

PCB Mass Loading  
Former Christina Marina  
SIRB ID: DE-1293  
Wilmington, Delaware



**BrightFields, Inc.**

## **Appendix 8**

# **FORMER CHRISTINA MARINA PROPERTY WILMINGTON, DELAWARE**

**SIRB ID: DE-1293**



## GENERAL SITE INFORMATION

**Site Name:** Former Christina Marina

**SIRB ID Number:** DE-1293

**Site Location and Description:** The Former Christina Marina is located on the E. 7<sup>th</sup> Street Peninsula at 1126 E. 7<sup>th</sup> Street in Wilmington (Figure 1). The property is bordered to the north by various commercial properties, to the south by the Christina River, to the east by the E. 7<sup>th</sup> Street Park, and to the west by Marine Lubricants. The nearest intersecting street is Industrial Street. There are currently no structures on the property.

The site is currently vacant, consists of one approximately 6.31 acre parcel (tax parcel ID# 26-044.00-013) and one approximately 1.64 acre parcel (tax parcel ID# 26-044.00-044) (total approximately 8.3 acres). The property is comprised of approximately 5.5 acres of land and approximately 2.8 acres of water. Surrounding land is generally commercial and/or industrial.

**Previous Site Uses:** Based on the review of historical maps dating from 1868 to 1927 and aerial photographs dating from 1937 to 1998, there does not appear to have been any development on the property prior to the Fort Christina Marina. Much of the peninsula was reportedly used by the City of Wilmington as a municipal landfill from the 1940s through the 1960s. The peninsula was then covered with varying depths of ash from Wilmington's incinerators. Portions of the peninsula were also filled with various construction debris and fill material.

An interview with the previous owner, Mr. Donald Wright, indicated that fill material had been placed on the site prior to his father's ownership of the property in the 1960s. The marina began operations in 1963-1964 and operations consisted primarily of boat storage and routine servicing including gasoline fueling. The marina ceased operations in the late 1980s.

It is possible that PCBs were introduced to the site as a result of the use of the property as a municipal landfill from the 1940s through the 1960s or as a result of the boat servicing operations that occurred on the site from the 1960s through the 1980s.

**Site Regulatory Status:** This section briefly summarizes previous investigations performed on the site through the SIRB program. A current SIRB regulatory status is also included.

**DNREC Brownfield Preliminary Assessment (DNREC, 1999)**

The DNREC Site Investigation and Restoration Branch (SIRB) conducted a Brownfield Preliminary Assessment (BPA) II for the E. 7<sup>th</sup> Street Peninsula in 1998. It was divided into the North Side and the South Side. The Marina is within the South Side area.

Test pits S7TP6, S7TP7, S7TP8, S7TP9 and S7TP23 were excavated, sediment sample S7SED-3, surface water sample S7SW-1 and groundwater monitoring well sample S7GW-2 were collected from the Marina Property.

**Remedial Investigation (BrightFields, 2005)**

The site remedial investigation consisted of the installation of 3 monitoring wells and excavation of 12 test pits to facilitate the collection of 24 soil samples, 6 sediment samples, and 4 groundwater samples. Shallow (0 to 2 feet) and deep (greater than 2 feet (bgs)) soil samples were collected from each test pit. The soil and sediment samples were screened at the SIRB laboratory for volatile organic compounds (VOCs), pesticides, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and metals.

Test pit and well boring logs indicated that portions of the site are filled with municipal garbage (up to 9 feet thick) and underlain by marsh deposits.

Five of the soil samples were analyzed at STL Edison for confirmatory analysis for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals and cyanide. Six sediment samples were analyzed for TCL SVOCs, TCL Pesticides/PCBs, and TAL metals and cyanide and two sediment samples were analyzed for TCL VOCs. Three new monitoring wells were installed and four groundwater samples were collected and analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals and cyanide. One groundwater sample was collected from an existing well that remained onsite from the BPA investigation by DNREC in 1999 (S7GW-2). The compounds with DNREC Uniform Risk Based Remediation Standards (URS) exceedances from these samples are summarized below.

**Soil:**

- Arsenic, iron, lead, and PAHs were detected in site soil above the restricted use URS.

**Sediment:**

- Metals, pesticides, and PAHs were detected in site sediment samples above the URS.



**Groundwater:**

- Arsenic, iron, and manganese were detected in site groundwater above the URS.

**Current Regulatory Status:**

The Former Christina Marina Site is currently in the remedial action phase. DNREC published a Final Plan of Remedial Action in April 2007. This Final Plan includes capping of the site with a minimum of two feet of DNREC-approved fill, installation and maintenance of sufficient stabilization measures to prevent contributions of contaminated material to the Christina River, monitoring of groundwater quality from the existing wells to determine if metal content significantly increases, health and safety oversight during intrusive construction activities, implementation of an Operations and Maintenance (O&M) Plan to provide procedures for evaluating the integrity of the cap following site construction, and the placement of an environmental covenant prohibiting any land disturbing activities without DNREC's prior written approval and a restriction on the use of groundwater as specified in the groundwater management zone (GMZ). Sediment remediation will be addressed at the time of development.

The site capping was completed in November 2008.

## SUMMARY OF SITE PCB INFORMATION

### Site Investigation PCB Findings:

PCBs (Aroclor-1262) are present in surface soil at one location, TP11-S001 (0.75 to 2 feet bgs) at a concentration below both the unrestricted use and restricted use URS values for human health for total PCBs (a URS value does not exist for Aroclor-1262).

PCBs (Aroclor-1248 and Aroclor-1252) are present in the subsurface soil at TP12-S002 (5.0 to 5.5 feet bgs) at concentrations above the unrestricted URS values for human health, but below the restricted URS values.

Due to the fact that there was only one detection in the surface soil and one detection in the subsurface soil, the maximum detected values were used in the calculations instead of calculating the 95% UCL of the mean across the site.

There were no PCBs detected in groundwater but there are PCBs in the subsurface that are in contact with the groundwater (saturated soil). The saturated soil detection was evaluated through the equilibrium partitioning equation to approximate a groundwater concentration of 3µg/L.

<b>Concentrations of PCBs on Site</b>			
<b>Sample Matrix</b>	<b>Corresponding Figure</b>	<b>Analytical Methods</b>	<b>Range of Total PCBs</b>
Surface Soil	Figure 2	Method 8082 and Immunoassay Kits	Not detected to 0.16 mg/kg
Subsurface Soil (unsaturated)	Figure 3	Method 8082 and Immunoassay Kits	Not detected
Subsurface Soil (saturated)	Figure 4	Method 8082 and Immunoassay Kits	Not detected to 2.7 mg/kg
Groundwater	Figure 5	Method 8082 and Immunoassay Kits	Not detected

A summary of all samples collected for PCBs are presented in the attached Tables 1 through 3.

