BIOASSAYS OF THE FORTENBERRY WASTEWATER TREATMENT PLANT

PRE AND POST ALUM TREATED WASTEWATERS

MERRITT ISLAND, BREVARD COUNTY, FLORIDA

NPDES #FL0026816

SAMPLED 6/19/84

Biology Section
Bureau of Laboratories
September 14, 1984

BIOASSAYS OF THE FORTENBERRY WASTEWATER TREATMENT PLANT

PRE AND POST ALUM TREATED WASTEWATERS

MERRITT ISLAND, BREVARD COUNTY, FLORIDA

NPDES #FL0026816

Biology Section
Bureau of Laboratories
September 14, 1984

EXECUTIVE SUMMARY

Fortenberry WWTP, NPDES #FL0026816, Merritt Island, on 20 to 22 June, 1984.

To determine if the recently instituted alum flocculation treatment for phosphorus removal would also mitigate this plant's consistantly toxic effluent (FDER Biology Section 1982, 1983a, 1983b), additional bioassays were conducted. The following is a description of the samples on which the bioassays were performed and the resultant LC_{50} values: (1) Industrial grade alum ($Al_2(SO_4)_3$) solution used for the alum flocculation treatment, LC_{50} = considerably higher than highest concentration tested (500 ppm); (2) Wastewater collected from the aeration chamber prior to alum addition, LC_{50} = 28.8%; (3) wastewater (effluent) collected after alum addition but prior to chlorination, LC_{50} = 31.2%; (4) wastewater (effluent) collected after alum addition and chlorination, LC_{50} = 32%; (5) wastewater (effluent) collected after alum addition and chlorination but subsequently de-chlorinated with sodium thiosulfate, LC_{50}=32%.

These results indicate that there was no significant reduction in effluent toxicity (to Mysidopsis bahia, the test organism) from alum flocculation treatment. These LC_{50} values are similar to the past three test series (Table 1).

The results of chemical analyses, performed by Enviropact of Jacksonville, failed to indicate the presence of any organic or metal constituents in potentially toxic concentrations.

INTRODUCTION

The Fortenberry Wastewater Treatment Plant is located at the corner of South Plumosa and Fortenberry Roads, in Merritt Island, Brevard County, Florida (Fig. 1). This facility has a design capacity of 0.8 MGD and treats an average of 0.69 MGD of domestic wastewater from a population of approximately 10,000. According to the NPDES permit, no industrial wastes are treated at this facility. Effluent is discharged to Fortenberry Ditch which flows to Sykes Creek, a tributary of Newfound Harbor. Newfound Harbor is a portion of the Banana River (Fig. 1).

The Biology Section has previously performed bioassays on this plant in April, 1982, January, 1983, and October, 1983. The results of each of these series of tests indicated that the facility's effluent was toxic (Table 1).

Since the last DER bioassays in October, 1983, the Fortenberry personnel have implemented an alum flocculation procedure as part of their treatment process for phosphorus removal. To determine if this alum treatment would also reduce the inherent toxicity of the effluent, the Biology Section performed a series of bioassays on samples of various wastewaters, collected both prior to and after the addition of the alum. The tests were conducted from 20 to 22 June, 1984. The results are presented in this report. Those involved in performing these tests and in preparation of this report were: P. D. Brooks, C. W. Dye, R. B. Frydenborg, and M. L. Roll.

