5.3.3 Wooded Bottomland Area

The WBA does not contain any man-made surface or subsurface features.

Figure 16: Wooded Bottomland Area

5.4 Sampling Strategy

RCRA referred the site to Superfund in 2002. Since that time, several different entities have conducted numerous sampling events. The sections below provide a summary of the field activities conducted since 2002, and incorporation of historical RCRA data where appropriate.

5.4.1 Surveys

Surface features of the site were documented through historical engineering drawings, aerial and field surveys by registered land surveyors (RLS), field measurements and observations. The information below provides a general description of these surveys:

- 1978: Simons - Eastern Company, Inc. prepared a survey plat of the process area and related topographic conditions, operational areas, and drainage features. Historical surface features were also evaluated through vintage engineering drawings.
- 1999: American Geographic. Inc. RLS conducted a topographic aerial survey of the site and portions of the surrounding IP property using the National Geodetic Vertical Datum of 1929 (NGVD 29). This survey was conducted as part of a RCRA Hazardous Waste Permit application renewal. The geospatial data from this survey was later used in the initial portions of the EE/CA Phase I investigation.
- 2005: W. K. Dickson RLS completed a survey of the former and newly installed groundwater monitoring wells within the UNPA using the NGVD 29.

- 2006: Taylor Wiseman & Taylor RLS conducted a survey of the site's topography, drainage features and horizontal control for the site structures, the EE/CA Phase II soil, sediment, surface water, and air sampling locations, and groundwater monitoring wells using the NAVD 88. Sampling locations from previous assessment work including the iESI/RA and EE/CA Phase I investigations were incorporated into the 2006 survey. This survey has been used as a base map for subsequent sampling efforts.
- 2007: CH2M Hill conducted a survey of the drainage channels in the WBA using a Global Positioning System (GPS) unit.
- 2009: Cape Fear Design Services prepared an as-built survey of the two engineered stockpiles.

5.4.2 Air

The following historical information was reviewed to evaluate meteorological data and characterize the atmospheric transport of contaminants:

- air quality records and related air permits for the discharge of chlorine, hydrochloric acid, and mercury during facility operations;
- past operational processes including the impregnation of Aroclor 1268 into graphite anodes and mercury emissions from the cell building ventilation fans;
- the *Waccamaw Atmospheric Mercury Study* published by the North Carolina Division of Air Quality in March 2002, which examined air quality in the Riegelwood area from 1998 to 2000.

Monitoring

From 2002 to the present, air monitoring for mercury occurs daily when staff are present on-site. In September 2005, a radiation survey was conducted.

Sampling

Between December 2004 and May 2007, seven Time Integrated Air Sampling (TIAS) events were conducted. These events took place quarterly and consisted of six days of sample collection performed within a three-week period. Air samples were collected using air sample pumps over a six to seven-hour period each day from six locations surrounding the former Cell Building's concrete pad.

In 2005, air samples were collected to evaluate indoor air. The buildings sampled included the Office Building, Membrane Building, Prep Building, and Air Compressor Building. Samples were collected from both inside the buildings and just outside exits to the buildings.

5.4.3 Surface Water and Sediment

5.4.3.1 Surface Water Sampling

During 2002, 2004, 2005, 2006 and 2009, a total of 40 surface water samples were collected at the site and surrounding waterways. The sampling conducted in 2002 was part of the iESI/RA. The sampling conducted in 2004 and 2005 was part of the EE/CA. The sampling in 2006 was immediately following a storm event to evaluate potential surface water transport of contamination. The sampling conducted in 2009 was to fill in data gaps in order to complete the Baseline Ecological Risk Assessment (BERA). The focus of each sampling event varied in purpose, location and analysis and is summarized in **Table 4**.

Table 4: Surface Water Sampling Strategy Summary 2002-2009

Area	# of samples	Parameters	Sample Year	Sample ID
Cape Fear River	3	Full Scan	2002	LCP-001, -006, -007
Cape Fear River	1	TAL Metals, TCL VOCs and SVOCs	2002	LCP-005
	4	**Number of Surface Water Samples Collected In 2002**		
Cape Fear River	6	Full Scan; Aroclor 1268; pH; Dioxins for IP-2	2004	IP-2; River Ref-1; River Up-1, -2; River Down-1, -2
Livingston Creek	1	Full Scan; Aroclor 1268	2004	Wright-2
	7	**Number of Surface Water Samples Collected In 2004**		
Cape Fear River	3	Mercury	2005	SW-1, -2, -3
Western Drainage Ditch	3	Full Scan; Aroclor 1268; TOC; Hardness; TSS; Dioxins for SW-11, -12	2005	SW-11, -12, -28
Eastern Drainage Ditch	7	Full Scan; Aroclor 1268; TOC; Hardness; TSS; Dioxins for SW-22	2005	SW-17, -18, -20, -22, -24, -29, -30
Central Drainage Ditch	5	Full Scan; Aroclor 1268; TOC; Hardness; TSS; Dioxins for SW-7, -13, -15	2005	SW-7, -9, -10, -13, -15
	18	**Number of Surface Water Samples Collected In 2005**		
Stormwater Event Western Drainage Ditch	2	Full Scan; Aroclor 1268; TOC; Hardness; TSS; Dioxins	2006	SW-4, -14
Stormwater Event Central Drainage Ditch	2	Full Scan; Aroclor 1268; TOC; Hardness; TSS; Dioxins; (SW-5 no TOC analysis)	2006	SW-5, -16
Stormwater Event Eastern Drainage Ditch	3	Full Scan; Aroclor 1268; TOC; Hardness; TSS; Dioxins	2006	SW-6, -8, -19
	7	**Number of Surface Water Samples Collected In 2006**		
Eastern Drainage Ditch	3	Full scan (no VOCs); Aroclor 1268; pH; Hardness; methyl mercury; amphibian toxicity	2009	SW-40, -41, -42
Background Off-site	1	Full scan; Aroclor 1268; methyl mercury	2009	SWREF-1
	4	**Number of Surface Water Samples Collected In 2009**		
	40	**TOTAL NUMBER OF SURFACE WATER SAMPLES 2002-2009**		

Notes:

Full Scan = Target Analyte List Metals (TAL metals); Target Compound List Volatile Organic Compounds (TCL VOCs), Semi-Volatile Organic Compounds (SVOCs), Polychlorinated Biphenyls (PCBs) + Aroclor 1268, pesticides (Aroclor 1268 is noted when added to the PCB analysis).

TOC = Total Organic Carbon

TSS = Total Suspended Solids

5.4.3.2 Sediment Sampling

Over 130 sediment samples were collected in the combined years of 2002, 2004, 2005, 2007 and 2009.[3] The sampling conducted in 2002 was part of the iESI/RA. The sampling conducted in 2004 and 2005 was part of the EE/CA. The sampling conducted in 2007 was to address data gaps identified at the conclusion of the EE/CA Phase 2 sampling. The sampling conducted in 2009 was to fill in data gaps in order to complete the BERA. The focus of each sampling event varied in purpose, location and analysis and is summarized in **Table 5.**

