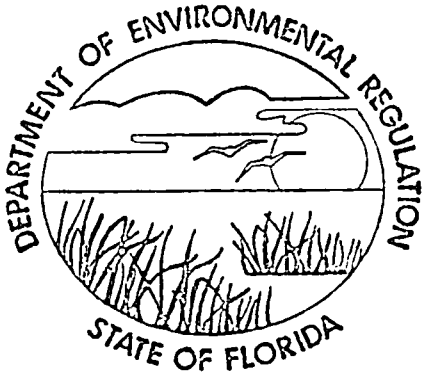


BIOASSAYS OF THE SEMINOLE ELECTRIC COOPERATIVE

PALATKA, PUTNAM COUNTY, FLORIDA

NPDES #FL0036498

MARCH 9, 1988

Biology Section
Division of Environmental Programs

BIOASSAYS OF THE SEMINOLE ELECTRIC COOPERATIVE

PALATKA, PUTNAM COUNTY, FLORIDA

NPDES #FL0036498

Biology Section
Bureau of Laboratories and
Special Programs
March 9, 1988

EXECUTIVE SUMMARY

Seminole Electric Cooperative, Palatka, Putnam County, Florida, NPDES #FL0036498, 20 to 22 October, 1987.

The Seminole Electric Cooperative generates electricity for parts of Putnam County and Palatka. The cooling water effluent from this facility was acutely toxic to the water flea, Ceriodaphnia dubia, with a 48 hour LC_{50} of 55.8% effluent concentration. Although there was some mortality with the other water flea, Daphnia pulex, and the fish, Notropis leedsi, it was considered to be a random pattern and not due to toxicity.

Toxicity is most likely the result of the synergistic effects of several metals. Copper (299 ug/l), Cadmium (2.7 ug/l), and zinc (32.3 ug/l) levels were much higher than the Class III water quality standards (30 ug/l, 1.2 ug/l, and 30 ug/l, respectively).

INTRODUCTION

The Seminole Electric Cooperative generates power for the City of Palatka and portions of Putnam County. Figure 1 shows the approximate location of the facility in Palatka. The plant is a coal fired plant using cleaned Kentucky coal in two 600 megawatt generator units. The main plant discharge through Outfall #001 has a flow rate of approximately 5 MGD consisting of 4 MGD blowdown water from 2 cooling towers and 1 MGD from the plant's waste treatment facility. This waste treatment consists of washdown water and water from other operations. Approximately 18,000 GPD come from the plant's sewage treatment facility which serves a daily population of approximately 375 people. These flows combine in a surge tank and are discharged to the St. Johns River.

To evaluate the existence and extent of toxicity in the cooling water effluent the Northeast District of FDER requested bioassays to be performed. Three static acute screening toxicity bioassays were performed during October, 1987. Results are presented in this report. Those involved in performing the tests and in preparation of the report were: D. A. Chasteen and J. M. Faircloth.