### Acreage where PCBs detected:

The estimated surface soil area impacted by PCBs is 0.45 acres in the vicinity of TP11 (Figure 2). There were no reported concentrations of PCBs in the subsurface unsaturated soil. The

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estimated subsurface saturated soil area impacted by PCBs is 3.9 acres in the vicinity of TP12 (Figure 4).

**PCB Remediation Status:**

PCB concentrations did not exceed the URS criteria; therefore, no PCB remediation is required at the Former Christina Marina site. However, the site has been capped with two feet of clean fill to prevent contact with native site soil.

## PCB MASS LOADING SUMMARY

The PCB mass loading rate to surface water via overland flow and via groundwater transport were estimated for the Former Christina Marina Site. A summary of the results is included below and the details of the calculations are included as attachments to this Appendix.

### OVERLAND FLOW:

Overland flow has been determined on this site by using the Revised Universal Soil Loss Equation (RUSLE). The RUSLE predicts the long term average annual rate of erosion on an area based on rainfall patterns, soil type, topography, cover/canopy factors and support management practices. These factors are site-specific and require information pertaining directly to the site. A breakdown of the individual factors is presented below with a brief explanation of their selection.

#### Ground Cover and Canopy:

A site inspection was performed on August 26, 2008 to estimate the current site ground cover and canopy. The cover/management factor (C) assigned to the site and associated flow path is 0.244, which corresponds to idle land with no appreciable shrub or tree canopy (77%), little crushed stone mulch (15%), and little wood mulch (8%). Photographs of the site ground cover and canopy are attached.

#### Site Sediment and Erosion Control Practices:

At the time of the inspection the site contained silt fence around the perimeter of the property to help prevent the off site migration of soil. The site also contained a stone construction entrance to minimize the amount of soil migrating off site during the site capping. Photographs of these sediment and erosion control techniques in use at the site are attached.

#### Input Factors and Results:

A breakdown of the individual factors is presented below with a brief explanation of their choice.

RUSLE Factors	Values	Explanation of Selection
R = rainfall-runoff erosivity index (10 <sup>2</sup> ft-tonf-in/ac-hr)	170	An appropriate value for R for the site was determined from plots of Rainfall patterns for the Eastern U.S. (Wischmeier and Smith, 1978).
K = soil erodibility (0.01 tonf acre hr/acre ft-ton in)	0.365	The soil erodibility factor was chosen based on the information collected from the boring logs of the BrightFields 2005 Remedial Investigation Report.

<b>RUSLE Factors</b>	<b>Values</b>	<b>Explanation of Selection</b>
LS = topographic factor (dimensionless)	0.132	The slope length was estimated to be 184 feet, which is the distance between the area of concern and the Christina River along the overland flow path. The assumed slope (0.86 %) and slope length were used to calculate a topographic factor of 0.132.
C = cover/management factor (dimensionless)	0.244	The cover/management factor C assigned to the site and associated flow path was 0.244, which corresponds to idle land with no appreciable shrub or tree canopy (77%), little stone mulch (15%), and little wood mulch (8%). Actual factor assigned was chosen by the USGS windows based program based on site coverage information.
P = support practice factor (dimensionless)	0.19	Silt fencing was instituted around the perimeter of the property in an effort to prevent the off site migration of native soils. Actual factor was assigned based on the USGS windows based program

The average annual erosion rate is based on the windows based RUSLE2 program (RUSLE2 License, version 2006-Jul-24).

Based on the calculations performed, the total PCB loading from the former Christina Marina site to the Christina River via erosion under site conditions in August 2008 is 0.02 grams per year.

**Uncertainty Analysis Associated with Overland Flow:**

**Specific Areas and Degree of Uncertainty for the Christina Marina Site**

	<b>Samples Per Acre (site)</b>	<b>Chemical Data Quality*</b>	<b>Topography</b>	<b>Soil Type</b>	<b>Site Coverage</b>	<b>Map Quality</b>	<b>Distance to Discharge Points</b>
<b>Site Specific Information</b>	1.1	Immunoassay Kits	Estimated based off of site inspection	Detailed logs that are located within the area of concern	Based on a limited site assessment	Scaled Map	184 feet
<b>Degree of Uncertainty</b>	Moderate to High	High	High	Low	Moderate	Moderate	Moderate

\* Primary analysis used in the historical samples

Sources of uncertainty for the Christina Marina Property include the following: the site is in a continuous state of change because of the site redevelopment; the erodable area in this site specific scenario is bounded by the boundaries of the property and by the non-detects observed in other samples in the vicinity; the slope was an estimated value to reflect flooding conditions

because the area of concern is in a depression. In addition some sample depths were not found for sample locations S7TP6 & S7TP7. BrightFields had to infer the sample depths from surface and deep descriptors and use surrounding observed groundwater depths to determine the proper zone to which they corresponded.

Based on this evaluation the overall level of uncertainty associated with PCB mass loading from the Christina Marina site via overland flow is **Moderate to High**.

**GROUNDWATER DISCHARGE ANALYSIS**

Groundwater discharge is based on the hydraulic conductivity of the soil, the groundwater gradient, and the cross-sectional area of the aquifer. A breakdown of the individual factors used in the Darcy equation is presented below.

Because PCBs were detected in saturated soil, but not in groundwater, the calculated concentration of PCBs in pore water, based on partitioning, was used to calculate the mass loading. The calculated PCB concentration in the pore water ranges from 0.59 to 3.0 µg/L. The calculations are presented in Table B in the groundwater transport calculations attachment.

**Input Factors:**

A breakdown of the individual factors is presented below with a brief explanation of their choice.

Groundwater Transport Factors	Value Used		Justification/Derivation of Value Used
	min	max	
K = Hydraulic Conductivity (ft/day)	0.28	5.67	Information from drilling logs prepared by BrightFields in July 2003 and the September 1998 DNREC boring log for well S7GW-2 was used to evaluate the lithology beneath the site. An examination of the drilling logs shows that the groundwater being monitored is within a predominantly fine grained unit located within the fill and above the marsh deposit clay that ranges in composition from fine sand and silt to clay. The hydraulic conductivity for sandy silt ranges from approximately $1 \times 10^{-4}$ to $2 \times 10^{-3}$ cm/sec (Cernica, 1995).
I = Horizontal Groundwater Gradient	0.005	0.024	Because of its location along the Christina River, the groundwater flow direction was measured to be toward the Christina River. Direct measurements of the groundwater elevations were made on July 28, 2003 and during high and low tides on September 25, 2003 in wells M-GW01 through M-GW03, and in a similarly constructed well (PV-GW08), located off site.
Saturated Thickness (ft)	6.5	6.5	Based on the borings logs, the saturated zone in the vicinity of M-GW01 is approximately 6.5 feet.

