1, Definitions, of the HRS (Refs. 1, Section 1.1; 49).

Logbook notes are in Reference 11. Chain-of-custody records are in Reference 50. Locations of the samples listed in Table 2 are in Reference 13, page 14 (also see Figure 3 of this HRS documentation record). Specific page numbers in chain-of-custody records and logbook notes are listed in Table 2.

Table 2: Analytical Results from Source No. 1

Sample ID/Laboratory ID	Hazardous Substance	Hazardous Substance Concentration	MRL	References
4.48-acre Sludge Storage Basin – Waste Sludge (0 to 6 inches below the sludge surface)				
GL-041-SD/ E192904-07	PFOA	7,300 ng/kg	2,600 ng/kg	13, p. 121; 11, p. 26; 50, p. 7
GL-041-SD/ E192904-07	PFOS	19,000 ng/kg	2,400 ng/kg	13, p. 121; 11, p. 26; 50, p. 7
GL-041-SD/ E192904-07	Arsenic	0.22 mg/kg	0.20 mg/kg	13, p. 39; 11, p. 26; 50, p. 7
GL-041-SD/ E192904-07	Chromium	4.8 mg/kg	0.49 mg/kg	13, p. 39; 11, p. 26; 50, p. 7
GL-041-SD/ E192904-07	Copper	4.1 mg/kg	0.99 mg/kg	13, p. 39; 11, p. 26; 50, p. 7
GL-041-SD/ E192904-07	Lead	2.2 mg/kg	0.20 mg/kg	13, p. 39; 11, p. 26; 50, p. 7
GL-041-SD/ E192904-07	Manganese	4.8 mg/kg	0.49 mg/kg	13, p. 39; 11, p. 26; 50, p. 7
GL-042-SD/ E192904-08	PFOA	2,300 ng/kg	120 ng/kg	13, p. 123; 11, p. 25; 50, p. 7
GL-042-SD/ E192904-08	PFOS	7,800 ng/kg	1,100 ng/kg	13, p. 123; 11, p. 25; 50, p. 7
GL-042-SD/ E192904-08	Arsenic	0.29 mg/kg	0.20 mg/kg	13, p. 41; 11, p. 25; 50, p. 7
GL-042-SD/ E192904-08	Chromium	2.7 mg/kg	0.49 mg/kg	13, p. 41; 11, p. 25; 50, p. 7
GL-042-SD/ E192904-08	Copper	2.1 mg/kg	0.99 mg/kg	13, p. 41; 11, p. 25; 50, p. 7
GL-042-SD/ E192904-08	Lead	1.3 mg/kg	0.20 mg/kg	13, p. 41; 11, p. 25; 50, p. 7
GL-042-SD/ E192904-08	Manganese	3.7 mg/kg	0.49 mg/kg	13, p. 41; 11, p. 25; 50, p. 7
4.48-acre Sludge Storage Basin – Waste Sludge (12 to 18 inches below the sludge surface)				
GL-091-SD/ E192904-28	PFOA	1,700 ng/kg	120 ng/kg	13, p. 166; 11, p. 26; 16, p. 1; 50, p. 9
GL-091-SD/ E192904-28	PFOS	6,500 ng/kg	1,100 ng/kg	13, p. 166; 11, p. 26; 16, p. 1; 50, p. 9

Table 2: Analytical Results from Source No. 1				
Sample ID/Laboratory ID	**Hazardous Substance**	**Hazardous Substance Concentration**	**MRL**	**References**
GL-091-SD/ E192904-28	Arsenic	0.24 mg/kg	0.20 mg/kg	13, p. 81; 11, p. 26; 16, p. 1; 50, p. 9
GL-091-SD/ E192904-28	Lead	1.1 mg/kg	0.20 mg/kg	13, p. 81; 11, p. 26; 16, p. 1; 50, p. 9
GL-092-SD/ E192904-29	PFOA	1,900 ng/kg	230 ng/kg	13, p. 168; 11, p. 25; 16, p. 1; 50, p. 9
GL-092-SD/ E192904-29	PFOS	22,000 ng/kg	5,400 ng/kg	13, p. 168; 11, p. 25; 16, p. 1; 50, p. 9
GL-092-SD/ E192904-29	Arsenic	0.56 mg/kg	0.20 mg/kg	13, p. 83; 11, p. 25; 16, p. 1; 50, p. 9
GL-092-SD/ E192904-29	Chromium	6.1 mg/kg	0.50 mg/kg	13, p. 83; 11, p. 25; 16, p. 1; 50, p. 9
GL-092-SD/ E192904-29	Lead	2.6 mg/kg	0.20 mg/kg	13, p. 83; 11, p. 25; 16, p. 1; 50, p. 9
GL-092-SD/ E192904-29	Manganese	13 mg/kg	0.50 mg/kg	13, p. 83; 11, p. 25; 16, p. 1; 50, p. 9

Notes:

GL	Galey and Lord
ID	Identification
MRL	Minimum reporting limit
mg/kg	Milligrams per kilogram
ng/kg	Nanograms per kilogram
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
SD	Sediment

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

Samples collected from Source No. 1 contained PFOA, PFOS, arsenic, cadmium, chromium, copper, lead, and manganese (see Tables 1 and 2 of this HRS documentation record). Source No. 1 consists of four WWTP basins designed to contain waste (Refs. 16, p. 1; 64, p. 93). Source No. 1 contains wastes resulting from facility operations as documented by hazardous substances listed in Tables 1 and 2 of this HRS documentation record. When the facility closed in 2016, the WWTP was shut down but was not remediated or cleaned (Ref. 24, pp. 2, 3; 30, p. 18).

Containment for Source No. 1 via Overland Flow

As documented in Section 4.1.2.1.1 of this HRS documentation record, contaminants attributable to Source No. 1 are present in wetlands lining Cedar Creek and the Great Pee Dee River. Each basin comprising Source No. 1 (equalization basin, digester, 4.48-acre sludge storage basin, and 0.2-acre sludge storage basin) contain free liquids and diking that is not regularly inspected and maintained (Ref. 16, pp. 2, 22). Therefore, the containment factor for the surface water migration pathway via overland flow is assigned a value of 10 (Ref. 1, Section 4.1.2.1., Table 4-2).

TABLE 3a: Containment Factor (Overland Flow) for Source No. 1

Containment Description	Containment Factor Value	References
Gas release to air	Not scored	Not applicable
Particulate release to air	Not scored	Not applicable
Release to groundwater	Not scored	Not applicable
Release to surface water via overland migration: Evidence of hazardous migration from surface impoundment; free liquids and diking that is not regularly inspected and maintained	10	1, Table 4-2; 16, p. 2

Containment for Source No. 1 via Flood

On September 14, 2018, Hurricane Florence made landfall and spent the next 2 days producing record breaking rainfall across eastern North Carolina and a portion of northeastern South Carolina (Ref. 58, p. 1). Society Hill received between 20 and 30 inches of rainfall (Ref. 58, p. 2). The high amount of rainfall caused flooding of the northern portion of Source No. 1 (4.48-acre sludge storage basin), which was observed actively releasing wastewater to Cedar Creek and the Great Pee Dee River (Ref. 16, p. 2). Source No. 1 lacks a designed, constructed, operated, and maintained containment to prevent a washout of hazardous substances (Ref. 16, p. 2). Therefore, the containment factor for the surface water migration pathway flood component is assigned a value of 10 (Ref. 1, Section 4.1.2.1.2.2.1, Table 4-8).

TABLE 3b: Containment Factor (Flood) for Source No. 1

Containment Description	Containment Factor Value	References
Gas release to air	Not scored	Not applicable
Particulate release to air	Not scored	Not applicable
Release to groundwater	Not scored	Not applicable
Release to surface water via Flood: Other	10	1, Table 4-8; 16, p. 2

2.4.2.1 HAZARDOUS WASTE QUANTITY

2.4.2.1.1 Hazardous Constituent Quantity

The total hazardous constituent quantity for Source No. 1 could not be adequately determined according to the HRS requirements; that is, total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). Insufficient historical and current data (manifests, potentially responsible party [PRP] records, state records, permits, waste concentration data, etc.) are available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, information is insufficient to calculate a total or partial Hazardous Constituent Quantity estimate for Source No. 1 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Assigned Value: NS

2.4.2.1.2 Hazardous Wastestream Quantity

The total hazardous wastestream quantity for Source No. 1 could not be adequately determined according to the HRS requirements; that is, total mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.2). Insufficient historical and current data (manifests, PRP records, state records, permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total or partial mass of the wastestream plus the mass of all CERCLA pollutants and contaminants in the source and the associated release from the source. Therefore, information is insufficient to evaluate the associated releases from the source to calculate the hazardous wastestream quantity for Source No. 1 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, Volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Assigned Value: NS

2.4.2.1.3 Volume (Tier C)

Information available on the depth of Source No. 1 is not sufficiently specific to support a volume of contaminated waste with reasonable confidence; therefore, it is not possible to assign a volume (Tier C) in cubic yards (yd^3) for Source No. 1 (Ref. 1, Section 2.4.2.1.3). Source No. 1 has been assigned a value of 0 for the volume measure (Ref. 1, Section 2.4.2.1.3). As a result, the evaluation of hazardous waste quantity proceeds to the evaluation of Tier D, area (Ref. 1, Sec. 2.4.2.1.3).

Volume Assigned Value: 0
Are the data complete for volume quantity for this area? No

2.4.2.1.4 Area (Tier D)

The approximate area of Source No. 1 is 488,109 square feet (11.2 acres) (Refs. 4; 19). The equalization basin is approximately 275,345 square feet (6.32 acres), the digester is 8,749 square feet (0.2 acre), the sludge storage basin is 195,225 square feet (4.48 acres), and the second sludge storage basin is 8,790 square feet (0.2 acre) (Refs. 4; 19). The approximate area of Source No. 1 was determined using an AutoCAD R12W Computer and Design drawing of the facility produced by Galey and Lord (Ref. 19). Each individual basin comprising Source No. 1 contains hazardous substances throughout its entire extent (Ref. 16, pp. 1, 2) (see Section 2.2.1, Source No. 1 of this HRS documentation record). Additionally, each individual basin comprising Source No. 1 is not lined and was designed to contain waste (Refs. 14, p. 7; 16, p. 1).

Sum (square feet): 488,109
Equation for Assigning Value (Ref. 1, Table 2-5): Area (A)/13

Area Assigned Value: 37,546.84

2.4.2.1.5 Source Hazardous Waste Quantity Value

The source hazardous waste quantity (HWQ) value for Source No. 1 is 37,546.84 (Ref. 1, Section 2.4.2.1.5).

