PEDRICKTOWN NORTH CONFINED DISPOSAL FACILITY WATER QUALITY ANALYSIS

Prepared for

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Contract No. W912BU-06-R-0006
Task Order No. 0040

Prepared under the Supervision of
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March 2009

EXECUTIVE SUMMARY

This study was undertaken in October 2008 to estimate the potential for mobilization of dissolved and suspended contaminants through the discharge of the dewatering weir at the Pedricktown North Confined Disposal Facility (CDF). The U.S. Army Corps of Engineers (USACE), Philadelphia District routinely monitors CDF discharges to demonstrate compliance with relevant and applicable water quality standards defined by regional environmental agencies. Discharges from the Pedricktown CDF were monitored for contaminants from 20 October through 4 December 2008. Water samples were collected from the weir, weir discharge plume, and a river background site. All samples were analyzed for total and dissolved inorganics, cyanide, and total suspended solids. Additionally, water collected at the weir was analyzed for pesticides, PCBs, and semi-volatile organic compounds (SVOC). Water samples were compared to the appropriate Delaware River Basin Commission (DRBC) water quality criteria.

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1.0 INTRODUCTION

1.1 BACKGROUND

The U.S. Army Corps of Engineers (USACE) is responsible for maintaining safe navigation in the Delaware River. Environmental concerns over hydraulic dredging include the potential that contaminants trapped within river sediments will be released and mobilized to the water column (and hence to biota) at the cutter head and through the discharge water of Confined Disposal Facilities (CDFs). In a typical dredging operation hydraulically dredged material is pumped into an upland disposal site (a CDF) with a 25 percent sediment to 75 percent water ratio to facilitate efficient pumping of sediment and rock through the dredge pipeline. Upland disposal sites are designed to maximize the water's residence time in the CDF to allow suspended sediments associated with the dredged slurry time to settle out. Many chemical contaminants bind to solid particles rather than readily dissolve into water. Therefore, sequestering solids in upland CDFs also sequesters contaminants from the estuary.

The present study was conducted by the USACE to address concerns related to the potential mobilization of contaminants through the discharge water of a typical CDF. For this maintenance dredging project, approximately 1,165,000 cubic yards of material were placed in a 567 acre upland disposal site known as Pedricktown North. This site is located on the eastern shore of the Delaware River in Salem County, New Jersey, approximately 2 miles north of the town of Penns Grove (Figure 1-1). This site is adjacent to two other CDFs, Pedricktown South and Oldmans.

1.2 OBJECTIVES AND STUDY APPROACH

The objective of this study was to evaluate the contaminant concentrations of the outfall, discharge plume, and a down-river background site relative to regulatory criteria.

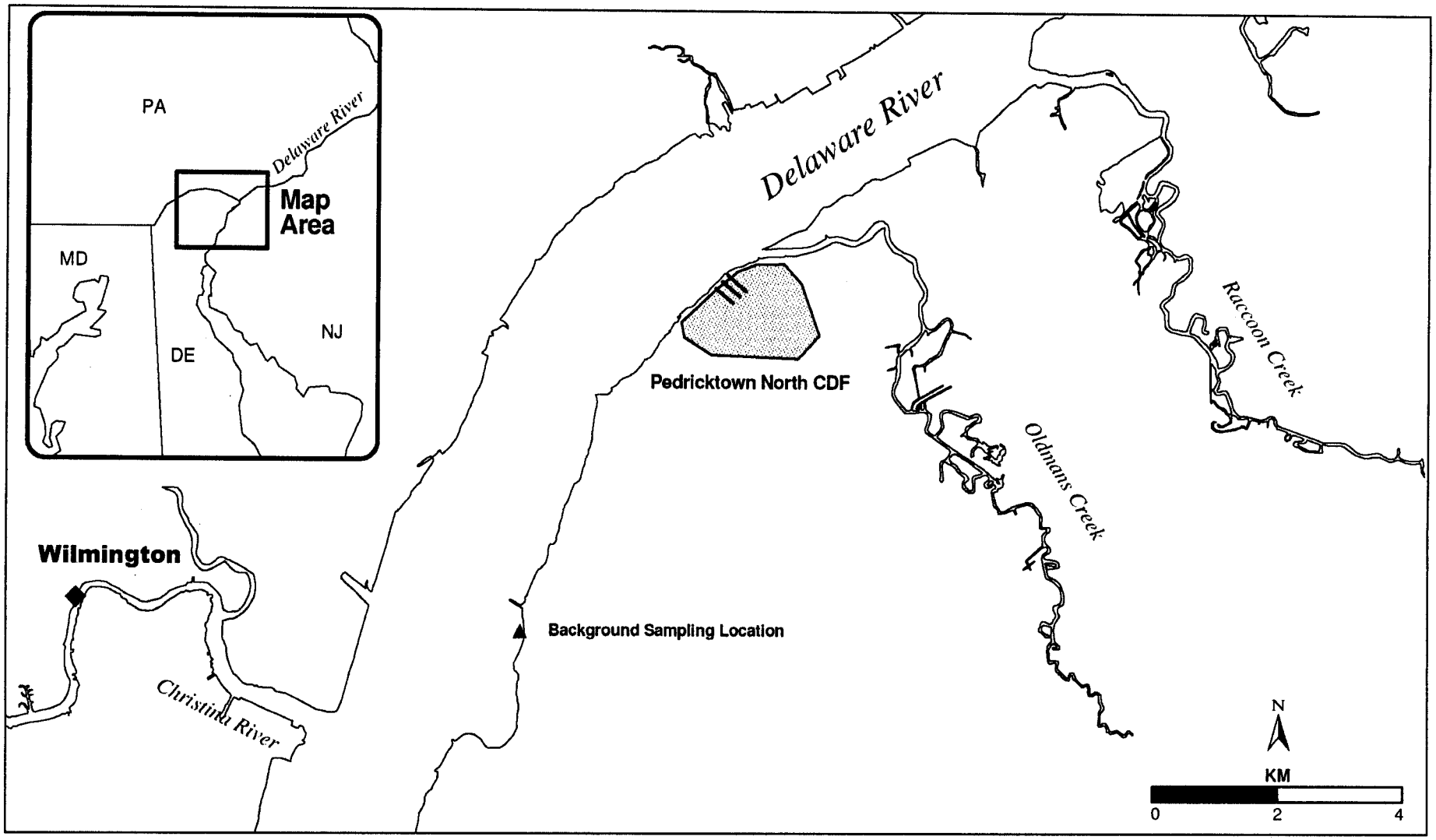


Figure 1-1. Map of the Pedricktown North Confined Disposal Facility location

2.0 STUDY DESIGN AND METHODS

The maintenance dredging operation that took place within the Marcus Hook range in October 2008 lasted for approximately seven weeks. Given the size of the Pedricktown North CDF, the residence time is roughly two weeks. Residence time is the length of time from when dredged material is placed in the site until the water portion of the slurry is discharged from the weir. Residence time is determined by several factors; including the size of the site; soil qualities, such as type of substrate and moisture content; and engineering controls, such as the division of the CDF with berms to direct water throughout the site and the height of the weir. In addition, the presence of vegetation throughout a site can alter the residence time through the uptake of water and by slowing water and suspended material flow. A CDF with a large residence time, such as Pedricktown North, also loses water to evaporation, uptake by vegetation, and through filtration into the ground. Although the dredge operation began in October, the weir did not discharge water until the middle of October. Weir samples were collected throughout the period of water discharge from the CDF in order to monitor the water quality. Flow meters were installed in all three discharge pipes and outflow data from the Pedricktown North CDF was collected.

To evaluate contaminant concentrations in the vicinity of the weir, discharge plume samples were collected in the vicinity of the discharge pipes at a mid-water depth. A background location of similar physical characteristics was sampled in order to estimate ambient river conditions throughout the study. This background site was located along the eastern shore of the river, the same side as Pedricktown, approximately 2 miles south of the CDF and just north of the Penns Grove public beach at the terminus of Main Street (Figure 1-1). This site was selected because of its close proximity without influence of site-related activities, as well as similar physical conditions, and its relative distance from any known contaminant source. Samples were collected at a similar distance from shore and depth as the discharge plume samples in order to approximate conditions of the Pedricktown discharge.

2.1 FIELD METHODS

2.1.1 Water Quality Samples

The weir samples were analyzed for total and dissolved inorganics, cyanide, pesticides, PCBs, semi-volatile organic compounds (SVOCs), and total suspended solids (TSS). The background and discharge plume samples were analyzed for total and dissolved inorganics, cyanide, and TSS. Samples collected from the Pedricktown North weir, discharge plume, and background site were compared to the DRBC acute and chronic freshwater quality criteria.

2.1.1.1 Weir

The weir discharge was sampled using an ISCO® automatic sampler to obtain composite samples throughout the discharge period as well as daily TSS samples. The sampler consists of a peristaltic pump, controlled by a computer, which allows for collecting fixed amounts of water into sample containers over a period of time. The sample was collected through Teflon tubing that was suspended into the weir at the mouth of the outfall pipe. The sample routine for this project was designed to collect water at 6-hour intervals. Sample jars for inorganics, pesticides, PCBs, and TSS were filled over the course of a week. SVOC samples at the weir were not collected in this manner, since the samples must be sealed immediately following collection. A grab sample was collected when the field crew arrived at the site, by manually starting the sampler pump.

2.1.1.2 Discharge Plume

Discharge plume samples were collected at a distance of roughly 100 yards along the shore from the point of discharge, either up or down river, depending on the tidal flow. A grab sample was taken using a swing-arm sampler with individual sample containers fixed onto one end.

2.1.1.3 Background

Background samples were collected following the methods established for collection of the discharge plume area sample. The background sample location, just north of the Penns Grove public beach, at the terminus of Main Street, was determined to be similar to the discharge plume site in physical regime and free from direct chemical influence from any known source of pollutants.

2.1.1.4 Influent

Given the high-pressure flow out of the influent pipe, a grab sample was taken using a swing-arm sampler with individual sample containers fixed onto one end. The sample container was lowered into the influent flow, at the point where the dredged material was falling into the accumulated dredged material in the CDF. This is an area of rapid mixing, which allowed for us to sample the influent as close to the hydraulic pipeline discharge point as possible.

