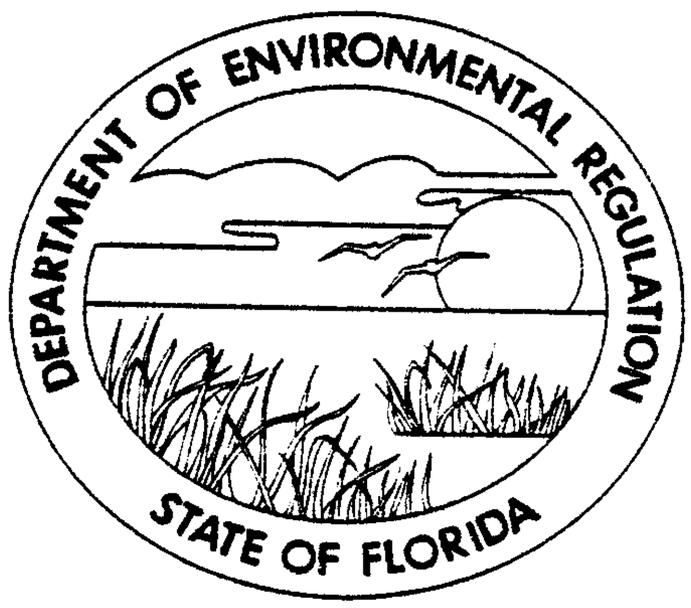


BIOASSAYS OF GARDINIER, INC., U.S. PHOSPHORIC PRODUCTS

TAMPA, HILLSBOROUGH COUNTY, FLORIDA

NPDES #FL0000761 #001, #005, #012

SAMPLED 9/21/81

Biological Section
Bureau of Water Analysis
January 25, 1982

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EXECUTIVE SUMMARY

Bioassays of Gardinier, Inc., U.S. Phosphoric Products, Tampa, NPDES #FL0000761

To evaluate the existence and extent of toxicity of these effluent samples to the biota of the receiving waters, the Biological Section performed static acute toxicity bioassays on grab samples, on 22 to 24 September, 1981. Effluent samples from Outfalls #001, #005 and #012 were assayed using Mysidopsis bahia as the test organism.

Although some mortality occurred in the highest test concentrations, an insufficient number of organisms died for the calculation of LC_{50} values.