Source HWQ Value: 37,546.84

2.2.1 SOURCE IDENTIFICATION

Number of source: 2

Name of source: WWTP aeration basin

Source Type: Surface impoundment

Description and Location of Source (with reference to a map):

Source No. 2 consists of a surface impoundment containing wastes resulting from facility operations, as documented by hazardous substances contained in five samples collected in June 2018 (see Figures 2 and 3 and Table 4 of this HRS documentation record). Surface impoundment waste consists of fly ash (grey black coarse powder), black sludge, and black muck with a hydrogen sulfide-containing material (Refs. 9, pp. 28, 29; 16, p. 1). Samples GL-046-SD, GL-047-SD, GL-048-SD, and GL-069-SD are consistent with waste but referred to as sediment samples in the SCDHEC 2018 ESI (Ref. 8, p. 17; 16, p. 1). However, as noted above, these samples are waste and will be referred to as waste samples in this HRS documentation record (Ref. 16, p. 1).

The aeration basin was a part of WWTP operations between 1974 and 1994 (Ref. 23, pp. 2, 8, 10, 11). The aeration basin was divided into three sections, consisting of two aeration basins divided by a wooden partition (7.5-MG each) and a sludge storage basin (15-MG). The 15-MG sludge storage basin was separated from the aeration basins by a synthetic fabric curtain (Ref. 14, pp. 7, 10). The aeration basin, as defined in this HRS documentation record, consists of the entire 30-MG basin (two 7.5-MG basins and one 15-MG basin) (Refs. 14, pp. 7, 8, 10; 19). For a detailed description of WWTP operations, see Operational History, Wastewater Treatment Operations in this HRS documentation record.

In 1993 and 1994, the WWTP was modified, and the aeration basin was not included in operational activities (Refs. 23, pp. 10, 11; 30, pp. 20, 33; 39, p. 4). In May 1999, Galey and Lord submitted a modification request for its Sludge Lagoon Closure Plan (aeration basin) (Ref. 39, pp. i, 4, 5, 11). The modification included adding coal boiler ash (fly ash and bottom ash) to the sludge lagoon over about 9 years until the basin was full. Once full, a final cover of earthen materials would be installed (Ref. 39, pp. 4, 5, 14). SCDHEC approved the modifications in June 1999 (Ref. 40). Addition of coal boiler ash continued until the facility closed in 2016 (Ref. 30, p. 20). Following closure of the facility, the WWTP was shut down but was not remediated or cleaned (Refs. 24, pp. 2, 3; 30, p. 22).

Operations at Galey and Lord included dyeing and finishing cotton and synthetic blend fabrics (Ref. 28, p. 4). Metals, including arsenic, cadmium, chromium, copper, lead, and mercury, are widely used for production of color pigments of textile dyes (Refs. 41, pp. 22, 23; 42, p. 664; 43, p. 217). Manganese in textile wastewater is due to impurities present in chemicals used in various steps (Ref. 74, p. 142). Chromium is used as a mordant to form a dye complex that fixes the fiber and dye together (Ref. 41, p. 22). Permits submitted in 1973 list raw materials (finishing chemicals) used during the finishing process. The finishing chemicals included fluorochemical polymers and fluorochemical co-polymers, which were used as water and oil repellants (Refs. 27, p. 6; 33, pp. 1, 2, 4, 7, 8, 11, 12). “Fluorinated polymer or fluoropolymer” means that the polymer contains some perfluorinated or partially fluorinated alkyl chains to impart water and oil repellency (Ref. 44, p. 4).

Samples collected to characterize Source No. 2 in 2018 contained PFOA, PFOS, arsenic, cadmium, chromium, copper, lead, manganese, and mercury (see Table 4 of this HRS documentation record).

SCDHEC 2018 ESI

Source No. 2 samples listed in Table 4 of this HRS documentation record were collected in June 2018 as documented in the ESI report dated September 7, 2018 (Ref. 8, pp. 7, 8). The samples consisted of wastewater and waste sludge from the aeration basin. The wastewater samples were collected from the surface of the basin. The waste sludge samples were collected from 0 to 2 or 6 to 12 inches below the sludge surface. All samples were collected in accordance with the approved QAPP, dated May 21, 2018; the EPA Region LSASD FBQSTP for Wastewater Sampling, SESDPROC-306-R4, dated February 13, 2017; and Sediment Sampling, SESDPROC-200-R3, dated August 21, 2014 (Refs. 9, pp. 28, 29; 10; 16, p. 1; 45; 46).

The samples were analyzed for PFAS and total metals by the EPA Region 4 LSASD ASB via Method ASBPROC-800 PFAS (PFAS) and EPA Methods 6010 and 200.8 (total metals) (Ref. 8, pp. 60, 97, 98, 100, 102, 127). The data were verified in accordance with the EPA Region 4 ASB LOQAM (Refs. 8, pp. 30, 77, 151; 47; 48). MRLs are listed on the analytical data sheets in Reference 8. Each MRL is sample-specific and corresponds to the lowest quantitative point on the calibration curve; it is adjusted for the amount of sample prepared and any dilutions performed, as well as for percent moisture. MRLs are equivalent to SQLs as defined in Section 1.1, Definitions, of the HRS (Refs. 1, Section 1.1; 49).

Logbook notes are in Reference 9. Chain-of-custody records are in Reference 50. Locations of the samples listed in Table 4 are in Reference 8, p. 17 (also see Figure 3 of this HRS documentation record). Specific page numbers in chain-of-custody records and logbook notes are listed in Table 4. Samples contained in Table 4 are mislabeled in logbook notes. The correct sample identifications are provided in the chain-of-custody records (Refs. 9, pp. 28, 29, 49; 16, p. 2; 50, pp. 4, 6).

Table 4: Analytical Results for Source No. 2

Sample ID	Hazardous Substance	Hazardous Substance Concentration	MRL	References
Aeration Basin - Wastewater				
GL-045-WW	PFOA	4,900 ng/L	420 ng/L	8, pp. 17, 60; 9, p. 49; 50, p. 4
GL-045-WW	PFOS	8,300 ng/L	420 ng/L	8, pp. 17, 60; 9, p. 49; 50, p. 4
GL-045-WW	Arsenic	5.9 µg/L	1.0 µg/L	8, pp. 17, 97; 9, p. 49; 50, p. 4
GL-045-WW	Manganese	54 µg/L	5.0 µg/L	8, pp. 17, 97; 9, p. 49; 50, p. 4
Aeration Basin - Waste Sludge				
GL-046-SD	Arsenic	63 mg/kg	1.0 mg/kg	8, pp. 17, 98; 9, p. 28; 50, p. 4
GL-046-SD	Chromium	7.9 mg/kg	1.0 mg/kg	8, pp. 17, 98; 9, p. 28; 50, p. 4
GL-046-SD	Copper	37 mg/kg	2.0 mg/kg	8, pp. 17, 98; 9, p. 28; 50, p. 4
GL-046-SD	Lead	12 mg/kg	0.20 mg/kg	8, pp. 17, 98; 9, p. 28; 50, p. 4
GL-046-SD	Manganese	77 mg/kg	1.0 mg/kg	8, pp. 17, 98; 9, p. 28; 50, p. 4
GL-047-SD	Arsenic	4.5 mg/kg	0.20 mg/kg	8, pp. 17, 100; 9, p. 28; 50, p. 4
GL-047-SD	Chromium	5.8 mg/kg	0.50 mg/kg	8, pp. 17, 100; 9, p. 28; 50, p. 4
GL-047-SD	Copper	20 mg/kg	0.99 mg/kg	8, pp. 17, 100; 9, p. 28; 50, p. 4
GL-047-SD	Lead	6.0 mg/kg	0.20 mg/kg	8, pp. 17, 100; 9, p. 28; 50, p. 4
GL-047-SD	Manganese	160 mg/kg	0.50 mg/kg	8, pp. 17, 100; 9, p. 28; 50, p. 4
GL-048-SD	Arsenic	110 mg/kg	2.5 mg/kg	8, pp. 17, 102; 9, p. 29; 50, p. 4
GL-048-SD	Cadmium	0.59 mg/kg	0.10 mg/kg	8, pp. 17, 102; 9, p. 29; 50, p. 4

Table 4: Analytical Results for Source No. 2				
Sample ID	**Hazardous Substance**	**Hazardous Substance Concentration**	**MRL**	**References**
GL-048-SD	Chromium	21 mg/kg	1.0 mg/kg	8, pp. 17, 102; 9, p. 29; 50, p. 4
GL-048-SD	Copper	160 mg/kg	2.0 mg/kg	8, pp. 17, 102; 9, p. 29; 50, p. 4
GL-048-SD	Lead	11 mg/kg	0.20 mg/kg	8, pp. 17, 102; 9, p. 29; 50, p. 4
GL-048-SD	Manganese	95 mg/kg	1.0 mg/kg	8, pp. 17, 102; 9, p. 29; 50, p. 4
GL-048-SD	Mercury	0.23 mg/kg	0.080 mg/kg	8, pp. 17, 102; 9, p. 29; 50, p. 4
GL-069-SD	Arsenic	8.2 mg/kg	0.20 mg/kg	8, pp. 17, 127; 9, p. 29; 50, p. 6
GL-069-SD	Cadmium	0.54 mg/kg	0.099 mg/kg	8, pp. 17, 127; 9, p. 29; 50, p. 6
GL-069-SD	Chromium	25 mg/kg	0.99 mg/kg	8, pp. 17, 127; 9, p. 29; 50, p. 6
GL-069-SD	Copper	210 mg/kg	2.0 mg/kg	8, pp. 17, 127; 9, p. 29; 50, p. 6
GL-069-SD	Lead	10 mg/kg	0.20 mg/kg	8, pp. 17, 127; 9, p. 29; 50, p. 6
GL-069-SD	Manganese	54 mg/kg	0.99 mg/kg	8, pp. 17, 127; 9, p. 29; 50, p. 6
GL-069-SD	Mercury	0.57 mg/kg	0.080 mg/kg	8, pp. 17, 127; 9, p. 29; 50, p. 6

Notes:

GL	Galey and Lord
ID	Identification
MRL	Minimum reporting limit
µg/L	Micrograms per liter
mg/kg	Milligrams per kilogram
ng/L	Nanograms per liter
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
SD	Sediment

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

Samples collected from Source No. 2 contained PFOA, PFOS, arsenic, cadmium, chromium, copper, lead, manganese, and mercury (see Table 4 of this HRS documentation record). Source No. 2 is the WWTP aeration basin, designed to contain waste (Refs. 14, pp. 7, 8, 10; 16, p. 1). Source No. 2 contains wastes resulting from facility operations as documented by hazardous substances listed in Table 4 of this HRS documentation record. When the facility closed in 2016, the WWTP was shut down but was not remediated or cleaned (Ref. 24, pp. 2, 3; 30, p. 18).