Groundwater Transport Factors	Value Used		Justification/Derivation of Value Used
	min	max	
Lateral Discharge Distance (ft)	85	275	The lateral distance across the impacted area of the site (assuming a radius of ½ the distance between S7TP-19 and TP07) is approximately 85 feet.
A= Cross-Sectional Area (ft <sup>2</sup> )	553	1,790	Calculated from the saturated thickness and lateral discharge distance.
Groundwater PCB Concentration (µg/L)	0.59	3.0	The maximum concentration observed in the saturated subsurface soil (2.7 mg/kg) was used to determine the estimated concentration in groundwater.
Distance to Discharge point (ft)	Directly adjacent		Approximate distance from property boundary to closest surface water location.

**Mass Loading Via Groundwater Transport Result:**

The groundwater discharge is 22 to 6,900 L/day (attached Table A). The maximum detected PCB concentration (2.7 mg/kg) was used to calculate the groundwater concentrations for the loading estimate. The estimated minimum and maximum contaminant mass loading contributions are shown in the Table C in the groundwater transport calculations attachment, assuming that there are no contaminant losses due to degradation, dispersion, sorption, volatilization, etc.

The total PCB loading via groundwater discharge is between 0.03 and 7.5 grams per year (attached Table C).

**Uncertainty Analysis Associated with Groundwater Transport:**

**Specific Areas and Degree of Uncertainty for the Christina Marina**

	Groundwater PCB Concentration	Hydraulic Conductivity	Horizontal Groundwater Gradient	Saturated Thickness	Lateral Discharge Distance	Distance to Discharge point
<b>Site Specific Information</b>	Groundwater concentration based on Aroclor data in saturated soil	Conductivity based on good quality logs or geotechnical logs	Gradient based on few professionally surveyed wells and/or tidal influenced wells	Few logs, consistent saturated thickness	Laboratory sample data, acceptable ground-water flow data	Directly adjacent
<b>Degree of Uncertainty</b>	Moderate	Moderate	Moderate	Low to Moderate	Moderate	Low

Based on this evaluation the overall uncertainty associated with PCB mass loading via groundwater discharge at the Christina Marina is **low to moderate**.

**Site References:**

BrightFields, 2005, Remedial Investigation Report, Former Christina Marina, Wilmington, Delaware (DE-1293), June 2005.

Delaware Department of Natural Resources and Environmental Control (DNREC) – Site Investigation and Restoration Branch (SIRB), 2007, Final Plan of Remedial Action, 7th Street Associates, LLC Property, the Former Christina Marina, April 2007.

DNREC, 1999, Brownfield Preliminary Assessment II Wilmington, Delaware E. Seventh Street Peninsula – “Northside”. September 1999.

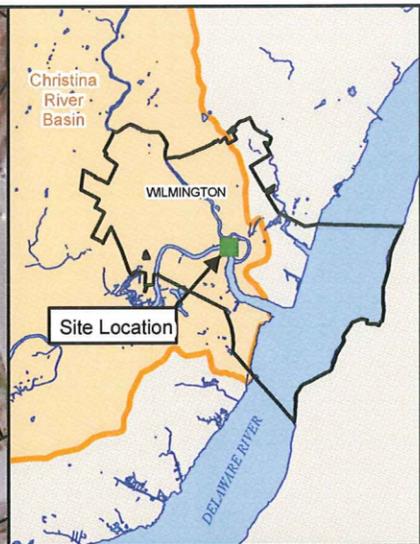
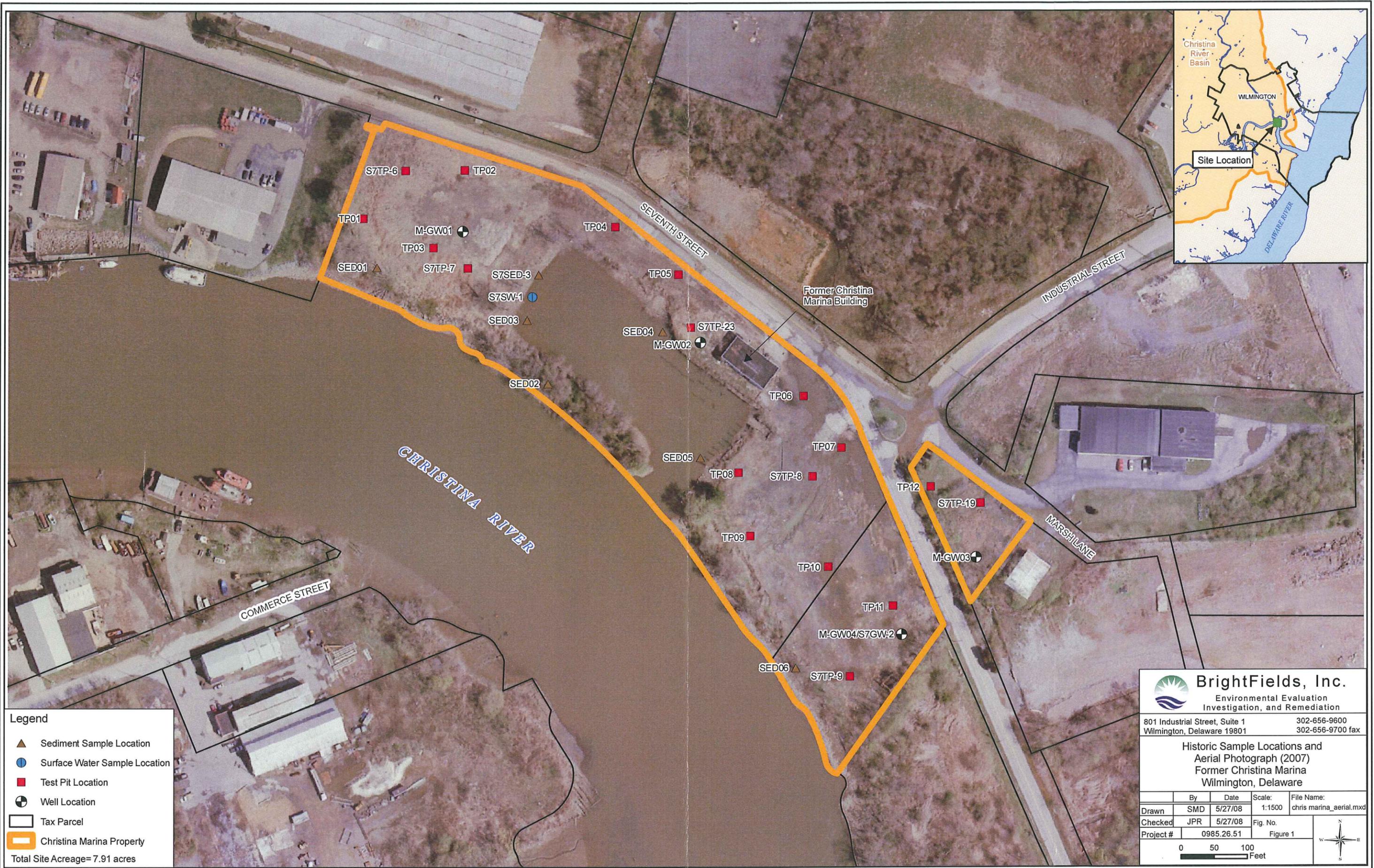
DNREC, 1999, Brownfield Preliminary Assessment II Wilmington, Delaware E. Seventh Street Peninsula – “Southside”. June 1999.