Table 5: Sediment Sampling Strategy Summary 2002-2009

Area	# of samples	Parameters	Year	Sample ID
Central Drainage Ditch	2	Full Scan; Total Cyanide	2002	HC-15, -16
Eastern Drainage Ditch	7	Full Scan; Total Cyanide	2002	HC-17 through HC-22
Cape Fear River	4	Full Scan; Dioxins	2002	LCP-001, -002, -005 and -007
	13	**Number of Sediment Samples Collected in 2002**		
Cape Fear River	9	Full Scan; Aroclor 1268; TOC; pH; Dioxins for IP-1, -3	2004	IP-1, -3; Site-1, -2; River Up-1, -2; River Down-1, -2; and Creek Discharge
Sewer System (SS)	5	Full Scan; Aroclor 1268	2004	SED-1 through -4, -6
Cape Fear River Background	5	Full Scan; Aroclor 1268; TOC	2004	River Ref-1 through Ref-5
North Retention Basin	3	Full Scan; Aroclor 1268; TCLP	2004	SED-7, -8
South Retention Basin	4	Full Scan; Aroclor 1268; TCLP	2004	SED-9, -10
Livingston Creek	3	Full Scan; Aroclor 1268; TOC	2004	Wright-1 through -3
Central Drainage Ditch	5	Full Scan; Aroclor 1268	2004	WSED-1 and -2
Eastern Drainage Ditch	6	Full Scan; Aroclor 1268	2004	WSED-3 through -5
	40	**Number of Sediment Samples Collected in 2004**		
Eastern Drainage Ditch	8	Mercury, PCB; Aroclor 1268; TOC; pH for WSED-19	2005	WSED-16, -19, -21, -25
Eastern Drainage Ditch	16	Full Scan; Aroclor 1268; TOC; pH; Dioxins for WSED-17, -18, -20	2005	WSED-17, -18, -20, -22 to -24, -29, -30
Western Drainage Ditch	6	Full Scan; Aroclor 1268; TOC; Dioxins for WSED-28	2005	WSED-26 to -28
Central Drainage Ditch	10	mercury; PCB; Aroclor 1268; TOC	2005	WSED-6, -8, -11, -12, -14
Central Drainage Ditch	10	Full Scan; Aroclor 1268; TOC; pH; Dioxins for WSED-9	2005	WSED-7, -9, -10, -13, -15
	50	**Number of Surface Water Samples Collected in 2005**		
Western Drainage Ditch	3	Aroclor 1268	2007	WSED-39
Eastern Drainage Ditch	4	Mercury	2007	WSED-31, -32
Central Drainage Ditch	9	Aroclor 1268	2007	WSED-33, -35, -37
Central Drainage Ditch	4	Mercury	2007	WSED-34, -38

[3] Note: This does not include the sampling conducted by IP's contractors in their former wastewater treatment lagoon. Information about sampling of that area is included in section 5.4.4.3.

Area	# of samples	Parameters	Year	Sample ID
Central Drainage Ditch	3	mercury and Aroclor 1268	2007	WSED-36
	23	**Number of Sediment Samples Collected in 2007**		
Eastern Drainage Ditch	4	Full scan (no VOCs); Aroclor 1268; methyl mercury	2009	WSED-40, -41, -42, SEDREF-1
Background Off-site	1	Full scan; Aroclor 1268; methyl mercury	2009	SEDREF-1
	5	**Number of Sediment Samples Collected in 2009**		
	131	**TOTAL NUMBER OF SEDIMENT SAMPLES 2002-2009**		

Notes:

Full Scan = Target Analyte List Metals (TAL metals); Target Compound List Volatile Organic Compounds (TCL VOCs), Semi-Volatile Organic Compounds (SVOCs), Polychlorinated Biphenyls (PCBs) + Aroclor 1268, pesticides (Aroclor 1268 is noted when added to the PCB analysis).

TCLP = Toxicity characteristic leaching procedure

TOC = Total Organic Carbon

5.4.3.3 WWTS

During June through October 2008, 19 samples were collected of the WWTS transported to the ESPs. Samples were collected at a rate of one sample per approximately 1,000 yd^3. The purpose was to assist in evaluating treatment options for this material relative to constituents other than PCBs.

5.4.4 Geology

Geological investigations for the site and surrounding area included research of published literature of the regional and local geologic conditions, and the evaluation of subsurface information obtained during geological and environmental investigations.

Over 50 soil borings were advanced at the site primarily for purposes of geologic evaluation and well installation. The majority of the borings were drilled in the mid-1980s through the late 1990s. This work focused primarily on the surficial portion (upper 30 to 40 feet) of the underlying materials within the UNPA near the two closed surface impounds (Old North and South Ponds), the retention basins, and the WBA. Deeper subsurface conditions were also investigated while the site was regulated under RCRA by drilling and sampling three soil borings to depths of approximately 140 ft bgs and one boring to approximately 200 ft bgs. Down-hole geophysical logging, including electrical (apparent resistivity, spontaneous potential) and gamma logging, was performed on each of the four deep borings. Grain size distribution analyses was also conducted. In 2004, seven additional groundwater monitoring wells were installed in the UPA, with depth ranges of 12 to 20 ft bgs.

5.4.5 Soil

Over 660 soil samples were collected in the years 2002 – 2005, 2007 and 2009. In 2002, soil samples were collected during the iESI/RA. In 2003, high-density soil sampling was performed around the Retort Pad perimeter; surface and subsurface soil samples were collected from 46 locations. In 2004, two soil sampling events occurred. The first one was part of legal discovery in which surface and subsurface soil samples were split from the plaintiffs' consultant. The second soil sampling event in 2004 was

conducted as part of the EE/CA Phase 1 activities. In 2005, soil samples were collected as part of EE/CA Phase 2 activities. At the completion of the Phase 1 work, mercury and Aroclor 1268 were identified as the primary contaminants the site. Vertical and horizontal delineation sampling was performed in areas identified in Phase 1 with high concentrations of mercury and/or Aroclor 1268. In 2007, surface and subsurface soil samples were collected from 21 locations in the WBA to address data gaps identified after the EE/CA Phase 2 sampling was completed. In 2009, CH2M Hill collected 16 additional soil samples from the WBA to fill in data gaps in order to complete the BERA. The focus of each sampling event varied in purpose, location and analysis and is summarized in **Table 6**.

Table 6: Soil Sampling Strategy Summary 2002-2009

Area	# of samples	Parameters	Sample Year	Sample ID
Background Off-site	3	Full Scan	2002	HC-23
Fill Area	7	Full Scan; Total Cyanide	2002	HC-06, -07, -12
Old Parking Area	2	Full Scan; Total Cyanide	2002	HC-24
Retort Area	15	Full Scan; Total Cyanide	2002	HC-01 to -05
Roberts Pond	6	Full Scan; Total Cyanide	2002	HC-08 and -09
WBA	2	Full Scan; Total Cyanide	2002	HC-13 and -14
	35	**Soil Samples Collected in 2002**		
Retort Area	118	mercury	2003	LC Samples
	118	**Soil Samples Collected in 2003**		
Litigation Samples	22	mercury, PCB; Aroclor 1268	2004	Site #1 B1, #1 B2, #1 B3, #1 B4, #1 Surface, #2 B1, #2 B2, #2 Debris, #2 Surface
Background	6	Full Scan; Aroclor 1268	2004	SB-26 to -28
Bleach Plant	1	Full Scan; Aroclor 1268	2004	SB-15
North Cell Building Pad Area	5	Full Scan; Aroclor 1268	2004	SB-4, -11, -12
Old Parking Area	6	Full Scan; Aroclor 1268; pH	2004	SB-21 to -23
Old Salt Dock	2	Full Scan; Aroclor 1268	2004	SB-13
Products Area	2	Full Scan; Aroclor 1268	2004	SB-14
Rail Yard Area	5	Full Scan; Aroclor 1268	2004	SB-5, -16, -17
Rail Yard Area	7	mercury and Aroclor 1268	2004	Site #3 B1, Site #3 Surface
Retort Area	4	Full Scan; Aroclor 1268	2004	SB-1, -2
SWDS	6	Full Scan; Aroclor 1268; SPLP	2004	W-1, W-2 and W-3
South Cell Building Pad Area	2	Full Scan; Aroclor 1268; pH	2004	SB-9
Wastewater Treatment Area	3	Full Scan; Aroclor 1268; pH	2004	SB-19 and -20
West Cell Building Pad Area	10	Full Scan; Aroclor 1268	2004	SB-3, -6, -7, -8, -10
	81	**Soil Samples Collected in 2004**		
Background	6	Full scan; Aroclor 1268; Dioxins; TOC	2005	SB-104 to -106