Containment for Source No. 2 via Overland Flow

As documented in Section 4.1.2.1.1 of this HRS documentation record, source-related contaminants are present in wetlands lining Cedar Creek and the Great Pee Dee River. Source No. 2 contains free liquids and diking that is not regularly inspected and maintained (Ref. 16, p. 2). Therefore, the containment factor for the surface water migration pathway via overland flow is assigned a value of 10 (Ref. 1, Section 4.1.2.1.2.1.1, Table 4-2).

TABLE 5a: Containment Factor (Overland Flow) for Source No. 2

Containment Description	Containment Factor Value	References
Gas release to air	Not scored	Not applicable
Particulate release to air	Not scored	Not applicable
Release to groundwater	Not scored	Not applicable
Release to surface water via overland migration: Evidence of hazardous migration from surface impoundment; free liquids and diking that is not regularly inspected and maintained	10	1, Table 4-2; 16, p. 2

Containment for Source No. 2 via Flood

On September 14, 2018, Hurricane Florence made landfall and spent the next 2 days producing record-breaking rainfall across eastern North Carolina and a portion of northeastern South Carolina (Ref. 58, p. 1). Society Hill received between 20 and 30 inches of rainfall (Ref. 58, p. 2). The rainfall caused flooding of the Source No. 2 overflow structure, which resulted in wastewater entering Cedar Creek and the Great Pee Dee River (Refs. 16, p. 2; 19; 53). Source No. 2 lacks a designed, constructed, operated, and maintained containment to prevent a washout of hazardous substances (Ref. 16, p. 2). Therefore, the containment factor for the surface water migration pathway flood component is assigned a value of 10 (Ref. 1, Section 4.1.2.1.2.2.1, Table 4-8).

TABLE 5b: Containment Factor (Flood) for Source No. 2

Containment Description	Containment Factor Value	References
Gas release to air	Not scored	Not applicable
Particulate release to air	Not scored	Not applicable
Release to groundwater	Not scored	Not applicable
Release to surface water via Flood: Other	10	1, Table 4-8; 16, p. 2

2.4.2.1 HAZARDOUS WASTE QUANTITY

2.4.2.1.1 Hazardous Constituent Quantity

The total hazardous constituent quantity for Source No. 2 could not be adequately determined according to the HRS requirements; that is, total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). Insufficient historical and current data (manifests, PRP records, state records, permits, waste concentration data, etc.) are available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, information is insufficient to calculate a total or partial Hazardous Constituent Quantity estimate for Source No. 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Assigned Value: NS

2.4.2.1.2 Hazardous Wastestream Quantity

The total hazardous wastestream quantity for Source No. 2 could not be adequately determined according to the HRS requirements; that is, total mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.2). Insufficient historical and current data (manifests, PRP records, state records, permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total or partial mass of the wastestream plus the mass of all CERCLA pollutants and contaminants in the source and the associated release from the source. Therefore, information is insufficient to evaluate the associated releases from the source to calculate the hazardous wastestream quantity for Source No. 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, Volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Assigned Value: NS

2.4.2.1.3 Volume (Tier C)

Information available on depth of Source No. 2 is not sufficiently specific to support a volume of contaminated waste with reasonable confidence; therefore, it is not possible to assign a volume (Tier C) in yd^3 for Source No. 2 (Ref. 1, Section 2.4.2.1.3). Source No. 2 has been assigned a value of 0 for the volume measure (Ref. 1, Section 2.4.2.1.3). As a result, the evaluation of hazardous waste quantity proceeds to the evaluation of Tier D, area (Ref. 1, Sec. 2.4.2.1.3).

Volume Assigned Value: 0
Are the data complete for volume quantity for this area? No

2.4.2.1.4 Area (Tier D)

The estimated area of Source No. 2 is approximately 420,689 square feet (9.65 acres) (Ref. 19) (see Figures 2 and 3 of this HRS documentation record). The approximate area of Source No. 2 was determined by use of an AutoCAD R12W Computer and Design drawing of the facility produced by the Galey and Lord (Ref. 19).

Prior to 1999, Source No. 2 was comprised of one 15-MG sludge storage basin and two 7.5 MG aeration basins. Source No. 2 was a part of an activated sludge wastewater treatment system, sludge contained in each of the three sections comprising Source No. 2 could be mixed during varying stages of the treatment process (Ref. 14, pp. 4, 7, 8, 9, 10). Source No. 2 contains hazardous waste throughout its entire extent (Ref. 16, p. 1). Samples collected from each of the three areas comprising Source No. 2 (one 15-MG

sludge storage basins and two 7.5 MG aeration basins) contain the same hazardous substances (Refs. 8, p. 17; 14, p. 10) (see Table 4 and Figure 3 of this HRS documentation record).

Sum (square feet): 420,689
Equation for Assigning Value (Ref. 1, Table 2-5): Area (A)/13

Area Assigned Value: 32,360.69

2.4.2.1.5 Source Hazardous Waste Quantity Value

The source HWQ value for Source No. 2 is 32,360.69 (Ref. 1, Section 2.4.2.1.5).

Source HWQ Value: 32,360.69

SUMMARY OF SOURCE DESCRIPTIONS

TABLE 6: Summary of Source Descriptions

Source No.	Source Hazardous Waste Quantity Value	Source Hazardous Constituent Quantity Complete? (Yes/No)	Containment Factor Value by Pathway			
			Ground Water (Ref. 1, Table 3-2)	Surface Water Overland/ Flood (Ref. 1, Table 4-2)	Air	
					Gas (Ref. 1, Table 6-3)	Particulate (Ref. 1, Table 6-9)
1	37,546.84	No	NS	10	NS	NS
2	32,360.69	No	NS	10	NS	NS

Notes:

NS Not scored

Description of Other Possible Site Sources

Other possible site sources include, but are not limited to, contaminated soil, water sludge ponds, coal pile, coal pile runoff, sand drying beds, clarifiers, aeration tanks, and equalization tanks (Refs. 8, pp. 10, 17, 20; 14, pp. 9, 10, 11; 15, pp. 12, 14; 19; 24, p. 3). SCDHEC collected samples from some of these other possible sources in 2018 and 2019, as discussed below. Sample locations are depicted in Reference 8, pages 17 and 20, and in Reference 13, page 16. Reference 19 provides a layout of the facility and conveys locations of water sludge ponds, coal pile, coal pile runoff, sand drying beds, clarifiers, aeration tanks, and equalization tanks. Evaluating and scoring these possible site sources would not affect the site score and decision whether to list this site on the NPL. These possible site sources are of concern to the EPA and may be considered during future evaluation.

- Contaminated soil – within areas near Plant I and Plant II, coal pile, suspected spray field, and a dump area (Refs. 8, pp. 10, 20; 13, pp. 16, 21; 19). Samples collected from these areas contained PCBs, TCE, polycyclic aromatic hydrocarbons (PAH), and metals, among others (Refs. 8, pp. 26, 27; 13, pp. 16, 21, 22).
- TCE-contaminated soil and groundwater – three areas identified during numerous investigations include Area 1, in the vicinity of the chemical blend area where a TCE-based dewaxing system and TCE reclamation and storage operated in the 1960s; Area 2, in the vicinity of a catch basin in the rear of Plant I; and Area 3, along storm drains and inlets leading from Areas 1 and 2 (Ref. 38, pp. 4, 5, 14, 15). In August 2012, Galey and Lord voluntarily agreed to enter the SCDHEC

voluntary cleanup program (VCP) in order to reach a CERCLA-quality cleanup (Ref. 17, p. 4). A voluntary cleanup contract (VCC) was executed in April 2013 (Ref. 17, p. i). Areas 2 and 3 underwent soil remediation using a soil vapor extraction (SVE) system and a recovery well was installed to remove TCE-contaminated groundwater (Refs. 30, p. 27; 38, p. 5). Galey and Lord ceased monitoring and remediation activities related to the TCE plume in 2015. Subsequently, SCDHEC issued a Notice of Intent to Terminate the VCC in 2017 (Ref. 30, p. 28).

- Water sludge ponds – acetone, chloromethane, dimethyl phthalate, phenol, and metals (Refs. 8, pp. 17, 22; 19).
- Coal pile and coal pile runoff – PFOA, PFOS, dimethyl phthalate, phenol, and metals (Refs. 8, pp. 17, 21, 22, 26; 19).
- Sand drying beds – acetone, 2-methylnaphthalene, dimethyl phthalate, phenol, methyl ethyl ketone, styrene, and metals (Refs. 8, pp. 17, 22; 19).
- WWTP clarifiers, aeration tanks, and equalization tanks – PFOA, PFOS, dimethyl phthalate, acetone, toluene, and metals (Refs. 8, pp. 17, 21, 22; 19).
- Parshall flume – PFOA, PFOS, arsenic, cadmium, chromium, copper, lead, manganese, and mercury (Ref. 13, pp. 3, 14, 17, 18; 14, p. 10).
- Former chromic acid pit – toluene, chromium, lead, and manganese (Refs. 35, pp. 1, 2; 36, pp. 3, 6; 37, pp. 7, 10).

Additional Areas of Concern

EPA has concerns about the areas listed below; however, sampling data, detailed information, and/or the current status are not available for each of these areas of concern (Refs. 22, pp. 1, 2, 3; 30, pp. 5, 6).

- Numerous drains, sumps, drain inlets, and other drainage features through the interior of Plants I and II;
- Stormwater inlets and drainage features through the exterior of Plants I and II;
- 1-MG well/reservoir;
- 2.6-MG standpipe;
- Boiler house with two coal-powered boilers and two coal silos;
- Aboveground propane tanks;
- Former landfill; and
- 1,000-gallon waste oil underground storage tank.

4.0 SURFACE WATER MIGRATION PATHWAY

4.1 OVERLAND/FLOOD MIGRATION COMPONENT – Cedar Creek and Great Pee Dee River

4.1.1.1 Definition of Hazardous Substance Migration Path for Overland/Flood Component

The hazardous substance migration pathway includes both the overland segment and the in-water segment that hazardous substances would take as they migrate away from sources. The overland segment begins at the source and proceeds downgradient to the probable point of entry (PPE) to surface water. The in-water segment at the PPE continues in the direction of flow (Ref. 1, Section 4.1.1.1) (see Figure 4 of this HRS documentation record).