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## Figures



**Legend**

- ▲ Sediment Sample Location
- Surface Water Sample Location
- Test Pit Location
- ⊕ Well Location
- ▭ Tax Parcel
- ▭ Christina Marina Property

Total Site Acreage= 7.91 acres

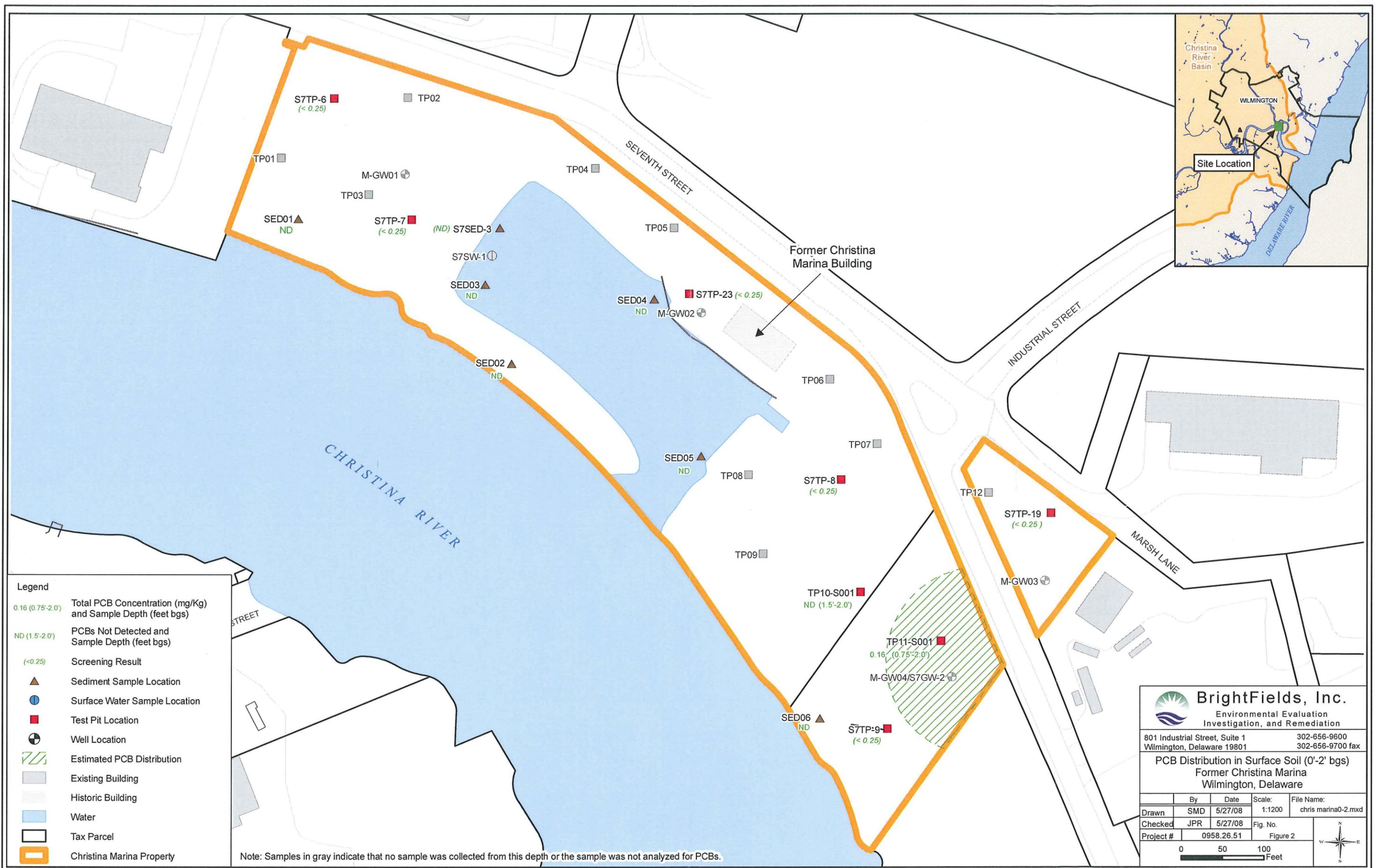
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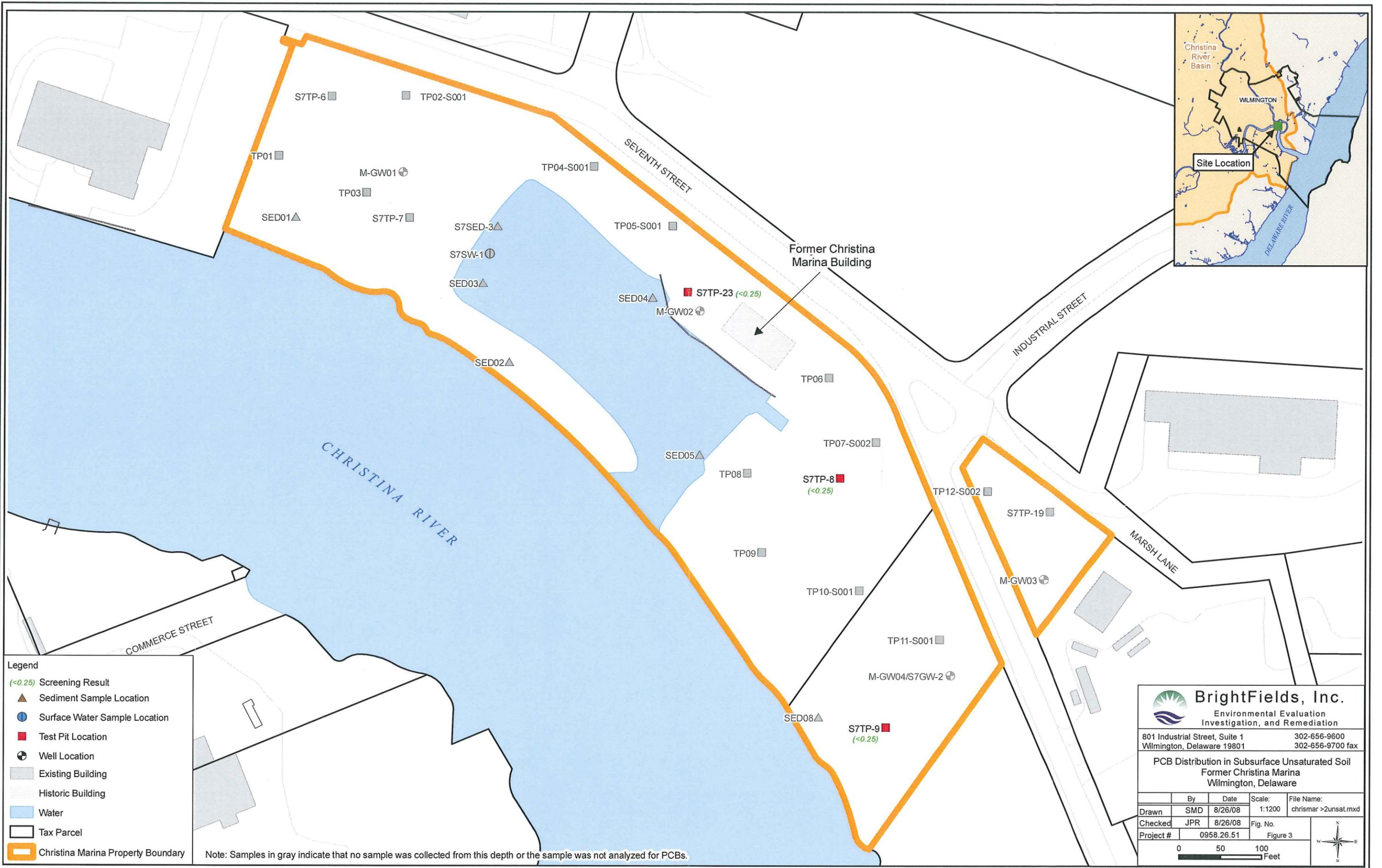
801 Industrial Street, Suite 1      302-656-9600  
 Wilmington, Delaware 19801      302-656-9700 fax