Area	# of samples	Parameters	Sample Year	Sample ID
East Cell Building Pad Area	2	Full scan; Aroclor 1268; Dioxins	2005	SB-73
East Cell Building Pad Area	18	mercury	2005	SB-118 to -121, -134, -135
Fill Area	69	Aroclor 1268	2005	SB-47 to -56, -58, -59, -301, -302
North Cell Building Pad Area	16	Aroclor 1268	2005	SB-30, -31, -33 to -38
North Cell Building Pad Area	15	mercury	2005	SB-122 to -126
Old North Pond	3	Full scan; Aroclor 1268; Dioxins for SB-77	2005	SB-76 to -78
Old North Pond	1	Full scan (no VOCs); Aroclor 1268	2005	UNP-5
Old Parking Area	6	Aroclor 1268	2005	SB-65 to -67
Rail Yard Area	22	Aroclor 1268	2005	SB-39 to -42, -57, -64
Rail Yard Area	4	Full scan; Aroclor 1268; Dioxins	2005	SB-71, -74
Retort Area	25	Aroclor 1268	2005	SB-43 to -46, -60
Retort Area	8	Full scan; Aroclor 1268; Dioxins	2005	SB-68 to -70
Retort Area	65	mercury	2005	SB-108 to -117, -136 to -150, -152 to -154
Roberts Pond	15	Aroclor 1268	2005	SB-61 to -63
SWDS	6	Total metals	2005	W-4 to -6
South Cell Building Pad Area	2	Full scan; Aroclor 1268; Dioxins	2005	SB-72
South Cell Building Pad Area	6	mercury	2005	SB-132, -133
Wastewater Treatment Area	2	Full scan; Aroclor 1268; Dioxins	2005	SB-75
West Cell Building Pad Area	2	Aroclor 1268	2005	SB-29, -32
West Cell Building Pad Area	21	mercury	2005	SB-127 to -131, -155 to -157
North Retention Basin	5	Full scan; Aroclor 1268; Dioxins for SB-102, -103, 310	2005	SB-81, -82, -102, -103, -310
South Retention Basin	2	Full Scan; Aroclor 1268	2005	SB-83, -84
WBA	2	Full Scan; Aroclor 1268	2005	SB-79 and -80
WBA	22	Full scan; Aroclor 1268; Dioxins; TOC for SB-98; VOCs and SVOCs for SB-89	2005	SB-85 to -101
	345	**Soil Samples Collected in 2005**		
WBA	59	Aroclor 1268	2007	SB-158 to -178

Area	# of samples	Parameters	Sample Year	Sample ID
	59	**Soil Samples Collected in 2007**		
WBA	17	Full scan; Aroclor 1268	2009	TERA-1 to -5, WB-1 to -5
UNPA	5	Full scan; Aroclor 1268	2009	UNP-1 to -5
Background Off-site	1	Full scan; Aroclor 1268; methyl mercury	2009	SEDREF-1
	23	**Soil Samples Collected in 2009**		
TOTAL OF	**661**	**SOIL SAMPLES 2002-2009**		

Notes:

Full Scan = Target Analyte List Metals (TAL metals); Target Compound List Volatile Organic Compounds (TCL VOCs), Semi-Volatile Organic Compounds (SVOCs), Polychlorinated Biphenyls (PCBs) + Aroclor 1268, pesticides (Aroclor 1268 is noted when added to the PCB analysis).

SPLP = synthetic precipitation leaching procedure

TOC = Total Organic Carbon

5.4.6 Groundwater

Prior to the year 2000, over 50 groundwater monitoring wells were installed at the site. In 2004, seven groundwater monitoring wells were installed in the UPA as part of the EE/CA. In 2012, one additional groundwater monitoring well was installed in the WBA near the head of the central drainage ditch. Some of the wells have been abandoned or destroyed. Currently there are 45 groundwater monitoring wells on-site. All of the wells consist of PVC pipes with diameters ranging from one to four inches. A summary of the construction data for the wells currently on-site is in **Table 7**.

Table 7: Groundwater Monitoring Well Construction Information

Well ID	Date Installed	Screen Interval (ft bgs)	Well Diameter/ Type	Current Status
BG	4/20/1992	18-28	2"/PVC	Background Monitoring Well
NUS-4R	4/20/1992	12.5-17.5	4"/PVC	Monitoring Well
4A	11/24/1986	10-15	2"/PVC	Monitoring Well
4B	11/24/1986	25-30	2"/PVC	Monitoring Well/Piezometer
5A	11/24/1986	15-20	2"/PVC	Monitoring Well
5B	11/24/1986	30-35	2"/PVC	Monitoring Well/Piezometer
6A	11/24/1986	15-20	2"/PVC	Monitoring Well/Piezometer
6B	11/24/1986	30-35	2"/PVC	Monitoring Well/Piezometer
B8	10/20/1986	13-23	2"/PVC	Monitoring Well/Piezometer
9A	Jun-1989	~1-6	2"/PVC	Monitoring Well
9B	Jun-1989	~5-10	2"/PVC	Monitoring Well/Piezometer
9C	Jun-1989	~8.5-13.5	2"/PVC	Monitoring Well/Piezometer
10AR	1/13/2000	10-20	2"/PVC	Monitoring Well
10BR	6/23/1999	34.5-39.5	2"/PVC	Monitoring Well
11A	1/19/1987	14-19	2"/PVC	Monitoring Well
11B	1/19/1987	29-34	2"/PVC	Monitoring Well
11C	2/16/1990	14-23.5	2"/PVC	Monitoring Well/Piezometer
12A	1/19/1987	10-15	2"/PVC	Monitoring Well/Piezometer
12B	1/20/1987	29.5-34.5	2"/PVC	Monitoring Well/Piezometer
13A	1/20/1987	10-15	2"/PVC	Monitoring Well
13B	1/20/1987	29.5-34.5	2"/PVC	Monitoring Well/Piezometer
14A	1/20/1987	10-15	2"/PVC	Monitoring Well
14B	1/20/1987	24.5-29.5	2"/PVC	Monitoring Well/Piezometer
POC-1R	Dec-1999	14-19	4"/PVC	Monitoring Well
POC-2R	1/12/2000	10-20	4"/PVC	Monitoring Well
POC-3	4/20/1992	13.5-18.5	4"/PVC	Monitoring Well
PZ-1	11/20/2001	2-12	2"/PVC	Monitoring Well/Piezometer
PZ-2	11/20/2001	1.5-11.5	2"/PVC	Monitoring Well/Piezometer
PZ-3	11/20/2001	1.5-11.5	2"/PVC	Monitoring Well/Piezometer

Well ID	Date Installed	Screen Interval (ft bgs)	Well Diameter/ Type	Current Status
PZ-4	11/20/2001	2-12	2"/PVC	Monitoring Well/Piezometer
PZ-5	11/20/2001	2-12	2"/PVC	Monitoring Well/Piezometer
PZ-6	11/20/2001	2-12	2"/PVC	Monitoring Well/Piezometer
P5	8/11/1999	10-20	1"/PVC	Monitoring Well/Piezometer
P6	8/11/1999	10-20	1"/PVC	Monitoring Well/Piezometer
P8	8/11/1999	10-20	1"/PVC	Monitoring Well/Piezometer
P9	8/2/2012	2-7	2"/PVC	Monitoring Well/Piezometer
RW-1	2/14/1990	14.2-23.7	4"/PVC	Recovery well/Inactive
RW-2	2/15/1990	17.4-26.9	4"/PVC	Recovery well/Inactive
MW-15	11/4/2004	2-12	4"/PVC	Monitoring Well
MW-16	11/10/2004	4.2-14.2	4"/PVC	Monitoring Well
MW-17	11/11/2004	3.4-13.4	4"/PVC	Monitoring Well
MW-18	11/9/2004	4.8-14.8	4"/PVC	Monitoring Well
MW-19	11/9/2004	7.7-17.7	4"/PVC	Monitoring Well
MW-20	11/9/2004	8.7-18.7	4"/PVC	Monitoring Well
MW-21	11/11/2004	9.3-19.3	4"/PVC	Monitoring Well
Notes:				
ft bgs = feet below ground surface				
PVC = polyvinyl chloride				

5.4.6.1 Groundwater Level Measurements

Groundwater levels have been measured for differing purposes over time. In the mid-1980s water levels were measured to evaluate the vertical and horizontal gradients of the underlying aquifers. Since 2004, three groundwater gauging events (2004, 2007 and 2009) were conducted to evaluate groundwater flow conditions as part of the EE/CA and RI work.

5.4.6.2 Aquifer Testing

Slug testing was performed on over 20 wells to assess subsurface hydraulic conductivity. In addition to the slug testing, long term groundwater extraction rates from recovery wells RW-1 and RW-2 were evaluated for purposes of RCRA corrective action. The hydraulic conductivity values and flow rates from the recovery wells were used in developing the hydrogeologic characteristics at the site.

5.4.6.3 Groundwater Sampling and Analysis

Historical RCRA compliance monitoring activities included: quarterly monitoring for mercury and indicator parameters for 12 compliance monitoring wells and one background monitoring well (1992 through 2003); and annual monitoring for RCRA Appendix 9 constituents from the point of compliance (POC) monitoring wells during January 1993 through December 2003.