2.2 LABORATORY METHODS

Sample containers were promptly shipped following collection to the contract laboratory performing chemical analysis. Test America used USEPA method 6010 for inorganics, 8270 for SVOCs, 8081 for pesticides, and 2540 for TSS (Table 2-1).

Table 2-1. Analyte list, methods, and detection limits for chemical analyses used for the Pedricktown North CDF study

Analyte	Detection Limit (µg/l)	Method	Analyte	Detection Limit (µg/l)	Method
SVOC					
1,2,4-Trichlorobenzene	11	8270C	Benzo(a)pyrene	11	8270C
1,2-Dichlorobenzene	11	8270C	Benzo(b)fluoranthene	11	8270C
1,3-Dichlorobenzene	11	8270C	Benzo(ghi)perylene	11	8270C
1,4-Dichlorobenzene	11	8270C	Benzo(k)fluoranthene	11	8270C
2,2'-oxybis(1-Chloropropane)	11	8270C	bis(2-Chloroethoxy)methane	11	8270C
2,4,5-Trichlorophenol	11	8270C	bis(2-Chloroethyl)ether	11	8270C
2,4,6-Trichlorophenol	11	8270C	bis(2-Ethylhexyl)phthalate	11	8270C
2,4-Dichlorophenol	11	8270C	Butylbenzylphthalate	11	8270C
2,4-Dimethylphenol	11	8270C	Carbazole	11	8270C
2,4-Dinitrophenol	57	8270C	Chrysene	11	8270C
2,4-Dinitrotoluene	11	8270C	Dibenzo(a,h))anthracene	11	8270C
2,6-Dinitrotoluene	11	8270C	Dibenzofuran	11	8270C
2-Chloronaphthalene	11	8270C	Diethylphthalate	11	8270C
2-Chlorophenol	11	8270C	Dimethylphthalate	11	8270C
2-Methylnaphthalene	11	8270C	Di-n-butylphthalate	11	8270C
2-Methylphenol	11	8270C	DI-n-octylphthalate	11	8270C
2-Nitroaniline	57	8270C	Fluoranthene	11	8270C
2-Nitrophenol	11	8270C	Fluorene	11	8270C
3,3'-Dichlorobenzidine	57	8270C	Hexachlorobenzene	11	8270C
3-Nitroaniline	57	8270C	Hexachlorobutadiene	11	8270C
4,6-Dinitro-2-methylphenol	57	8270C	Hexachlorocyclopentadiene	57	8270C
4-Bromophenyl-phenylether	11	8270C	Hexachloroethane	11	8270C
4-Chloro-3-methylphenol	11	8270C	Indeno(1,2,3-cd)pyrene	11	8270C
4-Chloroaniline	11	8270C	Isophorone	11	8270C
4-Chlorophenyl-phenylether	11	8270C	Naphthalene	11	8270C
4-Methylphenol	11	8270C	Nitrobenzene	11	8270C
4-Nitroaniline	57	8270C	N-Nitroso-di-n-propylamine	11	8270C
4-Nitrophenol	57	8270C	N-Nitrosodimethylamine	11	8270C
Acenaphthene	11	8270C	Pentachlorophenol	57	8270C
Acenaphthylene	11	8270C	Phenanthrene	11	8270C
Anthracene	11	8270C	Phenol	11	8270C
Benzo(a)anthracene	11	8270C	Pyrene	11	8270C

Table 2-1. (Continued)

Analyte	Detection Limit (µg/l)	Method	Analyte	Detection Limit (µg/l)	Method
Pesticides					
4,4'-DDD	0.05	8081A	Endosulfan sulfate	0.05	8081A
4,4'-DDE	0.05	8081A	Endrin	0.05	8081A
4,4'-DDT	0.05	8081A	Endrin aldehyde	0.05	8081A
Aldrin	0.05	8081A	Endrin ketone	0.05	8081A
alpha-BHC	0.05	8081A	gamma-BHC (Lindane)	0.05	8081A
alpha-Chlordane	0.05	8081A	gamma-Chlordane	0.05	8081A
beta-BHC	0.05	8081A	Heptachlor	0.05	8081A
delta-BHC	0.05	8081A	Heptachlor epoxide	0.05	8081A
Dieldrin	0.05	8081A	Methoxychlor	0.1	8081A
Endosulfan I	0.05	8081A	Toxaphene	2.0	8081A
Endosulfan II	0.05	8081A			
Inorganics					
Aluminum	200	6010B	Magnesium	5000	6010B
Antimony	10	6010B	Manganese	15	6010B
Arsenic	10	6010B	Mercury	0.20	7470A
Barium	200	6010B	Nickel	40	6010B
Beryllium	4	6010B	Potassium	5000	6010B
Cadmium	5	6010B	Selenium	5	6010B
Calcium	5000	6010B	Silver	5	6010B
Chromium	5	6010B	Sodium	5000	6010B
Cobalt	50	6010B	Thallium	10	6010B
Copper	25	6010B	Vanadium	50	6010B
Iron	100	6010B	Zinc	20	6010B
Lead	3	6010B			
Total Suspended Solids	4	2540D			

2.2.1 Grain-size and Total Organic Content

Grain-size analysis was performed according to ASTM Method D422-63. Sieve sizes ranged from 4.25 mm (U.S. Standard Sieve No. 4) to 63 µm (U.S. Standard Sieve No. 230). Sediments were categorized by Wentworth's classifications (Table 2-2). Total organic content (TOC) was measured by weight loss upon ignition at 500°C for 4 hours.

Table 2-2. Sieve sizes used for sediment particle distribution and the Wentworth sediment size categories (Buchanan 1984)

Sieve Number	Sieve Size	Wentworth Size Category
4	4.75-mm	Pebble
10	2.00-mm	Granule
20	850-µm	Very Coarse Sand
40	425-µm	Coarse Sand
60	250-µm	Medium Sand
140	106-µm	Fine Sand
200	75-µm	Undefined
230	63-µm	Very Fine Sand
	< 63-µm	Silt-Clay

2.3 DATA ANALYSIS

2.3.1 Water Quality Criteria Comparison

Weir, discharge plume, and background samples were compared to relevant DRBC water quality criteria (DRBC 2004). Several of the criteria for inorganics are hardness-dependent values. For these compounds, the chronic criteria were calculated using the most conservative hardness value calculated for each of the sampling locations.

The water quality criteria for inorganic elements defined by the DRBC are intended for comparison to dissolved inorganic concentrations. The justification for such a comparison is that only dissolved inorganics are biologically available, whereas particulate inorganics are not likely to undergo incorporation into organisms. Therefore, the comparison of inorganic concentrations detected in the weir, discharge plume, and background data is made using dissolved inorganic concentrations. Total inorganics data is also available, and are compared to DRBC criteria designed for dissolved inorganics. By comparing total inorganic concentrations to criteria designed for dissolved inorganics, the data are likely to indicate exceedances of water quality criteria due solely to suspended particulates containing inorganics. These data do not necessarily indicate a true exceedance of water quality criteria and are shown for informational purposes.

3.0 RESULTS

3.1 WATER QUALITY ANALYSIS

Chemical analytical results from Test America are included in Appendix A. Results from the field blank collected in the field using de-ionized, ultra-filtered water are used to estimate the levels of contamination that are introduced by field and laboratory activities. For the field blank, deionized water was transported to the monitoring site and handled the same as the weir, discharge plume, and background samples (Table 3-1).

Table 3-1. Chemical analytes detected in the field blank from Pedricktown North CDF.

	Units			Units	
Total Inorganics					
Aluminum	µg/l	27.7	Magnesium	µg/l	<5000
Antimony	µg/l	<10.0	Manganese	µg/l	0.72
Arsenic	µg/l	<10.0	Mercury	µg/l	<0.20
Barium	µg/l	<200	Nickel	µg/l	<40.0
Beryllium	µg/l	<4.0	Potassium	µg/l	<5000
Cadmium	µg/l	<5.0	Selenium	µg/l	<5.0
Calcium	µg/l	128	Silver	µg/l	<5.0
Chromium	µg/l	<5.0	Sodium	µg/l	<5000
Cobalt	µg/l	<50.0	Thallium	µg/l	<10.0
Copper	µg/l	<25.0	Vanadium	µg/l	<50.0
Iron	µg/l	8.8	Zinc	µg/l	3.4
Lead	µg/l	<3.0			
Total Cyanide	µg/l	< 10.0			
Dissolved Inorganics					
Aluminum	µg/l	<200	Magnesium	µg/l	<5000
Antimony	µg/l	<10.0	Manganese	µg/l	0.74
Arsenic	µg/l	<10.0	Mercury	µg/l	0.017
Barium	µg/l	<200	Nickel	µg/l	<40.0
Beryllium	µg/l	0.25	Potassium	µg/l	<5000
Cadmium	µg/l	<5.0	Selenium	µg/l	<5.0
Calcium	µg/l	21.9	Silver	µg/l	<5.0
Chromium	µg/l	<5.0	Sodium	µg/l	<5000
Cobalt	µg/l	<50.0	Thallium	µg/l	<10.0
Copper	µg/l	<25.0	Vanadium	µg/l	<50.0
Iron	µg/l	<100	Zinc	µg/l	<20.0
Lead	µg/l	<3.0			

Table 3-1. (Continued)