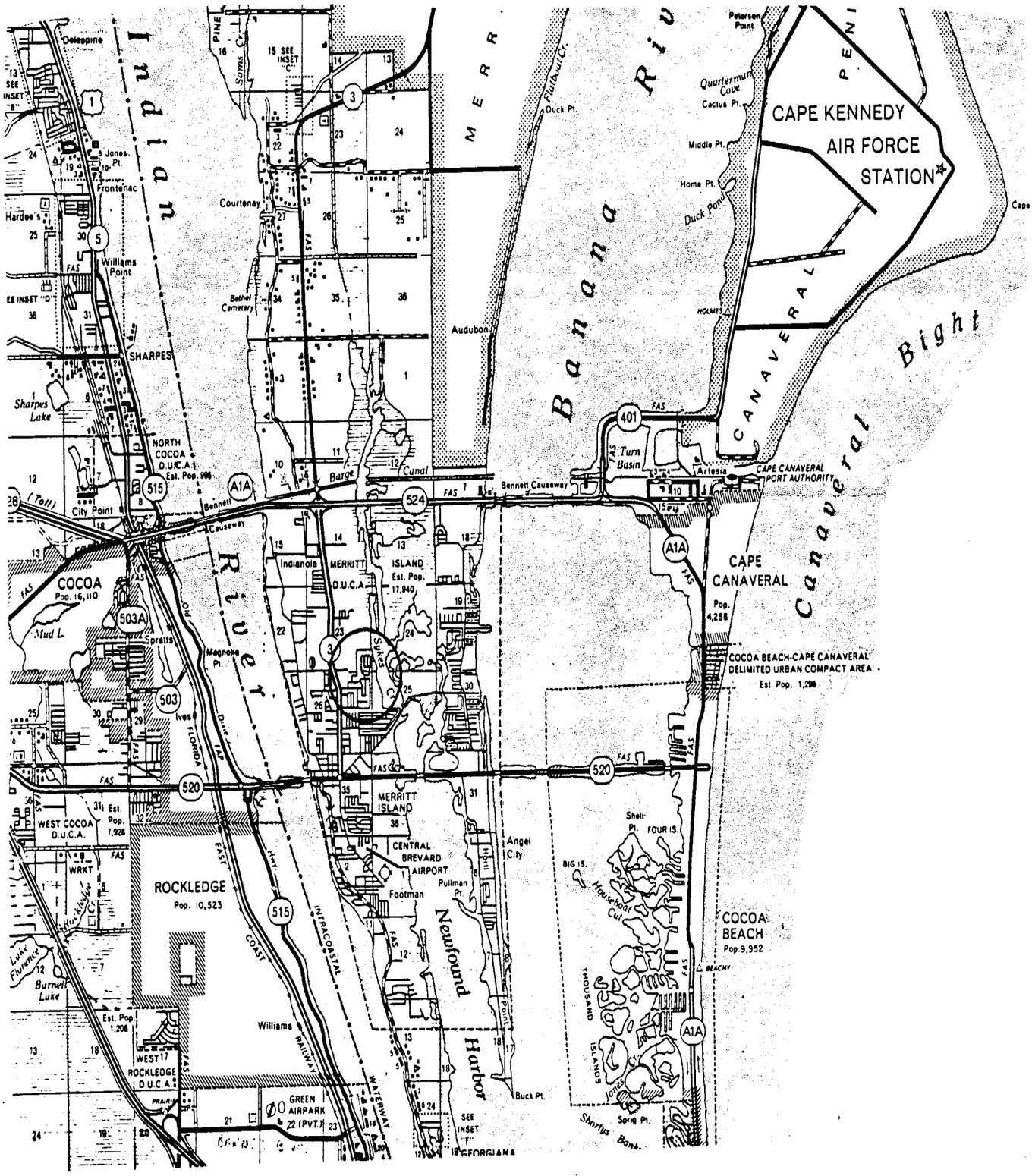


Figure 1. Portions of Brevard County, Florida, including City of Merritt Island and study area.

Table 1. Summary of acute toxicity tests performed by FDER Biology Section from 1982 to present, using Mysidopsis bahia as the test organism.

Test Date	Industrial Grade Treatment Alum LC_{50}	Pre-Alum Effluent LC_{50}	Pre-Cl_2 LC_{50} Effluent	Cl_2 LC_{50} Effluent	DE-Cl_2 LC_{50} Effluent
April 1982	NA	NA	12%	12%	13%
January 1983	NA	NA	21.5%	23.9%	24.5%
October 1983	NA	NA	24.3%	22.2%	19%
June 1984	*	28.8%	31.2%	32%	32%

* Minor mortality exhibited in this test indicates that the LC_{50} is considerably higher than both the highest concentration tested (500 ppm) and the highest concentration used for treatment (135 ppm) at the Fortenberry WWTP (Mr. Dick Martin, personal communication).

Table 2. Concentration Series and Volumes Used for These Static Bioassays

Mysidopsis bahia (mysid shrimp)

Concentration	Dilution Water	Effluent	Total Volume
Control	500 ml	------	500 ml
10.0%	450 ml	50 ml	500 ml
32.0%	340 ml	160 ml	500 ml
100.0%	------	500 ml	500 ml

Alum Bioassay

Concentration	Total Volume
10 ppm	500 ml
50 ppm	500 ml
100 ppm	500 ml
250 ppm	500 ml
500 ppm	500 ml

METHODS AND MATERIALS

Test methods used to conduct these static bioassays are extensively described by Peltier (1978) and the FDER Biology Section (1983). The organism selected for this study is among those recommended by Peltier (1978), the U.S. EPA (1978), and the FDER Biology Section (1983). The life history and maintenance procedures used to culture the organism are detailed below.

