Water Quality Assessment
Parkerson Mill Creek
Auburn, Alabama
Lee County

October 1997

Environmental Indicators Section
Field Operations Division
Alabama Department of Environmental Management

Introduction

The city of Auburn in Lee County has an NPDES permit (AL0050237) to discharge treated wastewater to Parkerson Mill Creek downstream of Lee County Road 10. Parkerson Mill Creek is a tributary to Chewacla Creek and located in the Tallapoosa River basin.

At the request of the Municipal Branch of the Water Division of the Alabama Department of Environmental Management (ADEM), staff members of the Environmental Indicators Section of Field Operations Division conducted a study to document the effects of the wastewater discharge on the in-stream macroinvertebrate community of Parkerson Mill Creek. This effort included aquatic macroinvertebrate sampling, habitat assessment, toxicity testing and chemical analyses.

The Aquatic macroinvertebrate sampling and habitat assessments along with the chemical sample collection were conducted on October 15, 1997. The toxicity portion of the study was initiated on November 18, 1997.

Sampling Locations and Methodology

The following sampling locations were chosen for Parkerson Mill Creek (see Figure 1). In addition, an established ecoregional reference stream with similar stream characteristics and habitat types was sampled and compared to Parkerson Mill Creek to further assess the conditions of the stream.

PM-1 (control)	T18N, R25E, Sec 24, NW 1/4 Parkerson Mill Creek approximately 0.3 mile downstream of Lee County Road 10, immediately upstream of the Auburn Southside WWTP effluent mixing zone.
PM-1a	T18N, R25E, Sec 24, NW 1/4 Parkerson Mill Creek just downstream of the Auburn Southside WWTP effluent mixing zone.
PM-3	T18N, R25E, Sec 24, NW 1/4 Parkerson Mill Creek approximately 0.25 mile downstream of the Auburn Southside WWTP outfall.
HCR-1 (ecoregional reference)	T21S, R10E, Sec 29, SW 1/4 Hurricane Creek just upstream of the bridge on an unnamed gravel road located off Alabama Highway 77.

Macroinvertebrate samples were collected using the intensive Multihabitat Bioassessment method (MB-I) described in the *ADEM Standard Operating Procedures and Quality Control Assurance Manual, Volume 2* (1996). Habitat quality was assessed using the modified Barbour & Stribling (1996) habitat assessment form. All macroinvertebrate assessments were calculated using the Biological Condition Scoring Criteria (BCSC) (EPA 1989). Table 1 provides a simplified interpretation of the biological metrics used to evaluate this stream. Individual station metrics are listed in Figure 3.

In-stream water samples collected for field parameters and chemical analyses were grab collections using the methodology outlined in the *ADEM Standard Operating Procedures and Quality Control Assurance Manual, Volume 1*, (1994).

Samples collected from the WWTP discharge for toxicity testing were 24-hour composite samples taken at the permitted sampling point. The toxicity test was conducted as specified in NPDES permit number AL0050237 and per methodology outlined in *ADEM Standard Operating Procedures and Quality Control Assurance Manual, Volume 4*, (1994).

Sample handling techniques, physical data collection and chain-of-custody procedures utilized during this assessment were as described in the *ADEM Standard Operating Procedures and Quality Control Assurance Manual, Volumes 1*(1994), *2*(1996) & *4*(1994). Chain-of-custody was maintained by locking the samples in a Departmental vehicle when not in sight of a Field Operations Division employee.

Discussion and Results

A. Physical

Parkerson Mill Creek at the studied reaches was estimated to have hardwood canopy of varying amounts partially shading the stream. Parkerson Mill Creek is a rapidly moving non-braided stream comprised mainly of sandy substrate with run depths of approximately 0.5-1.5 feet and pools of 2-2.5 feet. Multiple habitats suitable for colonization by aquatic macroinvertebrates are present at each sampling location. Habitat assessments indicate that all locations have similar habitat quality (Table 2). However, the score for the most downstream station (PM-3) is less similar than those of the two upstream stations. Evaluating the individual assessment parameters indicates that this is largely due to changes in substrate composition between the control (PM-1) and downstream locations as well as changes in stream morphology. The ecoregional reference site HCR-1 was similar to the study stations in stream characteristics and habitat types. The habitat quality (Table 2) of two of the three study locations was within ninety percent of the ecoregional reference station. The station with the lowest habitat assessment was still within seventy-five percent of the ecoregional reference station. EPA suggests sites are considered similar when habitat assessments are at least seventy-five percent comparable.

B. Chemical

The Water Use Classification for Parkerson Mill Creek is Fish & Wildlife, which specifies that the waters be suitable for fishing, propagation of fish, aquatic life, and wildlife, and any other usage except for swimming, and water-contact sports or as a source of water supply for drinking or food processing purposes (*Rules and Regulations: Water Quality Criteria and Use Classifications*, Water Division-Water Quality Program, ADEM, Ch.335-6-10).