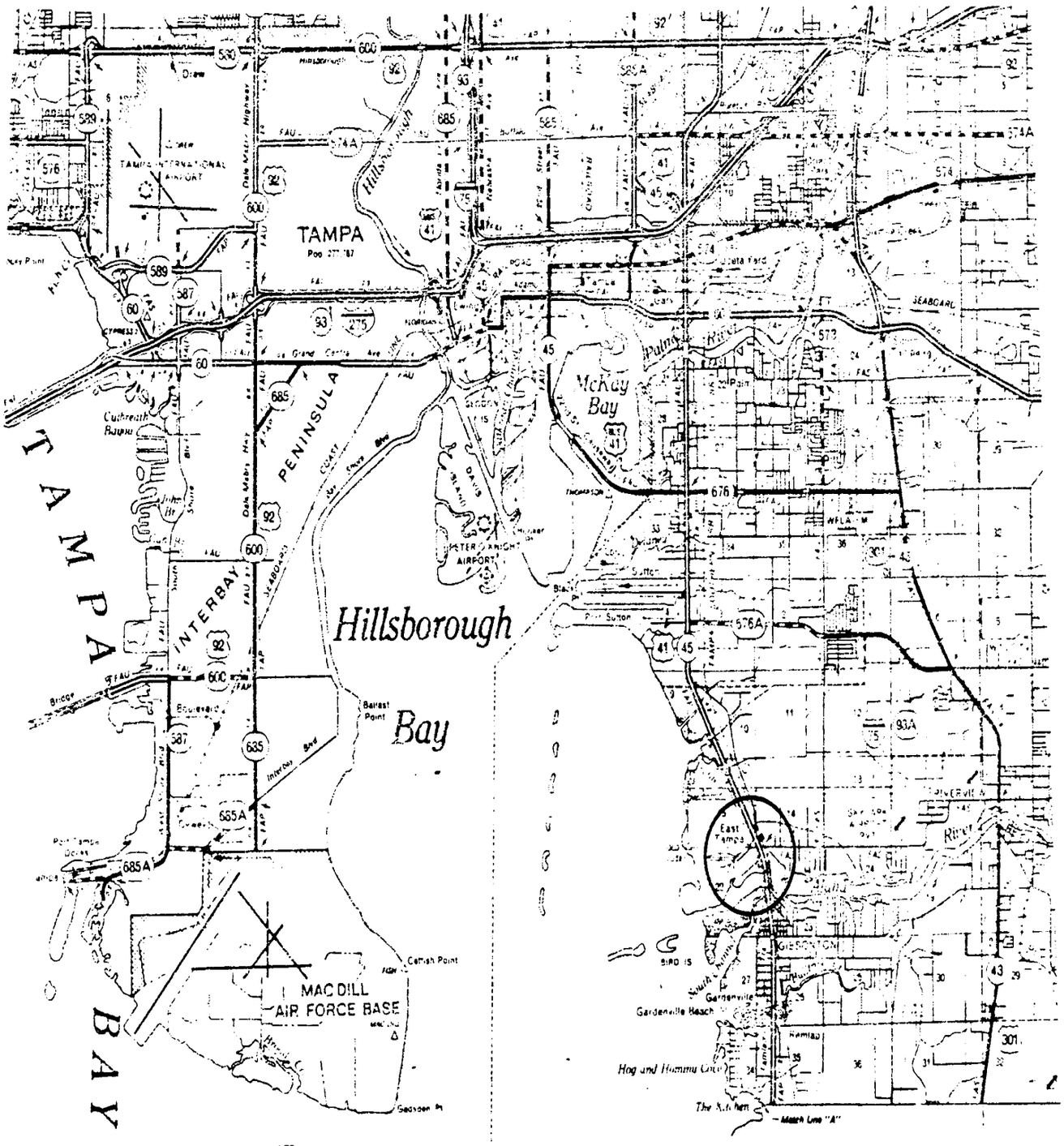
Chemical analysis indicated that zinc and selenium were present in an effluent sample from Outfall #005. Unionized ammonia was detected in potentially toxic concentrations in effluent from Outfall #012. It is suggested that testing be repeated on samples from Outfall #012, because of the high concentration of ammonia found in the sample.

INTRODUCTION

Gardinier, Inc., U.S. Phosphoric Products, is located at US 41 and Riverview Drive, just north of the mouth of the Alafia River on Hillsborough Bay, Tampa, Hillsborough County, Florida (Figure 1). This facility manufactures fertilizer and inorganic chemicals, including sulfuric, phosphoric and fluosilicic acids (11567 tons per day), triple super and super phosphate (2600 tons per day), ammonium phosphate (1728 tons per day), anhydrous ammonia (385 tons per day) and gypsum (14320 tons per day). Wastewater from the various operations is treated by liming and retention in three sludge ponds. As many as six NPDES permitted outfalls are located on the site, three of which (#001, #005 and #012) discharge to surface waters. Outfalls #001 and #005 contain cooling water, non-contact process water, treated process wastewater and wastewater from the sulfuric acid plant. They discharge to the Alafia River. Outfall #012 contains supernatant from the sludge ponds, and is discharged to Archie Creek, a tributary of Hillsborough Bay. A schematic of the facility and its wastewater outfalls shown in Figure 2.

In 1973, Gardinier, Inc., was fined for damaging public lands (DER NPDES file). Since then, major modifications were introduced in the manufacturing of phosphate chemicals, including a new gypsum disposal field (Figure 3). These modifications reduced engery consumption, and increased efficiency and production.

Since the various discharges from this manufacture of fertilizers and chemicals may adversely affect the aquatic community, the Biological Section performed 48 hour static acute toxocity bioassays on effluent from each of the three surface water outfalls #001, #005 and #012 , on 22 to 24 September, 1981. The results of these bioassays are presented in this report.