	Units			Units	
Pesticides					
4,4-DDD	µg/l	<0.050	Endosulfan II	µg/l	<0.050
4,4-DDE	µg/l	<0.050	Endosulfan Sulfate	µg/l	<0.050
4,4-DDT	µg/l	0.02	Endrin	µg/l	<0.050
Aldrin	µg/l	<0.050	Endrin Aldehyde	µg/l	<0.050
Alpha BHC	µg/l	<0.050	Endrin Ketone	µg/l	<0.050
Alpha Chlordane	µg/l	<0.050	Gamma BHC - Lindane	µg/l	<0.050
Beta BHC	µg/l	<0.050	Gamma Chlordane	µg/l	<0.050
Delta BHC	µg/l	<0.050	Heptachlor	µg/l	<0.050
Dieldrin	µg/l	<0.050	Heptachlor Epoxide	µg/l	<0.050
Endosulfan I	µg/l	0.07	Methoxychlor	µg/l	<0.10
			Toxaphene	µg/l	<2.0
PCBs					
PCB-1016	µg/l	<0.40	PCB-1248	µg/l	<0.40
PCB-1221	µg/l	<0.40	PCB-1254	µg/l	<0.40
PCB-1232	µg/l	<0.40	PCB-1260	µg/l	<0.40
PCB-1242	µg/l	<0.40			
Semivolatiles					
1,2,4-Trichlorobenzene	µg/l	<10	Benzo(a)pyrene	µg/l	<10
1,2-Dichlorobenzene	µg/l	<10	Benzo(b)fluoranthene	µg/l	<10
1,3-Dichlorobenzene	µg/l	<10	Benzo(g,h,i)perylene	µg/l	<10
1,4-Dichlorobenzene	µg/l	<10	Benzo(k)fluoranthene	µg/l	<10
2,2'-oxybis(1-Chloropropane)	µg/l	<10	bis(2-Chloroethoxy)methane	µg/l	<10
2,4,5-Trichlorophenol	µg/l	<10	bis(2-Chloroethyl)ether	µg/l	<10
2,4,6-Trichlorophenol	µg/l	<10	bis(2-Ethylhexyl)phthalate	µg/l	<10
2,4-Dichlorophenol	µg/l	<10	Butylbenzylphthalate	µg/l	<10
2,4-Dimethylphenol	µg/l	<10	Carbazole	µg/l	<10
2,4-Dinitrophenol	µg/l	<50	Chrysene	µg/l	<10
2,4-Dinitrotoluene	µg/l	<10	Di-n-butylphthalate	µg/l	<10
2,6-Dinitrotoluene	µg/l	<10	Di-n-octylphthalate	µg/l	<10
2-Chloronaphthalene	µg/l	<10	Dibenz(a,h)anthracene	µg/l	<10
2-Chlorophenol	µg/l	<10	Dibenzofuran	µg/l	<10
2-Methylnaphthalene	µg/l	<10	Diethylphthalate	µg/l	1.9
2-Methylphenol	µg/l	<10	Dimethylphthalate	µg/l	<10
2-Nitroaniline	µg/l	<50	Fluoranthene	µg/l	<10
2-Nitrophenol	µg/l	<10	Fluorene	µg/l	<10
3,3'-Dichlorobenzidine	µg/l	<50	Hexachlorobenzene	µg/l	<10
3-Nitroaniline	µg/l	<50	Hexachlorobutadiene	µg/l	<10
4,6-Dinitro-2-methylphenol	µg/l	<50	Hexachlorocyclopentadiene	µg/l	<50
4-Bromophenyl-phenylether	µg/l	<10	Hexachloroethane	µg/l	<10
4-Chloro-3-methylphenol	µg/l	<10	Indeno(1,2,3-cd)pyrene	µg/l	<10
4-Chloroaniline	µg/l	<10	Isophorone	µg/l	<10

Table 3-1. (Continued)

	Units			Units	
4-Chlorophenyl-phenylether	µg/l	<10	N-Nitroso-di-n-propylamine	µg/l	<10
4-Methylphenol	µg/l	<10	N-Nitrosodiphenylamine	µg/l	<10
4-Nitroaniline	µg/l	<50	Naphthalene	µg/l	<10
4-Nitrophenol	µg/l	<50	Nitrobenzene	µg/l	<10
Acenaphthene	µg/l	<10	Pentachlorophenol		<50
Acenaphthylene	µg/l	<10	Phenanthrene	µg/l	<10
Anthracene	µg/l	<10	Phenol	µg/l	<10
Benzo(a)anthracene	µg/l	<10	Pyrene	µg/l	<10

3.1.1 Water Quality Criteria

3.1.1.1 Weir Data

The comparison of total inorganics concentrations to water quality criteria are shown for informational purposes only, as described in Section 2.3.1 (Table 3-2). Total aluminum exceeded its chronic and acute water quality criterion in all five samples and just the chronic criteria in the October 29th sample. Total mercury exceeded chronic criteria five times. Total chromium exceeded chronic criteria twice and acute criteria once. Total lead zinc exceeded acute and chronic criterion once. Total copper exceeded chronic criteria once.

The Pedricktown North CDF discharge monitoring resulted in only two disolved inorganics that exceeded water quality criteria. Aluminum exceeded both acute and chronic criteria once during this study while mercury exceeded chronic criteria in four out of five samples (Table 3-2). Mercury concentrations above the chronic criteria were also observed in the field blank (Table 3-1).

Five of the pesticides (4,4-DDT, delta-BHC, Endosulfan I, Endosulfan II, and Heptachlor epoxide) were detected at the weir. Pesticide 4,4-DDT exceeded chronic criterion on the October 29 sample. Pesticide 4,4-DDT concentrations above the chronic criteria were also observed in the field blank (Table 3-1). None of the PCB arochlors were detected in the weir samples. Only three out of 64 SVOCs were detected. Diethyl phthalate, 4-Methylphenol, and 4-chloro-3-methylphenol were detected on 18 November and Diethyl phthalate on 4 December; however, there is no criteria listed for either parameter (Table 3-2).

3.1.1.2 Discharge Plume Data

Six total inorganics exceed at least one water quality criteria. All samples had total aluminum concentrations greater than the acute and chronic water quality criterion. Chromium exceeded acute and chronic criterion twice while lead exceeded both criteria on Novermber 11 and just chronic criteria on the December 4th sample. Total mercury

exceeded chronic criteria in four out of five mixing zone samples. Total copper exceeded both acute and chronic criteria once and only exceeded chronic criterion on the Dec 12th collection. Total zinc exceeded both criteria in three out of the six mixing zone samples.

Only three dissolved inorganics, aluminum, mercury, and zinc exceeded water quality criterion in the Pedricktown North CDF discharge plume (Table 3-3). Aluminum exceeded both acute and chronic in one out of five samples and just chronic criteria in the Novemer 10th sample. Mercury exceeded chronic criteria on all except the last event but the detection limit was high for the December 4th sample. Dissolved zince exceeded both criteria on the October 29th sample but just the chronic criterion on the November 4th collection.

3.1.1.3 Background Data

As for total inorganics, aluminum exceeded both acute and chronic water quality criteria in all of the background samples (Table 3-4). Total lead exceeded chronic criteria twice and mercury exceeded chronic criteria in all four background samples. Total chromium concentrations exceeded both acute and chronic criteria twice. Four dissolved inorganics in the background samples (aluminum, chromium, lead, and mercury) occasionally exceeded water quality criteria.

3.1.1.4 Influent Data

Influent contaminant concentrations are given for comparison purposes and are not compared to water quality criteria. These samples were analyzed as slurry; both the water and sediment fractions were homogenized prior to analysis. They are not compared to water quality criteria because the contaminant concentrations represent both sediment and water concentrations and do not represent a discharge concentration to the waters of the Delaware River, which is the intended focus of water quality criteria.

Many inorganics were present at least once in the inlet samples throughout the sampling period (Table 3-5). Aluminum and iron were present in every sample at high concentrations; however, these are common elements in the environment. As for pesticides, there were several present throughout the sampling event. Pesticide 4,4-DDE was the only one present in all four inlet samples. In the first sampling event there were three PCB arochlors present.

Seventeen SVOCs were detected in the influent samples throughout the sampling period. Benzo(a)anthracene, chrysene, fluoranthene, phenanthrene, and pyrene were detected in every sample with values ranging from 220 to 2,000 μg/kg.

Table 3-2. Pedricktown North CDF weir samples compared to DRBC water quality criteria.

	Units	WEIR1029	WEIR1104	WEIR1110	WEIR1118	WEIR1124	WEIR1204	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Total Inorganics									
Aluminum	µg/l	737	**3600**	**2460**	**34000**	**2460**	**4060**	**750**	87
Antimony	µg/l	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	**NL**	NL
Arsenic	µg/l	2.7	3.4	4.7	32.6	14.7	11.8	**360**	190
Barium	µg/l	55.2	109	132	408	144	154	**NL**	NL
Beryllium	µg/l	<4.0	0.46	<4.0	1.8	<4.0	<4.0	**NL**	NL
Cadmium	µg/l	2.7	1.7	1	0.46	<5.0	<5.0	**21.2[a]**	3.7[a]
Calcium	µg/l	126000	104000	107000	121000	79200	82900	**NL**	NL
Chromium	µg/l	2.8	7	6.4	**88.4**	6.9	11	**16[b]**	11[b]
Cobalt	µg/l	1.7	3	4.6	26.3	5.5	5.8	**NL**	NL
Copper	µg/l	14	15.9	15.9	71.5	10.2	12.1	**72.5[a]**	42.4[a]
Iron	µg/l	867	3400	2690	53600	4950	6610	**NL**	NL
Lead	µg/l	3	7.8	5.5	**81.5**	7	8.2	**48**	16
Magnesium	µg/l	80800	67200	70400	88700	60500	62200	**NL**	NL
Manganese	µg/l	4280	3910	7190	10900	7720	8180	**NL**	NL
Mercury	µg/l	0.049	0.049	0.033	0.32	<0.20	0.039	**2.4**	0.012
Nickel	µg/l	29.2	26.8	22.6	61.4	11.9	15.5	**5024[a]**	559[a]
Potassium	µg/l	24500	22300	19500	23300	13900	15700	**NL**	NL
Selenium	µg/l	<5.0	<5.0	<5.0	3.9	<5.0	<5.0	**20**	5
Silver	µg/l	1.3	0.76	2.2	3.4	2.1	2.1	**53.1[a]**	NL[a]
Sodium	µg/l	273000	205000	117000	108000	102000	97000	**NL**	NL
Thallium	µg/l	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	**NL**	NL
Vanadium	µg/l	5.6	10.2	9.4	83.5	6.8	11.9	**NL**	NL
Zinc	µg/l	346	251	184	**451**	104	79.9	**415[a]**	376[a]
Cyanide, Total	µg/l	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	22000	5200
Hardness	mg/l	646	536	556	666	446	462		