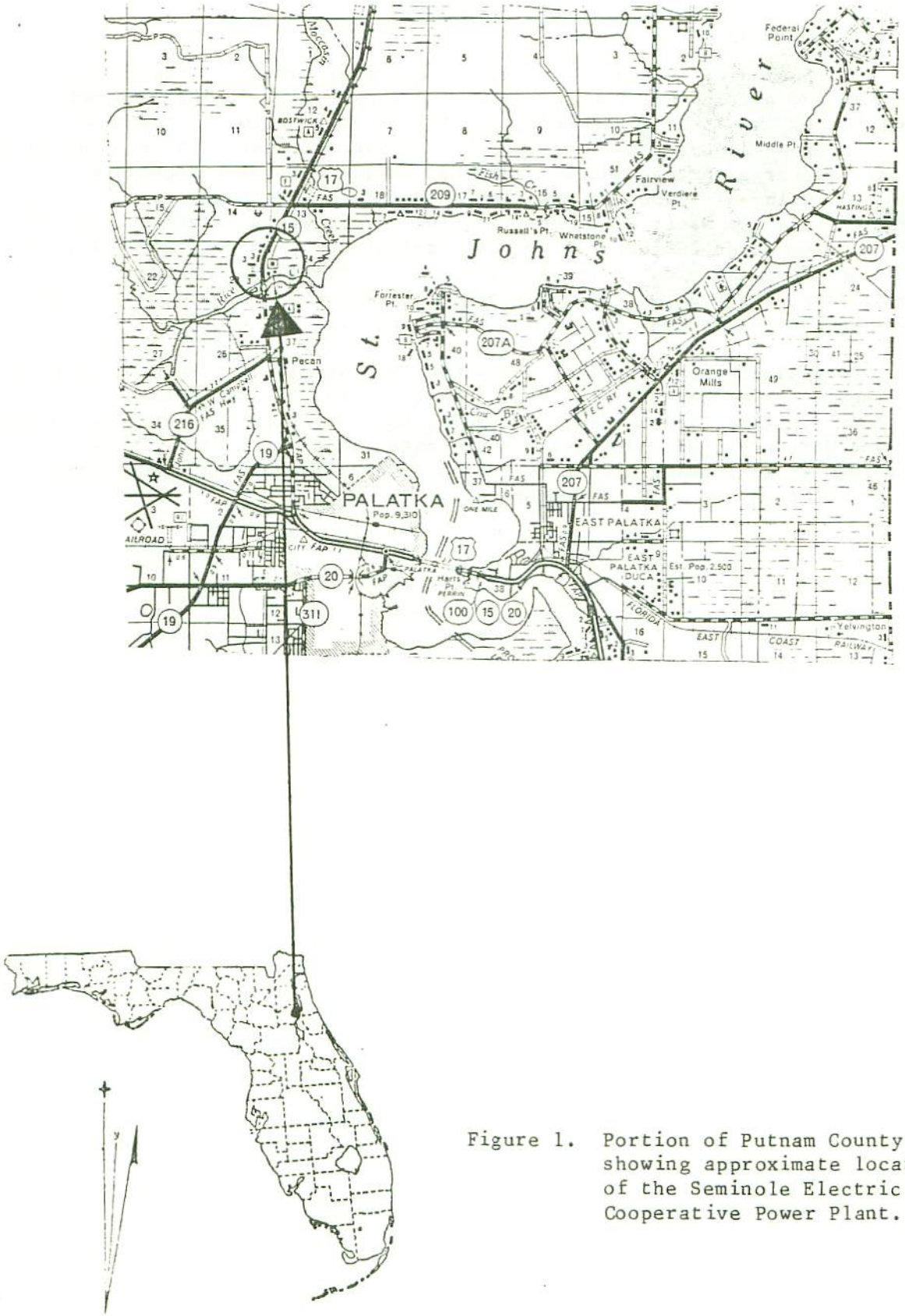


Figure 1. Portion of Putnam County showing approximate location of the Seminole Electric Cooperative Power Plant.

METHODS AND MATERIALS

Test methods used to conduct these static bioassays are extensively described by Peltier and Weber (1985) and the FDER Biology Section (1985). The organisms selected for this study include species recommended by Peltier and Weber (1985) and the FDER Biology Section (1985). Additionally, the Biology Section maintains cultures of several species of organisms indigenous to the State of Florida. One of these indigenous species was also selected for testing. Life histories of these test organisms and maintenance procedures used to culture them are detailed below.

History and Maintenance of Bioassay Organisms

Daphnia pulex (water flea) - A breeding culture of Daphnia pulex was obtained from the EPA laboratory in Athens, Georgia, in June, 1987. This culture has been maintained since its arrival in 2 1/2 gallon all-glass aquaria, filled with unchlorinated DER well water, under a 16:8 hour light-dark cycle. Organisms are fed a liquified blend of Purina Trout Chow® and Cerophyl® twice daily, once daily on weekends, and are kept at a constant temperature of 22° ± 2°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess organisms, and then refilling with fresh aerated well water. Additional measures are taken and/or new cultures started in the event of abnormal circumstances such as: declining populations, ephippia formation, or excessive fungal or bacterial growth.

Ceriodaphnia dubia (water flea) - A breeding culture of Ceriodaphnia dubia was obtained from the EPA laboratory in Athens, Georgia, in June, 1985. The culture is maintained in 2-1/2 gallon all-glass aquaria, filled with unchlorinated DER well water, under a 16:8 hour light-dark cycle. Organisms are fed a liquified blend of Purina Trout Chow®, Cerophyl® and Fleischmann's® yeast twice daily, once daily on weekends, and are kept at a constant temperature of 26° ± 2°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess organisms, and then refilling with fresh aerated well water. Additional measures are taken and/or new cultures started in the event of abnormal circumstances such as: declining populations, ephippia formation, or excessive fungal or bacterial growth.