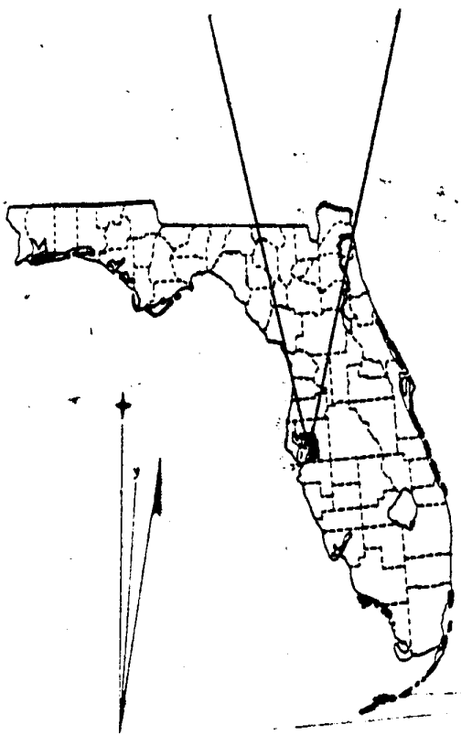


Figure 1. Portions of Tampa and Hillsborough County, Florida, including study area.

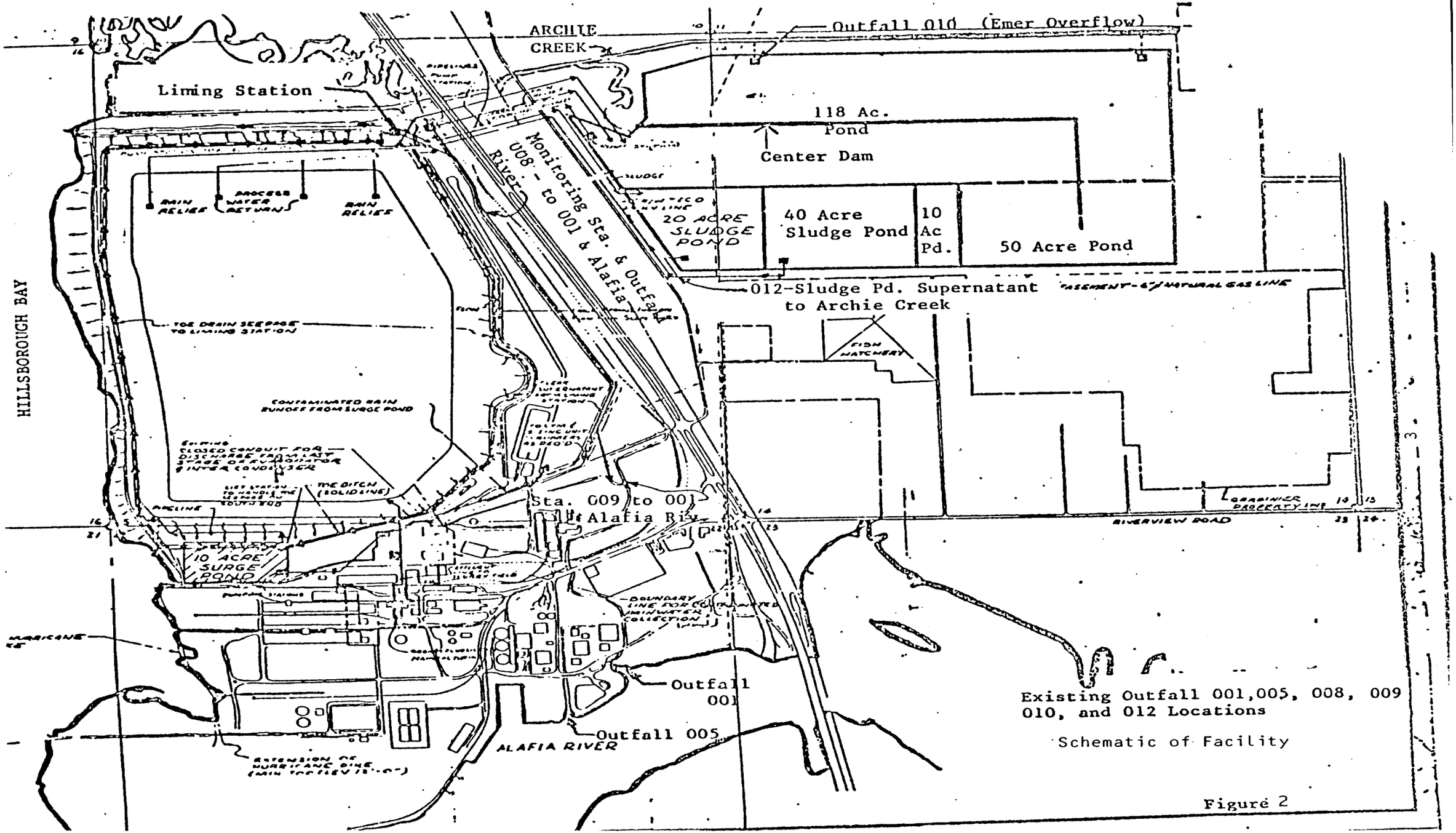

ARCHIE CREEK
Outfall 010 (Emer Overflow)
Liming Station
118 Ac. Pond
Center Dam
Monitoring Sta. & Outfall U08 - to 001 & Alafia River
20 ACRE SLUDGE POND
40 Acre Sludge Pond
10 Ac Pd.
50 Acre Pond
012-Sludge Pd. Supernatant to Archie Creek
HILLSBOROUGH BAY
FISH HATCHERY
CONTAMINATED RAIN RUNOFF FROM SLUDGE POND
Sta. 009 to 001
Alafia Riv
10 ACRE SURGE POND
RIVERVIEW ROAD
Outfall 001
Outfall 005
ALAFIA RIVER
Existing Outfall 001,005, 008, 009 010, and 012 Locations
Schematic of Facility