Table 3-2. (Continued)

	Units	WEIR1029	WEIR1104	WEIR1110	WEIR1118	WEIR1124	WEIR1204	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Dissolved Inorganics									
Aluminum	µg/l	649	60.9	<200	**1560**	27.1	20.9	**750**	87
Antimony	µg/l	<10.0	<10.0	1.9	<10.0	<10.0	<10.0	**NL**	NL
Arsenic	µg/l	2.7	<10.0	3.6	5.4	6.5	3.6	**360**	190
Barium	µg/l	56.5	85.6	112	169	113	116	**NL**	NL
Beryllium	µg/l	<4.0	0.24	<4.0	0.2	<4.0	<4.0	**NL**	NL
Cadmium	µg/l	2.6	1.2	0.7	<5.0	<5.0	<5.0	**22.69[a]**	3.8[a]
Calcium	µg/l	130000	103000	110000	116000	79400	83900	**NL**	NL
Chromium	µg/l	2.3	<5.0	2.2	5.8	1.8	2.1	**16[b]**	11[b]
Cobalt	µg/l	1.9	1.6	3.6	3.6	4.1	3.6	**NL**	NL
Copper	µg/l	14.5	8.1	9.4	8.9	<25.0	4.7	**76.8[a]**	44.7[a]
Iron	µg/l	819	<100	<100	2170	<100	<100	**NL**	NL
Lead	µg/l	2.6	<3.0	<3.0	4	<3.0	<3.0	**48**	16
Magnesium	µg/l	84200	66800	71500	80200	67400	64400	**NL**	NL
Manganese	µg/l	4370	3750	6980	7370	6080	7730	**NL**	NL
Mercury	µg/l	0.053	0.028	0.024	0.049	0.019	<0.20	**2.4**	0.012
Nickel	µg/l	29.6	20.6	20.1	11.8	9.7	10	**5290[a]**	588[a]
Potassium	µg/l	25800	21800	19500	17500	15000	15400	**NL**	NL
Selenium	µg/l	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	**20**	5
Silver	µg/l	1.1	<5.0	1.9	1.7	1.5	2.1	**59000[a]**	NL[a]
Sodium	µg/l	287000	204000	122000	105000	112000	101000	**NL**	NL
Thallium	µg/l	<10.0	2.8	<10.0	<10.0	4.9	<10.0	**NL**	NL
Vanadium	µg/l	5.9	3.9	4.6	10.7	2.8	<50.0	**NL**	NL
Zinc	µg/l	349	158	134	32.2	38.7	14.2	**437[a]**	396[a]
Hardness	mg/l	670	531	568	619	475	474		

Table 3-2. (Continued)

	Units	WEIR1029	WEIR1104	WEIR1110	WEIR1118	WEIR1124	WEIR1204	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Pesticides									
4,4-DDD	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048	0.55	0.001
4,4-DDE	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048	0.55	0.001
4,4-DDT	µg/l	0.035	<0.047	<0.047	<0.050	<0.047	<0.048	0.55	0.001
Aldrin	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048	1.5	
alpha-BHC	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048		
alpha-Chlordane	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048	1.2	0.0043
beta-BHC	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048		
delta-BHC	µg/l	<0.050	0.035	<0.047	<0.050	<0.047	<0.048		
Dieldrin	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048	1.25	0.0019
Endosulfan I	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	0.067		
Endosulfan II	µg/l	<0.050	0.021	<0.047	<0.050	<0.047	<0.048		
Endosulfan sulfate	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048		
Endrin	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048	0.09	0.0023
Endrin aldehyde	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048		
Endrin ketone	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048		
gamma-BHC (Lindane)	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048	1	0.08
gamma-Chlordane	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048		
Heptachlor	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	<0.048	0.26	0.0038
Heptachlor epoxide	µg/l	<0.050	<0.047	<0.047	<0.050	<0.047	0.04		
Methoxychlor	µg/l	<0.099	<0.094	<0.094	<0.10	<0.094	<0.095		
Toxaphene	µg/l	<2.0	<1.9	<1.9	<2.0	<1.9	<1.9	0.73	0.0002
PCBs									
Aroclor 1016	µg/l	<0.40	<0.38	<0.38	<0.40	<0.38	<0.38		
Aroclor 1221	µg/l	<0.40	<0.38	<0.38	<0.40	<0.38	<0.38		
Aroclor 1232	µg/l	<0.40	<0.38	<0.38	<0.40	<0.38	<0.38		
Aroclor 1242	µg/l	<0.40	<0.38	<0.38	<0.40	<0.38	<0.38		
Aroclor 1248	µg/l	<0.40	<0.38	<0.38	<0.40	<0.38	<0.38		
Aroclor 1254	µg/l	<0.40	<0.38	<0.38	<0.40	<0.38	<0.38		
Aroclor 1260	µg/l	<0.40	<0.38	<0.38	<0.40	<0.38	<0.38		

Table 3-2. (Continued)

	Units	WEIR1029	WEIR1104	WEIR1110	WEIR1118	WEIR1124	WEIR1204	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Semi volatiles									
1,2,4-Trichlorobenzene	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
1,2-Dichlorobenzene	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
1,3-Dichlorobenzene	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
1,4-Dichlorobenzene	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2,2-oxybis(1-Chloropropane)	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2,4,5-Trichlorophenol	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2,4,6-Trichlorophenol	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2,4-Dichlorophenol	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2,4-Dimethylphenol	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2,4-Dinitrophenol	µg/l	<50	<57	<47	<48	<48	<48		
2,4-Dinitrotoluene	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2,6-Dinitrotoluene	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2-Chloronaphthalene	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2-Chlorophenol	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2-Methylnaphthalene	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2-Methylphenol	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
2-Nitroaniline	µg/l	<50	<57	<47	<48	<48	<48		
2-Nitrophenol	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
3,3-Dichlorobenzidine	µg/l	<50	<57	<47	<48	<48	<48		
3-Nitroaniline	µg/l	<50	<57	<47	<48	<48	<48		
4,6-Dinitro-2-methylphenol	µg/l	<50	<57	<47	<48	<48	<48		
4-Bromophenyl phenyl ether	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
4-Chloro-3-methylphenol	µg/l	<10	<11	<9.4	0.26	<9.5	<9.7		
4-Chloroaniline	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
4-Chlorophenyl phenyl ether	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
4-Methylphenol	µg/l	<10	<11	<9.4	0.67	<9.5	<9.7		
4-Nitroaniline	µg/l	<50	<57	<47	<48	<48	<48		
4-Nitrophenol	µg/l	<50	<57	<47	<48	<48	<48		
Acenaphthene	µg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		

Table 3-2. (Continued)

	Units	WEIR1029	WEIR1104	WEIR1110	WEIR1118	WEIR1124	WEIR1204	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Acenaphthylene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Anthracene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Benzo(a)anthracene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Benzo(a)pyrene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Benzo(b)fluoranthene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Benzo(ghi)perylene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Benzo(k)fluoranthene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
bis(2-Chloroethoxy)methane	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
bis(2-Chloroethyl) ether	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
bis(2-Ethylhexyl) phthalate	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Butyl benzyl phthalate	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Carbazole	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Chrysene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Di-n-butyl phthalate	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Di-n-octyl phthalate	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Dibenz(a,h)anthracene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Dibenzofuran	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Diethyl phthalate	μg/l	<10	<11	<9.4	1.3	<9.5	4.4		
Dimethyl phthalate	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Fluoranthene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Fluorene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Hexachlorobenzene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Hexachlorobutadiene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Hexachlorocyclopentadiene	μg/l	<50	<57	<47	<48	<48	<48		
Hexachloroethane	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Indeno(1,2,3-cd)pyrene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Isophorone	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
N-Nitrosodi-n-propylamine	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
N-Nitrosodiphenylamine	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Naphthalene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		

Table 3-2. (Continued)

	Units	WEIR1029	WEIR1104	WEIR1110	WEIR1118	WEIR1124	WEIR1204	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Nitrobenzene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Pentachlorophenol	μg/l	<50	<57	<47	<48	<48	<48	9.1	5.7
Phenanthrene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Phenol	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		
Pyrene	μg/l	<10	<11	<9.4	<9.6	<9.5	<9.7		

[a]Water quality standards for these chemicals are hardness dependent and were calculated based on lowest value of 474 mg/l for dissolved and 446 mg/l for total inorganics.
[b]The lower of the water quality standards for chromium III, which is hardness dependent, and chromium VI were used – chromium VI was lower under these conditions.

Table 3-3. Pedricktown North CDF discharge plume samples compared to DRBC water quality criteria.