The Galey and Lord facility flooded in 2018 due to high amounts of rainfall during Hurricane Florence resulting in the release of hazardous substances to Cedar Creek and the Great Pee Dee River (Ref. 16, p. 2). Therefore, both components of the hazardous substance migration path (overland and flood) are presented below prior to the discussion of PPEs.

Hazardous Substance Migration Path for Overland Component

Overland flow from Source No. 1 (digester and the two sludge storage basins) is sheet flow directly into wetlands that abut Source No. 1 along most of the length of the source (Refs. 19; 91, pp. 10, 15, 16; 92). Overland flow from the southern portion of Source No. 1 (equalization basin) is sheet flow into a drainage ditch that discharges into wetlands along the Great Pee Dee River (Ref. 19; 91, pp. 10, 15).

During operations, overflow from Source No. 2 discharged through an overflow structure located at the northeastern corner of Source No. 2, flowed about 550 feet northeast, along the western border of the 4.48-acre sludge storage pond. Flow continued east about 200 feet and met wetlands located north of the 4.48-acre sludge storage pond. Flow continued about 800 feet southeast before joining the Great Pee Dee River. After the WWTP shutdown, overland flow from Source No. 2 continued to follow the same route discussed above (Ref. 53).

Hazardous Substance Migration Path for Flood Component

Source Nos. 1 and 2 are surrounded by Cedar Creek and the Great Pee Dee River floodplains, which are Federal Emergency Management Agency (FEMA)-designated Zones A and AE Flood Hazard Areas, indicating the areas are subject to inundation by the 1-percent-annual-chance flood event (Refs. 55; 88, p. 1) (see Figures 2 and 4 of this HRS documentation record). On September 14, 2018, Hurricane Florence made landfall. Over the next 2 days, record-breaking rainfall occurred across eastern North Carolina and a portion of northeastern South Carolina (Ref. 58, p. 1). Society Hill received between 20 and 30 inches of rainfall (Ref. 58, p. 2). The rainfall caused flooding in many portions of Society Hill, including the Galey and Lord facility (Ref. 16, pp. 2 through 22). Due to flooding, road closures, and other hazards, SCDHEC was not able to visit the facility until September 18, 2018, 4 days after Hurricane Florence had made landfall (Ref. 16, p. 2). The following observations were reported:

- The distinction between Cedar Creek and the Great Pee Dee River could not be determined on the northern portion of the facility property.
- The northern portion of the 4.48-acre sludge storage basin (Source No. 1) was actively releasing wastewater to Cedar Creek/the Great Pee Dee River.
- The overflow structure located on the northeastern corner of Source No. 2 flooded and released wastewater.
- Flooding of the Great Pee Dee River was evident in areas surrounding the aeration, equalization, and clarifier tanks.

The time frame between Hurricane Florence's landfall, September 14, 2018, and the SCDHEC facility visit, September 18, 2018, was 4 days. Probably, additional portions of Source No. 1 flooded (mainly the equalization basin, digestor, and 0.2-acre sludge storage basin); however, flooding at these basins was not observed during the SCDHEC facility visit (Ref. 16, p. 2). Source Nos. 1 and 2 released wastewater into Cedar Creek and the Great Pee Dee River as a result of Hurricane Florence (Refs. 16, p. 2; 53). An aerial photograph, dated September 17, 2018, shows the extent of flooding at the Galey and Lord facility (Ref. 16, p. 22).

Probable Points of Entry (PPE)

PPE 1 – Overland flow from Source No. 1 (digester and the two sludge storage basins) is sheet flow directly into wetlands that abut Source No. 1 along most of the length of the source (Refs. 19; 91, pp. 10, 15, 16; 92). Direct release from the northern portion of Source No. 1 (4.48-acre sludge storage basin) into wetlands, Cedar Creek, and the Great Pee Dee River by means of flooding has been documented. During which time, the distinction between Cedar Creek and the Great Pee Dee River could not be determined on the northern portion of the facility property (Ref. 16, p. 2). Therefore, the point at which the flooded water met wetlands is PPE 1 (see Figure 4 of this HRS documentation record).

During operations, overflow from Source No. 2 discharged through an overflow structure located at the northeastern corner of Source No. 2, flowed about 550 feet northeast, along the western border of the 4.48-acre sludge storage pond. Flow continued east about 200 feet and met wetlands located north of the 4.48-acre sludge storage pond. Flow continued about 800 feet southeast before joining the Great Pee Dee River. After the WWTP shutdown, overland flow from Source No. 2 continued to follow the same route discussed above (Ref. 53). Direct release from Source No. 2 into wetlands, Cedar Creek, and the Great Pee Dee River by means of flooding has been documented. In September 2018, the overflow structure flooded due to heavy rainfall caused by Hurricane Florence. As a result, wetlands, Cedar Creek, and the Great Pee Dee River received wastewater from the aeration basin. The distinction between Cedar Creek and the Great Pee Dee River could not be determined in the area of the overflow structure (Ref. 53). Flow from Source No. 2 most likely met surface water along the northern stretch of PPE 1 (see Figure 4 of this HRS documentation record) (Refs. 16, pp. 2, 22; 53).

PPE 2 – Overland flow from the southern portion of Source No. 1 (equalization basin) is sheet flow into a drainage ditch that discharges into wetlands along the Great Pee Dee River (Ref. 19; 91, pp. 10, 15). The point at which the drainage ditch meets the wetlands is PPE 2 (see Figure 4 of this HRS documentation record). The Society Hill 2017 topographic map indicates that Source No. 1 gently slopes toward the adjacent wetlands and Great Pee Dee River (Ref. 6).

4.1.1.2 Target Distance Limit

The 15-mile surface water migration pathway target distance limit (TDL) is measured from the most downstream PPE, PPE 2 (see Figures 4 and 5 of this HRS documentation record). From PPE 2, the Great Pee Dee River flows south and east for 15 miles, completing the 15-mile surface water migration pathway TDL (see Figure 5 of this HRS documentation record). The zone of contamination includes the in-stream areas between observed release sediment samples GL-085-SD (Cedar Creek) and GL-073-SD (Great Pee Dee River) and associated PPEs (see Figure 4 of this HRS documentation record). Sediment sample GL-085-SD is a flood-related location. When major streams flood, water overflows the channel and moves away from the stream. This type of flooding is depicted in a September 17, 2018 aerial photograph of the Galey and Lord facility taken three days after Hurricane Florence made landfall (Refs. 16, pp. 2, 22; 51, p. 2-18). Due to the flooding at the Galey and Lord facility, the location of sediment sample GL-085-SD is considered downstream of PPE 1 (see Figure 4 of this HRS documentation record).

Cedar Creek is a perennial creek from upstream of the location of background sample GL-084-SD to its confluence with the Great Pee Dee River (Ref. 6) (see Figure 4 of this HRS documentation record). The annual mean flow rate in Cedar Creek over water years 1971 to 1981 ranged from 46.5 to 129.7 cubic feet per second (cfs) (Ref. 57, pp. 1, 2). The annual mean flow rate in the Great Pee Dee River at Pee Dee,

South Carolina over water years 1939 to 2019 ranged from 2,778 to 16,470 cfs (Ref. 56, pp. 1 to 4). Cedar Creek and the Great Pee Dee River floodplains are FEMA-designated Zones A and AE Flood Hazard Areas, indicating the areas are subject to inundation by the 1-percent-annual-chance flood event (Refs. 55; 88, p. 1)

Targets associated with the surface water bodies along the 15-mile TDL include fisheries and HRS-eligible palustrine forested, palustrine emergent, and riverine emergent wetlands along Cedar Creek and the Great Pee Dee River (Refs. 7; 52; 91, pp. 10, 15) (see Figure 4 of this HRS documentation record). The Great Pee Dee River within the 15-mile TDL is fished for human consumption. Fish caught and consumed include catfish, black bass, and bream (Ref. 7). Additionally, the Great Pee Dee River, which includes the entire 15-mile TDL, is designated as critical habitat for the federally endangered Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) (Ref. 7; 59, pp. 39160, 39260) (see Figure 5 of this HRS documentation record)). South Carolina Department of Natural Resources (SCDNR) personnel stated that the Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) and Shortnose Sturgeon (*Acipenser brevirostrum*), federally endangered species, occur and spawn within the 15-mile TDL (Ref. 7).

4.1.2.1 LIKELIHOOD OF RELEASE

4.1.2.1.1 OBSERVED RELEASE

Direct Observation

An observed release by direct observation is established when a material that contains one or more hazardous substances has been seen entering surface water through migration, or is known to have entered surface water through direct deposition, or a source area has been flooded at a time that hazardous substances were present and one or more hazardous substances were in contact with the flood waters, or when evidence supports the inference of a release of a material that contains one or more hazardous substances by the site to surface water. Demonstrated adverse effects associated with that release may also be used to establish an observed release (Ref. 1, Section 4.1.2.1.1).

An observed release to palustrine forested, palustrine emergent, and riverine emergent wetlands lining Cedar Creek and the Great Pee Dee River is documented by direct observation. The basis for observed release by direct observation is discussed below.

In June 2018, prior to Hurricane Florence's landfall and subsequent flooding of the Galey and Lord facility, samples collected from Source Nos. 1 and 2 were found to contain hazardous substances including PFOA, PFOS, arsenic, cadmium, chromium, copper, lead, mercury, and manganese (Ref. 58, pp. 1, 2) (see Tables 1, 2, and 4 of this HRS documentation record).

Hurricane Florence made landfall on September 14, 2018 (Ref. 58, p. 1). SCDHEC visited the facility on September 18, 2018, and observed (1) the northern portion of the 4.48-acre sludge storage basin (Source No. 1) actively releasing wastewater to wetlands, Cedar Creek, and the Great Pee Dee River; and (2) the aeration basin (Source No. 2) discharging wastewater via the overflow structure into wetlands, Cedar Creek, and the Great Pee Dee River (Refs. 16, p. 2; 53; 91, pp. 10, 15; 92). The distinction between the wetlands along Cedar Creek and the Great Pee Dee River and the surface water bodies themselves could not be distinguished in the northern portion of the 4.48-sludge storage basin and in the area of the overflow structure (Refs. 16, p. 2; 53; 91, pp. 10, 15; 92). Therefore, portions of Source Nos. 1 and 2 were flooded at the time that hazardous substances were present, and these substances were in contact with flood waters.

Samples were not collected from Cedar Creek, Great Pee Dee River, or wetlands lining these surface water bodies immediately after the flooding of the Galey and Lord facility (Ref. 16, p. 2). However, in July 2019, samples were collected from wetlands that line Cedar Creek and the Great Pee Dee River. The samples contained the same hazardous substances as those in Source Nos. 1 and 2 (PFOA, PFOS, arsenic, chromium, copper, lead, and manganese) (see Chemical Analysis, Tables 8 and 10 of this HRS documentation record).