Figure 2

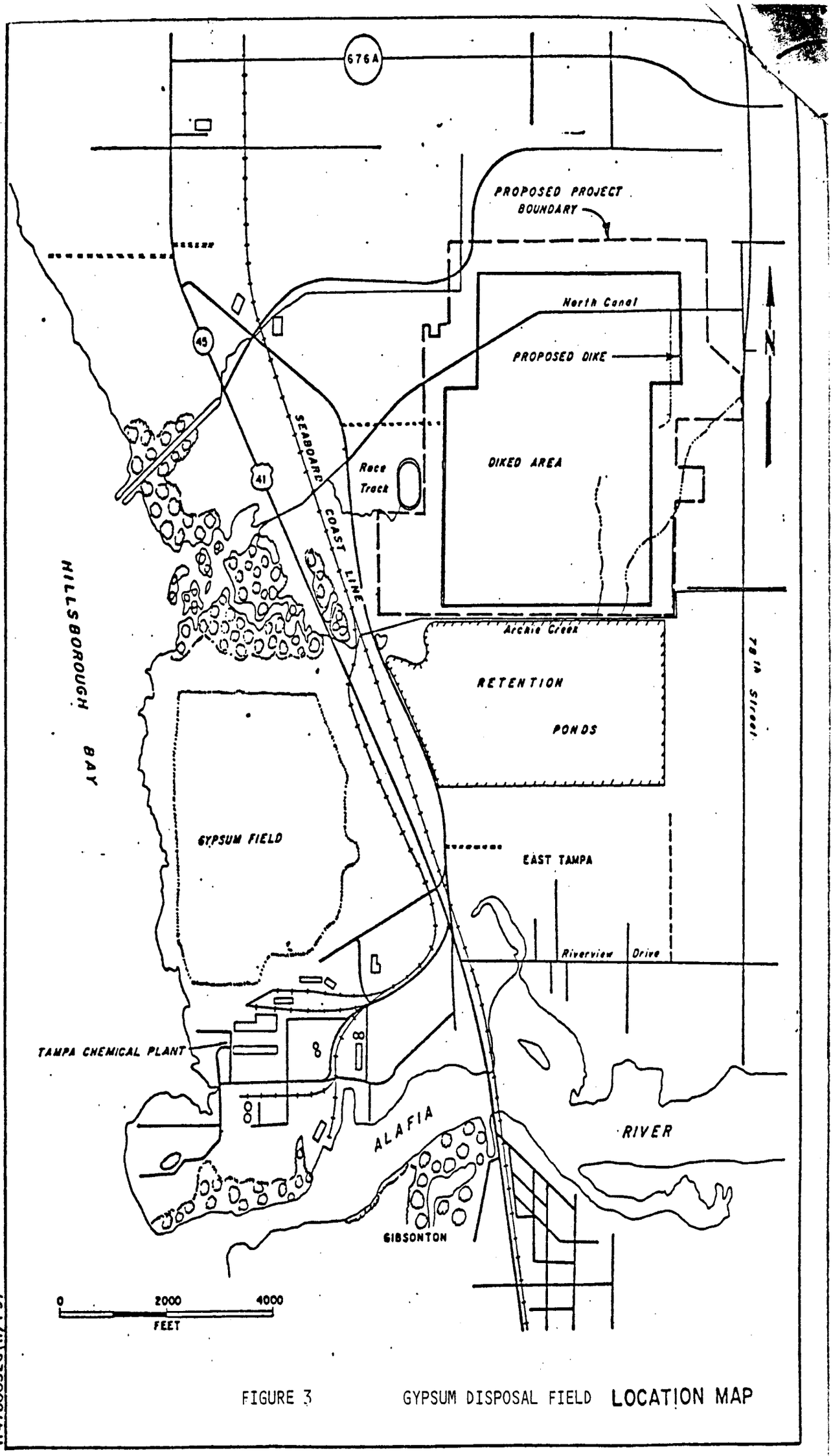


FIGURE 3 GYPSUM DISPOSAL FIELD LOCATION MAP

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METHODS AND MATERIALS

Test methods used to conduct these static bioassays are extensively described by Peltier (1978). The organism selected for this study is among those recommended by Peltier (1978) and the U.S. EPA (1978). The life history and maintenance procedures used to culture the organism are detailed below.

Mysidopsis bahia (mysid shrimp) - In September, 1978, approximately 300 adult mysid shrimp were obtained from the EPA laboratory in Gulf Breeze, Florida. The mysids are cultured under continuous lighting in 10 and 15 gallon all glass aquaria equipped with undergravel filtration and aeration. The mysid shrimp are cultured over a wide range of salinities (10-30 ppt) to minimize acclimation periods to low or high salinity effluents. Seawater is obtained from the FSU Marine Laboratory located at Turkey Point, Florida (salinity range 17-31 ppt) and partial water changes are performed weekly. Freshwater, for dilution of the seawater as necessary, is obtained from a deep well near the DER laboratory. The mysids are fed twice daily with freshly hatched Artemia (brine shrimp) and are kept at a constant temperature of 22° plus or minus 1°C. Ten to fifteen day old (three-quarter adult size) mysids were used in this test.

To ensure the uniform sensitivity of these test organisms to toxic substances, the Biological Section conducts monthly standard reference toxicant bioassays using sodium lauryl sulfate as the reference toxicant.

Test Methods

Three separate 48 hour static acute toxicity bioassays were performed from 1045 hours on 22 September to 1045 hours on 24 September, 1981, on grab samples of effluent from Outfalls #001, #005, and #012. The samples were collected by Mr. Matt McCann of DER's Southwest District at 1100 hours on 21 September, 1981, using standard wastewater sampling procedures. Separate samples were obtained for chemical (Outfalls #001 and #005 only) and biological testing. Samples for metal analysis (Outfall #005) were preserved with HNO_3. Samples for organic chemical analysis and for the bioassays were unpreserved. The samples were iced and transported to the DER laboratory in Tallahassee for analysis within 24 hours of collection.

Saltwater for dilution of the effluent samples was obtained from the FSU Marine Laboratory at Turkey Point (salinity= 30ppt). For the bioassays of Outfalls #001 and #005 (saltwater), this saltwater diluent was adjusted to the salinity of these effluents (approximately 26.5ppt) by adding an appropriate amount of DER well water. For test concentrations of 56% and below this adjusted diluent was mixed directly with the effluents, achieving a range of final salinities of 26.0ppt to 27.5ppt. For the bioassay of Outfall #012 (salinity = 4ppt), and for test concentrations of 56% and below, this adjusted diluent (salinity = 26.5ppt) was mixed directly with the effluent, achieving a range of final salinities (14.5ppt to 25.0ppt). For the 100% effluent test concentration, freshly autoclaved artificial sea salts (Ocean 50®) were added until a salinity of approximately 7.5ppt was achieved (the lower limit of mysid shrimp salinity tolerance). Since this addition of sea salts increased the pH of this effluent by 0.5 units, the pH was readjusted with 1 N hydrochloric (approximately 3-4 drops) to that of the original sample (6.7 units). A series of 3 control groups (Table 5) were then used to ensure that any mortality in the test organisms was not the result of toxic properties associated with the diluent, the pH adjusted artificial sea salts, or the salinity range. The control groups included: adjusted Turkey Point seawater (salinity= 26.8ppt), pH adjusted artificial sea salt (Ocean 50®) adjusted well water (salinity= 8.0ppt), and a salinity control consisting of Turkey Point seawater and well water (salinity= 15.0ppt). The concentration series selected for this study (Table 1) is that recommended by the APHA (1980).