Under CERCLA, groundwater samples were collected and analyzed in 2002, 2004, 2008, 2009, and 2012. The sampling conducted in 2002 was performed during the iESI/RA. The sampling conducted in 2004 and 2009 were part of the EE/CA and RI. The single sample collected in 2008 was during the IP Removal Action. The single sample collected in 2012 was to fill in a data gap for completion of the RI. The focus of each sampling event varied in purpose, location and analysis and is summarized in **Table 8**.

Table 8: Groundwater Sampling Strategy Summary

Area	# of samples	Parameters	Sample Year	Sample ID
UPA	1	Hg, inorganics	1992-2003 (Q)	BG
UNPA	7	Hg, inorganics	1992-2003 (Q)	POC-2R, 10AR, 10 BR, 11A, 11B, 13A, 14A
WBA	5	Hg, inorganics	1992-2003 (Q)	POC-3, NUS-4R, 4A, 5A, 9A
	13	**Groundwater Samples Collected Each Quarter during 1992-2003**		
UNPA	2	Appendix 9	1993-2003 (A)	POC-1R*, POC-2R
WBA	1	Appendix 9	1993-2003 (A)	POC-3
	3	**Groundwater Samples Collected Annually during 1993-2003**		
Old Parking Area	1	Full scan	2002	HC-24
Roberts Pond	1	Full scan	2002	HC-09
Fill Area	1	Full scan	2002	HC-07
Retort Area	5	Full scan	2002	HC-01 to -05
	8	**Groundwater Samples Collected in 2002**		
UPA	8	Full scan; Aroclor 1268; cations & anions	2004	BG; MW-15, -16, -17, -18, -19, -20, -21
UNPA	2	Full scan; Aroclor 1268; cations & anions	2004	POC-2R, 14A
WBA	4	Full scan; Aroclor 1268; cations & anions	2004	POC-3R, NUS-4R, 6A, 6B
	14	**Groundwater Samples Collected in 2004**		
SWDS	1	Hg; Aroclor 1268	2008	AV-1
	1	**Groundwater Samples Collected in 2008**		
UPA	8	Full scan; Aroclor 1268; cations & anions	2009	BG; MW-15, -16, -17, -18, -19, -20, -21
UNPA	3	Full scan; Aroclor 1268; cations & anions	2009	POC-2R, 11A, 14A
WBA	3	Full scan; Aroclor 1268; cations & anions	2009	POC-3R, NUS-4R, B8
	14	**Groundwater Samples Collected in 2009**		
WBA	1	Hg; Aroclor 1268	2012	P9
	1	**Groundwater Sample Collected in 2012**		

Notes:

Full Scan = Target Analyte List Metals (TAL metals); Target Compound List Volatile Organic Compounds (TCL VOCs), Semi-Volatile Organic Compounds (SVOCs), Polychlorinated Biphenyls (PCBs) + Aroclor 1268, pesticides (Aroclor 1268 is noted when added to the PCB analysis).

A = annually

Hg = mercury

Q = quarterly

5.5 Sources of Contamination

5.5.1 On-site

Based on the site use and operational history, the manufacturing process areas represent the bulk of the potential source areas. Mercury and Aroclor 1268 are the contaminants that pose the greatest risks to human health and the environment (see **Section 7.0, Summary of Site Risks**). The facility operated a mercury cell electrolytic process. The facility treated the graphite anodes of the mercury cell with chlorinated hydrocarbons, including Aroclor 1268, to remove impurities from the anodes. Mercury and Aroclor 1268 are concentrated in operational areas and in the drainage pathways across the site. Other contaminants posing risks were commonly located with these main contaminants.

Historical photographs and engineering drawings indicate that early plant operations may not have adequately contained runoff from process areas. Storm water runoff from the chemical storage and process operations was likely a primary source of contamination for the soils and sediment in the WBA.

Above ground sources of contamination was removed from the site as part of the 2002-2004 Removal Action. These areas included the former Mercury Cell Building, the Retort equipment, the MESS equipment, equipment and tanks within the Products Area, the salt brine saturator tanks and associated equipment within Salt Dock Area, and equipment and tanks within the Bleach Plant area.

A summary of the remaining source areas:

- The Cell Building Pad Area: This area is suspected to contain PTW. Elemental mercury was observed in cracks and fissures in the concrete pad, prior to and following the removal of the building. Mercury is likely present within the concrete pad and beneath the pad within the underlying soils. However, the PRP's contractor did not conduct sampling to define the depth of this contamination.
- The Retort Pad Area: This area is suspected to contain PTW. Elemental mercury was observed in cracks and fissures in the concrete pad, prior to and following the removal of the retort equipment. Mercury is likely present within the concrete pad and immediately beneath the pad within the underlying soils. Densely gridded soil sampling and analysis in this area indicated the presence of mercury within the soils immediately adjacent to the concrete pad.
- The Fill Area: The facility created the Fill Area in the late 1990s during the construction of the Membrane Building. This area contains process chemicals and waste materials from past operations.
- PCB Impregnation and Use of Graphite Anodes: There is no available documentation regarding using PCBs at the site. However, Aroclor 1268 was detected in site samples and in IP's waste water treatment lagoon at concentrations that pose risks to human health and the environment. Information regarding other chlor-alkali facilities suggest that Aroclor 1268 was likely used to remove impurities from the graphite anodes.
- The Solid Waste Disposal Site Area: This RCRA unit reportedly contains encapsulated process sludge materials. Records indicate that the SWDS had a PVC liner and an asphalt cap. The waste material was stabilized and the unit was closed in place.
- The Old South Pond: This RCRA unit reportedly contains encapsulated process sludge materials along with materials excavated from the Old North Pond. The Old South Pond has a synthetic liner and cap

- The Old North Pond: This RCRA unit formerly contained wastes which were excavated, stabilized, and placed into the Old South Pond. Afterwards it was backfilled with clean soil. However, it did not receive RCRA clean closure status.
- Robert's Pond Area: This RCRA unit operated for nearly a decade and was unlined. It was used to dispose of brine wastes containing mercury impurities. Roberts Pond was excavated and backfilled in 1987. The closure activities conducted at Robert's Pond did not satisfy requirements for clean closure under RCRA authority. Historical soil sample analytical results from this area suggest mercury is present in low concentrations within the soil.
- The North and South Retention Basins: The North and South Retention Basins were constructed sometime between the late 1970's to earlier 1980's. The basins receive surface water runoff, which the facility pumps to the wastewater treatment area and processes it prior to discharge. The retention basins are unlined but reportedly have a clay base or rest directly on top of the Peedee Formation.
- Sewer System: The sewer system winds through the UPA to carry process wastewater and storm water to the Wastewater Treatment Area. The sewer system was evaluated via visual assessment and video survey in 2002. The video survey was limited in some portions due to pipe blockages. The video documented cracks near several of the joints and completely corroded piping in some areas. It also documented multiple impacted areas north of the Cell Building Pad and in the piping leading to and from the diversion chamber in the wastewater treatment area.
- Historical Process Area Drainage Pathways: Historically, two other drainage pathways existed at the site that no longer exist. One includes a former drain from IP through the northern portion of the Manufacturing Process Area to the WBA. The second includes a former drainage ditch from the Wastewater Treatment Area to IP's wastewater lagoon.
- Wastewater Area: The sewer lines congregate in the Wastewater Area for processing. Processing includes a settling tank, stabilization, flocculation, and filtration. Prior to development of the Wastewater Area in 1987, the facility diverted process water and storm water through a drainage ditch extending to the east from the wastewater treatment area to the adjacent IP facility for off-site treatment and disposal. Herman's Hollow is a sump area that historically received pretreated water from the Mercury Cell Building and associated process areas as well. The base of the sump has eroded away and filled with sediment.
- Wooded Bottomland Area: The WBA has been undeveloped throughout the site operational history. The drainage areas in the WBA received unprocessed water prior to implementation of environmental regulations.
- Engineered Stockpiles: Although currently completely contained, PCB-contaminated material in the engineered stockpiles described in **Section 2.4.2**, could become a source of contamination if a remedial action does not occur.

5.5.2 Off-site

Potential off-site sources of contamination to the site may include current and former operations from the adjacent IP facility. Historical information indicates two former sources of potential contamination to the site.