Chemical Analysis

An observed release by chemical analysis is established by showing that the hazardous substances in release samples are significantly greater in concentration than the background level and by documenting that at least part of the significant increase is the result of a release from the site under evaluation. The significant increase can be documented in one of two ways for HRS purposes. If the background sample concentration is not detected (or is less than the detection limit), an observed release is established when the sample measurement equals or exceeds sample-specific background SQLs. If the background sample concentration equals or exceeds the detection limit, an observed release is established when the sample measurement is three times or more above the background concentration and above the sample-specific SQL (Ref. 1, Table 2-3).

Observed releases of PFOA, PFOS, arsenic, chromium, copper, lead, and manganese are documented in the following sections by comparing the hazardous substances in similar background and contaminated

sediment samples and by attributing the increase to the site (see Tables 7 through 10 in this section, Section 4.1.2.1.1, of this HRS documentation record). The samples documenting this release were collected by SCDHEC during the July 2019 ESI Update (Ref. 13, pp. 15, 16) (see Figure 4 of this HRS documentation record).

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Background Samples

Background and contaminated samples were collected from wetlands lining Cedar Creek and the Great Pee Dee River (Refs. 13, pp. 15, 16; 91, pp. 10, 15; 92) (see Figure 4 of this HRS documentation record). Because the background and contaminated sediment samples were collected from wetlands, they will be referred to as wetland samples.

In July 2019, SCDHEC collected one background wetland sample (GL-084-SD) from Cedar Creek (a perennial surface water body) and one background wetland sample (GL-070-SD) from the Great Pee Dee River. Both samples were collected outside the influence of Source Nos. 1 and 2, and results from these samples were compared to results from observed release wetland samples collected along Cedar Creek and the Great Pee Dee River, respectively (Refs. 13, p. 15; 16, p. 2). Background and contaminated wetland samples were collected within 0 to 6, 2 to 4, or 4 to 8 inches below the creek bed (bcb) or below the riverbed (brb) (Ref. 11, pp. 2, 3, 11, 12, 19, 21, 22, 29; 16, p. 2). Samples were collected in accordance with the EPA Region 4 LSASD FBQSTP for Sediment Sampling, SESDPROC-200-R3, August 21, 2014 (Refs. 16, p. 1; 46).

Background and contaminated samples were collected from wetlands during the same time frame (July 2019) by the same sampling procedures and in accordance with the EPA-approved QAPP dated June 21, 2019 (Refs. 11, pp. 2, 3, 11, 12, 19, 21, 22, 29; 12; 16, pp. 1, 2; 50, pp. 7, 8, 9; 91, pp. 10, 15; 92). The background and contaminated samples were collected from similar sediment types that were typically clay, silty clay, clay sand, sand, sandy silt (Ref. 11, pp. 2, 3, 11, 12, 19, 21, 22, 29; 16, p. 2). The wetland type, physical characteristics, sample collection methods, time frame, and depths of the background and contaminated wetland samples were similar (Refs. 11, pp. 2, 3, 11, 12, 19, 21, 22, 29; 12; 16, pp. 1, 2; 46; 50, pp. 7, 8, 9; 91, pp. 10, 15; 92).

Background samples were collected in accordance with the EPA approved QAPP dated June 21, 2019 (Refs. 12; 16, p. 2). Logbook notes are in Reference 11, pp. 12, 22. The chain-of-custody record is in Reference 50, pp. 7, 9.

TABLE 7: Background Sediment Samples

Sample ID	Sample Location[1]	Sediment Type	Depth (inches bcb/brb)	Date Sampled	References
GL-084-SD	Riverine emergent wetlands; Cedar Creek	Sand (light brown)	0 to 6	7/17/2019	11, p. 12; 13, p. 15; 50, p. 9; 91, pp. 10, 15; 92
GL-070-SD	Riverine emergent wetlands; Great Pee Dee River	Sand (fine light brown)	4 to 8	7/17/2019	11, p. 22; 13, p. 15; 50, p. 7; 91, pp. 10, 15; 92

Notes:

[1] See Figure 4 of this HRS documentation record
bcb Below the creek bed
brb Below the riverbed
GL Galey and Lord
ID Identification number
SD Sediment sample

Background Concentrations

Background wetland samples GL-084-SD and GL-070-SD, collected from Cedar Creek and the Great Pee Dee River, respectively, were evaluated to establish background PFOA, PFOS, and metals concentrations in wetlands for comparison to concentrations of those analytes in contaminated wetland samples collected along Cedar Creek and the Great Pee Dee River (see Figure 4 of this HRS documentation record) (Refs. 13, pp. 15, 16; 50, pp. 7, 9; 91, pp. 10, 15; 92).

The background samples listed in Table 8 were collected by SCDHEC during the July 2019 ESI Update (Refs. 11, pp. 12, 22; 50, pp. 7, 9). The samples were analyzed for PFAS and total metals by the EPA Region 4 LSASD LSB via Methods ASBPROC-800 PFAS and EPA Methods 6010 and 200.8 (total metals) (Ref. 13, pp. 25, 107). The data were verified in accordance with the EPA Region 4 LSB LOQAM (Refs. 13, pp. 25, 107; 47; 48). MRLs are listed on the analytical data sheets in Reference 13. Each MRL is sample-specific and corresponds to the lowest quantitative point on the calibration curve; it is adjusted for the amount of sample prepared and any dilutions performed, as well as for percent moisture. MRLs are equivalent to SQLs as defined in Section 1.1, Definitions, of the HRS (Refs. 1, Section 1.1; 49).

TABLE 8: Analytical Results for Background Samples

Sample ID	Hazardous Substance	Concentration	MRL	References
Cedar Creek				
GL-084-SD	PFOS	140 ng/kg	110 ng/kg	13, p. 155
GL-084-SD	Arsenic	0.20 U mg/kg	0.20 mg/kg	13, p. 71
GL-084-SD	Chromium	0.60 J (0.60) mg/kg	0.49 mg/kg	13, p. 71
GL-084-SD	Copper	0.99 U mg/kg	0.99 mg/kg	13, p. 71
GL-084-SD	Lead	2.7 mg/kg	0.20 mg/kg	13, p. 71
GL-084-SD	Manganese	1.6 J (1.6) mg/kg	0.49 mg/kg	13, p. 71
Great Pee Dee River				
GL-070-SD	PFOA	450 ng/kg	140 ng/kg	13, p. 125
GL-070-SD	PFOS	1,800 ng/kg	130 ng/kg	13, p. 125

Notes:

GL Galey and Lord
ID Identification number
J MRL verification recovery greater than upper control limits, possibly biased high (Refs. 13, pp. 28, 71; 89). The value presented parenthetically is the concentration obtained by applying EPA fact sheet Using Qualified Data to Document an Observed Release and Observed Contamination (November 1996) (Ref. 54, p. 8).
mg/kg Milligrams per kilogram
MRL Minimum reporting limit
ng/kg Nanograms per kilogram
PFOA Perfluorooctanoic acid
PFOS Perfluorooctanesulfonic acid
SD Sediment sample
U The analyte was not detected at concentration at or above the reporting limit (Ref. 13, p. 28)

Contaminated Samples

The wetland samples listed in Table 9 were collected by SCDHEC during the July 2019 ESI Update. The samples were collected from wetlands along Cedar Creek and the Great Pee Dee River. Wetland samples were collected within 0 to 6, 2 to 4, or 4 to 8 inches bcb or brb (Refs. 11, pp. 2, 3, 11, 12, 19, 21, 22, 29; 13, pp. 3, 15; 16, pp. 1, 2; 91, pp. 10, 15; 92) (see Figure 4 of this HRS documentation record). Samples were collected in accordance with the approved QAPP dated June 21, 2019 and the EPA Region 4 LSASD FBQSTP for Sediment Sampling, SESDPROC-200-R3, August 21, 2014 (Refs. 16, p. 2; 46). Samples GL-082-SF, GL-083-SF, and GL-087-SF are referred to as surface soil samples in the 2019 SCDHEC ESI Update; however, these samples were collected in wetlands and will be referred to as wetland samples (Refs. 16, p. 1; 91, pp. 10, 15; 92).

The background and contaminated wetland samples were collected during the same time frame, from wetlands, using the same sampling procedures, and at similar depths. The samples were collected from sediment that were typically clay, clay sand, sand, sandy silt, and silty clay (11, pp. 2, 3, 11, 12, 19, 21, 22, 29; 12; 16, pp. 1, 2; 46; 50, pp. 7, 8, 9; 91, pp.10, 15; 92).

The contaminated samples were collected in accordance with the approved QAPP dated June 21, 2019 (Refs. 12; 16, p. 1). Logbook notes are provided in Reference 11, pp. 2, 3, 11, 19, 21, 22, 29. The chain-of-custody record is provided in Reference 50, pp. 7, 8, 9.

TABLE 9: Contaminated Wetland Samples – July 2019

Sample ID	Sample Location[1]	Sediment Type	Distance from PPE[2] (feet)	Depth (inches bgs)	Date Sampled	References
Cedar Creek						
GL-085-SD	Palustrine forested and riverine emergent wetlands on Cedar Creek	Brown sandy silt	35 feet from PPE 1	0 to 6	7/17/2019	16, p. 2; 50, p. 9; 91, pp. 10, 15; 92
GL-086-SD	Riverine emergent wetlands on Cedar Creek	Brown sandy silt	420 feet from PPE 1	0 to 6	7/17/2019	11, p. 11; 50, p. 9; 91, pp. 10, 15; 92
GL-018-SD	Riverine emergent wetlands on Cedar Creek	Fine brown sand	465 feet from PPE 1	4 to 8	7/17/2019	11, p. 22; 50, p. 7; 91, pp. 10, 15; 92
Great Pee Dee River						
GL-015-SD	Palustrine forested and riverine emergent wetlands on the Great Pee Dee River	Fine tan sand	70 feet from PPE 1	4 to 8	7/17/2019	11, p. 21; 50, p. 7; 91, pp. 10, 15; 92
GL-073-SD	Riverine emergent wetlands on the Great Pee Dee River	Greyish fine sand	85 feet from PPE 2	4 to 8	7/17/2019	11, p. 19; 50, p. 8; 91, pp. 10, 15; 92