Two replicates of each test concentration and of the controls were used to test with Mysidopsis bahia. Immediately prior to the bioassays, a suitable number of mysids were transferred by net from the 10ppt, 15ppt, 20ppt and 25ppt salinity aquaria to culture dishes for observation and selection of individuals for the tests. Ten to fifteen day old (three-quarter adult size) mysids were used in these tests. Individual mysid shrimp were siphoned using a glass tube, carefully examined for injury, and transferred to wide mouth quart jars, each containing 500 ml of the appropriate concentration. For each concentration, the mysid shrimp were pre-acclimated to within 4 ppt salinity. Five organisms were loaded per test chamber, giving ten per concentration. Based on the recommendations of EPA (1978), the mysids were fed brine shrimp (Artemia) nauplii at the rate of approximately 10 to 20 nauplii per mysid per day to minimize cannibalism.

Dissolved oxygen, pH, temperature, and the number of live organisms were recorded for each test chamber at 0 hours, 24 hours, and 48 hours. The salinity of each test concentration was recorded at the beginning and end of the test. Ammonia concentrations, including total and unionized fractions (expressed in mg/l as N and as NH_3, respectively), were recorded in the controls and the 100% effluent test concentration at the beginning and end of the test. Total ammonia concentrations were determined using an Orion® specific ion probe and a Corning® pH/millivolt meter. The unionized fraction was then determined based on the total ammonia concentration, and the pH, temperature, and salinity of the sample. These values were recorded on the bioassay data forms and are presented in Tables 2 through 5.

Table 1. Concentration Series and Volumes Used for These Static Bioassays *Mysidopsis bahia* (mysid shrimp)

Concentration	Dilution Water	Effluent	Total Volume
Control	500 ml	---	500 ml
5.6%	472 ml	28 ml	500 ml
10.0%	450 ml	50 ml	500 ml
18.0%	410 ml	90 ml	500 ml
32.0%	340 ml	160 ml	500 ml
56.0%	220 ml	280 ml	500 ml
100.0%	---	500 ml	500 ml

Table 2. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Gardinier, Inc., Tampa, Hillsborough County, Florida. NPDES #FL0000761, on 22 to 24 September, 1981.

Outfall #001

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			NI_3/NI_3+NI_4 (mg/l)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
5.6%	5	5	5	7.5	7.0	7.2	7.5	7.7	7.7	21.4	21.4	21.3				
5.6%	5	5	5	7.5	6.4	7.3	7.5	7.7	7.7						26.5	27.3
10.0%	5	5	5	7.4	6.8	7.1	7.5	7.7	7.8	21.4	21.3	21.2				
10.0%	5	5	5	7.4	6.9	7.2	7.5	7.7	7.8						27.0	27.3
18.0%	5	5	5	7.1	6.5	7.3	7.4	7.7	7.8	21.4	21.3	21.1				
18.0%	5	5	5	7.1	6.6	7.3	7.4	7.7	7.8						27.0	27.5
32.0%	5	5	5	7.0	6.8	7.5	7.3	7.7	7.9	21.3	21.4	21.2				
32.0%	5	5	5	7.0	6.8	7.4	7.3	7.7	7.9						26.0	27.0
56.0%	5	5	5	6.4	6.8	7.4	7.1	7.7	7.9	21.1	21.4	21.2				
56.0%	5	5	4(5) [a]	6.4	6.8	7.4	7.1	7.7	7.9						26.5	27.5
100.0%	5	5	4	5.6	6.8	7.5	7.0	7.7	7.9	21.0	21.6	21.4	.01/1.64	.03/.90		
100.0%	5	5	4	5.6	6.6	7.5	7.0	7.7	7.9						27.5	28.8

Remarks: a. Number in parentheses used in calculations since one organism was cannibalized between 24 and 48 hours.