Historical photographs and drawings indicate IP maintained an open ditch that discharged effluent directly into the WBA. The source of this effluent was reportedly seepage from the black liquor pond located to the west and adjacent to the site. This ditch was later covered and piped. IP closed the black liquor pond in the mid-2000s. Black liquor is the spent cooking liquor from the kraft process when

digesting pulpwood into paper pulp removing lignin, hemicelluloses and other extractives from the wood to free the cellulose fibers. Spent pulping liquor is a corrosive complex mixture with a pH ranging from approximately 11.5 to 13.5. The inorganic constituents in black liquor come from the cooking liquor used to pulp the wood chips and comprised of sodium hydroxide, sodium sulfide, sodium carbonate, sodium sulfate, sodium thiosulfate and sodium chloride. Collectively, inorganic salts constitute 18% to 25% of the solids in black liquor.

The process of bleaching pulp at paper mills using cellulose fibers produces dioxins and furans. Currently, bleaching pulp and paper mills are the only significant known source of dioxins released into surface waters. Since the IP mill used the chlorine gas produced from the site in their pulp bleaching process, this facility may have contributed to the detectable concentrations of dioxins furans at the site through air emissions and effluent discharges. IP reportedly began production of their own chlorine dioxide in the 1990s. Published literature suggests that the use of chlorine dioxide in the bleaching process at pulp and paper mills greatly reduces the production of dioxins and furans.

5.6 Types of Contamination and Affected Media

This section is organized by media. Contamination was found in all media (air, surface water, sediment, WWTS, soil and groundwater) at varying concentrations. However, only soil, sediment and surface water have concentrations detected of contaminants that pose risks to human health and the environment. See **Section 7.0** for information regarding risk assessments. Summaries of the sampling results for each media are discussed in the following subsections.

5.6.1 Air

Air monitoring using a handheld mercury vapor analyzer began during the first removal action and continues to occur daily when staff are present on-site. Documentation of air monitoring data is extensive and is available in the site file.

Air samples were collected inside and outside of buildings on several occasions. The first event occurred as part of the Post-Removal Site Control Plan (PRSCP) to evaluate whether mercury contributed to air contamination from the former Mercury Cell Building pad after the first removal action was completed (discussed further in **Section 5.6.1.1**). The second event occurred during the EE/CA-RI for the purposes of determining if a risk was posed to human health via vapor intrusion (discussed further in **Section 5.6.1.2**).

5.6.1.1 Time Integrated Air Sampling

After the first removal action concluded at the site, (summarized in **Section 2.4.2**), seven Time Integrated Air Sampling (TIAS) events occurred between December 2004 and May 2007. During each sampling event, air samples were collected from six locations on six days during an approximate three-week period. This resulted in the collection of over 250 air samples between 2004 and 2007.

The daily sampling period was approximately 6-7 hours. Sample locations included upgradient, center of the mercury cell building pad, downgradient edge of the mercury cell building pad, and three other downgradient locations. The locations for all but the center sample varied daily depending on the wind direction.

On most dates, the laboratory detected mercury in the "blank" sample. The sample location with the highest average mercury concentration overall was TI-D1. **Table 9** includes sample results for that location, minus the concentration found in the blank sample(s) of that batch.

Each sample location, except for the upgradient locations, had a mercury concentration that exceeded the residential Removal Action Level (RAL) of 0.9 micrograms per cubic meter ($\mu g/m^3$) for mercury on at least one day. Mercury concentrations ranged from not detected to 17 $\mu g/m^3$. All results were below the commercial/industrial RAL of 25 $\mu g/m^3$. The laboratory did not detect mercury in any of the samples on two dates: May 12, 2006 and May 15, 2007. The highest concentration detected was on May 16, 2006. Location D3 concentration was 17 $\mu g/m^3$ with location D1 a close second at 16 $\mu g/m^3$. The temperature that day was 64-75°F and wind was coming from the west at 3 mph. The sample locations for the May 16, 2006 sampling event are included in **Figure 17**. A summary of the results from 2004-2007 are included in **Table 9.**

Figure 17: TIAS sample locations on date of highest concentrations

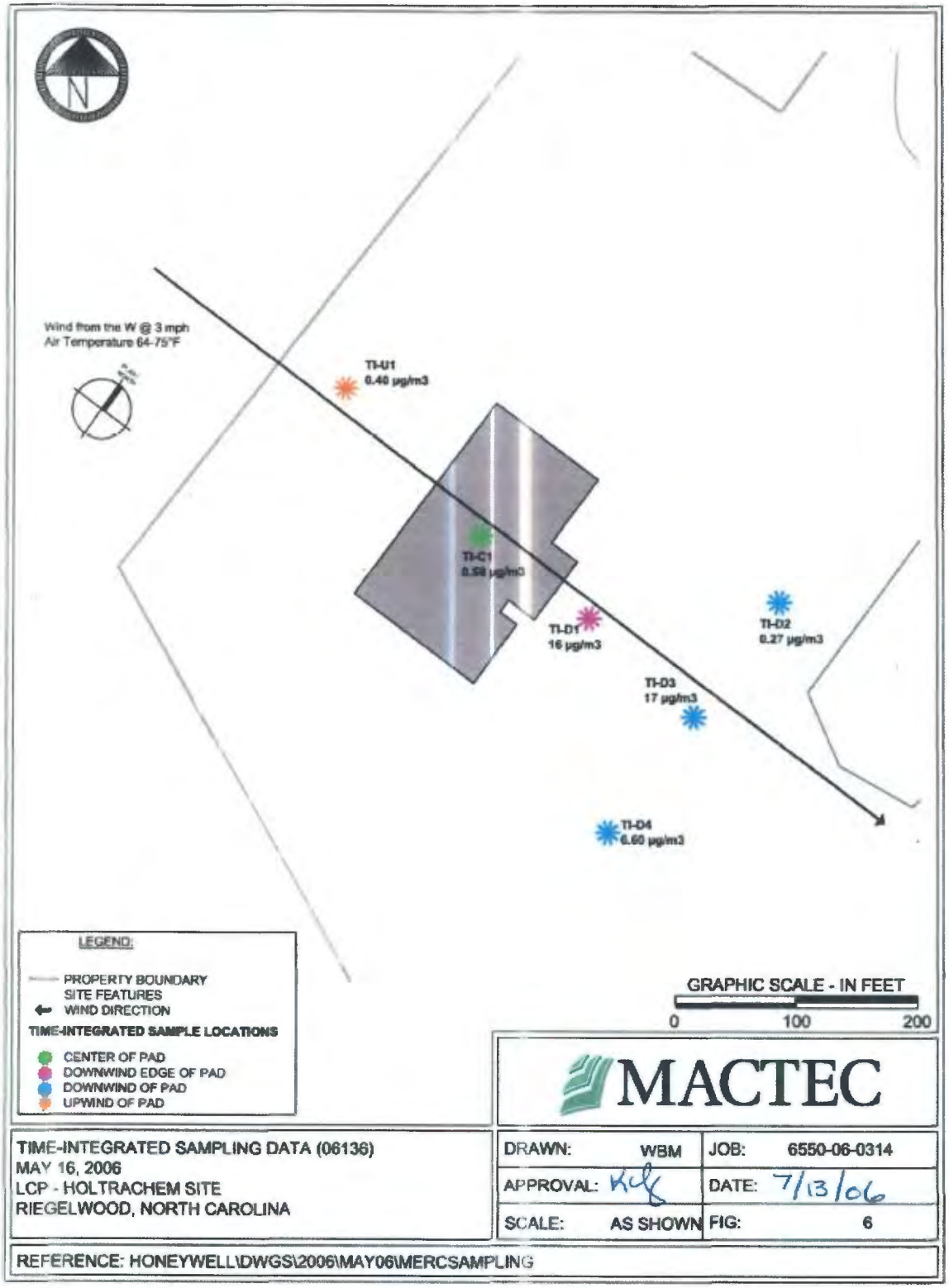


Table 9: TIAS Data Summary for the Location with the Highest Average Concentration

