Bioassay of Coleman-Evans Wood Preserving Company

Duval County, Florida

(NPDES #FL0031054)

SAMPLED 10/29/79

Biological Section
Bureau of Water Analysis
21 March 1980

INTRODUCTION

The Coleman-Evans Wood Preserving Company is located approximately eight miles west of Jacksonville on Highway 90 (Figure 1). The company preserves wooden ties, posts, etc. by pressure treatment with pentachlorophenol.

This facility has a permitted discharge of .0025 MGD consisting of sanitary wastes, cooling and process water. Effluent treatment includes oil skimming, coagulation with lime and alum, sludge settling, sand filtration and gas chlorination prior to discharge. A flow schematic of the waste water treatment is provided in figure 2. The NPDES effluent limitations are listed in Table 1.

The treated effluent is discharged to McGirts Creek which is a tributary of the Ortega River. The Ortega River eventually joins the St. Johns River in Clay County.

On 17 July 1978, the Coleman-Evans Wood Preserving Company received a Notice of Violation from Mr. D. J. Guinyard, Chief Fla./Ga. Compliance Group, Water Enforcement Branch, Enforcement Division, EPA for not reporting effluent temperatures and because the reported pH values exceeded the NPDES limitations (see Table 1) between September 1977 and April 1978. In addition unsatisfactory levels of oil and grease (45 mg/l) were noted during a reconnaissance inspection by DER Field personnel during that same year.

On 29 October 1979, the Biological Section obtained effluent samples from the Coleman-Evans Company outfall #001 at McGirts Creek and performed bioassays to determine the existence and extent of toxicity to the biota of the receiving waters. Toxicants suspected in this effluent include: phenols, polychlorinated biphenols, chromium, zinc, copper, and lead. The results of these tests are reported here.

METHODS AND MATERIALS

Test methods used for conducting these static bioassays are extensively described by Peltier (1978). The organisms selected for this study are among those recommended by Peltier (1978) and the U.S. EPA (1978). Life histories of these test organisms and maintenance procedures used to culture them are detailed below.

Table 1. NPDES permitted effluent limitations for the Coleman-Evans Wood Preserving Company

Parameter	Daily Average	Daily Maximum
Temperature	35°C	38°C
COD	15.7 kg/day	31.1 kg/day
Phenols	0.02 kg/day	0.06 kg/day
Oils and Grease	0.30 kg/day	0.70 kg/day
pH	6.0 to 8.5	-