History and Maintenance of Bioassay Organisms

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 a 16:8 hour light-dark cycle 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 and once daily on weekends with freshly hatched Artemia (brine shrimp) and are kept at a constant temperature of 23° plus or minus 3°C. Adult or large juvenile mysids were used in this test.

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

Test Methods

Five separate 48 hour static acute toxicity bioassays were performed on samples of industrial grade alum, pre-alum treated wastewater, pre-chlorinated, chlorinated, and de-chlorinated effluents from the Fortenberry WWTP. The tests were performed from 1030 hours on 20 June to 1030 hours on 22 June, 1984. The samples were collected by Mr. Gary J. Groghean, employed by the Fortenberry plant, using standard wastewater sampling procedures. Separate samples were obtained for chemical and biological testing. The bioassay samples were iced and transported to the DER laboratory in Tallahassee for analyses within 24 hours of collection. The samples for chemical analyses were shipped to Enviropact Inc., of Jacksonville, for analyses.

To differentiate between the toxicity resulting from chlorine or alum, and the toxicity associated with some other component of the effluent, the Biology Section adopted the following test procedure:

Test 1. Industrial grade alum solution (Table 3). This test was performed on a sample of the actual alum solution used by the plant in the treatment process, and was intended to evaluate the toxic properties of the alum.

Test 2. Wastewater collected from the aeration chamber[a] (Table 4). This test was performed on a sample of wastewater collected prior to alum treatment to compare its toxicity with the toxicity of the treated effluent after alum addition.

Test 3. Pre-chlorinated Effluent (Table 4). This test was performed on an effluent sample collected at the end of the treatment process but prior to chlorination, and was intended to evaluate the toxicity of the effluent without the added toxic effects of chlorine.

Test 4. Chlorinated Effluent (Table 5). This test was performed on an effluent sample collected at the point of discharge.

Test 5. De-chlorinated Effluent (Table 5). This test was performed on a subsample of the chlorinated effluent sample in which the chlorine had been neutralized. De-chlorination was accomplished by adding a calculated amount of 0.025 N sodium thiosulfate. This test was intended to evaluate the combined toxicity of the effluent and the chlorine reaction products.

Saltwater for dilution of the effluent samples was obtained from the FSU Marine Laboratory at Turkey Point (salinity = 21.7 ppt). For test concentrations below 100%, this diluent was mixed directly with the effluent, achieving a range of final salinities (15 ppt to 19 ppt). For the

[a] This wastewater was collected prior to the major treatment steps of sludge removal and clarification.

100% effluent test concentrations, freshly autoclaved artificial sea salts were added until salinities of approximately 7 ppt were achieved (the lower limit of mysid shrimp salinity tolerance). For the alum bioassay, precise quantities of the 48.8% alum solution were added directly to this saltwater diluent, achieving a concentration series of approximately 10 ppm to 500 ppm (Table 2). The salinities of these concentrations ranged from 21.8 ppt to 22.2 ppt. Two control groups (Table 3) were then used to ensure that any mortality in the test organisms was not the result of toxic properties associated with the diluent, the artificial sea salts, or the salinity range. The control groups included:

1) Diluent Control - Turkey Point water (21.7 ppt). This represents the highest concentration of Turkey Point water used in the bioassays, and tests for toxicity in the diluent. This is also the highest salinity used in the bioassays, and therefore tests the tolerance of the organisms to this salinity.

2) Sea Salts Control - Well water, adjusted with artificial sea salts to approximately 7 ppt salinity. This tests for toxicity of the highest concentration of artificial sea salts used in the bioassays, as well as for tolerance of the organisms to the lowest salinity used in the bioassays.