**Historic Sample Locations and  
 Aerial Photograph (2007)  
 Former Christina Marina  
 Wilmington, Delaware**

By	Date	Scale:	File Name:
SMD	5/27/08	1:1500	chris marina_aerial.mxd
Checked	JPR	5/27/08	Fig. No.
Project #	0985.26.51	Figure 1	

0 50 100 Feet





**Legend**

- <math><0.25</math> Screening Result
- ▲ Sediment Sample Location
- Surface Water Sample Location
- Test Pit Location
- ⊕ Well Location
- ▒ Existing Building
- ▒ Historic Building
- Water
- ▭ Tax Parcel
- ▭ Christina Marina Property Boundary

Note: Samples in gray indicate that no sample was collected from this depth or the sample was not analyzed for PCBs.

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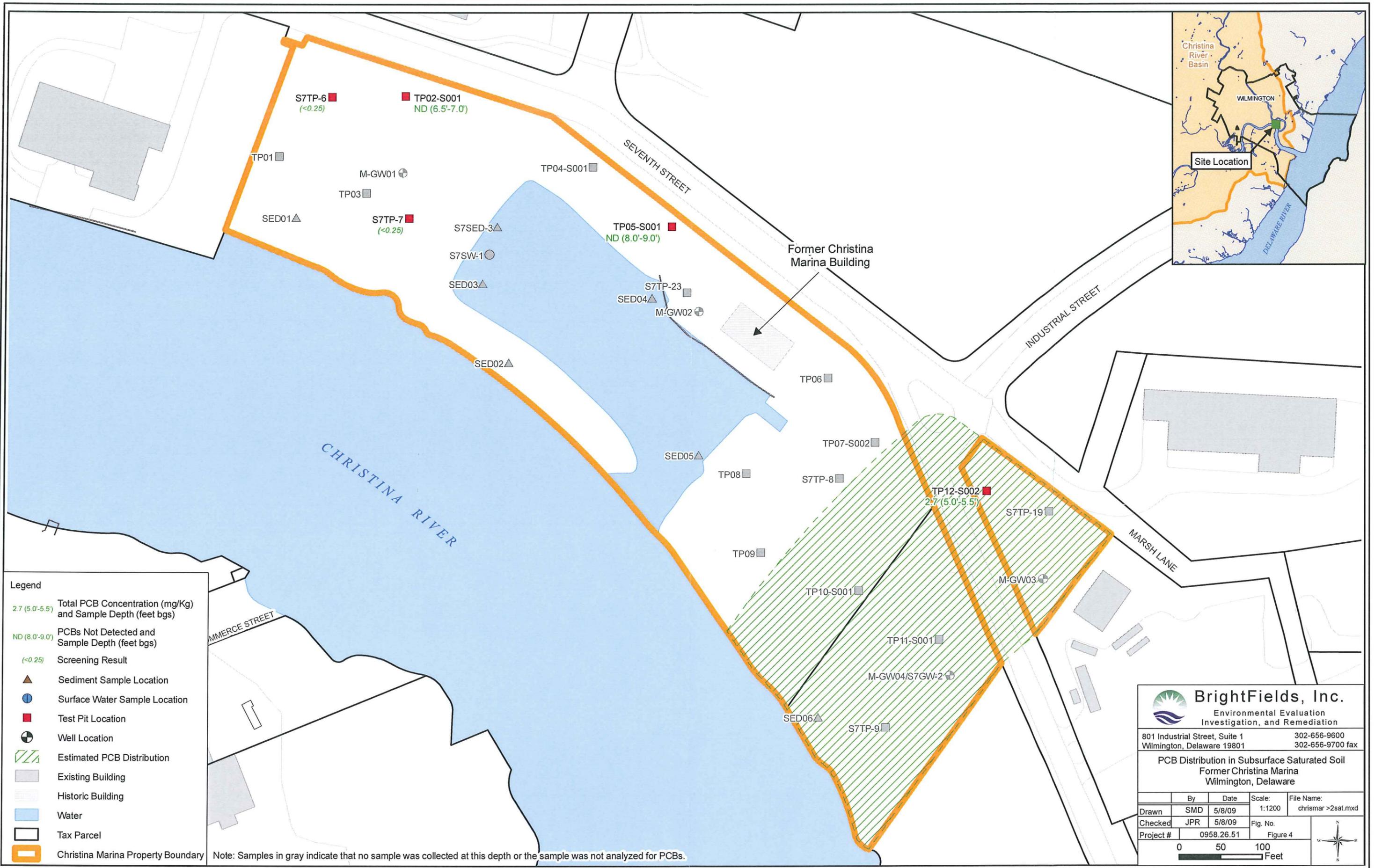
801 Industrial Street, Suite 1  
 Wilmington, Delaware 19801

302-656-9600  
 302-656-9700 fax

PCB Distribution in Subsurface Unsaturated Soil  
 Former Christina Marina  
 Wilmington, Delaware

	By	Date	Scale:	File Name:
Drawn	SMD	8/26/08	1:1200	chrismar >2unsat.mxd
Checked	JPR	8/26/08	Fig. No.	
Project #	0958.26.51		Figure 3	

0 50 100 Feet



- Legend**
- 2.7 (5.0'-5.5') Total PCB Concentration (mg/Kg) and Sample Depth (feet bgs)
  - ND (8.0'-9.0') PCBs Not Detected and Sample Depth (feet bgs)
  - <0.25 Screening Result
  - ▲ Sediment Sample Location
  - Surface Water Sample Location
  - Test Pit Location
  - ⊕ Well Location
  - ▨ Estimated PCB Distribution
  - ▭ Existing Building
  - ▭ Historic Building
  - Water
  - ▭ Tax Parcel
  - ▭ Christina Marina Property Boundary

Note: Samples in gray indicate that no sample was collected at this depth or the sample was not analyzed for PCBs.