	Units	MIX 1029	MIX 1104	MIX 1110	MIX 1118	MIX 1124	MIX 1204	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Total Inorganics									
Aluminum	µg/l	**1790**	**5120**	**2100**	**64700**	**1530**	**11200**	**750**	87
Antimony	µg/l	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	**NL**	NL
Arsenic	µg/l	4.1	9.7	3.7	47.1	5.3	13.2	**360**	190
Barium	µg/l	56.6	126	71.3	425	56.8	164	**NL**	NL
Beryllium	µg/l	<4.0	0.58	<4.0	3.9	0.26	0.41	**NL**	NL
Cadmium	µg/l	1.6	0.77	0.38	0.47	<5.0	0.28	**8.1**[a]	1.9[a]
Calcium	µg/l	79000	82000	59400	34100	36900	77100	**NL**	NL
Chromium	µg/l	4.9	15	5.9	**174**	4.4	**29.9**	**16**[b]	11[b]
Cobalt	µg/l	2	5.2	2.5	44	2.5	10.8	**NL**	NL
Copper	µg/l	11.2	15.4	9.2	**116**	4.7	25.3	**32.6**[a]	20.6[a]
Iron	µg/l	2400	6750	2630	101000	2780	19500	**NL**	NL
Lead	µg/l	4.7	14.2	5.3	**148**	5.3	27.4	**48**	16
Magnesium	µg/l	56800	52400	40600	35000	24000	57100	**NL**	NL
Manganese	µg/l	2610	4260	3210	6320	2320	8050	**NL**	NL
Mercury	µg/l	0.05	0.077	0.038	0.78	<0.20	0.22	**2.4**	0.012
Nickel	µg/l	20.4	23.5	10.8	94.8	6.4	26.5	**2452**[a]	273[a]
Potassium	µg/l	20400	15800	11800	17900	6750	17100	**NL**	NL
Selenium	µg/l	3.6	<5.0	<5.0	5.4	<5.0	<5.0	**20**	5
Silver	µg/l	0.71	1	0.99	2.2	<5.0	2.3	**12.4**[a]	NL[a]
Sodium	µg/l	249000	111000	107000	78200	58900	83100	**NL**	NL
Thallium	µg/l	<10.0	<10.0	<10.0	<10.0	4.6	<10.0	**NL**	NL
Vanadium	µg/l	8.1	13.6	7.7	170	5.2	31	**NL**	NL
Zinc	µg/l	**235**	**215**	94	**690**	41.5	166	**202**[a]	183[a]
Cyanide, Total	µg/l	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	22000	5200
Hardness	mg/l	430	420	315	229	191	427		
Dissolved Inorganics									
Aluminum	µg/l	**1740**	72	264	20.4	30.3	19.4	**750**	87
Antimony	µg/l	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	**NL**	NL
Arsenic	µg/l	3.9	<10.0	2.4	2.8	2.8	<10.0	**360**	190
Barium	µg/l	57.8	100	85.7	31.3	47	52.3	**NL**	NL
Beryllium	µg/l	<4.0	0.3	<4.0	0.22	<4.0	<4.0	**NL**	NL
Cadmium	µg/l	1.7	0.6	0.38	<5.0	<5.0	<5.0	**4600**[a]	1300[a]
Calcium	µg/l	83000	89200	86000	21900	41500	57900	**NL**	NL
Chromium	µg/l	4.9	1.4	2.2	<5.0	<5.0	1.2	**16**[b]	11[b]
Cobalt	µg/l	2.3	3	2.7	0.67	1.6	2.1	**NL**	NL
Copper	µg/l	11.4	6.1	8.1	<25.0	<25.0	<25.0	**20.4**[a]	13.4[a]

Table 3-3. (Continued)

	Units	MIX 1029	MIX 1104	MIX 1110	MIX 1118	MIX 1124	MIX 1204	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Iron	µg/l	2420	<100	265	<100	<100	<100	**NL**	NL
Lead	µg/l	4.6	<3.0	1.7	<3.0	<3.0	<3.0	**48**	16
Magnesium	µg/l	60100	56500	57400	15000	27600	41000	**NL**	NL
Manganese	µg/l	2730	4610	5340	940	2520	3930	**NL**	NL
Mercury	µg/l	0.047	0.035	0.1	0.033	0.033	<0.20	**2.4**	0.012
Nickel	µg/l	21	17.4	15	0.79	4.3	6.9	**1608**[a]	179[a]
Potassium	µg/l	21300	16500	15100	5660	7450	11700	**NL**	NL
Selenium	µg/l	3.2	<5.0	<5.0	<5.0	<5.0	<5.0	**20**	5
Silver	µg/l	1	0.88	1.4	<5.0	<5.0	0.86	**5.2**[a]	NL[a]
Sodium	µg/l	262000	114000	111000	76200	65500	74300	**NL**	NL
Thallium	µg/l	3.6	4.1	<10.0	4.6	3.1	<10.0	**NL**	NL
Vanadium	µg/l	8.2	3.9	3.9	<50.0	<50.0	3.2	**NL**	NL
Zinc	µg/l	**248**	131	94.2	10.3	22	7.7	**133**[a]	120[a]
Hardness	mg/l	454	455	450	116	217	313		

[a] Water quality standards for these chemicals are hardness dependent and were calculated based on lowest value of 116 mg/l for dissolved and 191 mg/l for total inorganics.
[b] The lower of the water quality standards for chromium III, which is hardness dependent, and chromium VI were used – chromium VI was lower under these conditions.
NL – No DRBC Freshwater Criteria is listed.

Table 3-4. Results of Pedricktown North CDF background samples compared to DRBC water quality criteria.

	Units	BG1029	BG1104	BG1110	BG1118	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Total Inorganics							
Aluminum	µg/l	**7850**	**2030**	**1910**	**8880**	**750**	87
Antimony	µg/l	<10.0	<10.0	<10.0	<10.0	**NL**	NL
Arsenic	µg/l	6.4	2.4	<10.0	6.4	**360**	190
Barium	µg/l	72.7	40	35.3	69.6	**NL**	NL
Beryllium	µg/l	<4.0	0.39	<4.0	0.39	**NL**	NL
Cadmium	µg/l	<5.0	<5.0	<5.0	<5.0	**7.3**[a]	1.8[a]
Calcium	µg/l	46200	34200	33600	28100	**NL**	NL
Chromium	µg/l	**18.1**	4.4	4.6	**20.2**	**16**[b]	11[b]
Cobalt	µg/l	4.4	0.79	0.95	4.8	**NL**	NL
Copper	µg/l	15.8	<25.0	<25.0	12.5	**29.9**[a]	19[a]
Iron	µg/l	10100	2260	2150	11900	**NL**	NL
Lead	µg/l	19.8	4.3	3.8	17.6	**48**	16
Magnesium	µg/l	75600	34600	41900	25200	**NL**	NL
Manganese	µg/l	507	99.8	93.4	524	**NL**	NL
Mercury	µg/l	0.1	0.019	0.021	0.078	**2.4**	0.012
Nickel	µg/l	11	3.9	4.1	11.7	**2266**[a]	252[a]
Potassium	µg/l	31900	12800	16200	10500	**NL**	NL
Selenium	µg/l	3.3	<5.0	<5.0	<5.0	**20**	5
Silver	µg/l	<5.0	<5.0	<5.0	<5.0	**10.5**[a]	NL[a]
Sodium	µg/l	579000	229000	300000	144000	**NL**	NL
Thallium	µg/l	<10.0	4.4	<10.0	4.6	**NL**	NL
Vanadium	µg/l	21.8	9.2	7.7	20.7	**NL**	NL
Zinc	µg/l	81.9	21.2	30.4	90	**187**[a]	169[a]
Cyanide, Total	µg/l	11.5	<10.0	<10.0	<10.0	22000	5200
Hardness	mg/l	425	227	256	174		
Dissolved Inorganics							
Aluminum	µg/l	**7160**	52.6	<200	33.4	**750**	87
Antimony	µg/l	<10.0	<10.0	<10.0	<10.0	**NL**	NL
Arsenic	µg/l	6.9	<10.0	2.9	<10.0	**360**	190
Barium	µg/l	68	26.4	24	16.9	**NL**	NL
Beryllium	µg/l	<4.0	0.34	<4.0	0.26	**NL**	NL
Cadmium	µg/l	<5.0	<5.0	<5.0	<5.0	**6.4**[a]	1.6[a]
Calcium	µg/l	46000	31800	33500	25700	**NL**	NL
Chromium	µg/l	**17**	<5.0	<5.0	<5.0	**16**[b]	11[b]
Cobalt	µg/l	4.4	<50.0	<50.0	<50.0	**NL**	NL

Table 3-4. (Continued)

	Units	BG1029	BG1104	BG1110	BG1118	DRBC Acute Freshwater Criteria	DRBC Chronic Freshwater Criteria
Copper	μg/l	12.9	<25.0	<25.0	<25.0	**26.8**[a]	17.2[a]
Iron	μg/l	9820	<100	<100	<100	**NL**	NL
Lead	μg/l	17.7	<3.0	<3.0	<3.0	**48**	16
Magnesium	μg/l	75700	32300	41300	22200	**NL**	NL
Manganese	μg/l	494	3.7	2	10.6	**NL**	NL
Mercury	μg/l	0.03	0.016	<0.20	0.039	**2.4**	0.012
Nickel	μg/l	10.7	1.4	1.4	0.81	**2055**[a]	228[a]
Potassium	μg/l	31100	11600	15600	8210	**NL**	NL
Selenium	μg/l	<5.0	<5.0	<5.0	<5.0	**20**	5
Silver	μg/l	<5.0	<5.0	<5.0	<5.0	**8.6**[a]	NL[a]
Sodium	μg/l	571000	218000	302000	140000	**NL**	NL
Thallium	μg/l	3.1	5.9	<10.0	4.2	**NL**	NL
Vanadium	μg/l	20.8	3.8	4.8	3.8	**NL**	NL
Zinc	μg/l	72.8	9.2	9.4	12.3	**170**[a]	154[a]
Hardness	mg/l	425	212	253	155		

[a]Water quality standards for these chemicals are hardness dependent and were calculated based on lowest value of 155 mg/l for dissolved and 174 mg/l for total inorganics.
[b]The lower of the water quality standards for chromium III, which is hardness dependent, and chromium VI were used – chromium VI was lower under these conditions.
NL - No DRBC Freshwater Criteria is listed.

Table 3-5. Results of Pedricktown North CDF influent samples.