The concentration series selected for this study (Table 2) was an abbreviated form of that recommended by 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 10 ppt, 15 ppt, and 20 ppt salinity aquaria to culture dishes for observation and selection of individuals for the 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 (YSI Model 57 oxygen meter), pH (Corning Model 7 pH meter with Orion Ross® combination electrode), temperature (NBS calibrated glass thermometer), and the number of live organisms were recorded for each test concentration at 0 hours, 24 hours, and 48 hours. The salinity (YSI Model 33 S-C-T meter) of each test concentration was recorded at the beginning and end of the test. All instruments were calibrated daily according to manufacturer's recommendations. Ammonia concentrations, including the total and unionized fraction (expressed in mg/l as N and as NH_3, respectively), were recorded in the controls and the 100% effluent test concentrations at the beginning of the test. Total ammonia concentrations were determined using an Orion® specific ion probe and an Orion Ionalyzer®. The unionized fraction was then calculated 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 3 through 5.

Table 3. Data recorded during 48 hour, *Mysidopsis bahia*, static acute toxicity bioassay of Fortenberry WWTP, Merritt Island, Brevard County, Florida, NPDES #FL0026816, on 20 to 22 June, 1984.

Control Series and Test 1 - Industrial grade alum solution used in treatment process.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			NH_3/N (mg/l)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
Seawater Control	5	5	5	9.3	6.5	3.8	8.2	7.6	7.3	19.7	18.5	19.2	0/0	—		
Seawater Control	5	5	4	9.3	6.8	4.7	8.2	7.6	7.3						21.7	21.0
Sea Salts Control	5	5	4	8.2	7.8	3.4	8.4	8.0	7.5	21.0	18.4	19.1				
Sea Salts Control	5	5	5	8.2	7.9	3.1	8.4	8.0	7.5						7.0	7.0
Test 1 - Alum Solution																
10 PPM	5	5	3	8.7	6.9	4.6	7.7	7.7	7.4	21.0	18.3	19.0				
10 PPM	5	5	4	8.7	6.9	5.1	7.7	7.7	7.4						21.8	21.0
50 PPM	5	5	5	9.0	7.4	5.3	7.1	7.7	7.4	20.5	18.0	18.8				
50 PPM	5	5	5	9.0	7.5	5.7	7.1	7.7	7.4						21.8	20.5
100 PPM	5	5	5	8.9	7.7	5.7	6.6	7.5	7.3	21.6	18.0	18.6				
100 PPM	5	5	5	8.8	7.7	5.7	6.6	7.5	7.3						22.2	21.2
250 PPM	5	5	5	8.6	7.8	5.7	6.8[a]	7.5	7.3	20.6	18.0	18.6				
250 PPM	5	4	4	8.2	7.8	5.8	6.8[a]	7.5	7.3						21.8	21.2
500 PPM	5	4	3	8.7	7.8	6.2	6.8[a]	7.5	7.3	20.5	18.0	18.6				
500 PPM	5	4	4	8.7	7.8	6.2	6.8[a]	7.5	7.3						22.0	21.2

Remarks: [a] pH adjusted from 4.5 to 6.8 (approximate pH of final effluent).

Table 4. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Fortenberry WWTP, Merritt Island, Brevard County, Florida, NPDES #FL0026816, on 20 to 22 June, 1984.

Test 2 - Pre-Alum wastewater and Test 3 - Pre-Cl_2 effluent (after alum treatment).

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			NH_3/N (mg/l)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
Test 2 - Pre-Alum																
10%	5	4	4	8.7	6.5	5.2	8.1	7.7	7.4	19.8	18.5	19.2				
10%	5	5	4	8.7	6.9	5.2	8.1	7.7	7.4						19.8	19.8
32%	5	5	3	7.5	6.6	5.6	7.9	7.7	7.6	20.2	18.4	19.1				
32%	5	5	3	7.5	7.4	6.3	7.9	7.8	7.6						15.7	15.5
100%	5	1	0	4.3	5.5	4.7	7.5	7.8	7.7	19.9	18.5	19.1	4.0/.051			
100%	5	2	0	4.4	5.9	4.1	7.5	7.8	7.7						7.2	7.0
Test 3-Pre-Cl_2																
10%	5	5	5	8.7	6.0	4.4	8.1	7.6	7.5	20.0	18.1	18.7				
10%	5	5	4	8.7	6.4	4.7	8.1	7.6	7.5						19.9	19.2
32%	5	5	3	8.3	6.5	5.1	7.7	7.7	7.5	19.9	18.0	18.6				
32%	5	5	3	8.3	6.8	5.4	7.7	7.7	7.5						15.7	15.0
100%	5	1	0	6.6	6.6	5.2	7.4	7.8	7.7	19.8	18.0	18.6	5.5/.062			
100%	5	1	0	6.6	7.0	5.4	7.4	7.8	7.7						7.5	7.0

Table 5. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Fortenberry WWTP, Merritt Island, Brevard County, Florida, NPDES #FL0026816, on 20 to 22 June, 1984.