Notropis leedsi (bannerfin shiner) - Approximately 40 adult bannerfin shiners were obtained from an indigenous population in the upper Suwannee River during October, 1981. The breeding stock is maintained in 30 and 125 gallon all-glass aquaria equipped with a flow-through water exchange system. Water for this system is unchlorinated and is pumped from the DER deep well. The bannerfin shiners are reared at 22° ± 2°C under a 16:8 hour light-dark cycle and are fed Tetra-Min® and frozen Artemia (brine shrimp) twice daily, and once daily on weekends. Breeding and egg hatching are encouraged at 25°C. The eggs are laid between stacked red ceramic tiles separated by a 3mm bead of silicone. Most of the eggs adhere to the tiles and are easily removed to heated, aerated hatching tanks. The narrow space between the tiles eliminates egg predation by adult fish. New hatching tanks are started regularly to segregate fry

into even age groups. Newly hatched fry are fed a liquefied blend of Purina Trout Chow® and Cerophyl® twice daily. After one week, feeding is augmented with newly hatched Artemia nauplii and finely crushed Tetra Min®. The fish used in this test were 27 days old at the time of the test.

Standard Reference Toxicity Assays

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

Methods used to perform acute toxicity bioassays are described by Peltier and Weber (1985) and the FDER Biology Section (1985). Some of the methods described below are more specific than those of Peltier and Weber. These will be noted in more detail.

Sampling Methods and Test Dates

Three static acute toxicity screening bioassays were performed on a sample of cooling water effluent from outfall #001 of the Seminole Electric Cooperative power plant in Palatka. The tests were performed from 0945 hours on 20 October to 0945 hours on 22 October, 1987.

Separate samples were obtained for chemical and biological testing. Samples for metal analyses were preserved with HNO_3. Samples for organic chemical analyses and for the bioassays were unpreserved. The samples were collected by Mr. Mark Sittig of the Northeast District of FDER at 1100 hours on 19 October, 1987, using standard wastewater sampling procedures. The samples were iced and transported to the DER laboratory in Tallahassee for analyses within 24 hours of collection.

Test Temperature

Upon arrival of the iced (4°C) bioassay samples in the Tallahassee laboratory, the containers were placed in warm water and the temperature of the samples allowed to rise to 20° $\pm$ 2°C. Although this temperature may be different than the temperature of the sample during collection, it is the temperature range to which the test organisms are acclimatized and is the range recommended in the above referenced bioassay protocols. This avoids stressful effects caused by exposure to unusually cold or warm samples.

Total Residual Chlorine

Since many reclaimed waters are chlorinated, especially those originating from sewage treatment facilities, it is often desirable to differentiate between the toxicity resulting from chlorine and the toxicity associated with other constituents of the reclaimed water. To accomplish this, the Biology Section performed concurrent bioassays on a

sample of chlorinated reclaimed water in which the chlorine had been neutralized. De-chlorination was accomplished by adding a calculated amount of 0.025N sodium thiosulfate. The total residual chlorine concentrations of the tested sample of reclaimed water are given on the bioassay data forms. A comparison of the results of these tests will distinguish between the toxicity due solely to residual chlorine and the toxicity inherently contained in the reclaimed water.

Freshwater Tests

Freshwater for dilution of the recovered water samples was obtained from the same DER deep well that is used to culture the test organisms. The concentration series selected for this study is given in Table 1.

Two replicates, of each concentration and a control, were used to test with the water fleas, Ceriodaphnia dubia and Daphnia pulex. Flint glass jars of either 60 ml (for C. dubia) or 250 ml (for D. pulex) capacity were used as test chambers, and either 50 ml or 200 ml of the appropriate test concentration was placed in each chamber. Ceriodaphnia were siphoned into a large culture dish and neonates were transferred by glass pipette, and loaded 10 per chamber, resulting in 20 per test concentration. Daphnia were siphoned into a large culture dish to isolate the proper size and age organisms (neonates). To accomplish this, the Daphnia were siphoned through a stainless steel screen. The trapped adults were then discarded. These neonates were then transferred by glass pipette, examined for injury, and were loaded 10 per chamber, resulting in 20 per test concentration. Water fleas were not fed during these tests.