Location: Downgradient Edge of Pad (TI-D1)					
Sampling Event	Date	Average Ambient Temperature (°F)	Wind	Blank Corrected Concentration	Average Concentration for Sampling Event
December 2004	11/29/2004	57	from NE @ 7 mph	0.61	0.47
	12/2/2004	55	from NE @ 4 mph	0.36	
	12/3/2004	55	from N/NW @ 6 mph	0.33	
	12/8/2004	67	from SW @ 4 mph	0.68	
	12/13/2004	49	from SW @ 7 mph	0.39	
	12/16/2004	37	from N @ 1 mph	<0.2	
March 2005	3/30/2005	74-80	from ENE @ 2-8 mph	0.5	0.70
	4/4/2005	69-78	from W @ 2-12 mph	**1.36**	
	4/5/2005	76-83	from NE @ 2-4 mph	0.53	
	4/6/2005	75-84	from SE @ 3-6 mph	**0.96**	
	4/11/2005	70-77	from SE @ 2-4 mph	0.45	
	4/12/2005	66-69	from ESE @ 1-4 mph	0.37	
June 2005	6/21/2005	85		**2.66**	**1.09**
	6/22/2005	77		0.38	
	6/24/2005	84		0.24	
	6/28/2005	87		0.66	
	7/1/2005	87		0.65	
	7/6/2005	88		**1.96**	
November 2005	11/16/2005	72-76	from SE/S @ 5-11 mph	0.24	0.22
	11/17/2005	52-56	from NW @ 8 mph	0.29	
	11/18/2005	38-50	from NW/N @ 8 mph	0.13	
	11/22/2005	52-56	from NW/W shifting	0.23	
	11/23/2016	38-48	from W @ 1-6 mph	0.28	
	11/30/2016	60-78	from NW @ 5-8 mph	0.16	
May 2006	5/1/2006	60-72	from N/NW @ 3-8 mph	0.68	**4.11**
	5/3/2016	75-84	from W/NW @ 9-11 mph	0.85	
	5/5/2006	68-80	from S/SE @ 2-7 mph	**1.4**	
	5/10/2006	64-80	from SW @ 0-6 mph	**1.6**	
	5/12/2006	70-82	from S @ 6-16 mph	<0.26	
	5/16/2006	64-75	from W @ 3 mph	**16**	
August 2006	8/1/2006	88-100	from W/SW @ 3 mph	0.38	**2.92**
	8/2/2006	80-100	from S @ 4-7 mph	**4.8**	
	8/3/2006	82-102	from S @ 2-4 mph	**9.4**	
	8/7/2006	78-98	from SW-NW/N @ 0-7 mph	**0.92**	
	8/9/2006	84-92	from N/NE @ 0-4 mph	**0.94**	
	8/15/2006	84-90	from S/SW/SE @ 2-4 mph	**1.1**	
May 2007	5/14/2007	74-82	from N/NW-NE @ 2-4 mph	<0.3	0.63
	5/15/2007	84-86	from SE/E-S @ 3-7 mph	<0.3	
	5/21/2007	82-86	from SW @ 0-2 mph	0.7	
	5/23/2007	84-86	from SW @ 0-2 mph	<0.3	
	5/25/2007	84-86	from N-NE @ calm	0.7	
	5/30/2007	89-90	from W-NE @ 5-6 mph	0.5	
			Average:	**1.47**	**1.45**

Notes:

Samples were collected over a 6-7 hour period each day

All concentration results are in micrograms per cubic meter ($\mu g/m^3$)

-- means that information was not included in the report's summary table

Blank Corrected means that the concentration of mercury detected in the blank sample for that day was subtracted from the concentration detected in the sample.

Removal Action Levels (RALs) for mercury are 0.9 $\mu g/m^3$ for residential and 25 $\mu g/m^3$ for

Yellow highlight indicates concentration detected exceeds the residential RAL of 0.9 $\mu g/m^3$

5.6.1.2 Vapor Intrusion Assessment Sampling

In 2004, air samples were collected from nine locations within primary buildings and immediately adjacent to those buildings as part of a vapor intrusion (VI) evaluation. **Table 10** summarizes the analytical results.

Table 10: Vapor Intrusion Air Sample Results Summary

Analyte	Units	FOD%	Minimum Conc.	Maximum Conc.
mercury	mg/m^3	33	0.0006	0.00078
Volatile Organic Compounds detected in at least one sample:				
1,1,2-trichlorotrifluoroethane	PPBV	22	0.1 J	0.1 J
1,2,4-trimethylbenzene	PPBV	44	0.13 J	0.85
1,3,5-trimethylbenzene	PPBV	11	0.23 J	0.23 J
benzene	PPBV	89	0.22 J	1.3
bromomethane	PPBV	11	0.27 J	0.27 J
chlorobenzene	PPBV	11	0.13 J	0.13 J
chloroform	PPBV	89	0.22 J	0.96
chloromethane	PPBV	100	0.93	1.5
cis-1,2-dichloroethene	PPBV	11	1.1	1.1
dichlorodifluoromethane	PPBV	100	0.5	0.64
ethylbenzene	PPBV	44	0.27	0.5
methylene chloride	PPBV	11	0.39 J	0.39 J
m&p-xylene	PPBV	67	0.13 J	1.4
o-xylene	PPBV	33	0.44	0.52
styrene	PPBV	44	0.13 J	0.66
tetrachloroethene	PPBV	11	1.2	1.2
toluene	PPBV	89	0.23 J	2.9
trichloroethene	PPBV	11	0.31	0.31
trichlorofluoromethane	PPBV	100	0.23 J	1.2
vinyl chloride	PPBV	11	0.27	0.27

Notes:

Conc. = concentration

FOD% = percentage frequency of detection. 9 samples were analyzed for each analyte. Therefore, FOD% of 33 means that 3 of the 9 samples analyzed had detections of the analyte.

J = estimated value

mg/m^3 = milligrams per cubic meter

PPBV = parts per billion volume

5.6.2 Surface Water

Surface water samples were collected from multiple locations in the on-site WBA drainage pathways, the Cape Fear River and Livingston Creek. During 2004 through 2009, surface water samples were collected in the WBA during five separate sampling events. The 2006 sampling events were to evaluate conditions in the WBA drainage pathways when a storm event occurred. All three drainage paths (eastern, central and western) flow to the Cape Fear River. Flow through the western drainage ditch is ephemeral and dependent on rainfall, while flow through the central and east drainage ditches is perennial.

This section is divided into three subsections: on-site surface water, on-site storm water and off-site surface water. The laboratory reported multiple constituents detected. The following discussion provides a summary of the surface water and storm water analytical results for each of these areas. The notes below are applicable to each subsection table.

Notes:
$CaCO_3$ = calcium carbonate
Conc. = concentration
FOD% = percentage frequency of detection. For example, if 20 samples were analyzed for the analyte and only one had a detection FOD would be 1/20 = 5%.
ng/L = nanogram per liter
µg/L = micrograms per liter

5.6.2.1 WBA Surface Water

Water Quality Parameters

Seventeen surface water samples were collected from the WBA drainage ditches and analyzed for hardness, Total Suspended Solids (TSS) and Total Organic Carbon (TOC). **Table 11** summarizes the frequency of detection, range of concentrations, and location of the maximum detected concentration.

Table 11: Bottomland Drainage Ditch Surface Water Data Summary – Water Quality Parameters

Analyte	FOD%	Minimum Conc.	Maximum Conc.	Max location
Method E130.2. Concentration units are in µg/L				
hardness, Total as $CaCO_3$	100%	254,000	512,000	SW-9
Method E160.2. Concentration units are in µg/L				
Total Suspended Solids	100%	6,800	1,010,000	SW-24
Method SW9060. Concentration units are in µg/L				
total organic carbon (TOC)	100%	9,700	43,000	SW-10

VOCs

Seventeen surface water samples were collected from the WBA drainage ditches and analyzed for VOCs. Collectively, the samples contained nine detected VOCs. **Table 12** summarizes detected VOCs, frequency of detection, range of concentrations, and the location of the maximum concentration.

Table 12: Bottomland Drainage Ditch Surface Water Data Summary – VOCs

Analyte	FOD%	Minimum Conc.	Maximum Conc.	Max location
VOCs via method SW8260. Concentration units are in µg/L				
1,2,4-Trichlorobenzene	6%	0.79	0.79	SW-24
1,3-Dichlorobenzene	18%	0.69	3.3	SW-29
1,4-Dichlorobenzene	12%	1.3	2.6	SW-29
acetone	6%	2	2	SW-28
carbon disulfide	6%	0.57	0.57	SW-2
chlorobenzene	12%	0.77	1.6	SW-29
chloromethane	6%	0.24	0.24	SW-28
tetrachloroethene (PCE)	6%	0.14	0.14	SW-28
trichloroethene (TCE)	6%	0.51	0.51	SW-29

SVOCs

Twenty surface water samples were collected from the WBA drainage ditches and analyzed for SVOCs. Collectively, the samples contained seven detected SVOCs. **Table 13** summarizes detected SVOCs, frequency of detection, range of concentrations, and the location of the maximum concentration.