TABLE 9: Contaminated Wetland Samples – July 2019						
Sample ID	**Sample Location[1]**	**Sediment Type**	**Distance from PPE[2] (feet)**	**Depth (inches bgs)**	**Date Sampled**	**References**
GL-082-SF	Palustrine forested and palustrine emergent wetlands on the Great Pee Dee River	Light brown clay	130 feet from PPE 1	2 to 4	7/17/2019	11, p. 3; 50, p. 8; 91, pp. 10, 15; 92
GL-083-SF	Palustrine forested wetlands on the Great Pee Dee River	Medium brown clay sand	10 feet from PPE 1	2 to 4	7/17/2019	11, p. 2; 16, pp. 1, 2; 50, p. 9; 91, pp. 10, 15; 92
GL-087-SF	Palustrine forested and riverine emergent wetlands on the Great Pee Dee River	Brown grey silty clay	65 feet from PPE 1	0 to 6	7/17/2019	11, p. 29; 16, p. 2; 50, p. 9; 91, pp. 10, 15; 92

Notes:

[1] See Figure 4 of this HRS documentation record

[2] For distances measured relative to PPE 1, the distance is the shortest distance between the sample and a point on the PPE 1 line

bgs Below ground surface
GL Galey and Lord
ID Identification number
PPE Probable point of entry
SD Sediment sample
SF Surface soil sample

Contaminated Concentrations

The contaminated wetland samples listed in Table 10 were collected by SCDHEC during the July 2019 sampling event (Refs. 11, pp. 2, 3, 11, 19, 21, 22, 29; 13, pp. 3, 15, 16; 16, p. 2; 91, pp. 10, 15; 92). The samples were analyzed for PFAS and total metals by the EPA Region 4 LSASD LSB via Methods ASBPROC-800 PFAS, and EPA Methods 6010 and 200.8 (total metals) (Ref. 13, pp. 3, 25, 107). The data were verified in accordance with the EPA Region 4 LSB LOQAM (Refs. 13, pp. 25, 107; 47; 48). MRLs are listed on the analytical data sheets in Reference 13. Each MRL is sample-specific and corresponds to the lowest quantitative point on the calibration curve; it is adjusted for the amount of sample prepared and any dilutions performed, as well as for percent moisture. MRLs are equivalent to SQLs as defined in Section 1.1, Definitions, of the HRS (Refs. 1, Section 1.1; 49). All samples listed in Table 10 meet observed release criteria in accordance with Reference 1, Table 2-3.

TABLE 10: Analytical Results for Contaminated Wetland Samples

Sample ID	Hazardous Substance	Concentration	MRL	References
Cedar Creek				
GL-085-SD	PFOS	9,200 ng/kg	1,200 ng/kg	13, p. 157
GL-085-SD	Arsenic	1.1 mg/kg	0.20 mg/kg	13, p. 73
GL-085-SD	Chromium	21 mg/kg	0.49 mg/kg	13, p. 73
GL-085-SD	Copper	28 mg/kg	0.98 mg/kg	13, p. 73
GL-085-SD	Lead	15 mg/kg	0.20 mg/kg	13, p. 73
GL-085-SD	Manganese	540 mg/kg	0.49 mg/kg	13, p. 73
GL-086-SD	Arsenic	1.3 mg/kg	0.20 mg/kg	13, p. 75
GL-086-SD	Chromium	22 mg/kg	0.49 mg/kg	13, p. 75
GL-086-SD	Copper	12 mg/kg	0.98 mg/kg	13, p. 75
GL-086-SD	Lead	10 mg/kg	0.20 mg/kg	13, p. 75
GL-086-SD	Manganese	620 mg/kg	0.49 mg/kg	13, p. 75
GL-018-SD	Arsenic	0.83 mg/kg	0.20 mg/kg	13, p. 33
GL-018-SD	Chromium	7.5 mg/kg	0.50 mg/kg	13, p. 33
GL-018-SD	Copper	5.1 mg/kg	1.0 mg/kg	13, p. 33
GL-018-SD	Manganese	170 mg/kg	0.50 mg/kg	13, p. 33
Great Pee Dee River				
GL-015-SD	PFOA	7,500 ng/kg	1,300 ng/kg	13, p. 111
GL-015-SD	PFOS	6,500 ng/kg	1,200 ng/kg	13, p. 111
GL-073-SD	PFOA	1,400 ng/kg	160 ng/kg	13, p. 131
GL-082-SF	PFOA	2,400 ng/kg	250 ng/kg	13, p. 151
GL-082-SF	PFOS	38,000 ng/kg	2,300 ng/kg	13, p. 151
GL-083-SF	PFOA	53,000 ng/kg	590 ng/kg	13, p. 153
GL-083-SF	PFOS	2,600,000 ng/kg	1,400,000 ng/kg	13, p. 153

TABLE 10: Analytical Results for Contaminated Wetland Samples				
Sample ID	**Hazardous Substance**	**Concentration**	**MRL**	**References**
Great Pee Dee River				
GL-087-SF	PFOA	5,000 ng/kg	290 ng/kg	13, p. 161
GL-087-SF	PFOS	71,000 ng/kg	6,800 ng/kg	13, p. 161

Notes:

GL	Galey and Lord
ID	Identification number
mg/kg	Milligrams per kilogram
MRL	Minimum reporting limit
ng/kg	Nanograms per kilogram
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
SD	Sediment sample
SF	Surface soil sample

Attribution

Galey and Lord is a former textile manufacturing facility that dyed and finished cotton and synthetic fabrics from 1966 to 2016 (Refs. 21, p. 1; 27, p. 4). Textile dyeing and finishing industry operations, among the most chemically intensive of industrial processes, reportedly have significantly and negatively affected the environment (Ref. 41, pp. 22, 23). Metals, including arsenic, cadmium, chromium, copper, lead, and mercury, are widely used for production of color pigments of textile dyes (Refs. 41, pp. 22, 23; 42, p. 664; 43, p. 217). Manganese in textile wastewater is due to impurities present in chemicals used in various steps (Ref. 74, p. 142). Chromium is used as a mordant to form a dye complex that fixes the fiber and dye together (Ref. 41, p. 22). Finishing chemicals used at Galey and Lord included fluorochemical polymers and fluorochemical co-polymers (Refs. 27, p. 6; 33, pp. 1, 2, 4, 7, 8, 11, 12).

Fluorochemicals are a class of synthetically produced organic chemicals that contain a perfluoroalkyl residue in which all the hydrogen atoms have been replaced by fluorine atoms (Ref. 77, p. 2). Fluorochemicals are the most popular repellent finishes because they repel water and oil-water-borne stains, are very efficient, and require little add-on, and are particularly durable during laundering and dry cleaning (Ref. 26, p. 506). Fluorochemicals are typically provided to the textile industry as a concentrate that is later diluted to a specific concentration before application to the fabric. The diluted concentrate (treating solution), which may include additives such as surfactants, wetting aids, solvents, cross-linkers, etc., is applied in one of the following ways: fabric padding (dipping the fabric into the treating solution), spraying the fabric with the treating solution, or foaming the fabric with the treating solution (Ref. 78, pp. 3, 4). PFAS are a group of fluorinated, organic, man-made compounds that include PFOA and PFOS. PFAS are used to make fluoropolymer coatings and products that resist heat, oil, stains, grease, and water (Refs. 73; 75, pp. ES-1, 1-1; 76, pp. ES-1, 1-1; 77, pp. 2, 4). PFOA is a synthetic, fully fluorinated, organic acid used in a variety of consumer products and in production of fluoropolymers; it is generated as a degradation product of other perfluorinated compounds (Ref. 75, p. ES-1). PFOS is a fluorinated organic compound resulting from chemical or metabolic hydrolysis of perfluorooctanesulfonyl fluoride (POSF)-derived fluorinated chemicals (Refs. 76, pp. ES-1, 1-1; 81, p. 4). PFOS is the ultimate degradation product from POSF-derived fluorochemicals, and generally persists in that form. PFOS is also a commercialized product used for a variety of surfactant applications including coating additives (Ref. 81, p. 5).

Galey and Lord utilized many different fluorochemicals in its manufacturing process, including fluorochemicals sold under the names Zonyl, available from Dupont; Unidyne, available from Daikin Corp.; Repearl, available from Mitsubishi Corp.; NanoTex; and 3M (Scotchguard) (Refs. 82, pp. 3, 4, 5; 84, pp. 7, 8, 12). Discharge of municipal wastewaters is one of the principal routes of introduction of these chemicals into the aquatic environment. PFOA and PFOS persist during wastewater treatment, and they partition between aqueous and solid waste streams (Ref. 85, pp. 62, 63).

During operations, the Galey and Lord facility WWTP received wastewaters generated from preparation, dyeing, printing, and finishing of fabric (Ref. 14, p. 12). Most process wastewater was generated by operations on 100 percent cotton and cotton/synthetic woven fabric—dyeing, printing and finishing, and complex manufacturing (Refs. 14, p. 12; 15, p. 39; 27, p. 4). Wastewater moved through a series of basins, undergoing pH adjustment and biological and physical-chemical treatments (Refs. 14, p. 8; 15, pp. 10 through 18; 65, p. 98). The WWTP basins comprising Source No. 1 include equalization, digester, 4.48-acre sludge storage, and 0.2-acre sludge storage. Source No. 2 is the aeration basin (see Section 2.2.1 of this HRS documentation record).

Wastewater and sludge samples collected from Source Nos. 1 and 2 contained PFOA (up to 7,500 ng/L and 7,300 ng/kg) and PFOS (up to 8,300 ng/L and 22,000 ng/kg); and metals, including arsenic (up to 59 µg/L and 63 mg/kg), cadmium (up to 15 µg/L and 0.59 mg/kg), chromium (up to 860 µg/L and 25 mg/kg), copper (up to 4,700 µg/L and 210 mg/kg), lead (up to 600 µg/L and 13 mg/kg), manganese (up to 4,000 µg/L and 160 mg/kg), and mercury (up to 0.57 mg/kg) (see Tables 1, 2, and 4 of this HRS documentation record). These hazardous substances, other than cadmium and mercury, were detected in wetlands along Cedar Creek and the Great Pee Dee River at concentrations significantly above

background levels, indicating that a release had occurred or is occurring from the Galey and Lord facility (see Tables 1, 2, and 4 in Section 2.2.2, and Source Nos. 1 and 2 and Tables 7, 8, 9, and 10 in Section 4.1.2.1.1, Observed Release of this HRS documentation record).