Test 4 - Chlorinated effluent (after alum treatment) and Test 5 - De-chlorinated effluent (after alum treatment).

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			NH_3/N (mg/l)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
Test 4 - Cl_2																
10%	5	5	5	8.8	7.0	5.2	8.1	7.8	7.5	20.2	18.5	19.0				
10%	5	5	5	8.8	7.0	4.1	8.1	7.8	7.5						19.9	19.2
32%	5	5	3	8.8	7.2	5.1	7.8	7.8	7.5	20.4	18.5	19.0				
32%	5	5	2	8.8	7.6	5.7	7.8	7.8	7.5						15.8	15.1
100%	5	0	0	8.0	8.3	5.7	7.4	7.9	7.7	21.4	18.6	19.1	5.6/.070			
100%	5	2	0	8.0	8.3	5.8	7.4	7.9	7.7						7.5	7.0
Test 5 - De-Cl_2																
10%	5	5	5	8.8	6.4	4.5	8.2	7.8	7.5	19.9	18.2	18.8				
10%	5	5	5	8.8	6.5	5.0	8.2	7.8	7.5						19.9	19.2
32%	5	5	1	8.9	6.6	5.7	7.9	7.8	7.6	19.8	18.2	18.8				
32%	5	5	4	8.9	6.7	5.9	7.9	7.8	7.6						15.8	15.0
100%	5	2	0	8.2	6.5	5.5	7.7	7.9	7.8	20.1	18.4	19.0	5.6/.127			
100%	5	3	0	8.2	6.5	5.2	7.7	7.9	7.8						7.2	7.0

REMARKS:

Table 6. LC_{50} Data for Bioassays of Fortenberry WWTP, Merritt Island, on 20 to 22 June, 1984. NPDES #FL0026816.

Organism	Method of Data Analysis	24 Hour LC_{50} and 95% Confidence Intervals	48 Hour LC_{50} and 95% Confidence Intervals
Test #1:	Binomial	e	e
M. bahia	Moving Average	e	e
Alum Sample	Probit	e	e
Test #2:	Binomial	77.1% (32 and)	37.0% (0 and 100)
M. bahia	Moving Average	a	28.8% (16.6 and 47.4),d
Pre Alum Sample	Probit	78.5% (0 and),c	27.2% (14.7 and 47.7)
Test #3:	Binomial	70.0% (32 and)	37.0% (10 and 100)
M. bahia	Moving Average	a	31.2% (19.8 and 48.6),d
Pre Chlorinated Sample	Probit	a	30.7% (18.5 and 50.5)
Test #4:	Binomial	69.7% (32 and)	32% (10 and 100)
M. bahia	Moving Average	a	a
Chlorinated Sample	Probit	a	a
Test #5:	Binomial	100% (32 and)	32% (10 and 100)
M. bahia	Moving Average	a	a
De Chlorinated Sample	Probit	a	a

[a] Due to an insufficient number of dead organisms, or to the irregular distribution of mortality, an LC_{50} value cannot be calculated using this method of statistical analysis.

[b] Due to the distribution of mortality, the LC_{50} value calculated by this method of statistical analysis does not meet the criteria established by the Committee on Methods for Toxicity Tests with Aquatic Organisms.

[c] Due to the distribution of mortality, results calculated using the probit method are not statistically sound.

[d] This LC_{50} value is reported in the text since it is the most statistically conservative value of the data set.

[e] Minor mortality exhibited in this test indicates that the LC_{50} is considerably higher than both the highest concentration tested (500 ppm) and highest concentration used for treatment (135 ppm).

Table 7. Results of Chemical Analyses[a] on samples of Influent and Effluent Wastewaters[b] from the Fortenberry WWTP, collected June 20, 1984.