Table 13: Bottomland Drainage Ditch Surface Water Data Summary – SVOCs

Analyte	FOD%	Minimum Conc.	Maximum Conc.	Max location
SVOCs via method SW8270. Concentration units are in µg/L				
1,1-biphenyl	33%	0.023	0.023	SW-41
acenaphthene	10%	0.054	0.059	SW-40
anthracene	15%	0.023	0.048	SW-42
bis(2-Ethylhexyl)phthalate	20%	1.4	2.7	SW-11
carbazole	10%	0.031	0.031	SW-40, SW-41
fluoranthene	10%	0.074	0.13	SW-40
pyrene	15%	0.022	0.073	SW-40

Inorganics

Twenty surface water samples were collected from the WBA drainage ditches and analyzed for inorganics. Many inorganics are naturally occurring. **Table 14** summarizes detected inorganics, frequency of detection, range of concentrations, and the location of the maximum concentration.

Table 14: Bottomland Drainage Ditch Surface Water Data Summary – Inorganics

Analyte	FOD%	Minimum Conc.	Maximum Conc.	Max location
Inorganics via method SW6010. Concentration units are in µg/L				
aluminum	90%	119	8990	SW-2
arsenic	10%	5.8	6.8	SW-2
barium	100%	40.6	227	SW-2
cadmium	10%	5.8	6.8	SW-2
calcium	100%	54,200	172,000	SW-28
chromium	40%	0.82	20	SW-18
cobalt	10%	0.5	2.8	SW-2
copper	15%	3.2	8.4	SW-2
iron	95%	639	24,900	SW-2
lead	5%	11.3	11.3	SW-2
magnesium	100%	5,650	21,700	SW-42
manganese	100%	37.3	802	SW-30
nickel	70%	2	16.6	SW-2
potassium	100%	5,580	44,400	SW-9
selenium	20%	4.8	7.4	SW-7
sodium	100%	243,000	6,150,000	SW-9
vanadium	70%	3.2	41	SW-2
zinc	75%	6.9	181	SW-2
Mercury via methods SW7470 and SW7473. Concentration units are in µg/L				
mercury	78%	0.07	22.9	SW-28

Pesticides

Twenty surface water samples were collected from the WBA drainage ditches and analyzed for pesticides. Collectively, the analysis detected eight pesticides. **Table 15** summarizes detected pesticides, frequency of detection, range of concentrations, and the location of the maximum concentration.

Table 15: Bottomland Drainage Ditch Surface Water Data Summary – Pesticides

Analyte	FOD%	Minimum Conc.	Maximum Conc.	Max location
Pesticides via method SW8081. Concentration units are in µg/L				
4,4'-DDD	10%	0.023	0.024	SW-2
4,4'-DDT	10%	0.034	0.084	SW-7
delta-BHC	5%	0.045	0.045	SW-24
endosulfan II	5%	0.017	0.017	SW-7
endosulfan sulfate	5%	0.026	0.026	SW-28
endrin	5%	0.049	0.049	SW-24
endrin aldehyde	40%	0.022	0.26	SW-2
endrin ketone	33%	0.049	0.049	SW-40

PCBs

Twenty surface water samples from the WBA drainage ditches and were analyzed for Aroclors and four samples were analyzed for PCB congeners. Collectively, the analysis detected two Aroclors and 12 PCB congeners. **Table 16** summarizes detected PCBs, frequency of detection, range of concentrations, and the location of the maximum concentration.

Table 16: Bottomland Drainage Ditch Surface Water Data Summary – PCBs

Analyte	FOD%	Minimum Conc.	Maximum Conc.	Max location
Aroclors via method SW8082. Concentration units are in µg/L				
Aroclor 1254	5%	0.15	0.15	SW-7
Aroclor 1268	85%	0.062	17	SW-7
PCB Congeners via method E1668. Concentration units are in ng/L				
PCB-105	100%	0.0365	31.6	SW-7
PCB-106/118	100%	0.129	99.4	SW-7
PCB-114	50%	0.105	1.74	SW-7
PCB-123	50%	0.102	1.38	SW-7
PCB-126	50%	0.0867	0.873	SW-7
PCB-156	75%	0.131	11.7	SW-7
PCB-157	75%	0.0284	2.94	SW-7
PCB-167	75%	0.128	7.42	SW-7
PCB-169	75%	0.0299	0.86	SW-7
PCB-189	100%	0.0459	11.6	SW-7
PCB-77	75%	0.0592	5.47	SW-7
PCB-81	50%	0.0663	1.34	SW-7

Dioxins/Furans

Six surface water samples were analyzed for dioxin/furan congers, and four surface water samples for dioxin-like PCB congeners. A representative 2,3,7,8-TCDD toxicity equivalency quantity (TEQ) was calculated for each sample. Using the TEQ system, each of the dioxin/furan congeners and dioxin-like PCB congeners are assigned a Toxic Equivalency Factor (TEF) based on the congener's toxicity relative to 2,3,7,8-TCDD, with the toxicity of TCDD being equal to 1.0. The concentration of each dioxin/furan or dioxin-like PCB congener is multiplied by its respective TEF and the results are summed. The sum of the products of the concentrations multiplied by the appropriate TEF is known as the TEQ of the sample.

Table 17 summarizes detected dioxins and furans, frequency of detection, range of concentrations, and the location of the maximum concentration.

Table 17: Bottomland Drainage Ditch Surface Water Data Summary – Dioxins/Furans

Analyte	FOD%	Minimum Conc.	Maximum Conc.	Max location
Dioxins/Furans via method E1613. Concentration units are in ng/L				
1,2,3,4,6,7,8-HpCDD	83%	0.0156	0.493	SW-7
1,2,3,4,6,7,8-HpCDF	100%	0.0134	5.17	SW-7
1,2,3,4,7,8,9-HpCDF	83%	0.00681	0.181	SW-7
1,2,3,4,7,8-HxCDD	17%	0.00604	0.00604	SW-7
1,2,3,4,7,8-HxCDF	100%	0.00394	1.36	SW-7
1,2,3,6,7,8-HxCDD	17%	0.00726	0.00726	SW-7
1,2,3,6,7,8-HxCDF	83%	0.00773	0.279	SW-7
1,2,3,7,8,9-HxCDD	17%	0.00449	0.00449	SW-7
1,2,3,7,8,9-HxCDF	83%	0.0016	0.0492	SW-7
1,2,3,7,8-PeCDD	17%	0.00181	0.00181	SW-7
1,2,3,7,8-PeCDF	83%	0.00286	0.152	SW-7
2,3,4,6,7,8-HxCDF	83%	0.0136	0.391	SW-7
2,3,4,7,8-PeCDF	83%	0.00482	0.17	SW-7
2,3,7,8-TCDF	67%	0.013	0.0694	SW-7
HpCDD	83%	0.0377	1.1	SW-7
HpCDF	100%	0.0259	7.25	SW-7
HxCDD	83%	0.012	0.116	SW-7
HxCDF	100%	0.0205	4.93	SW-7
OCDD	100%	0.0574	8.86	SW-7
OCDF	100%	0.00997	4.33	SW-7
PeCDD	50%	0.00549	0.0281	SW-7
PeCDF	100%	0.0254	1.5	SW-7
TCDD	17%	0.00749	0.00749	SW-7
TCDF	100%	0.0113	0.532	SW-7
Total 2,3,7,8-TCDD TEQ (dioxin/furan & PCB) - Bird	100%	0.0107	1.02	SW-7
Total 2,3,7,8-TCDD TEQ (dioxin/furan & PCB) - Fish	100%	0.00404	0.372	SW-7
Total 2,3,7,8-TCDD TEQ (dioxin/furan & PCB) - Mammal	100%	0.00662	0.457	SW-7
Total 2,3,7,8-TCDD TEQ (dioxin/furan) - Bird	100%	0.00451	0.522	SW-7
Total 2,3,7,8-TCDD TEQ (dioxin/furan) - Fish	100%	0.0039	0.366	SW-7
Total 2,3,7,8-TCDD TEQ (dioxin/furan) - Mammal	100%	0.00338	0.338	SW-7
Total 2,3,7,8-TCDD TEQ (PCB) - Bird	100%	0.000142	0.00646	SW-7
Total 2,3,7,8-TCDD TEQ (PCB) - Fish	100%	0.00624	0.502	SW-7
Total 2,3,7,8-TCDD TEQ (PCB) - Mammal	100%	0.00324	0.119	SW-7

Surface Water Summary

Preliminary Remediation Goals (PRGs) were developed during the human health and ecological risk assessments, and were updated in the Feasibility Study.[4] **Table 18** lists sample locations that had at least one contaminant that exceeded a PRG concentration in WBA drainage ditch surface water. **Figure 18** highlights the sampling locations which had Aroclor 1268 and/or dioxin/furan concentrations that exceeded PRGs.