To attribute these releases to Source Nos. 1 and 2, background levels were established via sampling from Cedar Creek and the Great Pee Dee River at locations outside the influence of the Galey and Lord facility (Ref. 16, p. 2). All observed release samples were collected from wetlands (see Tables 7 and 9 and Figure 4 of this HRS documentation record). Wetland samples collected from wetlands lining Cedar Creek and the Great Pee Dee River contained PFOA (up to 53,000 ng/kg), PFOS (up to 2,600,000 ng/kg), arsenic (up to 1.3 mg/kg), chromium (up to 22 mg/kg), copper (up to 28 mg/kg), lead (up to 15 mg/kg), and manganese (up to 620 mg/kg) at concentrations significantly above background levels (see Tables 8 and 10 of this HRS documentation record).

The WWTP contained a Parshall flume which measured effluent flow before discharging to NPDES Outfall 001. During operations, the Parshall flume received wastewater from the 0.2-acre sludge storage basin, measured total effluent flow, and discharged wastewater through an underground pipe traveling about 670 feet to NPDES Outfall 001 (Refs. 14, pp. 9, 10; 15, p. 65; 19). Samples collected from the sludge at the base of the flume contained PFOA (up to 25,000 ng/kg), PFOS (up to 84,000 ng/kg), arsenic (up to 25 mg/kg), cadmium (up to 5.4 mg/kg), chromium (up to 84 mg/kg), copper (up to 640 mg/kg), lead (up to 91 mg/kg), manganese (up to 130 mg/kg), and mercury (up to 0.95 mg/kg) (Ref. 13, pp. 14, 17, 18).

Observed release by direct observation (flooding) has been documented in this HRS documentation record. In June 2018, prior to Hurricane Florence's landfall and subsequent flooding of the Galey and Lord facility, samples collected from Source Nos. 1 and 2 contained hazardous substances including PFOA, PFOS, arsenic, cadmium, chromium, copper, lead, manganese, and mercury (Ref. 58, pp. 1, 2) (see Tables 1, 2, and 4 of this HRS documentation record). Hurricane Florence made landfall on September 14, 2018 (Ref. 58, p. 1). SCDHEC visited the facility on September 18, 2018, and observed (1) the northern portion of the 4.48-acre sludge storage basin (Source No. 1) actively releasing wastewater to wetlands, Cedar Creek, and the Great Pee Dee River; and (2) flooding of the aeration basin (Source No. 2) overflow structure, releasing wastewater to wetlands, Cedar Creek, and the Great Pee Dee River. The distinction between the wetlands along Cedar Creek and the Great Pee Dee River and the surface water bodies themselves could not be distinguished in the northern portion of the 4.48-acre sludge storage basin and in the area of the overflow structure (Refs. 16, p. 2; 53; 91, pp. 10, 15; 92). Hazardous substances within Source Nos. 1 and 2 were directly released to Cedar Creek, the Great Pee Dee River, and wetlands that line these surface water bodies (see Section 4.1.2.1.1, Observed Release, Direct Observation of this HRS documentation record).

Domtar Paper Co. is at 585 Willamette Road, along the Great Pee Dee River, about 6 miles upstream of the Galey and Lord facility (Ref. 86, pp. 1, 9). Chemicals listed in the EPA Facility Detail Report regarding Domtar Paper Co. include acetaldehyde, acetone, ammonia, barium compounds, catechol, chlorine, chlorine dioxide, chloroform, cresol, dioxin and dioxin-like compounds, ethylene glycol, formaldehyde, formic acid, hydrochloric acid, hydrogen sulfide, lead, manganese, mercury, methanol, methyl ethyl ketone, phenol, PAHs, sulfuric acid, vanadium, and zinc (Ref. 86, pp. 6, 7). PFOA and PFOS are not listed on the EPA Facility Detail Report (Ref. 86, pp. 6, 7). PFOA and PFOS were detected in a sample collected from the Great Pee Dee River upstream from the Galey and Lord facility (at 450 and 1,800 ng/kg, respectively) (Ref. 13, pp. 15, 125). However, concentrations of these hazardous substances in samples collected from the Great Pee Dee River at the Galey and Lord facility were 117 and 1,444 times greater than background concentrations, respectively (see Tables 8 and 10 of this HRS documentation record).

The hazardous substances listed below have been detected in Source Nos. 1 and 2, as well as in sediment samples collected from wetlands along Cedar Creek and/or the Great Pee Dee River, indicating that a release had occurred or is occurring from the Galey and Lord facility (see Tables 1, 2, and 4 in Section

2.2.2, Source Nos. 1 and 2 and Tables 7 through 10 in Section 4.1.2.1.1, Observed Release of this HRS documentation record).

Hazardous Substances in the Release

PFOA
PFOS
Arsenic
Chromium
Copper
Lead
Manganese

Surface Water Observed Release Factor Value: 550

4.1.2 DRINKING WATER THREAT

The drinking water threat was not scored because it is not expected to contribute significantly to the overall site score.

4.1.3.2 HUMAN FOOD CHAIN THREAT WASTE CHARACTERISTICS

4.1.3.2.1 Toxicity/Persistence/Bioaccumulation

Table 11 summarizes toxicity, persistence, and bioaccumulation factor values for the hazardous substances and pollutants/contaminants detected in Source Nos. 1 and 2, with a containment factor value exceeding 0. Combined toxicity, persistence, and bioaccumulation factor values are assigned in accordance with Reference 1, Section 4.1.3.2.1.

TABLE 11: Toxicity/Persistence/Bioaccumulation

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value[1]	Human Food Chain Bioaccumulation Value[2]	Toxicity/ Persistence/ Bioaccumulation Factor Value (Ref. 1, Table 4-16)	Reference
PFOA	1, 2	10,000	0.4	5	20,000	79, pp. 1, 2, 3, 4; 80, pp. 1 to 4
PFOS	1, 2	10,000	0.4	5,000	20,000,000	79, pp. 1, 2, 3, 4; 80, pp. 1 to 4
Arsenic	1, 2	10,000	1	5	50,000	2, p. 1
Cadmium	1, 2	10,000	1	50,000	500,000,000	2, p. 3
Chromium	1, 2	10,000	1	5	50,000	2, p. 5
Copper	1, 2	100	1	50,000	5,000,000	2, p. 7
Lead	1, 2	10,000	1	5,000	50,000,000	2, p. 9
Manganese	1, 2	10,000	1	500	5,000,000	2, p. 11
Mercury	2	10,000	1	50,000	500,000,000	2, p. 13

Notes:

[1] Persistence factor value for rivers
[2] Bioaccumulation factor value for fresh water

PFOA Perfluorooctanoic acid
PFOS Perfluorooctanesulfonic acid

For the human food chain threat, cadmium and mercury have the highest toxicity/persistence/bioaccumulation factor value of 500,000,000 (Refs. 2, pp. 1, 3, 5, 7, 9, 11, 13; 79, pp. 1, 2, 3, 4; 80, pp. 1 to 4).

Toxicity/Persistence/Bioaccumulation Factor Value: 500,000,000
(Ref. 1, Section 4.1.3.2.1.4)

4.1.3.2.2 HAZARDOUS WASTE QUANTITY

TABLE 12: Hazardous Waste Quantity		
Source No.	**Source Type**	**Source Hazardous Waste Quantity**
1	Surface impoundments	37,546.84
2	Surface impoundment	32,360.69

See Section 2.4.2.1.5, Source Hazardous Waste Quantity Value, of this HRS documentation record.

Total Source Hazardous Waste Quantity: 69,908

The hazardous waste quantity for Source No. 1 is 37,546.84 (Refs. 1, Tables 2-5; 4; 19). The hazardous waste quantity for Source No. 2 is 32,360.69. The combined hazardous waste quantity for Source Nos. 1 and 2 is 69,908, which equals a hazardous waste quantity factor value of 10,000 (Refs. 1, Tables 2-5, 2-6; 4; 19).

Hazardous Waste Quantity Factor Value: 10,000
(Ref. 1, Table 2-6)

4.1.3.2.3 CALCULATION OF HUMAN FOOD CHAIN THREAT WASTE CHARACTERISTICS FACTOR CATEGORY VALUE

For the human food chain threat, cadmium and mercury yield the highest values for waste characteristics. The waste characteristics factor category was obtained by multiplying the toxicity, persistence, and HWQ factor values, subject to a maximum product of 1×10^8. Then, this product was multiplied by the human food chain bioaccumulation potential factor value, subject to a maximum product of 1×10^{12} (Ref. 1, Section 4.1.3.2.3). Based on this product, a value was assigned in accordance with Reference 1, Table 2-7.

Toxicity/Persistence Factor Value: 10,000.00
Hazardous Waste Quantity Factor Value: 10,000

Toxicity/Persistence Factor Value ×
Hazardous Waste Quantity Factor Value: 1×10^8

Toxicity/Persistence Factor Value ×
Hazardous Waste Quantity Factor Value × Bioaccumulation Factor Value (50,000): 5×10^{12} (subject to a maximum of 1×10^{12})

Waste Characteristics Factor Category Value: 1,000
(Ref. 1, Table 2-7)

4.1.3.3 HUMAN FOOD CHAIN THREAT TARGETS

4.1.3.3.1 Food Chain Individual

An observed release of a hazardous substance and CERCLA pollutant/contaminant having a bioaccumulation factor value of 500 or greater is documented in perennial surface water with a fishery downstream—specifically, an observed release to Cedar Creek and the Great Pee Dee River with the Great Pee Dee River as a downstream fishery (see Tables 8 and 10 and Figures 4 and 5 of this HRS documentation record) (Ref. 7). The Great Pee Dee River within the 15-mile TDL is fished for human consumption. Fish caught and consumed include catfish, black bass, and bream (Ref. 7).

Food Chain Individual Factor Value: 20
(Ref. 1, Section 4.1.3.3.1)

4.1.3.3.2 Population

4.1.3.3.2.1 Level I Concentrations

No Level I samples were collected.

4.1.3.3.2.2 Level II Concentrations

No Level II samples were collected.

4.1.3.3.2.3 Potential Human Food Chain Contamination

The entire portion of the Great Pee Dee River within the 15-mile surface water migration pathway TDL is fished (Ref. 7) (see Figure 5 of this HRS documentation record). The annual harvest rate for consumption for the 15-mile surface water migration pathway TDL is 1,000 to 10,000 pounds per year (Ref. 7).

TABLE 13: Potential Population Targets

Identity of Fishery	Annual Production (pounds)	Type of Surface Water Body	Average Annual Flow (cfs)	Population Value (P_i) (Ref. 1, Table 4-18)	Dilution Weight (D_i) (Ref. 1, Table 4-13)	$P_i \times D_i$	References
Great Pee Dee River	1,000 to 10,000	Large stream to river	9,456.91	3	0.001	0.003	1, Tables 4-13, Table 4-18; 7; 56[1], pp. 2, 3, 4
					Total	**0.003**	

Notes:

[1] Average annual flow rate was calculated by using data from 1938 to 2019.
cfs Cubic feet per second

For the potential human food chain contamination factor value, the sum of $P_i \times D_i$ is divided by 10.