	Units	INLET1015	INLET1029	INLET1104	INLET1110
Total Inorganics					
Aluminum	mg/kg	13800	13600	15700	20900
Antimony	mg/kg	0.66	<1.4	<2.3	<2.3
Arsenic	mg/kg	12.8	10.7	12.8	15.3
Barium	mg/kg	108	105	128	147
Beryllium	mg/kg	1.2	1	1.4	1.6
Cadmium	mg/kg	1.1	0.76	0.16	0.21
Calcium	mg/kg	3220	3310	4060	4790
Chromium	mg/kg	49.6	42.4	51.1	64.5
Cobalt	mg/kg	13.7	13.2	14.9	17.5
Copper	mg/kg	36.1	32.5	37.8	42.3
Iron	mg/kg	27100	26600	32300	39600
Lead	mg/kg	56.2	44.6	52.5	59.9
Magnesium	mg/kg	4730	4600	6040	7590
Manganese	mg/kg	1320	1260	1760	2090
Mercury	mg/kg	0.3	0.21	0.28	0.11
Nickel	mg/kg	27.3	24.5	28.7	34.9
Potassium	mg/kg	1920	2020	2330	3150
Selenium	mg/kg	0.83	0.68	<1.1	<1.2
Silver	mg/kg	0.83	0.71	0.66	0.85
Sodium	mg/kg	822	462	584	773
Thallium	mg/kg	<1.4	<1.4	<2.3	<2.3
Vanadium	mg/kg	44.5	38.9	46.1	58.2
Zinc	mg/kg	224	227	230	263
Cyanide, Total	mg/kg	2.4	<1.4	5.2	<2.3
Pesticides					
4,4-DDD	μg/kg	<2.4	8.4	18	6.2
4,4-DDE	μg/kg	14	12	15	2.4
4,4-DDT	μg/kg	2.4	<25	<38	2.4
Aldrin	μg/kg	<2.4	<25	<38	<3.9
alpha-BHC	μg/kg	<2.4	12	7.7	<3.9
alpha-Chlordane	μg/kg	<2.4	<25	<38	<3.9
beta-BHC	μg/kg	<2.4	<25	<38	<3.9
delta-BHC	μg/kg	0.85	<25	<38	<3.9
Dieldrin	μg/kg	1.4	<25	<38	<3.9
Endosulfan I	μg/kg	<2.4	<25	<38	<3.9
Endosulfan II	μg/kg	<2.4	<25	<38	<3.9
Endosulfan sulfate	μg/kg	<2.4	<25	<38	<3.9
Endrin	μg/kg	<2.4	<25	<38	<3.9
Endrin aldehyde	μg/kg	<2.4	<25	<38	<3.9
Endrin ketone	μg/kg	1	<25	<38	<3.9

Table 3-5. (Continued)

	Units	INLET1015	INLET1029	INLET1104	INLET1110
gamma-BHC (Lindane)	µg/kg	<2.4	<25	<38	<3.9
gamma-Chlordane	µg/kg	2.2	<25	<38	<3.9
Heptachlor	µg/kg	<2.4	<25	<38	<3.9
Heptachlor epoxide	µg/kg	<2.4	<25	<38	<3.9
Methoxychlor	µg/kg	<4.7	<48	<74	<7.6
Toxaphene	µg/kg	<95	<970	<1500	<160
PCBs					
Aroclor 1016	µg/kg	<24	<48	<75	<39
Aroclor 1221	µg/kg	<24	<48	<75	<39
Aroclor 1232	µg/kg	<24	<48	<75	<39
Aroclor 1242	µg/kg	<24	<48	<75	<39
Aroclor 1248	µg/kg	47	<48	<75	<39
Aroclor 1254	µg/kg	43	<48	<75	<39
Aroclor 1260	µg/kg	20	<48	<75	<39
Semi volatiles					
1,2,4-Trichlorobenzene	µg/kg	440	<2400	<3700	<3800
1,2-Dichlorobenzene	µg/kg	<2400	<2400	<3700	<3800
1,3-Dichlorobenzene	µg/kg	<2400	<2400	<3700	<3800
1,4-Dichlorobenzene	µg/kg	<2400	<2400	<3700	<3800
2,2-oxybis(1-Chloropropane)	µg/kg	<2400	<2400	<3700	<3800
2,4,5-Trichlorophenol	µg/kg	<2400	<2400	<3700	<3800
2,4,6-Trichlorophenol	µg/kg	<2400	<2400	<3700	<3800
2,4-Dichlorophenol	µg/kg	<2400	<2400	<3700	<3800
2,4-Dimethylphenol	µg/kg	<2400	<2400	<3700	<3800
2,4-Dinitrophenol	µg/kg	<11000	<12000	<18000	<18000
2,4-Dinitrotoluene	µg/kg	<2400	<2400	<3700	<3800
2,6-Dinitrotoluene	µg/kg	<2400	<2400	<3700	<3800
2-Chloronaphthalene	µg/kg	<2400	<2400	<3700	<3800
2-Chlorophenol	µg/kg	<2400	<2400	<3700	<3800
2-Methylnaphthalene	µg/kg	<2400	<2400	<3700	1200
2-Methylphenol	µg/kg	<2400	<2400	<3700	<3800
2-Nitroaniline	µg/kg	<11000	<12000	<18000	<18000
2-Nitrophenol	µg/kg	<2400	<2400	<3700	<3800
3,3-Dichlorobenzidine	µg/kg	<11000	<12000	<18000	<18000
3-Nitroaniline	µg/kg	<11000	<12000	<18000	<18000
4,6-Dinitro-2-methylphenol	µg/kg	<11000	<12000	<18000	<18000
4-Bromophenyl phenyl ether	µg/kg	<2400	<2400	<3700	<3800
4-Chloro-3-methylphenol	µg/kg	<2400	<2400	<3700	<3800
4-Chloroaniline	µg/kg	<2400	<2400	<3700	<3800
4-Chlorophenyl phenyl ether	µg/kg	<2400	<2400	<3700	<3800
4-Methylphenol	µg/kg	<2400	<2400	<3700	<3800
4-Nitroaniline	µg/kg	<11000	<12000	<18000	<18000
4-Nitrophenol	µg/kg	<11000	<12000	<18000	<18000
Acenaphthene	µg/kg	<2400	<2400	<3700	910

Table 3-5. (Continued)

	Units	INLET1015	INLET1029	INLET1104	INLET1110
Acenaphthylene	μg/kg	<2400	<2400	<3700	610
Anthracene	μg/kg	<2400	140	<3700	830
Benzo(a)anthracene	μg/kg	350	290	340	330
Benzo(a)pyrene	μg/kg	320	240	<3700	<3800
Benzo(b)fluoranthene	μg/kg	460	410	320	<3800
Benzo(ghi)perylene	μg/kg	150	<2400	<3700	<3800
Benzo(k)fluoranthene	μg/kg	<2400	<2400	<3700	<3800
bis(2-Chloroethoxy)methane	μg/kg	<2400	<2400	<3700	<3800
bis(2-Chloroethyl) ether	μg/kg	<2400	<2400	<3700	<3800
bis(2-Ethylhexyl) phthalate	μg/kg	270	250	<3700	<3800
Butyl benzyl phthalate	μg/kg	<2400	<2400	<3700	<3800
Carbazole	μg/kg	<2400	<2400	<3700	<3800
Chrysene	μg/kg	360	290	290	390
Di-n-butyl phthalate	μg/kg	<2400	<2400	<3700	<3800
Di-n-octyl phthalate	μg/kg	<2400	<2400	<3700	<3800
Dibenz(a,h)anthracene	μg/kg	<2400	<2400	<3700	<3800
Dibenzofuran	μg/kg	<2400	<2400	<3700	640
Diethyl phthalate	μg/kg	<2400	<2400	<3700	<3800
Dimethyl phthalate	μg/kg	<2400	<2400	<3700	<3800
Fluoranthene	μg/kg	450	430	510	1200
Fluorene	μg/kg	<2400	<2400	<3700	810
Hexachlorobenzene	μg/kg	<2400	<2400	<3700	<3800
Hexachlorobutadiene	μg/kg	<2400	<2400	<3700	<3800
Hexachlorocyclopentadiene	μg/kg	<11000	<12000	<18000	<18000
Hexachloroethane	μg/kg	<2400	<2400	<3700	<3800
Indeno(1,2,3-cd)pyrene	μg/kg	160	<2400	<3700	<3800
Isophorone	μg/kg	<2400	<2400	<3700	<3800
N-Nitrosodi-n-propylamine	μg/kg	<2400	<2400	<3700	<3800
N-Nitrosodiphenylamine	μg/kg	<2400	<2400	<3700	<3800
Naphthalene	μg/kg	<2400	<2400	<3700	5600
Nitrobenzene	μg/kg	<2400	<2400	<3700	<3800
Pentachlorophenol	μg/kg	<11000	<12000	<18000	<18000
Phenanthrene	μg/kg	220	350	510	2000
Phenol	μg/kg	<2400	<2400	<3700	<3800
Pyrene	μg/kg	410	340	410	670

3.1.2 Total Suspended Solids

The TSS measured from the weir spiked on 12 November to a value of 884 mg/l. (Table 3-6). Weir TSS ranged from 2.4 to 884 mg/l but generally was less than 50 mg/l throughout the monitoring period (Figure 3-1). Discharge plume TSS ranged from 42.5 to 2,420 mg/l and background TSS ranged from 37 to 301 mg/l (Figure 3-1).