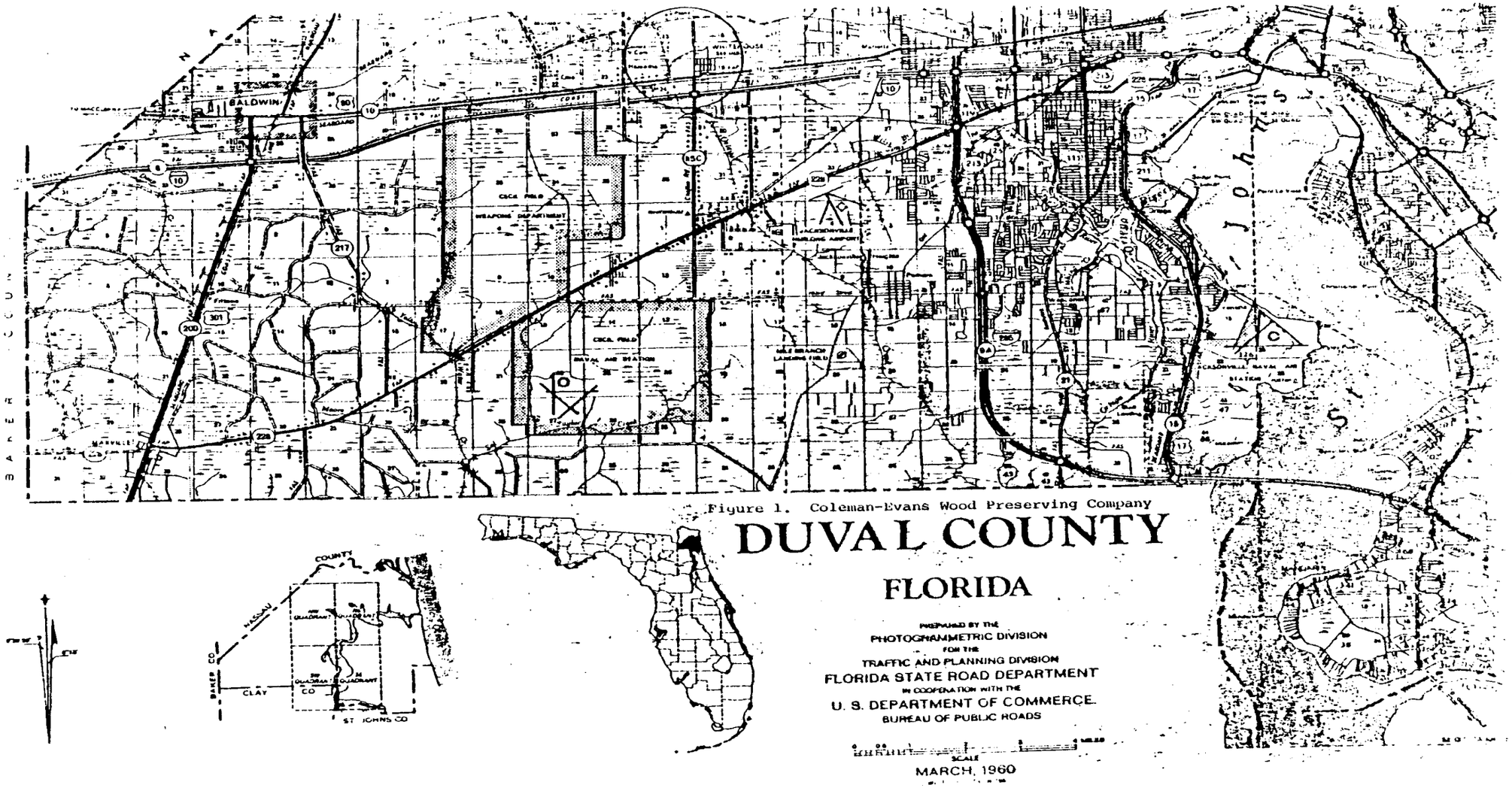
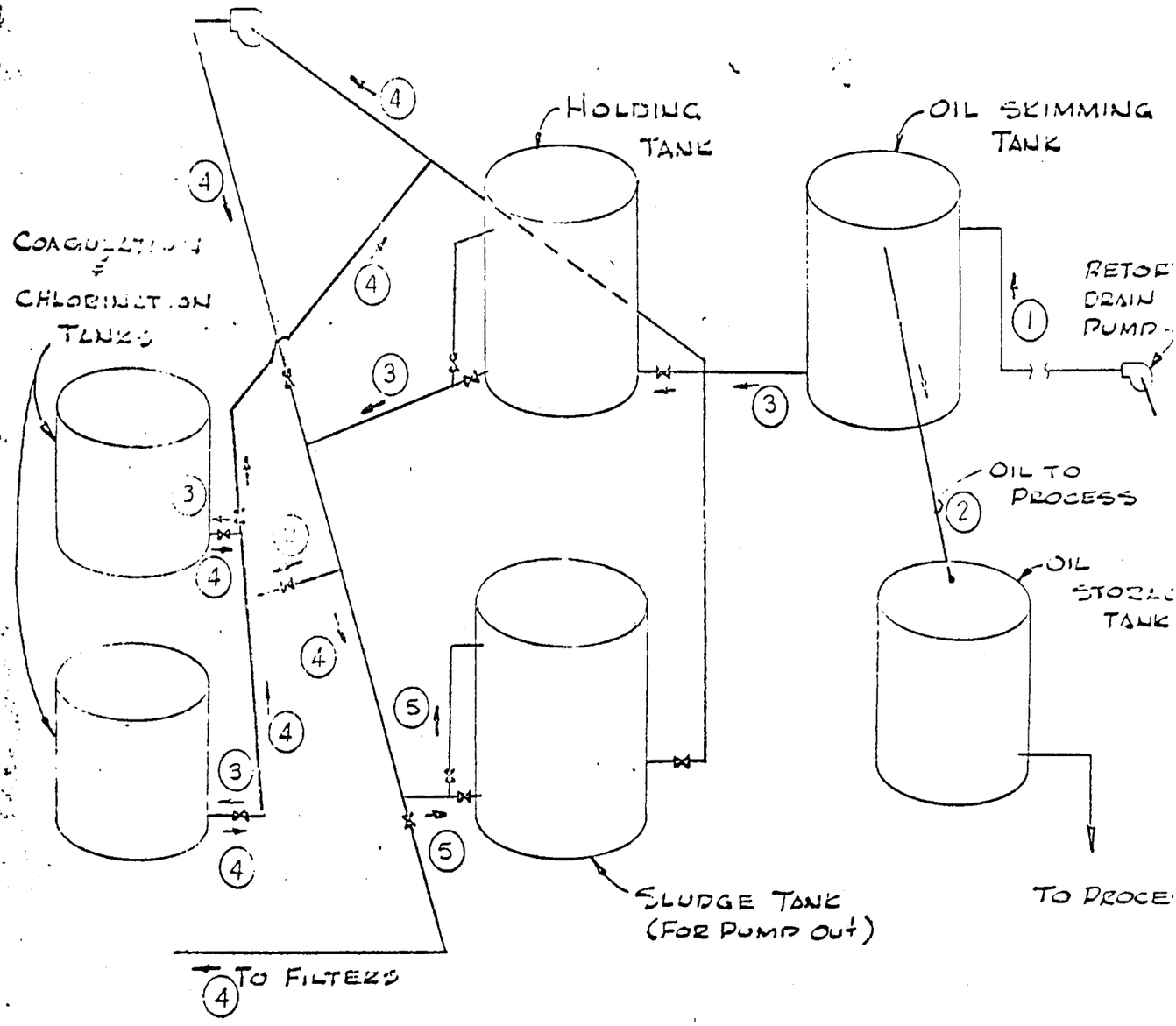