Organics

	Influent	Effluent
Acid Extractables:	< Detection Limit	< Detection Limit
Base Neutral Extractables:	< Detection Limit	< Detection Limit
Pesticide Extractables:	< Detection Limit	< Detection Limit

Metals

	Influent	Effluent
Antimony	< Detection Limit	< Detection Limit
Arsenic	< Detection Limit	< Detection Limit
Beryllium	< Detection Limit	< Detection Limit
Cadmium	< Detection Limit	< Detection Limit
Chromium	< Detection Limit	< Detection Limit
Copper	0.03 mg/l	< Detection Limit
Lead	< Detection Limit	< Detection Limit
Mercury	< Detection Limit	< Detection Limit
Nickel	0.015 mg/l	0.015 mg/l
Selenium	< Detection Limit	< Detection Limit
Silver	< Detection Limit	< Detection Limit
Thallium	< Detection Limit	< Detection Limit
Zinc	0.12 mg/l	0.02 mg/l

Other Parameters

	Influent	Effluent
Ammonia as N	----------	17.7 mg/l
Unionized Ammonia	----------	0.05 mg/l

[a] Performed by Enviropact of Jacksonville
[b] Samples consisted of 24 hour composites

RESULTS AND DISCUSSION

Toxicity bioassays were performed on samples collected from the Fortenberry WWTP, consisting of wastewater before alum treatment, and pre-chlorinated, chlorinated, and de-chlorinated effluents that had been treated with alum. All samples exhibited similar toxicity. The 48 hour LC_{50} values for these tests were 28.8%, 31.2%, 32% and 32% respectively (Table 6). Besides indicating the presence of a consistent acute toxicity problem at this plant, these bioassays also show that neither the alum flocculation process, normal wastewater treatment, or chlorination mitigated this toxicity.

An additional bioassay was conducted on the actual industrial grade alum solution used for the alum flocculation treatment. This test indicated that the LC_{50} for the alum was significantly greater than the highest concentration tested (500 ppm), since only 3 shrimp died in that concentration (Table 3). Because the actual concentration of this alum solution used during treatment at the Fortenberry facility is 135 ppm (Mr. Dick Martin, personal communication) the alum probably did not contribute to the observed mortality in the three post-alum treated effluents during these tests.

The relatively small amounts of total and unionized ammonia detected in these effluents (5.6 mg/l and $\leq$ 0.127 mg/l, respectively) suggests that ammonia was not the cause for the observed mortality. The fact that the pre-chlorinated, chorinated, and de-chlorinated effluents all had virtually identical LC_{50} values suggests that chlorine (measured at 0.6 ppm HACH and 0.44 ppm iodometric) also was not responsible for this toxicity.

The results of chemical analyses (Table 7) failed to indicate the presence of any organic or metal constituents in potentially toxic concentrations. Only moderate concentrations of nickel (0.015 mg/l) and zinc (0.02 mg/l) were detected in the final effluent. Interestingly, however, the Enviropact analyses detected a higher concentration of total ammonia (17.7 mg/l) in the final effluent than did the DER analyses (5.6 mg/l). Even this higher concentration of total ammonia, however, could not be responsible for the extreme toxicities noticed in the Fortenberry samples. These chemical analyses suggest that the Fortenberry toxicity problem may not be readily identifiable by chemical means.

Discussion of the Toxicity Criteria

The toxicity standards of Chapters 17-3 and 17-4, F.A.C., are complex. Because of this complexity, they will be briefly reviewed here so that these test results may be more readily compared with the standards. For legal purposes, however, the language of the Florida Administrative Code should be consulted directly.

The two basic concepts utilized in the standards are acute and chronic toxicity (defined in 17-3.021(1) and (4), respectively). Simplifying the actual F.A.C. language somewhat, acute toxicity is defined as the presence of a substance in a concentration one-third as great as that concentration which kills one-half of the test organisms in 96 hours, i.e., one-third of the 96 hour LC_{50}. Chronic toxicity is similarly defined as one-twentieth of the 96 hour LC_{50}. Therefore, if a test solution kills one-half or more of a group of test organisms in 96 hours, it must contain at least three times the defined "acutely toxic" concentration and at least twenty times the "chronically toxic" concentration of some substance or substances. If a test solution causes that same mortality in less than 96 hours, (for example, in 24 or 48 hours), it is at least as toxic as the example given above, and actually is probably considerably more toxic.