Potential Human Food Chain Factor Value: 0.0003
(Ref. 1, Section 4.1.3.3.2.3)

4.1.4.2 ENVIRONMENTAL THREAT WASTE CHARACTERISTICS

4.1.4.2.1 Ecosystem Toxicity/Persistence/Bioaccumulation

Table 14 summarizes the ecosystem toxicity, persistence, and bioaccumulation factor values for the hazardous substances and pollutants/contaminants detected in Source Nos. 1 and 2 with a containment factor value exceeding 0. The combined ecosystem toxicity, persistence, and bioaccumulation factor values are assigned in accordance with Reference 1, Section 4.1.4.2.1.

TABLE 14: Ecosystem Toxicity/Persistence/Bioaccumulation

Hazardous Substances	Source No.	Ecosystem Toxicity Factor Value[1]	Persistence Factor Value[2]	Ecosystem Bioaccumulation Factor Value[3]	Ecosystem Toxicity/Persistence/ Bioaccumulation Factor Value (Ref. 1, Table 4-21)	Reference
PFOA	1, 2	1,000	0.4	5	2,000	79, pp. 2, 4, 5; 80, pp. 1 to 4
PFOS	1, 2	100	0.4	5,000	200,000	79, pp. 2, 4, 5; 80, pp. 1 to 4
Arsenic	1, 2	10	1	50,000	500,000	2, p. 1
Cadmium	1, 2	10,000	1	50,000	500,000,000	2, p. 3
Chromium	1, 2	10,000	1	500	5,000,000	2, p. 5
Copper	1, 2	1,000	1	50,000	50,000,000	2, p. 7
Lead	1, 2	1,000	1	50,000	50,000,000	2, p. 9
Manganese	1, 2	100	1	50,000	5,000,000	2, p. 11
Mercury	2	10,000	1	50,000	500,000,000	2, p. 13

Notes:

[1] Ecotoxicity for fresh water
[2] Persistence value for rivers
[3] Bioaccumulation factor value for fresh water, environmental threat

PFOA Perfluorooctanoic acid
PFOS Perfluorooctanesulfonic acid

Regarding the environmental threat, cadmium and mercury have the highest toxicity/persistence/ecosystem bioaccumulation factor value of 500,000,000 (Ref. 2, pp. 1, 3, 5, 7, 9, 11, 13; 79, pp. 2, 4, 5; 80, pp. 1 to 4).

Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value: 500,000,000
(Reference 1, Section 4.1.4.2.1.4)

4.1.4.2.2 HAZARDOUS WASTE QUANTITY

TABLE 15: Hazardous Waste Quantity

Source No.	Source Type	Source Hazardous Waste Quantity
1	Surface impoundment	37,546.84
2	Surface impoundment	32,360.69

See Section 2.4.2.1.5, Source Hazardous Waste Quantity of this HRS documentation record.

Total Source Hazardous Waste Quantity: 69,908

The HWQ for Source No. 1 is 37,546.84 (Refs. 1, Tables 2-5 and 2-6; 4; 19). The HWQ for Source No. 2 is 32,360.69. The combined HWQ for Source Nos. 1 and 2 is 69,908, which equals an HWQ factor value of 10,000 (Refs. 1, Tables 2-5, 2-6; 4; 19).

Hazardous Waste Quantity Factor Value: 10,000
(Ref. 1, Table 2-6)

4.1.4.2.3 CALCULATION OF ENVIRONMENTAL CHAIN THREAT WASTE CHARACTERISTICS FACTOR CATEGORY VALUE

For the environmental threat, cadmium and mercury yield the highest values for waste characteristics. The waste characteristics factor category was obtained by multiplying the ecosystem toxicity, persistence, and HWQ factor values, subject to a maximum product of 1×10^8. Then, this product was multiplied by the ecosystem bioaccumulation potential factor value, subject to a maximum product of 1×10^{12}. Based on this product, a value was assigned in accordance with Reference 1, Table 2-7.

Ecosystem Toxicity/Persistence Factor Value: 10,000.00
Hazardous Waste Quantity Factor Value: 10,000

Ecosystem Toxicity/Persistence Factor Value ×
Hazardous Waste Quantity Factor Value: 1×10^8

Ecosystem Toxicity/Persistence Factor Value ×
Hazardous Waste Quantity Factor Value × Bioaccumulation Factor Value (50,000): 5×10^{12} (subject to a maximum of 1×10^{12})

Waste Characteristics Factor Category Value: 1,000
(Ref. 1, Table 2-7)

4.1.4.3 Environmental Threat Targets

Level I Concentrations

No Level I concentrations have been documented.

Level II Concentrations

Actual contamination by direct observation and chemical analysis has been documented in Section 4.1.2.1.1 of this HRS documentation record. The sampling locations are depicted on Figure 4 of this HRS documentation record. Palustrine forested, palustrine emergent, and riverine emergent wetlands line Cedar Creek and the Great Pee Dee River and are present at the background and contaminated sampling locations (Ref. 13, pp. 15, 16; 91, pp. 10, 15; 92) (see Figure 4 of this HRS documentation record).

During the December 2020 Limited Wetland Investigation, SCDHEC evaluated sample locations from the SCDHEC 2019 updated ESI to assess the presence or absence of wetlands. Wetland boundaries were determined by applying the following criteria: (1) a prevalence of hydrophytic vegetation, (2) presence of hydric soils, and (3) wetland hydrology (Ref. 91, pp. 3, 4, 5). The wetland verification confirmed the

presence of wetlands. The wetlands assessed were palustrine forested, palustrine emergent, and riverine emergent (Refs. 52; 91, pp. 10, 15; 92).

The zone of actual contamination begins at wetland sample GL-085-SD and ends at wetland sample GL-073-SD (see Tables 8 and 10 and Figure 4 of this HRS documentation record). Because PPE 1 and PPE 2 are located within wetlands, a perimeter measurement is used to determine the length of the wetland by drawing an arc from each PPE to the most downstream observed release sample (GL-073-SD) (see Figure 6 of this HRS documentation record). This includes an arc from the northern end of PPE 1 to GL-073-SD and an arc from PPE 2 to GL-073-SD. The perimeter measurement does not include the wetlands separated by other surface water bodies (wetland areas along the northern bank of Cedar Creek and along the eastern bank of the Great Pee Dee River) (Ref. 1, Sections 4.1.4.3.1.1 and 4.1.4.3.1.2) (see Figure 6 of this HRS documentation record). The measured wetland perimeter of this area is 6,503 feet (1.23 miles) (Ref. 94).

Wetland frontage contiguous with the in-water segment of the hazardous substance migration path is used to calculate the wetland length along the northern bank of Cedar Creek (from sample GL-085-SD to the confluence with the Great Pee Dee River) and the eastern bank of the Great Pee Dee River (from confluence of Cedar Creek to sample GL-073-SD) (Ref. 1, Sections 4.1.4.3.1.1 and 4.1.4.3.1.2). The wetland frontage along the northern bank of Cedar Creek is 2,105 feet and the wetland frontage along the eastern bank of the Great Pee Dee River from the confluence with Cedar Creek to wetland sample GL-073-SD is 1,722 feet (Refs. 52; 91, pp. 10, 15; 92; 94) (see Figure 6 of this HRS documentation record).

Most Distant Level II Sample

Investigation:	July 2019 Sampling Event
Sample ID:	GL-073-SD
Sample Medium:	Sediment
Hazardous Substance:	PFOA
Location:	Great Pee Dee River
References:	13, pp. 15, 131; 52; 91, pp. 10, 15; 92 (see Figures 4 and 6 and Tables 9 and 10 of this HRS documentation record)

4.1.4.3.1 Sensitive Environments

4.1.4.3.1.1 Level I Concentrations

Sensitive Environments

Level I sensitive environments were not scored in this HRS documentation record.

Wetlands

Level I wetlands were not scored in this HRS documentation record.

4.1.4.3.1.2 Level II Concentrations

Sensitive Environments

Level II sensitive environments were not scored in this HRS documentation record.

Wetlands

The wetlands were identified from Reference 91, Limited Wetland Investigation Memorandum and Reference 52 (Refs. 91, pp. 10, 15; 92). Sediment samples (GL-085-SD, GL-086-SD, GL-018-SD, GL-082-SF, GL-083-SF, GL-087-SF, and GL-073-SD) evaluated at Level II concentrations are located in

palustrine forested, palustrine emergent, and riverine emergent wetlands along Cedar Creek and the Great Pee Dee River (Ref. 91, pp. 10, 15; 92) (see Figure 4 of this HRS documentation record). The total wetland length evaluated at Level II concentrations is approximately 10,330 feet (1.95 miles) as calculated by GIS software. A detailed description of the calculation is provided in Reference 94.

TABLE 16: Level II Wetland Frontage

Wetland	Water Body	Wetland Frontage	References
Palustrine forested, palustrine emergent, riverine emergent	Cedar Creek and Great Pee Dee River	6,503 feet (perimeter)	52; 91, pp. 10, 15; 92; 94
Riverine emergent - northern bank of Cedar Creek from sample GL-085-SD to confluence with the Great Pee Dee River	Cedar Creek	2,105 feet	
Palustrine forested – eastern bank of the Great Pee Dee River from confluence with Cedar Creek to wetland sample GL-073-SD	Great Pee Dee River	1,722 feet	
	Total Wetland Frontage	10,330 feet or 1.95 miles	

Total Wetland Frontage: 1.95 miles

The wetland ratings value for 1.95 miles is obtained from Reference 1, Table 4-24 and is 50.

Wetland Value: 50
(Ref. 1, Table 4-24)

For wetlands subject to Level II concentrations, the wetland value (50) is multiplied by 1 (Ref. 1, Section 4.1.4.3.1.2).

Wetland Value: 50 × 1
Level II Concentrations Factor Value: 50
(Ref. 1, Section 4.1.4.3.1.2)

4.1.4.3.1.3 Potential Contamination

Sensitive Environments

The federally endangered Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus)* and the Shortnose Sturgeon (*Acipenser brevirostrum*) occur and spawn in the Great Pee Dee River within the 15-mile TDL. It is not known if these species have been documented within the zone of actual contamination (GL-085-SD to GL-073-SD) (Refs. 7; 59, pp. 39160, 39260) (see Figure 4 of this HRS documentation record). Potential contamination of sensitive environments was not scored because potential contamination does not contribute significantly to the site score.

Wetlands

Potential contamination of wetlands was not scored because potential contamination does not contribute significantly to the site score.