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302-656-9600  
 302-656-9700 fax

**PCB Distribution in Subsurface Saturated Soil  
 Former Christina Marina  
 Wilmington, Delaware**

By	Date	Scale:	File Name:
SMD	5/8/09	1:1200	chrismar >2sat.mxd
Checked	JPR	5/8/09	Fig. No.
Project #	0958.26.51	Figure 4	

0 50 100 Feet



**Legend**

- ND PCBs Not Detected
- Well Location
- Existing Building
- Historic Building
- Water
- Tax Parcel
- Christina Marina Property Boundary

**BrightFields, Inc.**  
 Environmental Evaluation  
 Investigation, and Remediation

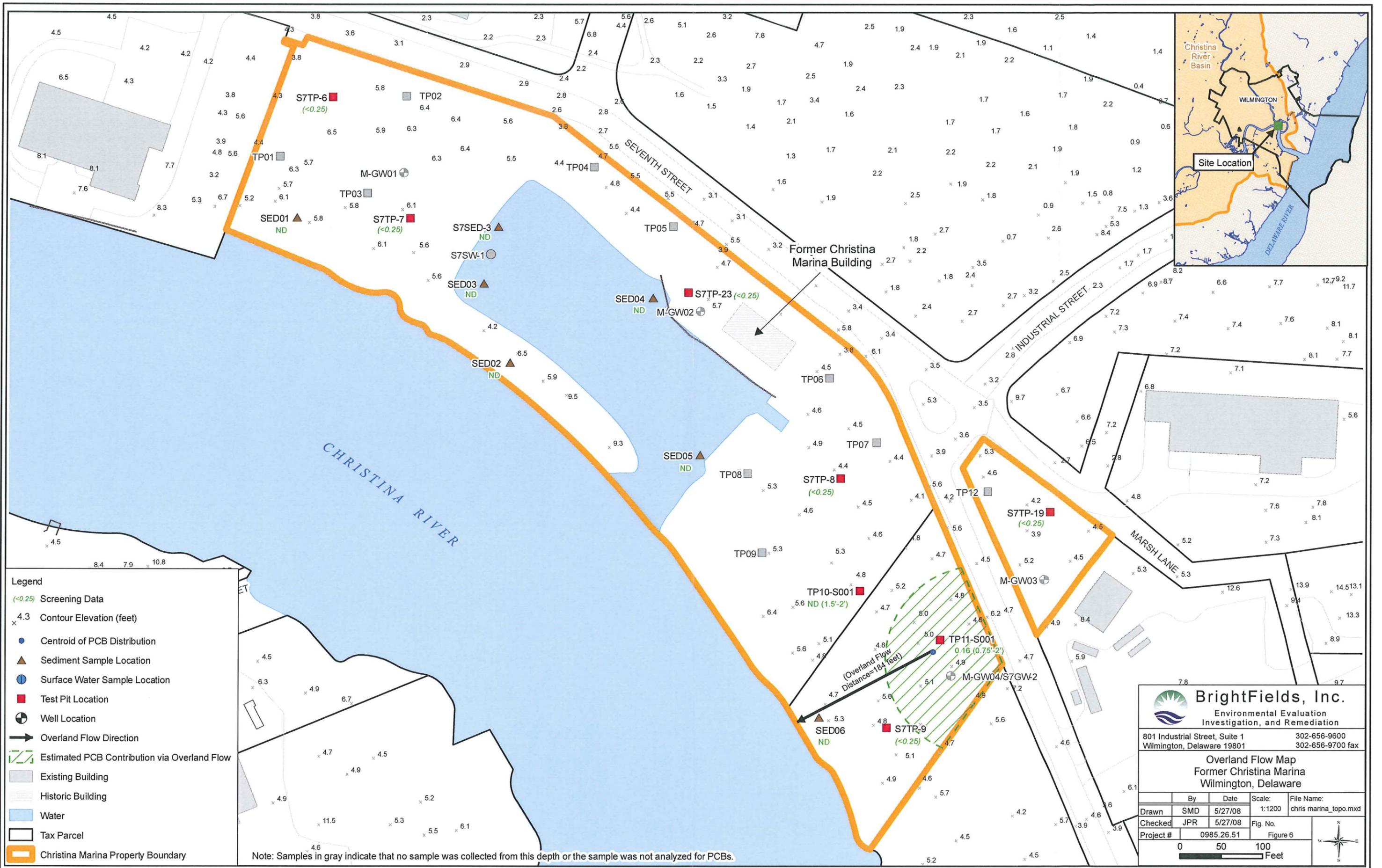
801 Industrial Street, Suite 1  
 Wilmington, Delaware 19801

302-656-9600  
 302-656-9700 fax

**PCB Distribution in Groundwater  
 Former Christina Marina  
 Wilmington, Delaware**

By	Date	Scale:	File Name:
SMD	5/27/08	1:1200	chris_mar_gw.mxd
Checked	JPR	5/27/08	Fig. No.
Project #	0985.26.51	Figure 5	

0 50 100 Feet



**Legend**

- (<0.25) Screening Data
- x 4.3 Contour Elevation (feet)
- Centroid of PCB Distribution
- ▲ Sediment Sample Location
- Surface Water Sample Location
- Test Pit Location
- ⊕ Well Location
- Overland Flow Direction
- ▨ Estimated PCB Contribution via Overland Flow
- ▭ Existing Building
- ▭ Historic Building
- Water
- ▭ Tax Parcel
- ▭ Christina Marina Property Boundary

Note: Samples in gray indicate that no sample was collected from this depth or the sample was not analyzed for PCBs.