Table 3. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Gardinier, Inc., Tampa, Hillsborough County, Florida. NPDES #FL0000761, on 22 to 24 September, 1981

Outfall #005

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			NI_3/NI_3+NI_4 (mg/l)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
5.6%	5	5	5	7.5	6.5	7.3	7.7	7.7	7.8	21.7	21.4	21.2				
5.6%	5	5	5	7.5	6.7	7.3	7.7	7.7	7.8						26.5	27.0
10.0%	5	5	5	7.4	6.8	7.3	7.7	7.8	7.9	21.4	21.3	21.2				
10.0%	5	5	5	7.4	6.8	7.3	7.7	7.7	7.8						27.0	27.5
18.0%	5	5	5	7.4	6.7	7.2	7.7	7.7	7.8	21.4	21.3	21.2				
18.0%	5	5	5	7.4	6.8	7.2	7.7	7.8	7.8						27.0	27.5
32.0%	5	5	5	7.3	6.8	7.2	7.7	7.8	7.9	21.3	21.3	21.2				
32.0%	5	5	5	7.3	6.8	7.2	7.7	7.8	7.9						26.5	27.0
56.0%	5(4) [a]	4	4	7.1	6.8	7.2	7.6	7.8	7.9	21.3	21.4	21.3				
56.0%	5(4) [a]	4	4	7.1	6.8	7.2	7.6	7.8	7.9						27.0	27.8
100.0%	5	5	4(5) [b]	6.8	7.0	7.3	7.6	7.8	7.9	21.1	21.6	21.6	.03/2.17	.05/1.68		
100.0%	5	4	4	6.8	7.0	7.3	7.6	7.8	7.9						27.5	29.0

Remarks: a. Number in parenthesis used in calculations since one organism jumped out between 0 and 24 hours.
b. Number in parenthesis used in calculations since one organism was cannibalized between 24 and 48 hours.

Table 4. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Gardinier, Inc., Tampa, Hillsborough County, Florida. NPDES #FL0000761, on 22 to 24 September, 1981.

Outfall #012

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Ni_3/Ni_3+Ni_4 (mg/l)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
5.6%	5	5	5	7.6	7.0	7.4	7.7	7.7	7.8	21.5	21.5	21.4				
5.6%	5	5	5	7.6	7.1	7.4	7.7	7.7	7.8						25.0	26.0
10.0%	5	5	5	7.5	7.1	7.4	7.6	7.7	7.8	21.4	21.5	21.4				
10.0%	5	5	5	7.6	7.1	7.5	7.6	7.8	7.8						24.5	25.0
18.0%	5(4) [a]	4	4	7.6	7.2	7.6	7.6	7.7	7.9	21.4	21.6	21.3				
18.0%	5	5	5	7.6	7.2	7.6	7.5	7.7	7.8						23.0	23.5
32.0%	5	5	5	7.7	7.6	8.2	7.3	7.7	7.8	21.3	21.6	21.4				
32.0%	5	5	5	7.7	7.6	8.0	7.3	7.6	7.8						20.0	20.5
56.0%	5	5	4(5) [b]	8.0	7.8	8.9	7.1	7.6	7.8	21.1	21.6	21.4				
56.0%	5	5	5	8.0	7.9	8.9	7.1	7.5	7.8						14.5	14.8
100.0%	5	3	3	8.4	8.2	8.8	6.7 [c]	7.0	7.1	20.6	21.5	21.4	.05/26.6	.13/25.2		
100.0%	5	5	4	8.4	8.1	8.3	6.7 [c]	6.9	7.0						7.5	7.5

Remarks: a. Number in parenthesis used in calculations since one organims was cannibalized between 0 and 24 hours.
b. Number in parenthesis used in calculations since one organism was cannibalized between 24 and 48 hours.
c. The pH of the 100% effluent was adjusted with HCl to the original pH of the sample before salinity adjustment (6.7 units)

Table 5. Data recorded during 48 hour, *Mysidopsis bahia*, static acute toxicity bioassay of Gardinier, Inc., Tampa, Hillsborough County, Florida. NPDES #FL0000761, on 22 to 24 September, 1981.