Two replicates, of each concentration and a control, were used for the Notropis leedsi (bannerfin shiner) bioassay. The fish were transferred individually or by twos, into wide mouth quart jars containing 500 ml each of the appropriate test concentration, and were loaded 5 per chamber, resulting in 10 per concentration. Fish were not fed during this test.

Test Parameters

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. Total alkalinity and total hardness (measured as $CaCO_3$ using HACH Chemical Company reagents) were recorded at the beginning of the test for the controls and the 100% effluent concentration. The specific conductance (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 concentration 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 Table 2.

RESULTS AND DISCUSSION

The Seminole Electric Cooperative cooling water effluent was acutely toxic (Table 2) to the water flea, Ceriodaphnia dubia, producing a 48 hour LC_{50} of 55.8% effluent concentration but was not toxic to the other water flea, Daphnia pulex, or the bannerfin shiner, Notropis leedsi. There was random mortality with these latter two species.

Chemical analyses (Table 3) revealed the presence of the metals arsenic (.85 ug/l), cadmium (2.7 ug/l), copper (299 ug/l), lead (6 ug/l), and zinc (323 ug/l). Cadmium, copper, and zinc were well above the Class III water quality standards of 1.2 ug/l, 30 ug/l, and 30 ug/l, respectively. LC_{50}'s performed by EPA (1976) of these metals reveal LC_{50} value ranges for copper in cladocerans, (water fleas) from 7.24 ug/l at a hardness of 48 mg/l as $CaCO_3$ for Daphnia pulicaria to 69 ug/l at a hardness of 207 mg/l as $CaCO_3$ for Daphnia magna. The LC_{50} range for cadmium in cladocerans is between 3.5 ug/l for Simocephalas serrulatas at a hardness of 11.1 mg/l as $CaCO_3$ to 120 ug/l for Daphnia magna at 45 mg/l hardness as $CaCO_3$. Zinc is relatively non toxic to the Daphnid cladocerans. Each of these compounds was more toxic to other organisms. The very high hardness (578 mg/l as $CaCO_3$) ameliorated some of the toxicity by providing competitive reactions with the active metal cations in the organism's physiology. The toxicity to Ceriodaphnia dubia is likely due to the high copper concentrations and the synergistic action of the other metals.

Table 1. Concentration Series and Volumes Used for These Static Bioassays.

Ceriodaphnia dubia (water flea)

Concentration	Dilution Water	Sample	Total Volume
Control	50.0 ml	--------	50 ml
50.0%	25.0 ml	25.0 ml	50 ml
100.0%	-------	50.0 ml	50 ml

Daphnia pulex (water flea)

Concentration	Dilution Water	Sample	Total Volume
Control	200.0 ml	--------	200 ml
50.0%	100.0 ml	100.0 ml	200 ml
100.0%	--------	200.0 ml	200 ml

Notropis leedsi (bannerfin shiner)

Concentration	Dilution Water	Sample	Total Volume
Control	500 ml	--------	500 ml
50.0%	250 ml	250 ml	500 ml
100.0%	------	500 ml	500 ml

Table 2. Data recorded during 48 hour static acute screening bioassays using Ceriodaphnia dubia, Daphnia pulex, and Notropis leedsi on Seminole Electric Cooperative Power Plant cooling water effluent, NPDES #FL0036498, on 20 to 22 October, 1987.

Facility:	Seminole Electric Cooperative			NPDES # FL0036498		Facility Type:	Industrial
Location:	Putnam County			Contact/District:	NE/Mark Sittig		
Sample Collection Date:	10/19/87	Time:	1100	Test type: Static Screening			
Test Beginning Date:	10/20/87	Time:	945	# tests:	3	Receiving Water: St. Johns River	
Test Ending Date:	10/22/87	Time:	945	Chlorination Type:	None Detected		

Parameter	
Total Residual Cl2:	None Detected
Method:	HACH
By:	DAC
Salinity:	0

Ammonia:	Control Water	100% Sample
Unionized NH3:	0.00	0.00
Total NH3:	0	0

Organism: *Ceriodaphnia dubia* Age/Life stage: Neonates

LC50: Binomial: 55.91 Moving Average: 55.91 Probit: 55.75 LC1: 7.428

55.75% 0 100 (0, 82.9) (0, 83.24)