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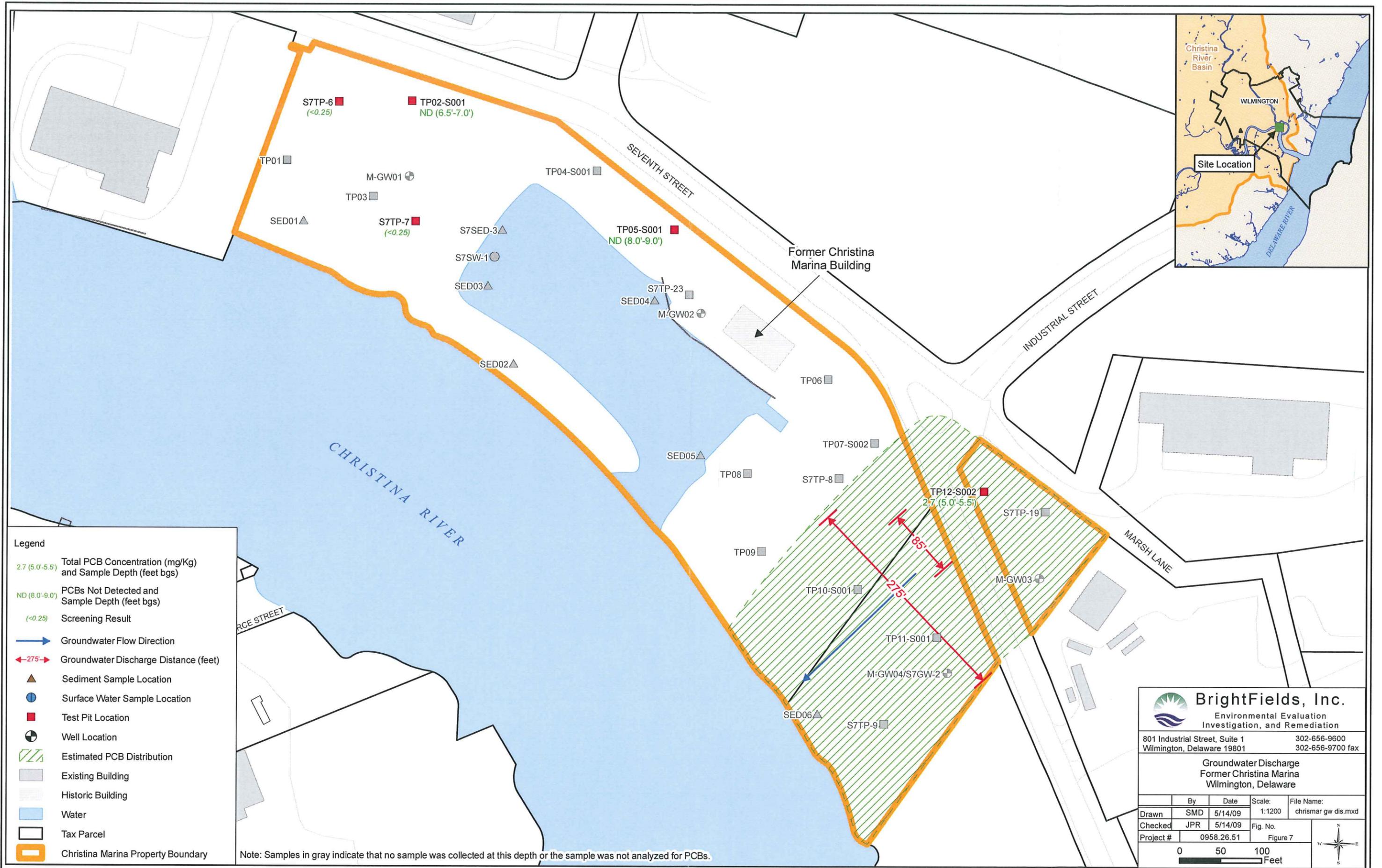
801 Industrial Street, Suite 1  
 Wilmington, Delaware 19801

302-656-9600  
 302-656-9700 fax

**Overland Flow Map**  
 Former Christina Marina  
 Wilmington, Delaware

By	Date	Scale:	File Name:
SMD	5/27/08	1:1200	chris_marina_topo.mxd
Checked	JPR	5/27/08	Fig. No.
Project #	0985.26.51		Figure 6

0 50 100 Feet



**Legend**

- 2.7 (5.0-5.5) Total PCB Concentration (mg/Kg) and Sample Depth (feet bgs)
- ND (8.0-9.0) PCBs Not Detected and Sample Depth (feet bgs)
- <0.25 Screening Result
- Groundwater Flow Direction
- ←275→ Groundwater Discharge Distance (feet)
- ▲ Sediment Sample Location
- Surface Water Sample Location
- Test Pit Location
- ⊕ Well Location
- ▨ Estimated PCB Distribution
- ▭ Existing Building
- ▭ Historic Building
- Water
- ▭ Tax Parcel
- ▭ Christina Marina Property Boundary

Note: Samples in gray indicate that no sample was collected at this depth or the sample was not analyzed for PCBs.

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**Groundwater Discharge  
 Former Christina Marina  
 Wilmington, Delaware**

By	Date	Scale:	File Name:
SMD	5/14/09	1:1200	chrismar gw dis.mxd
Checked	JPR	5/14/09	Fig. No.
Project #	0958.26.51	Figure 7	

0 50 100 Feet

PCB Mass Loading  
Former Christina Marina  
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Wilmington, Delaware



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# Tables

Table 1  
 PCB Analytical Results For Soil  
 Former Christina Marina Property  
 Wilmington, DE  
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Sample ID Sampling Depth (feet bgs) Sampling Date Units	DNREC URS for Protection of Human Health Non-critical Water Resource Area mg/kg		TP02-S002 6.5-7.0 07/08/03 mg/kg RI (BrightFields 2005)	TP05-S002 8.0-9.0 07/08/03 mg/kg RI (BrightFields 2005)	TP10-S001 1.5-2.0 07/08/03 mg/kg RI (BrightFields 2005)	TP11-S001 0.75-2.0 07/08/03 mg/kg RI (BrightFields 2005)	TP12-S002 5.0-5.5 07/09/03 mg/kg RI (BrightFields 2005)
	Unrestricted Use	Restricted Use					
<b>PESTICIDES/PCBS</b>							
Aroclor-1016	5	82	0.081 U	0.110 U	0.083 U	0.087 U	0.210 U
Aroclor-1221	0.3	3	0.081 U	0.110 U	0.083 U	0.087 U	0.210 U
Aroclor-1232	0.3	3	0.081 U	0.110 U	0.083 U	0.087 U	0.210 U
Aroclor-1242	0.3	3	0.081 U	0.110 U	0.083 U	0.087 U	0.210 U
Aroclor-1248	0.3	3	0.081 U	0.110 U	0.083 U	0.087 U	1.4
Aroclor-1254	0.3	3	0.081 U	0.110 U	0.083 U	0.087 U	1.3
Aroclor-1260	nca	nca	0.081 U	0.110 U	0.083 U	0.087 U	0.210 U
Aroclor-1262	nca	nca	0.081 U	0.110 U	0.083 U	0.160	0.210 U
Aroclor-1268	nca	nca	0.081 U	0.110 U	0.083 U	0.087 U	0.210 U
All other PCBs were not detected above laboratory detection limits							

RI (BrightFields 2005) - Remedial Investigation Report for the Former Christina Marina. BrightFields 2005

Qualifiers

- ND - The compound was not detected above laboratory detection limits
- NR - Not analyzed.
- nca - no criteria available
- bold - concentration is above DNREC URS unrestricted use criteria
- shaded - concentration is above DNREC URS restricted use criteria

Table 2  
 DNREC PCB Screening Data  
 Former Christina Marina Property  
 Wilmington, DE  
 SIRB ID: DE-1293