Control Series

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			NI_3/NI_3+NI_4 (mg/l)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
Seawater Control	5(4) [a]	4	3(4) [b]	7.7	6.5	7.1	7.7	7.8	7.7	21.9	22.0	21.7	.01/.46	.01/.57		
Seawater Control	5	5	5	7.7	6.8	7.1	7.7	7.8	7.7						26.8	27.0
Salinity Control	5	5	5	8.0	7.1	7.4	7.8	7.8	7.8	21.7	21.9	22.1	.01/.29	.01/.25		
Salinity Control	5	5	5	8.0	7.1	7.4	7.8	7.8	7.8						15.0	15.0
Sea Salts pH Adjusted	5	5	5	8.8	7.2	8.1	6.7 [c]	7.5	7.8	21.6	21.2	21.3	0/.18	———		
Sea Salts pH Adjusted	5(4) [a]	4	4	8.8	7.4	7.8	6.7 [c]	7.5	7.8						8.0	8.0

Remarks: a. Number in parentheses used in calculations since one organism was cannibalized between 0 and 24 hours.
b. Number in parentheses used in calculations since one organims was cannibalized between 24 and 48 hours.
c. The pH of the Sea Salts Control was adjusted with HCl to th original pH of the sample from Outfall #012 (6.7 units).

RESULTS AND DISCUSSION

The bioassays performed on effluent from Outfalls #001, #005 and #012 of Gardinier, Inc., resulted in some lethality in the 100% test concentrations. An insufficient number of organisms however, died to calculate LC_{50} values. Nevertheless, some of the mortality noted in the sample from Outfall #012 may be attributed, in part, to the high concentration of total ammonia in the sample (26.6 ug/l, Table 4). This concentration is slightly less than the range found to be lethal to certain aquatic organisms (Thurston and Russo 1981). The samples from Outfalls #001 and #005 contained significantly less ammonia. The concentrations of unionized ammonia in these samples were below reported toxicity range.

The DER Chemistry Section in Tallahassee has analyzed samples of effluent from Outfall #005 for metals and organics, and a sample from Outfall #001 for organics only. Results of these analyses are presented in Table 6. Unfortunately, samples from Outfall #012 were not collected for chemical analyses. No organic compounds were detected in either Outfall #001 or #005, and of the metals tested for in Outfall #005, only zinc and selenium were detected in sufficient concentration for accurate quantification. The concentrations of these metals independently should not be toxic in a 48 hour static test (U.S. EPA, 1976). However, their synergistic effects on aquatic organisms are as yet unknown. The cause(s) of the mortality observed in the higher test concentrations of Outfalls #001 and #005 are therefore unknown. Ammonia may account for some of the toxicity noted in Outfall #012. Due to a high concentration of ammonia, borderline acute toxicity, and an absence of chemical analyses we suggest that testing at Outfall #012 be repeated to include CSI-Toxics analyses with the bioassay.

Table 6. Results of Chemical Analyses Performed on Samples of Effluent from Outfalls #001 and #005, Gardinier, Inc., Tampa, collected on 21 September, 1981.

Organics

Parameter	Outfall #001	Outfall #005
Base/Neutral Extractables:	None Detected	None Detected
Acid Extractables:	None Detected	None Detected
Pesticide Extractables:	None Detected	None Detected

Metals

Antimony	--[a]	200 µg/l[b]
Arsenic	--	50 µg/l[b]
Beryllium	--	10 µg/l[b]
Cadmium	--	10 µg/l[b]
Chromium	--	50 µg/l[b]
Copper	--	25 µg/l[b]
Lead	--	50 µg/l[b]
Mercury	--	0.2 µg/l[b]
Nickel	--	50 µg/l[b]
Selenium	--	39 µg/l
Silver	--	15 µg/l[b]
Thallium	--	100 µg/l[b]
Zinc	--	122 µg/l

[a] Metals analyses were not performed on samples from Outfall #001.

[b] Actual value is known to be less than value given. Value given is generally the minimum limit of detection for accurate quantification.

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