Concentrations	SURVIVAL # at 0 hour	Live at 24 hr	Live at 48 hr	Dissolved Oxygen 0 hour	24 hour	48 hour	pH 0 hour	24 hour	48 hour	Temperature 0 hour	24 hour	48 hour	Conductivity 0 hour	48 hour
Control	10	10	10	8.7	8.7	8.4	8	7.9	8	20.6	19.4	19.2		
Control	10	10	10	8.7	8.7	8.5	8	8	8.1					
50%	10	10	7	8.6	8.3	7.5	7.8	7.8	7.8	20.5	19.3	19.3		
50%	10	10	4	8.6	8.3	7.5	7.8	7.8	7.8					
100%	10	10	3	8.4	8.2	7.8	7.4	7.6	7.5	20.6	19.3	19.6		
100%	10	10	2	8.3	8.2	7.8	7.4	7.5	7.5					

	Control water	100% sample
Alkalinity:	123	37
Hardness:	119	578

Organism: *Daphnia pulex* Age/Life stage: Neonates

LC50: Binomial: Moving Average: Probit:

non-toxic

Concentrations	SURVIVAL # at 0 hour	Live at 24 hr	Live at 48 hr	Dissolved Oxygen 0 hour	24 hour	48 hour	pH 0 hour	24 hour	48 hour	Temperature 0 hour	24 hour	48 hour	Conductivity 0 hour	48 hour
Control	10	9	9	8.8	8.5	8.3	8.1	7.9	8	20.7	19.2	19.2		
Control	10	10	10	8.8	8.5	8.4	8.1	7.9	8				218	212
50%	10	10	10	8.6	7.9	7	7.8	7.7	7.7	20.6	19.1	18.9		
50%	10	10	10	8.6	8	7	7.8	7.7	7.7				1550	1500
100%	10	10	9	8.5	7.7	7.3	7.4	7.4	7.4	20.6	19.4	19.4		
100%	10	10	9	8.5	7.7	7.3	7.4	7.4	7.4				2650	2800

	Control water	100% sample
Alkalinity:	123	37
Hardness:	119	578

Organism: *Notropis leedsi* Age/Life stage: 27 days

LC50: Binomial: Moving Average: Probit:

non-toxic

Concentrations	SURVIVAL # at 0 hour	Live at 24 hr	Live at 48 hr	Dissolved Oxygen 0 hour	24 hour	48 hour	pH 0 hour	24 hour	48 hour	Temperature 0 hour	24 hour	48 hour	Conductivity 0 hour	48 hour
Control	5	5	5	8.4	8.1	6.2	7.6	7.7	7.7	21	19.1	18.9		
Control	5	3	3	8.4	8	6.2	7.6	7.7	7.7				215	220
50%	5	3	3	8.5	7.1	6.7	7.5	7.5	7.4	21	18.8	18.6		
50%	5	5	5	8.5	7	6.7	7.5	7.5	7.5				1600	1520
100%	5	5	5	8.5	6.7	6.7	7.3	7.2	7.3	20.8	18.8	18.6		
100%	5	3	3	8.5	6.7	6.7	7.3	7.2	7.3				2820	2750

	Control water	100% sample
Alkalinity:	118	37
Hardness:	122	578

Table 3. Chemical constituents present in the effluent from the Seminole Electric Cooperative Power Plant, NPDES #FL0036498 on 19 October, 1987.

Organics

Acid Extractables	None Detected
Base Neutral Extractables	None Detected
Pesticide Extractables	Numerous very small early eluting components sensitive to an electron capture detector

	Metals	Class III Standard
Arsenic	0.75 ug/L	<50 ug/L
Cadmium	2.7 ug/L	<0.8 ug/L in waters with hardness <150 mg/L as CaCO3 <1.2 ug/L in harder waters
Copper	299 ug/L	30 ug/L
Lead	6 ug/L	30 ug/L
Zinc	323 ug/L	30 ug/L

LITERATURE CITED

Florida Department of Environmental Regulation, Biology Section. 1985. Quality Assurance Manual for Performing Acute Toxicity Tests (Second Edition). FDER.

Peltier, W. and C. I. Weber. 1985. Methods for measuring the acute toxicity of effluents to aquatic organisms (Third Edition). Environmental Research Laboratory. Athens, Georgia. EPA-600/4-85-012. 217 p.

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. Applicable portions of the F.A.C. are: 17-3.021(1), 17-3.021(4), 17-3.051(1)(d), 17-3.061(3)(p), 17-3.402(1), 17-4.244(4), and 17-4.244(6).