The field parameters measured at each station were pH, conductivity, dissolved oxygen, turbidity and water temperature (Figure 2). Results showed little change in the pH, dissolved oxygen, conductivity, or turbidity between stations (Table 3). The lower conductivity below the Auburn Southside WWTP discharge at PM-1a was possibly a recording error. The water temperature at PM-1a was found to exceed the temperature criterion included in the Water Use Classification of Fish &Wildlife. The criterion for water temperature states that the maximum in-stream temperature rise above ambient water temperature due to the addition of artificial heat by a discharger shall not exceed 5° F in streams, lakes, and reservoirs in non-coastal and estuarine areas.

Water samples were also collected for laboratory analyses and results are provided in Table 3. At locations below the effluent discharge, several parameters increased when compared to the control station PM-1. Among those were total dissolved solids (TSS) and chloride. Nutrient levels were also affected by the effluent discharge. Levels of ammonia, phosphate, total Kjeldahl nitrogen and total organic nitrogen (TON) increased at PM-1a. The downstream station (PM-3) had a higher level of nitrate and TON than any of the other studied stations, possibly influenced by the WWTP sludge field that runs adjacent to that segment of the creek. The concentration of zinc at PM-1a (0.072 mg/L) and at PM-3 (0.069 mg/L) were higher than the control station PM-1 (<0.030). The concentration of copper at PM-3 (0.032 mg/l) was higher than either of the other stations (<0.020 mg/L).

The National Criteria for in-stream zinc concentrations as described in *Quality Criteria for Water* (EPA 440/5-86-001, 1986) are calculated values that take into consideration in-stream hardness and are based on the one-hour average concentration and four-day average concentration for acute and chronic limits, respectively. These criteria indicate that the zinc concentration at PM-1a (72 µg/L) was below the acute limit of 79.2 µg/L and equaled the chronic limit of 71.8 µg/L. The zinc concentration at PM-3 (69 µg/L) was below both the acute (80.8 µg/L) and chronic (73.2 µg/L) limits. The National Criteria for in-stream copper concentrations as described in *Quality Criteria for Water* (EPA 440/5-86-001, 1986) indicate that the copper concentration at PM-3 (32 µg/L) exceeded both the acute limit of 11.0 µg/L and the chronic limit of 8.1µg/L.

C. Aquatic Macroinvertebrate Assessment

Aquatic macroinvertebrate data were analyzed according to the Biological Condition Scoring Criteria (BCSC) developed by EPA (Plafkin 1989). The control (PM-1) was considered slightly impaired when compared to the ecoregional reference station HCR-1. PM-1a was evaluated as slightly impaired, in comparison to the control PM-1 and moderately impaired in comparison to the ecoregional reference station HCR-1 (Table 2).

PM-3, the most downstream station, was also evaluated as slightly impaired when compared to the control PM-1 and moderately impaired when compared to the ecoregional reference HCR-1 (Table 2).

D. Bioassay

Short-term chronic toxicity tests conducted on the Auburn Southside WWTP effluent indicated that there was a significant difference to *Ceriodaphnia dubia* and *Pimephales promelas* survival when exposed to a 100% effluent concentration (Appendix A). This effluent concentration is similar to the measured in-stream waste concentration of approximately 100% at the time of aquatic macroinvertebrate and chemical sample collection.

The National Criteria for in-stream chlorine concentrations as described in *Quality Criteria for Water* (EPA 440/5-86-001, 1986) is based on the four-day average concentration for chronic limits. These criteria indicate that the chlorine concentration in the toxicity sample (0.49 mg/l) was above the chronic limit of 11 µg/L (0.011mg/l).

Effluent samples were also collected for laboratory analyses in conjunction with the toxicity test. Results summarized in Table 3 indicated that dissolved and total levels of zinc were detectable in the effluent sample collected on November 18, 1997.

Conclusions

The results of this study indicate the water quality of Parkerson Mill Creek below the Auburn Southside WWTP to be slightly impaired compared to the upstream control station. However, the results also indicate slight impairment of the control station suggesting impact in the upper watershed. Slight degradation to the macroinvertebrate community below the discharge was evidenced by decreased taxa richness and increased pollution tolerance of the community at PM-1a. Although nutrient concentrations increased below the discharge, there was no associated increase in total number of organisms collected (Figure 4). These results are indicative of an invertebrate community negatively impacted by toxic wastes (Welsh 1992). In addition, the results of the short-term chronic toxicity tests indicated a toxic effect present in the effluent. Associated water samples suggest that increased trace metal toxicity and/or chloride may be causing the slight impairment. The data from PM-3, further downstream from the WWTP, suggest that the stream has not recovered from the impacts of the WWTP, however the decrease in habitat may be exacerbating the water quality impacts. The presence of copper at PM-3 suggests an additional source of impact. The adjacent WWTP sludge fields may be causing impairment despite seemingly adequate riparian buffer zones.