Figure 1. Coleman-Evans Wood Preserving Company

Figure 2. WASTE TREATMENT FLOW SCHEMATIC

COLEMAN-EVANS WOOD PRESERVING CO.



(1) → INFLUENT

(2) → OIL (RETURNED TO PROCESS)

(3) → SAP WATER

(4) → COAGULATED EFFLUENT

(5) → SETTLED SLUDGE

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 on March 9, 1979. This culture has been maintained continually since their arrival, in 2½ gallon all glass aquaria using a 16:8 hour light-dark cycle. Organisms have been fed a liquified blend of Purina trout chow® and Cerophyl® twice daily. Daphnia used in this bioassay were syphoned into a large culture dish through a series of nested stainless screens to isolate the proper size and age organisms (neonates). These neonates were then pipetted individually from the culture dish and placed randomly into the test chambers at the beginning of the test.

Pimephales promelas (fathead minnow)

A breeding culture of approximately 100 adult fathead minnows were obtained from the EPA laboratory in Cincinnati, Ohio on 12 May 1979. The fish were transferred to three 125 gallon aquaria filled with unchlorinated City of Tallahassee well water and reared at 24-25°C under 16:8 hour light-dark cycle. Water circulation, aeration and purification was accomplished with heavy-duty outside motor filters. These fish were fed Purina Trout Chow® at a rate of .75g/30 fish twice daily. Breeding was encouraged by placing several halved clay pots in each tank to serve as a substrate for eggs and to provide cover for the fish. Tanks were examined twice daily (at feeding time) for egg production. Clay pots containing egg clusters were immediately transferred to 15 gallon aerated aquaria for hatching. A new aquaria was prepared for each week's production of eggs thereby segregating fish into even age groups to be used for testing. After hatching fathead fry were fed twice daily with freshly hatched Artemia (brine shrimp). The fish used in this test were all five weeks old at the time of the test.

Test Methods

Two separate 48-hour static bioassays were conducted from 30 October to 1 November 1979 on a grab sample of effluent from Coleman-Evans Wood Preserving Co., outfall #001. The sample was collected by Mr. Jean-Paul Nicol of the Bureau of Water Analysis

using standard waste water sampling procedures. Separate samples were obtained for chemical and biological testing. Samples for metal analysis were prepared with HNO_3 (2ml/liter). Samples for organic chemical analysis and the bioassays were unpreserved. The samples were iced and transported to the DER laboratory in Tallahassee within 24 hours of collection.

Fresh water dilution of the effluent sample was obtained from the same City of Tallahassee well that is used to culture the test organisms. The concentration series selected for this study are those recommended by APHA (1976) (Table 2).

Four replicates of six concentrations and a control were implemented for the fathead bioassay. The fish were transferred individually or by twos by net into wide mouth quart jars containing 500 ml each of the appropriate test concentration (Table 3). Fatheads were loaded 5 per chamber resulting in 20 organisms per concentration.