The particular restrictions applied to a given discharger depend upon the type of discharge, the type of water body which is impacted, and the type of mixing zone, if any, which has been permitted. The most stringent toxicity limitations which apply to the various combinations of these factors are listed below, specified in terms of the most dilute concentration of effluent which is allowed to kill 50% of the test organisms in 96 hours. Note that any listed concentration greater than 100% is extrapolated from toxicity curves determined from testing various effluent concentrations of 100% or less. Violations of the toxicity standards occur in the following conditions.

I. Discharges to Surface Water

A. With no mixing zone, or with only a dredge and fill mixing zone the discharge may not exhibit an $LC_{50} \leq 2000\%$ at the point of discharge.

B. With a non-dredge and fill mixing zone the discharge may not exhibit an $LC_{50} \leq 100\%$ at the point of discharge and may not exhibit an $LC_{50} \leq 2000\%$ at the edge of the mixing zone.

C. With a non-dredge and fill mixing zone, and either discharging to the open ocean through multiport diffusers or meeting the provisions of 17-4.244(4)(b) the LC_{50} at the point of discharge cannot exceed 30% sample concentration.

II. Discharges to ground water may not exceed an LC_{50} of 300% at the point of contact with surface waters

A violation of these provisions occurs if toxicity is found at a more dilute concentrations of the sampled discharge than allowed above.

Industry/Toxicant Seminole Electric Cooperative
Address Palatka
Contact/District NW - Dennis Murrin
Effluent Serial Number
NPDES Permit Number FL0 36 498

BIOASSAY DATA FORM

Test Number: 1 of 3
Test Type: (Static) Renewal, (Screening) Conventional
Other:

Sample Collection: Date 10/19/87 Time 1100
Test Beginning: Date 10/26/87 Time 0945
Test Ending: Date 10/29/87 Time 0945
Test Organism Ceriodaphnia pulex
Age/Life Stage Neonates

Conc. or %	Test Container Number	Number of Live Organisms 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 0	24	48	72	96	Temperature °C 0	24	48	72	96
Control	49	10	10	10			8.7	8.7	8.4			8.0	7.9	8.0			20.6	19.1	19.2		
Control	71	10	10	10			8.7	8.7	8.5			8.0	8.0	8.1							
50%	91	10	10	7			8.6	8.3	7.5			7.8	7.8	7.8			20.5	19.3	19.3		
50%	36	10	10	4			8.6	8.3	7.5			7.8	7.8	7.8							
100%	85	10	10	3			8.4	8.2	7.8			7.4	7.6	7.5			20.6	19.3	19.6		
100%	83	10	10	2			8.3	8.2	7.8			7.4	7.5	7.5							
Initial of Investigator		JMF	JMF	JMF			JMF	JMF	JMF			JMF	JMF	JMF			JMF	JMF	JMF		

Alkalinity/Hardness (mg/l as $CaCO_3$)
Control Water: 123/119
100% Sample: 375/375
Other:
Measured by: AK

Ammonia unionized/total (mg/l as NH_3/N)
Hour 0
Control Water: 0.0
100% Sample: 0.0
Other:

Hour ____
Control Water:
100% Sample:
Other:
Measured by: JMF

Signature: Daniel Chastain
Joseph M Fandel III

Instrument Calibrations:

	pH Meter:	DO Meter:	S-C-T Meter:
0 Hours	707 909	9.0@21.0°C	11.3@20 28@30
24 Hours	707 909	9.2@20°C	
48 Hours	707 909	9.2@20.2°C	10.2@10 29@30
72 Hours			
96 Hours			

Total Residual Chlorine:
Pre-Test data: ____ Method: ____
Lab: 0.0 Method: Hach DC
Lab: ____ Method: ____
Reviewed by:

Pre-chlorinated:
Measurements by:
Date: 3/3/88

Remarks:

Industry/Toxicant: Seminole Electric
Address:
Contact/District:
Effluent Serial Number:
NPDES Permit Number:

BIOASSAY DATA FORM

Test Number: 2 of 3
Test Type: (Static) Renewal (Screening) Conventional
Other:

Sample Collection: Date 10/19/87 Time 1120
Test Beginning: Date 10/20/87 Time 0945
Test Ending: Date 10/24/87 Time 0945
Test Organism: Daphnia pulex
Age/Life Stage: neonates