Table 3-6. Results of TSS monitoring from Pedricktown North Weir, Discharge Plume, and the Background location (mg/l)

Date	Weir	Discharge Plume	Background
10/22	10		
10/23	2.4		
10/24	2.8		
10/25	3.6		
10/26	5.2		
10/27	7		
10/28	7.2		
10/29	7.6	60.8	271
10/30	15.2		
10/31	112		
11/01	126		
11/02	32.4		
11/03	95		
11/04	14	165	37
11/05	12.8		
11/06	17.6		
11/07	55.6		
11/08	55.2		
11/09	43.5		
11/10	30.8	42.5	37.6
11/11	359		
11/12	884		
11/18	276	2420	301
11/24	56	66	
11/25	11.5		
11/26	26		
11/27	9.5		
11/29	27		
11/30	17.5		
12/02	19		
12/03	22.5		
12/04		744	

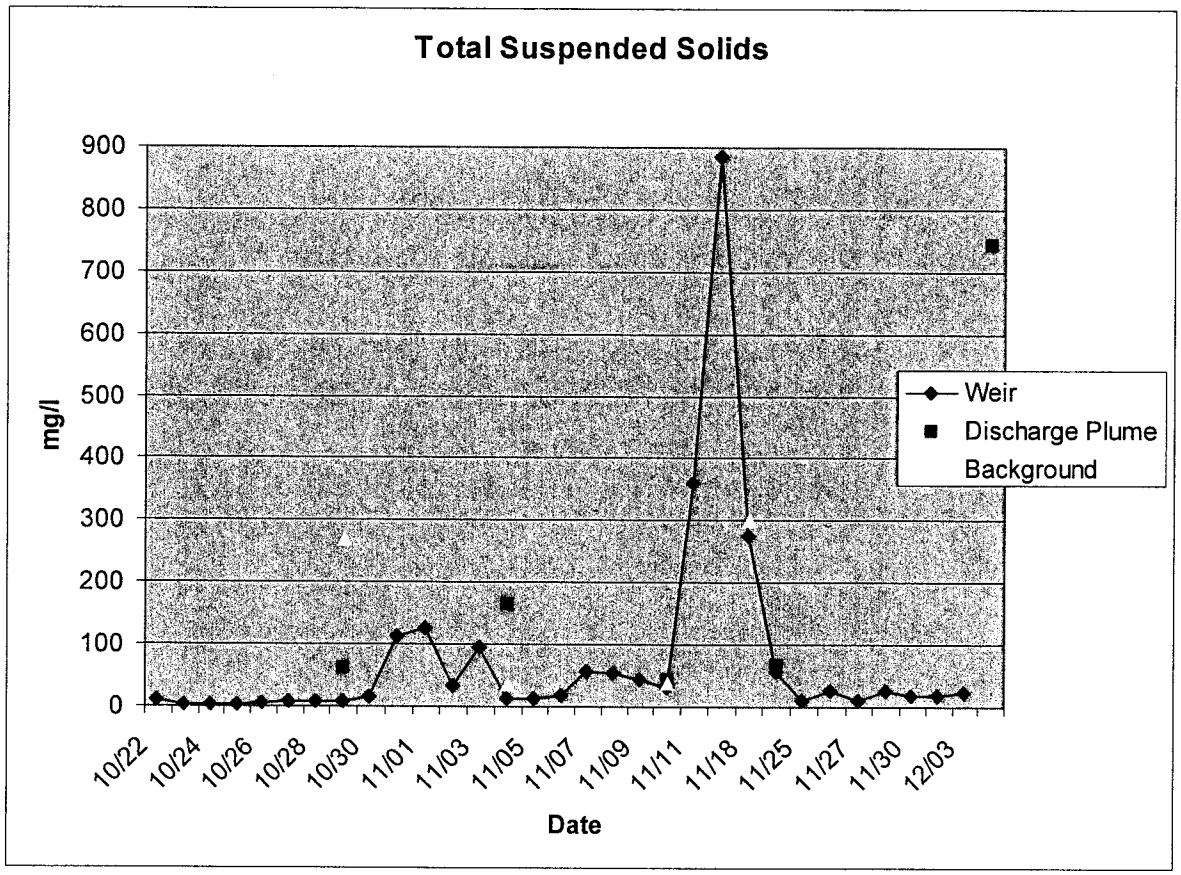


Figure 3-1. Total Suspended Solids in weir, discharge plume, and background samples (mg/l) at Pedricktown North

4.0 SUMMARY

Overall, water quality at the Pedricktown North CDF weir discharge was good. Inorganics that exceeded DRBC freshwater criteria in weir samples included aluminum, chromium, lead, mercury, and zinc. There were five pesticides (4,4-DDT, delta-BHC, Endosulfan I, Endosulfan II, and Heptachlor epoxide) detected in the weir samples. Pesticide 4,4-DDT was the only parameter with a concentration that exceeded its criterion. Only 3 out of 64 SVOCs were detected. None of PCB arochlors were detected in the weir samples throughout the monitoring period. TSS weir samples were higher in the middle of the sample period with a spike of 884 mg/l on 12 November. This was likely due to the height of the weir boards not being properly adjusted to increase residence time.

Discharge plume and background samples indicate that ambient water quality was similar to CDF discharge values. TSS values for background and discharge plume were generally low except for the peak value observed on 18 November (2420 mg/l) during a high wind event.

The results of this monitoring effort do not represent expected CDF water quality in other Delaware River facilites. Properties of CDFs, such as size, vegetation, and cell structure, play an important role in determining flow through the CDF. However, previous monitoring studies at the Pedricktown North CDF has demonstrated that it is highly effective in sequestering contaminants, and may provide a model for management of other CDFs. Contamininant monitoring of the maintenance dredging of the Marcus Hook reach of the Philadelphia to the Sea navigational channel and placement of material into the Pedricktown CDF inidicates that Delaware River navigational channel sediments can be dredged with minimal impacts to the environment.