Sample ID	Sample Depth	Report Issued	Sample Date	units	DNREC URS for Protection of the Environment mg/kg	Total Pesticides/PCBs (mg/kg)
TP01-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP01-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP02-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP02-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP03-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP03-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP04-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP04-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP05-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP05-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP06-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP06-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP07-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP07-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP08-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP08-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP09-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP09-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP10-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP10-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP11-S001	Shallow	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP11-S002	Deep	RI (BrightFields 2005)	7/8/03	mg/kg	1	ND
TP12-S001	Shallow	RI (BrightFields 2005)	7/9/03	mg/kg	1	ND
TP12-S002	Deep	RI (BrightFields 2005)	7/9/03	mg/kg	1	ND
S7TP-6	Shallow	BPA II Southside	10/01/98	mg/kg	1	<0.25
S7TP-6	Deep	BPA II Southside	10/01/98	mg/kg	1	<0.25
S7TP-7	Shallow	BPA II Southside	10/01/98	mg/kg	1	<0.25
S7TP-7	Deep	BPA II Southside	10/01/98	mg/kg	1	<0.25
S7TP-8	Shallow	BPA II Southside	10/01/98	mg/kg	1	<0.25
S7TP-8	Deep	BPA II Southside	10/01/98	mg/kg	1	<0.25
S7TP-9	Shallow	BPA II Southside	10/01/98	mg/kg	1	<0.25
S7TP-9	Deep	BPA II Southside	10/01/98	mg/kg	1	<0.25
S7TP-23	Shallow	BPA II Southside	10/01/98	mg/kg	1	<0.25
S7TP-23	Deep	BPA II Southside	10/01/98	mg/kg	1	<0.25

RI (BrightFields 2005) - Remedial Investigation Report for the Former Christina Marina. BrightFields 2005

BPA II Southside - Brownfield Preliminary Assessment II Wilmington, Delaware E. Seventh Street Peninsula - "Southside". DNREC June 1999

Qualifiers:

ND - compound was not detected above laboratory detection limits

Bold - concentration exceeds URS

nca - no criteria available

Table 3  
 PCB Analytical Results for Groundwater  
 Former Christina Marina Property  
 Wilmington, DE  
 SIRB ID: DE-1293

Sample ID Sampling Date Units Report Issued	DNREC URS for Protection of Human Health ug/L		M-GW01 11/11/2004 ug/L BrightFields	M-GW02 11/11/2004 ug/L BrightFields	M-GW04/S7GW-2/M 11/11/2004 ug/L BrightFields	M-GW03 11/11/2004 ug/L BrightFields
	Unrestricted Use	Restricted Use				
<b>PCBs</b>						
Aroclor-1016		0.1	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1221		0.03	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1232		0.03	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1242		0.03	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1248		0.03	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1254		0.03	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1260		0.03	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor-1262		nca	0.5 U	0.5 U	0.5 U	0.5 U

RI (BrightFields 2005) - Remedial Investigation  
 Report for the Former Christina Marina.  
 BrightFields 2005

Qualifiers

- U - The compound was not detected above laboratory detection limits
- NR - Not analyzed.
- nca - no criteria available
- bold - concentration is above DNREC URS unrestricted use criteria
- shaded - concentration is above DNREC URS restricted use criteria

PCB Mass Loading  
Former Christina Marina  
SIRB ID: DE-1293  
Wilmington, Delaware



**BrightFields, Inc.**

## Site Photographs

**PCB Mass Loading Evaluation  
Former Christina Marina Property**



Partial site cover (emplacing brick and block for berm installation).



Site entrance displaying erosion and sediment controls and stone access ramp.

**PCB Mass Loading Evaluation  
Former Christina Marina Property**



Site cover on western side of the property consisting of primarily little vegetation scrub.  
Erosion and sediment controls are in place around the complete perimeter.

PCB Mass Loading  
Former Christina Marina  
SIRB ID: DE-1293  
Wilmington, Delaware



**BrightFields, Inc.**

# Overland Flow Calculations

**PCB Loading Calculations from the Universal Soil Loss Equation**  
**Former Christina Marina**  
**Wilmington, DE**  
**DE-1293**

Surface PCB Concentration 0.16 mg/kg

Symbol	Factor	Value	Units
R	Rainfall/Runoff Erosivity Index	170	10 <sup>2</sup> ft-tonf in/acre hr
K	Soil Erodibility	0.365	0.01 tonf acre hr/ac ft-ton in
	Estimated Slope Length	184	Feet
	Estimated Elevation Difference	1.58	Feet
	Slope	0.86	Percent
	Erodeable Area	0.45	Acres
LS	Topographic Factor	0.132	Dimensionless
C	Cover and Management Factor	0.244	Dimensionless
P	Support Practice Factor	0.19	Dimensionless
	Average Annual Soil Loss	0.33	ton/ac/yr

PCB Loading via Overland  
Flow 0.021 grams/year - PCBs

# CHRISTINA MARINA - SILT FENCE

Location: USA\Delaware\New Castle County

Avg. slope steepness, %   
 Detachment on slope, t/ac/yr   
 Sediment delivery, t/ac/yr

Slope length (horiz), ft   
 Soil loss erod. position, t/ac/yr   
 Soil loss for cons. plan, t/ac/yr   
 T value, t/ac/yr

Crit. slope length, ft

Net C factor    
 Net LS factor    
 Net K factor    
 Net contour factor    
 Net ridge factor    
 Net ponding factor

Rock cover, %    
 Adjust rock cover    
 General yield level    
 Surf. res. cov. values    
 Adjust res. burial level    
 Soil conditioning index

Actual row grade, %

PCB Mass Loading  
Former Christina Marina  
SIRB ID: DE-1293  
Wilmington, Delaware



**BrightFields, Inc.**

# Groundwater Transport Calculations

**PCB Loading Calculations - Groundwater Discharge to Surface Water  
Former Christina Marina  
Wilmington, DE  
DE-1293**

**TABLE A  
Groundwater Discharge Calculations**

Location	Hydraulic Conductivity (K) (ft/day)	Horizontal Gradient (i) (ft/ft)	Cross-sectional Area (A) (ft <sup>2</sup> )	Groundwater Discharge*	
				Liters/day	Gallons/day
TP-12					
Minimum	0.28	0.005	550	22	6
Maximum	5.67	0.024	1,800	6,900	1,800

\* - Groundwater Discharge (Q) = KiA

**TABLE B  
Potential Groundwater PCB Concentration Calculation**

Location	Maximum Soil PCB (µg/kg)	f <sub>oc</sub> (fraction of organic carbon)		Pore Water PCB (µg/L)	
				Minimum	Maximum
TP-12	2,700	0.01	0.05	0.6	2.96

**TABLE C  
Estimated Mass Loadings of PCBs in Groundwater to Surface Water**

Location	Subsurface Soil Concentration/ Converted to Pore Water Concentration (µg/L)	Estimated PCB Mass Loading (g/yr)	
		Minimum	Maximum
TP-12	3.0	0.024	7.5