Conc. or %	Test Container Number	Number of Live Organisms 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 0	24	48	72	96	Temperature °C 0	24	48	72	96	Conductivity umhos 0	24	48	72	96
control	72	10	9	9			8.8 DC	8.5	8.3			8.1	7.9	8.0			20.7	19.2	19.2							
Control	49	10	10	10			8.8 DC	8.5	8.4			8.1	7.9	8.0								218		212		
50%	35	10	10	10			8.6	7.9	7.0			7.8	7.7	7.7			20.6	19.1	18.9							
50%	23	10	10	10			8.6	8.0	7.0			7.8	7.7	7.7								1550		1500		
100%	7	10	10	Trays 8	9		8.5	7.7	7.3			7.4	7.4	7.4			20.6	19.4	19.4							
100%	—	10	10	Trays 8	9		8.5	7.7	7.3			7.4	7.4	7.4								2650		2800		
Initial of Investigator		TMF	JMF	DAC			JMF	JMF	JMF			JMF	JMF	JMF			JMF	JMF	JMF			JMF		JMF		

Alkalinity/Hardness (mg/l as $CaCO_3$)
Control Water: 123/119
100% Sample: 37/578
Other:
Measured by: DAC

Ammonia unionized/total (mg/l as NH_3/N)
Hour 0
Control Water: 0.0
100% Sample: 0.0
Other:
Hour ____
Control Water:
100% Sample:
Other:
Measured by: JMF

Signature: David Chastain
Joseph M Faulkner

Instrument Calibrations:

	pH Meter:	DO Meter:	S-C-T Meter:
0 Hours			
24 Hours			
48 Hours			
72 Hours			
96 Hours			

Remarks:

Total Residual Chlorine:
Field data: ____ Method: ____
Lab: ____ Method: ____
Lab: ____ Method: ____
Dechlorinated:
Measurements by:

Reviewed by: [signature]
Date: 3/3/88

Industry/Toxicant Seminole Electric Coop.
Address Palatka
Contact/District NW - Dennis Murrin
Effluent Serial Number
NPDES Permit Number FL0036498

BIOASSAY DATA FORM

Test Number: 3 of 3
Test Type: (Static) Renewal, (Screening) Conventional
Other:

Sample Collection: Date 10/19/87 Time 1100
Test Beginning: Date 10/26/87 Time 0945
Test Ending: Date 10/22/87 Time 0945
Test Organism Notropis cerasi
Age/Life Stage 27 days

Conc. or %	Test Container Number	Number of Live Organisms 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 0	24	48	72	96	Temperature °C 0	24	48	72	96	Conductivity (umhos) 0	24	48	72	96
Control	65	5	5	5			8.4	8.1	6.2			7.6	7.7	7.7			21.0	19.1	18.9							
Control	—	5	3	3			8.4	8.0	6.2			7.6	7.7	7.7								215		220		
50%	4	5	3	3			8.5	7.1	6.7			7.5	7.5	7.4			21.0	18.8	18.6							
50%	30	5	5	5			8.5	7.0	6.7			7.5	7.5	7.5								[illegible]		1520		
100%	12	5	5	5			8.5	6.7	6.7			7.3	7.2	7.3			20.8	18.8	18.6							
100%	18	5	3	3			8.5	6.7	6.7			7.3	7.2	7.3								2820		2750		
Initial of Investigator		DAC	JMF	JMF		JMF	JMF	JMF				JMF	JMF	JMF			DAC	JMF	JMF			JMF		JMF		

Alkalinity/Hardness (mg/l as $CaCO_3$)
Control Water: 118/122
100% Sample: 37/5-78
Other:
Measured by: DAC

Ammonia unionized/total (mg/l as NH_3/N)
Hour 0
Control Water: 0.0
100% Sample: 0.0
Other:

Hour ____
Control Water:
100% Sample:
Other:
Measured by: JMF

Signature
David Chesler
Joseph Fiandt

Instrument Calibrations:

	pH Meter:	DO Meter:	S-C-T Meter:
0 Hours			
24 Hours			
48 Hours			
72 Hours			
96 Hours			

Remarks:

Total Residual Chlorine:
Field data: ____ Method:
Lab: ____ Method:
Lab: ____ Method:

Dechlorinated:
Measurements by:

Reviewed by:
Date: 3/3/88