The particular restrictions applied to a given discharger depend upon the existance of a mixing zone, whether as a specific part of the permit or based on the existance of a currently valid permit predating the language in Chapter 17-4 requiring mixing zone designation. In the absence of a mixing zone, the general criteria for surface waters (17-3.061) are applicable at all points, beginning at the point of discharge. This section prohibits the discharge of substances in concentrations which are chronically toxic (17-3.061(2)(p)); that is, the concentrations cannot exceed one-twentieth of the 96 hour LC_{50} as discussed above. If a mixing zone does exist, then this chronic toxicity standard is only applicable from the edge of the mixing zone and beyond. Within the mixing zone, the less stringent acute toxicity standard of the minimum criteria for all waters (17-3.051(1)(d)) applies: one-third of the 96 hour LC_{50}. The acute toxicity standard does not apply, however, to each point within a mixing zone not designated for dredge and fill permitting, but rather to the average of a number of points within such a mixing zone, based on the provisions of the surface water mixing zones section of Chapter 17-4 (17-4.244(4)). At the same time, though, this same rule prohibits waste concentrations within such a mixing zone (i.e., at any point within the mixing zone), from exceeding the 96 hour LC_{50}. Therefore, at any point within such a mixing zone, including the point of discharge, one-half of the test organisms cannot be killed in 96 hours. Within a mixing zone designated for dredge and fill permitting, the acute toxicity standard (one-third of the 96 hour LC_{50}) applies at all points, including the point of discharge.

From the above discussion, it should be clear that if the least stringent toxicity standard, the 96 hour LC_{50}, is exceeded at any point, from the point of discharge outwards, by any discharger, then a violation of the standards has occurred. This is an important consideration since the test

procedure here reported involves the measurement of the 50% lethal concentration, and not some fraction of that concentration. Any discharger required to meet the one-twentieth of the 96 hour LC_{50} standard is therefore being tested very leniently. Any reduction in the test period from 96 hours provides an added degree of leniency to a discharger.

A number of different dilutions were examined in order to determine by how much, if any, the discharge exceeds the 96 hour LC_{50}. For example, if the sample, after two-fold dilution with diluent (a 33% concentration), kills one-half of the test organisms after 96 hours, then the sample is three times as toxic as is allowed by that standard. Similarly, if a 5% solution of the sample kills 50% of the organisms, the sample is twenty times as toxic as is allowed. Toxicities are reported here in that manner, i.e., in terms of the percentage dilution of the test sample. The smaller the percentage which is reported means a correspondingly greater toxicity.

Note that even if a discharger receives a very large mixing zone not designated for dredge and fill permitting, the regulations require that the maximum toxicity at any point within the mixing zone be restricted to the 96 hour LC_{50}. The results here reported are based on actual effluent samples, representative of the effluent concentration which enters waters of the state at the point of discharge. If it is demonstrated that, under the conditions existing at the point of discharge, effluent concentrations will be less than at the actual sampling point (if the two points are different), the reported bioassay results will reflect the reduced discharge concentration.

With respect to the species of organisms used in these tests, the language of the F.A.C. indicates that they should be "significant to the indigenous aquatic community". All species used in these tests are significant to the indigenous aquatic community since they are sensitive to toxic substances which may be expected to impact the indigenous community.

The toxicity reported here is in excess of allowable limits.

LITERATURE CITED

American Public Health Association. 1980. Standard Methods for the Examination of Water and Wastewater. 15th ed. 1134 p.

Florida Department of Environmental Regulation, Biology Section. 1982. Bioassays of the Fortenberry Wastewater Treatment Plant, Merritt Island, Brevard County, Florida. NPDES #FL0026816. FDER. 17 p.

Florida Department of Environmental Regulation, Biology Section. 1983. Quality Assurance Manual for Performing Acute Toxicity Tests. FDER. 22 p.

Florida Department of Environmental Regulation, Biology Section. 1983a. Bioassays of the Fortenberry Wastewater Treatment Plant, Merritt Island, Brevard County, Florida. NPDES #FL0026816. FDER. 15 p.

_____. 1983b. Bioassays of the Fortenberry Wastewater Treatment Plant, Merritt Island, Brevard County, Florida. NPDES #FL0026816. FDER. 15 p.

Peltier, W. 1978. Methods for measuring the acute toxicity of effluents to aquatic organisms. Environmental Research Laboratory. Athens, Georgia. EPA-600/4-78-012 (Revised July 1978). 51 p.