Two replicates each with six concentrations and a control were used to test with Daphnia pulex. Flint glass jars of 250 ml capacity were used as test chambers; 200 ml of the appropriate test concentration was placed in each chamber (Table 4). Daphnia were transferred individually by glass pipette and were loaded 10 per chamber, resulting in 20 organisms per test concentration.

Dissolved oxygen, pH and the number of live organisms were recorded for each test chamber at 0 hours, 24 hours and 48 hours. These values were recorded daily on the Bioassay Data forms and are presented in Tables 3 and 4. Organisms were not fed during these tests.

Table 2. Concentration Series and Volumes used for these Static Bioassays

Fathead Minnow (Pimephales promelas)

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

Water flea (Daphnia pulex)

Concentration	Dilution Water	Effluent	Total Volume
Control	200 ml	-	200 ml
5.6%	189 ml	11 ml	200 ml
10.0%	180 ml	20 ml	200 ml
18.0%	164 ml	36 ml	200 ml
32.0%	136 ml	64 ml	200 ml
56.0%	88 ml	112 ml	200 ml
100.0%	-	200 ml	200 ml

Table 3. Data recorded during 48-hour, *Pimephales promelas*, static acute toxicity bioassay performed on Coleman-Evans Wood Preserving Company, Duval County, Florida 30 October to 1 November 1979 NPDES Permit #FL0031054 Outfall #001

Conc. or %	Test Container Number	Number of Live Organisms				Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l as $CaCO_3$)					Total Hardness (mg/l as $CaCO_3$)					Temperature				
		0	2	24	48	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
Control	A	5	5	5	5	10.0	7.0	6.6			8.15	7.71	7.37																	
Control	B	5	5	5	5	9.8	7.2	6.95			8.14	7.69	7.39																	
Control	F	5	5	5	5	9.9	7.2	7.0			8.11	7.71	7.46																	
Control	-	5	5	5	5	9.9	7.0	6.9			8.14	7.68	7.50																	
0.5%	A	5*	5	5	5	10.9	6.2	5.85			8.20	7.59	7.41																	
0.5%	B	5*	5	5	5	11.2	6.9	6.4			8.22	7.65	7.47																	
0.5%	F	5*	5	5	5	10.9	6.3	6.0			8.24	7.61	7.46																	
0.5%	-	5*	5	5	5	11.1	6.6	6.4			8.23	7.20	7.51																	
5.6%	A	5	2[1]	0	-	9.2	8.9	-			7.97	8.03	-																	
5.6%	B	5	3[1]	0	-	9.0	8.9	-			7.93	8.01	-																	
5.6%	F	5	3[1]	0	-	8.95	8.9	-			7.90	7.99	-																	
5.6%	-	5	3[1]	0	-	9.0	8.95	-			7.94	8.02	-																	
10.0%	A	5	0	-	-	9.55	-	-			7.93	-	-																	
10.0%	B	5	0	-	-	9.6	-	-			7.93	-	-																	

Remarks:

* Set up 1310 hours
Set up remaining test 11:30

Initial parameters performed at 13:00

① By 1515 hours all original test organisms were dead except controls and 0.5% concentration.

Coleman-Evans (cont.)

Conc. or %	Test Container Number	Number of Live Organisms					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l as $CaCO_3$)					Total Hardness (mg/l as $CaCO_3$)					Temperature				
		0	2	24	48	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
18.0	A	5	0	-	-		9.7	-	-			7.90	-	-																	
18.0	B	5	0	-	-		10.1	-	-			7.94	-	-																	
18.0	F	5	0	-	-		9.9	-	-			7.94	-	-																	
18.0	-	5	0	-	-		9.9	-	-			7.96	-	-																	
32.0	A	5	0	-	-		9.8	-	-			7.89	-	-																	
32.0	B	5	0	-	-		9.8	-	-			7.90																			
32.0	F	5	0	-	-		9.6	-	-			7.90	-	-																	
32.0	-	5	0	-	-		9.6	-	-			7.93	-	-																	
56.0	A	5	0	-	-		9.2	-	-			7.77	-	-																	
56.0	B	5	0	-	-		9.0	-	-			7.76	-	-																	
56.0	F	5	0	-	-		9.0	-	-			7.78	-	-																	
56.0	-	5	0	-	-		9.1	-	-			7.78	-	-																	
100.0	A	5	0	-	-		7.8	-	-			7.56	-	-																	
100.0	B	5	0	-	-		7.7	-	-			7.57	-	-																	

Remarks:

Coleman-Evans (cont.)