Table 18: Bottomland Drainage Ditch Surface Water Data – Sample Results that Exceeded a PRG

Site Area	Location ID	Aroclor 1268	Total 2,3,7,8-TCDD TEQ (dioxin/furan) Mammals	Total 2,3,7,8-TCDD TEQ (PCB) Mammals
Preliminary Remediation Goal (PRGs):		**0.44**	**0.0000087**	**0.0000095**
Central Drainage Ditch	SW-07	**17 B**	**0.000338**	**0.000119**
Central Drainage Ditch	SW-09	**2.4 B**	NA	NA
Central Drainage Ditch	SW-10	**3 B**	NA	NA
Central Drainage Ditch	SW-10	**7.6 B**	NA	NA
Central Drainage Ditch	SW-13	ND	**0.0000737**	NA
Central Drainage Ditch	SW-15	ND	**0.000012**	NA
Eastern Drainage Ditch	SW-17	**1.7**	NA	NA
Eastern Drainage Ditch	SW-24	**0.86 J**	NA	NA
Eastern Drainage Ditch	SW-40	**2.3**	NA	NA
Western Drainage Ditch	SW-11	**1.6**	**0.0000603**	5.61E-07
Western Drainage Ditch	SW-12	0.21 J	**0.0000524**	0.00000016
Western Drainage Ditch	SW-28	**3.7**	NA	NA

Notes:

Results are expressed in the concentration of micrograms per liter (µg/L)

Only samples that had a concentration that exceeded at least one PRG are included in this table.

B = blank contamination. The analyte was found in an associated blank as well as in the sample

J = estimated concentration

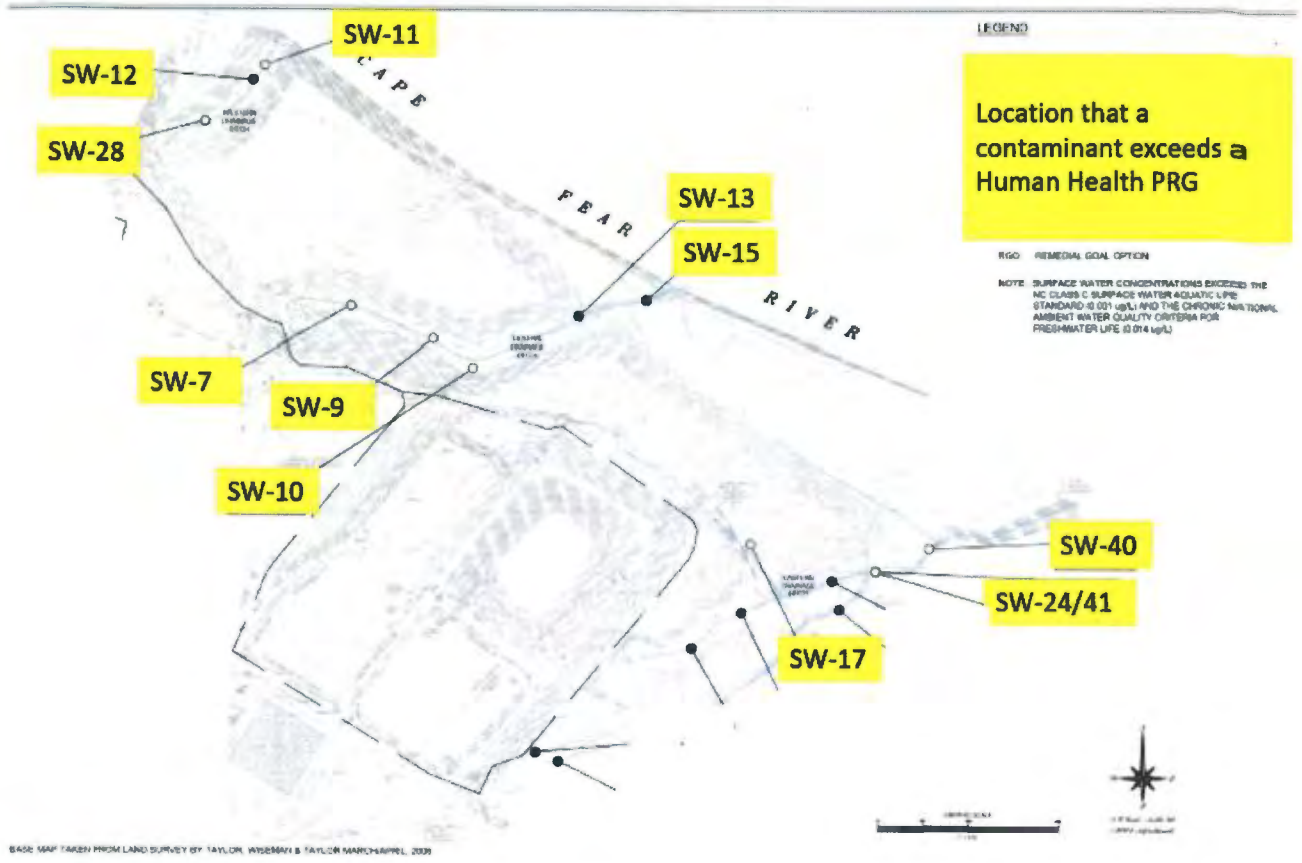
NA = not analyzed

ND = was not detected above the laboratory reporting limit of 1

Bold value exceeds PRG

[4]More information about PRGs can be found in **Section 7.0**, Summary of Site Risks.

Figure 18: Locations where constituents in Wooded Bottomland Drainage ditch surface water exceed a Human Health PRG



5.6.2.2 Storm Water

Storm water samples were collected from seven locations in the WBA drainage ditches during extreme rain events in 2006. As shown in **Figure 19**, the sample locations were in the western, central and eastern ditches. All three ditches flow to the Cape Fear River. An off-site laboratory analyzed the samples for VOCs, SVOCs, inorganics, pesticides, dioxins and water quality criteria.

Table 19 through **Table 24** summarize storm water results. With the exception of VOCs, a broad range of constituents was present in storm water in the WBA drainage ditches.

Water Quality Parameters

Seven storm water samples were collected from the WBA drainage ditches and analyzed for hardness, TSS and pH; and four storm water samples were analyzed for TOC. **Table 19** summarizes detected water quality parameters, frequency of detection, range of concentrations, and the location of the maximum concentration.

Table 19: Bottomland Drainage Ditch Storm Water Data Summary - Water Quality Criteria

Analyte	FOD%	Minimum Conc.	Maximum Conc.	Max location
Water Quality Parameters				
Method E130.2. Concentration units are in µg/L				
Hardness, Total as $CaCO_3$	100%	20,200	316,000	SW-19
Method E160.2. Concentration units are in µg/L				
Total Suspended Solids	100%	3,200	452,000	SW-8
Method SW9040B. No units.				
pH	100%	7	8	SW-8
Method SW9060. Concentration units are in µg/L				
Total Organic Carbon	100%	1,900	7,600	SW-4

VOCs and SVOCs

Eight storm water samples were collected from the WBA drainage ditches and analyzed for VOCs and SVOCs. VOCs were not detected. Collectively, the samples contained four detected SVOCs. The four SVOCs were present at concentrations greater than during normal flow conditions. For example, the maximum concentration of bis(2-ethylhexyl)phthalate during a non-storm event was 2.7 µg/L compared to 9.4 µg/L during the storm event. **Table 20** includes a summary of detected SVOCs in storm water, frequency of detection, range of concentrations, and the location of the maximum concentration.

Table 20: Bottomland Drainage Ditch Storm Water Data Summary - SVOCs

Analyte	FOD%	Minimum Conc.	Maximum Conc.	Max location
SVOCs via method SW8270. Concentration units are in µg/L				
bis(2-ethylhexyl)phthalate	25%	1.7	9.4	SW-5
Fluoranthene	13%	2.1	2.1	SW-8
Phenanthrene	13%	1.3	1.3	SW-8
Pyrene	13%	1.5	1.5	SW-8