APPENDIX A

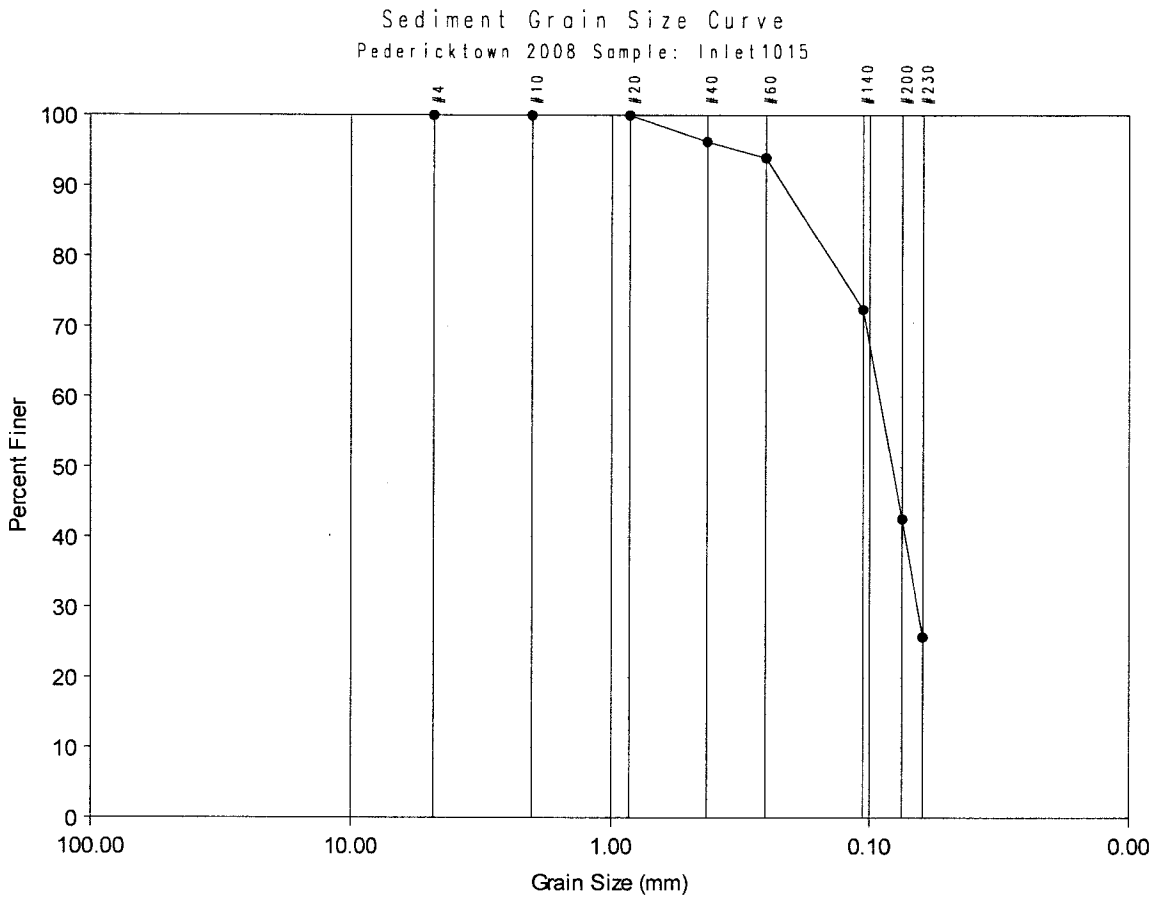
PEDRICKTOWN SOUTH CONFINED DISPOSAL FACILITY LABORATORY RESULTS

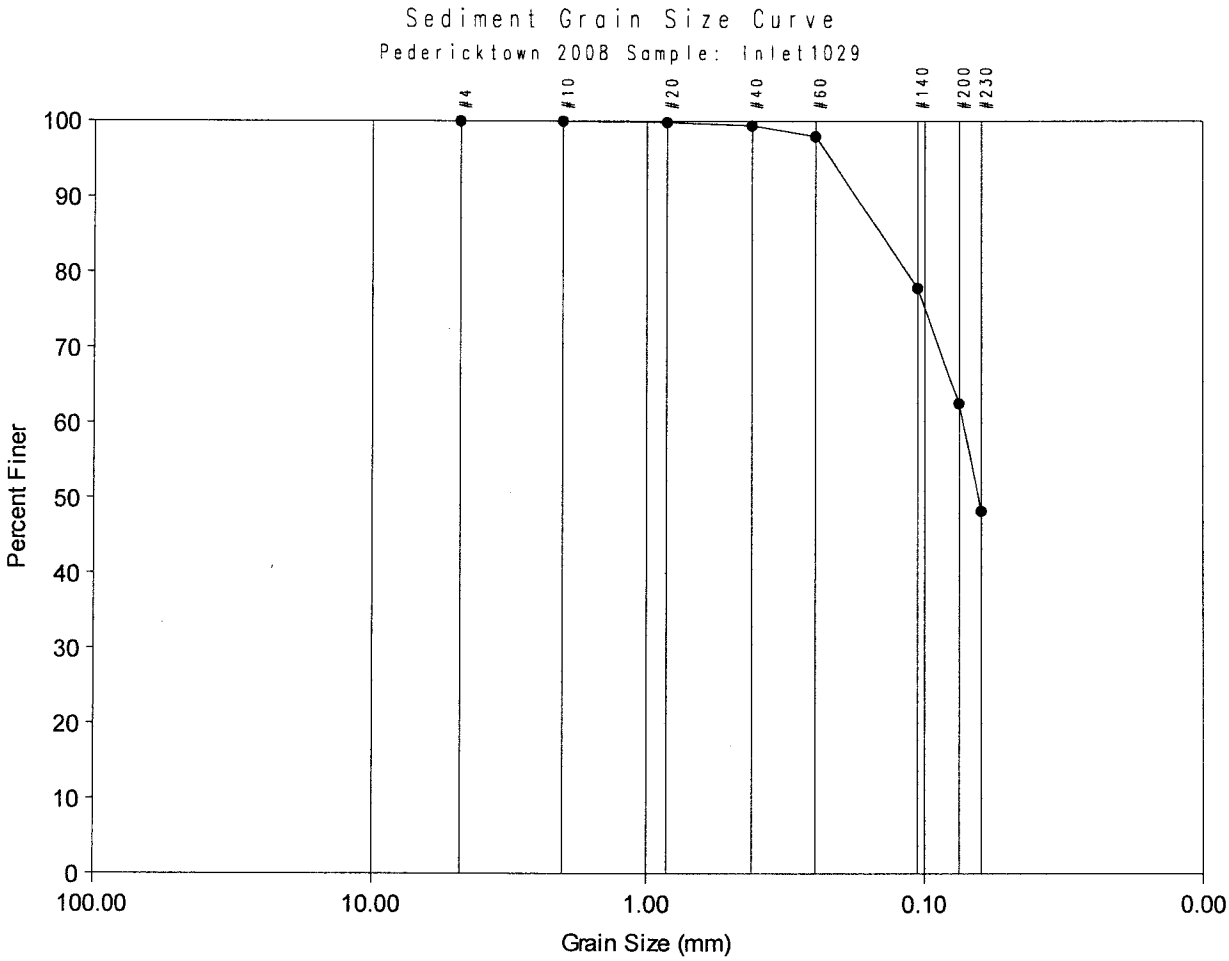
Weeks One to Seven

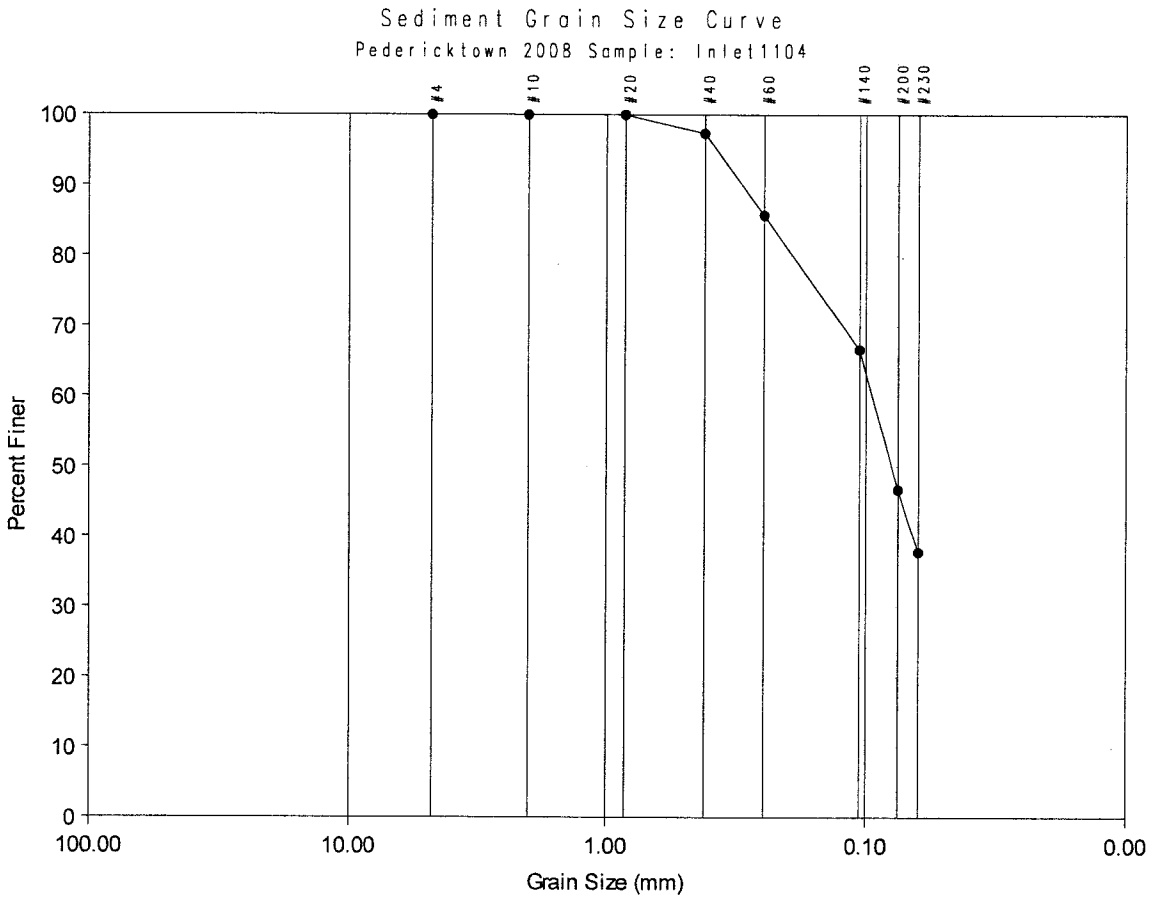
(Provided on CD)

APPENDIX B

SEDIMENT GRAIN SIZE CURVES


Sediment Grain Size Curve
Pedericktown 2008 Sample: Inlet1015
#4
#10
#20
#40
#60
#140
#200
#230
Percent Finer
100
90
80
70
60
50
40
30
20
10
0
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Pedericktown 2008 Sample: Inlet1029
#4
#10
#20
#40
#60
#140
#200
#230
Percent Finer
100
90
80
70
60
50
40
30
20
10
0
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)


Sediment Grain Size Curve
Pedericktown 2008 Sample: Inlet1104
#4
#10
#20
#40
#60
#140
#200
#230
100
90
80
70
60
50
40
30
20
10
0
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)

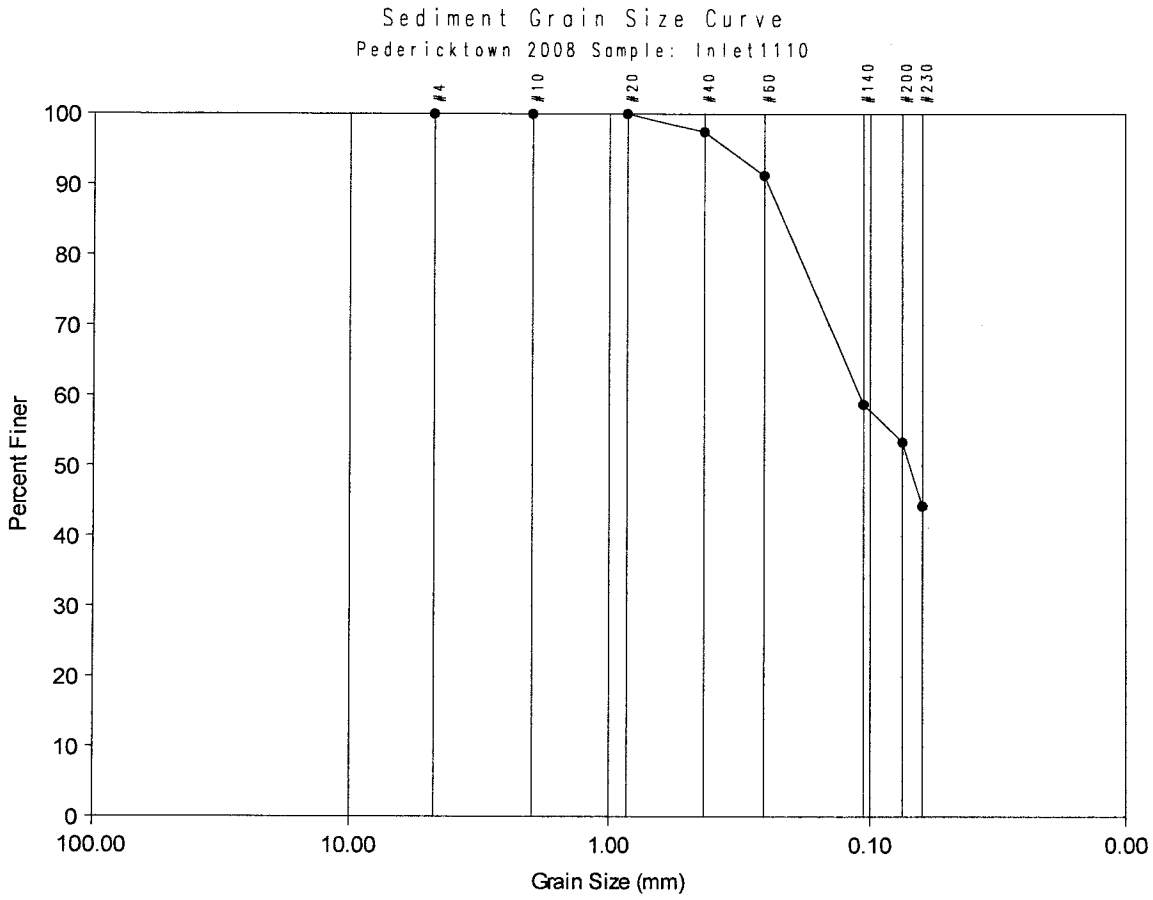

Sediment Grain Size Curve
Pedericktown 2008 Sample: Inlet1110
#4
#10
#20
#40
#60
#140
#200
#230
100
90
80
70
60
50
40
30
20
10
0
Percent Finer
100.00
10.00
1.00
0.10
0.00
Grain Size (mm)

Table B-1. Total Organic Carbon and Percent Silt/Clay for in the slurry samples collected from the Pedericktown CDF Influent

Sample ID	TOC	Siltclay	Sand	Gravel
Inlet 1015	4.11	25.79	74.21	0
Inlet 1029	5.66	48.29	51.71	0
Inlet 1104	8.01	37.82	62.18	0
Inlet 1110	7.62	44.31	55.69	0