Conc. or %	Test Container Number	Number of Live Organisms					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l as $CaCO_3$)					Total Hardness (mg/l as $CaCO_3$)					Temperature				
		0	2	24	48	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
100.0	F	5	0	-	-		7.75	-	-			7.55	-	-																	
100.0	-	5	0	-	-		7.9	-	-			7.54	-	-																	

Remarks:

Table 4. Data recorded during 48-hour, *Daphnia pulex*, static acute toxicity bioassay performed on Coleman-Evans Wood Preserving Company, Duval County, Florida 30 October to 1 November 1979 NPDES Permit #FL0031054

Conc. or %	Test Container Number	Number of Live Organisms					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l as $CaCO_3$)					Total Hardness (mg/l as $CaCO_3$)					Temperature				
		0	2	24	48	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
Control	A	10	10	10	10		10.8	9.4	8.8			8.16	8.14	7.97																	
Control	B	10	10	10	10		10.8	9.45	8.9			8.15	8.15	8.02																	
5.6	A	10	10	4	0		10.9	9.4	9.0			8.07	8.11	8.09																	
5.6	B	10	10	4	0		11.0	9.5	9.0			8.08	8.12	8.12																	
10.0	A	10	9	3	0		10.8	9.3	8.8			8.09	8.13	8.11																	
10.0	B	10	10	2	0		10.7	9.3	8.85			8.11	8.13	8.12																	
18.0	A	10	9	0	-		10.5	9.2	8.85			8.10	8.13	8.15																	
18.0	B	10	7	0	-		10.4	9.25	8.85			8.11	8.14	8.15																	
32.0	A	10	5	0	-		10.2	8.95	8.45			8.02	8.06	8.09																	
32.0	B	10	3	0	-		10.2	9.05	8.55			8.05	8.08	8.10																	
56.0	A	10	0	-	-		9.4	8.8	-			7.93	8.04	-																	
56.0	B	10	2	0	-		9.4	8.8	8.55			7.93	8.05	8.08																	
100.0	A	10	0	-	-		8.2	8.35	-			7.70	7.94	-																	
100.0	B	10	0	-	-		8.2	8.35	-			7.69	7.95	-																	

Remarks:

Table 5. Results of Chemical Analyses performed on Effluent from Coleman-Evans Wood Preserving Co.

Parameter	Results	Replicate
Pentachlorophenol	21 mg/liter	(required both samples)
PCB's	None detectable	
Lead	<5 µg/l	<5 µg/l
Copper	5 µg/l	<5 µg/l
Zinc	31.3 µg/l	23.1 µg/l
Chromium	<5 µg/l	<5 µg/l

Results & Discussion

This particular sample of effluent from Coleman-Evans Wood Preserving Company proved to be toxic to both fathead minnows (Pimephales promelas) and Daphnia pulex. Since mortality occurred quickly through all the concentration series, LC_{50}'s were determined at 2 hours of exposure for each species. The LC_{50} at 2 hours exposure for fathead minnows was calculated to be 5.8% and for Daphnia pulex the 2 hour LC_{50} was 27%. After four hours exposure all fish were dead in the initial concentration series. Because of this, a new and much lower concentration (.05%) was added to the fathead series. This selection proved to be below the acutely toxic threshold for 48 hours of exposure, as all fish survived this concentration (.05%). A 24 hour LC_{50} of 5.2% was calculated for Daphnia pulex exposed to this effluent. All Daphnia were dead at all test concentrations after 48 hours. Consequently, all that can be said of the 48 hour LC_{50} is that it is less than 5.2%. (See Table 4)

Results of chemical analyses performed on this effluent (Table 5) showed that penta-chloro-phenol was present at a concentration of 21 mg/l. This concentration of penta-chloral-phenol could have accounted for the toxicity observed. Other parameters analyzed were not present in amounts known to be toxic by themselves.

LITERATURE CITED

American Public Health Association. 1976. Standard Methods for the Examination of Water and Wastewater. 14th ed. pp. 1193.

Peltier, William. 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.

U.S. Environmental Protection Agency. 1978. Bioassay procedures for the Ocean Disposal Permit Program. Environmental Research Laboratory. Gulf Breeze, Florida. EPA-600/9-78-010.