TABLE 1
Biometric Interpretation

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METRIC	RANGE	INTERPRETATION
Habitat Assessment	170-220 118-169 60-117 0-59	Optimal Sub-optimal Marginal Poor
Total Taxa Richness EPT Taxa Index		Generally Increases with Increasing Water Quality
Biotic Index		Generally Increases with Increasing Water Quality
Community Loss Index		Generally Increases with Decreasing Water Quality
Percent Contribution of Dominant Taxon		Generally Decreases with Decreasing Water Quality
Ratio of EPT and Chironomidae Organism Abundances		Chironomids Increase with Decreasing Water Quality
% Contribution of Functional Feeding Types %Shredders %Scrapers %Predators %Collector Gatherers %Collector Filterers %Macrophyte Piercers %Others		Percentages and Composition should be similar to background station for similar stream sizes and habitat composition

BIOLOGICAL CONDITION SCORING CRITERIA

% Comparison to Reference Score	Biological Condition Category	Attributes
>81%	Nonimpaired	Comparable to best situation within ecoregion. Balanced trophic structure Optimum community structure for stream size and habitat
82-52%	Slightly impaired	Community structure less than expected Composition lower than expected due to loss of intolerant spp % contribution of tolerant forms increases
52-19%	Moderately impaired	Fewer species due to loss of most intolerant forms Reduction in EPT index
<19%	Severely impaired	Few species present

TABLE 2
Aquatic Macroinvertebrate Data

	PM-1 (Control)	PM-1a	PM-3	HCR-1 (Ref.)
Habitat Assessment	117	126	89	118
Habitat Quality (% comparability to Reference site)	99%	94%	75%	
Habitat Quality (% comparability to Control Site)		93%	76%	
Total Taxa Richness	34	24	28	48
Biotic Index	5.89	7.71	6.11	4.14
EPT/EPT+Chironomid	0.25	0.00	0.02	0.86
Percent Contribution of Dominate Taxa	33	47	78	20
EPT Index	8	2	4	13
Percent Shredders(CPOM)	0.62	0.42	0.86	0.12
Community Loss Index Compared to Control		0.70	0.46	
Community Loss Index Compared to Reference	0.94	1.58	1.25	
Biological Condition (Category) Compared to Control		**Slightly Impaired**	**Slightly Impaired**	
Biological Condition(Category) Compared to Reference	**Slightly Impaired**	**Moderately Impaired**	**Moderately Impaired**	

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TABLE 3
Chemical Analyses & Field Parameters

Parameter	PM-1	PM-STP	PM-STP[1]	PM-1a	PM-3	HCR-1
Date Collected	10/15/97	10/15/97	11/18/97	10/15/97	10/15/97	10/17/97
Organics (ug/L)						
Diazinon	<0.01	<0.01	<0.01	<0.01	<0.01	-
Ethion	<0.01	<0.01	<0.01	<0.01	<0.01	-
Malathion	<0.03	<0.03	<0.03	<0.03	<0.03	-
Methyl Parathion	<0.012	<0.012	<0.012	<0.012	<0.012	-
Paration	<0.015	<0.015	<0.015	<0.015	<0.015	-
Phosdrin	<0.05	<0.05	<0.05	<0.05	<0.05	-
Miscellaneous Inorganics (mg/l)						
Total Alkalinity	61.0	58.0	64	56.0	54.0	9.0
Hardness	63.2	62.9	80	63.1	64.6	4.9
BOD	0.7	0.4	6.0	0.6	1.3	0.5
Hexavalent Chromium	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Dissolved Solids	85	234	-	218	203	49
Total Suspended Solids	<1.0	1	1	2	<1.0	<1.0
Chloride	10.5	42.2	-	39.7	37.4	3.8
Nutrients (mg/L)						
Ammonia	<0.3	0.69	<0.3	0.47	0.15	<0.3
Nitrate	0.32	4.17	-	4.16	4.57	0.01
Phosphate	0.071	1.21	-	1.10	1.06	0.05
Total Kjeldahl Nitrogen	<0.15	0.79	-	0.74	0.65	<0.15
Total Organic Nitrogen	<0.2	0.10	-	0.27	0.50	<0.2
Trace Metals (mg/L)						
Arsenic	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	-
Cadmium	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	-
Calcium	13.2	17.5	-	17.2	17.5	-
Chromium	<0.015	<0.015	<0.015	<0.015	<0.015	-
Copper	<0.020	<0.020	<0.020	<0.020	0.032	-
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	-
Magnesium	7.349	4.657	-	4.903	5.067	-
Mercury	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Nickel	<0.009	<0.009	<0.009	<0.009	<0.009	-
Silver	<0.015	<0.015	<0.015	<0.015	<0.015	-
Zinc	<0.030	0.080	0.74	0.072	0.069	-
Fecal Coliform (colonies/100mL)						
Fecal Coliform Bacteria	Est.18	<1	-	Est. 1	Est.57	-
Field Parameters						
Flow (cfs)	0	6.4	-	6.4	5.1	5.1
pH (standard units)	8.3	6.6	7.3	7.1	7.3	7.6
Conductivity(umhos/cm)	162	381	342	172[2]	355	54
Dissolved Oxygen(mg/L)	9.9	7.0	-	8.1	7.8	5.5
Turbidity (NTU)	2.6	2.0	-	4.3	1.7	9.4
Water Temperature (C)	18	24	-	24	19	22

[1] This sample is a composite sample taken during the toxicity test.
[2] Possible recording error.

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Figure 1

Station Location Map

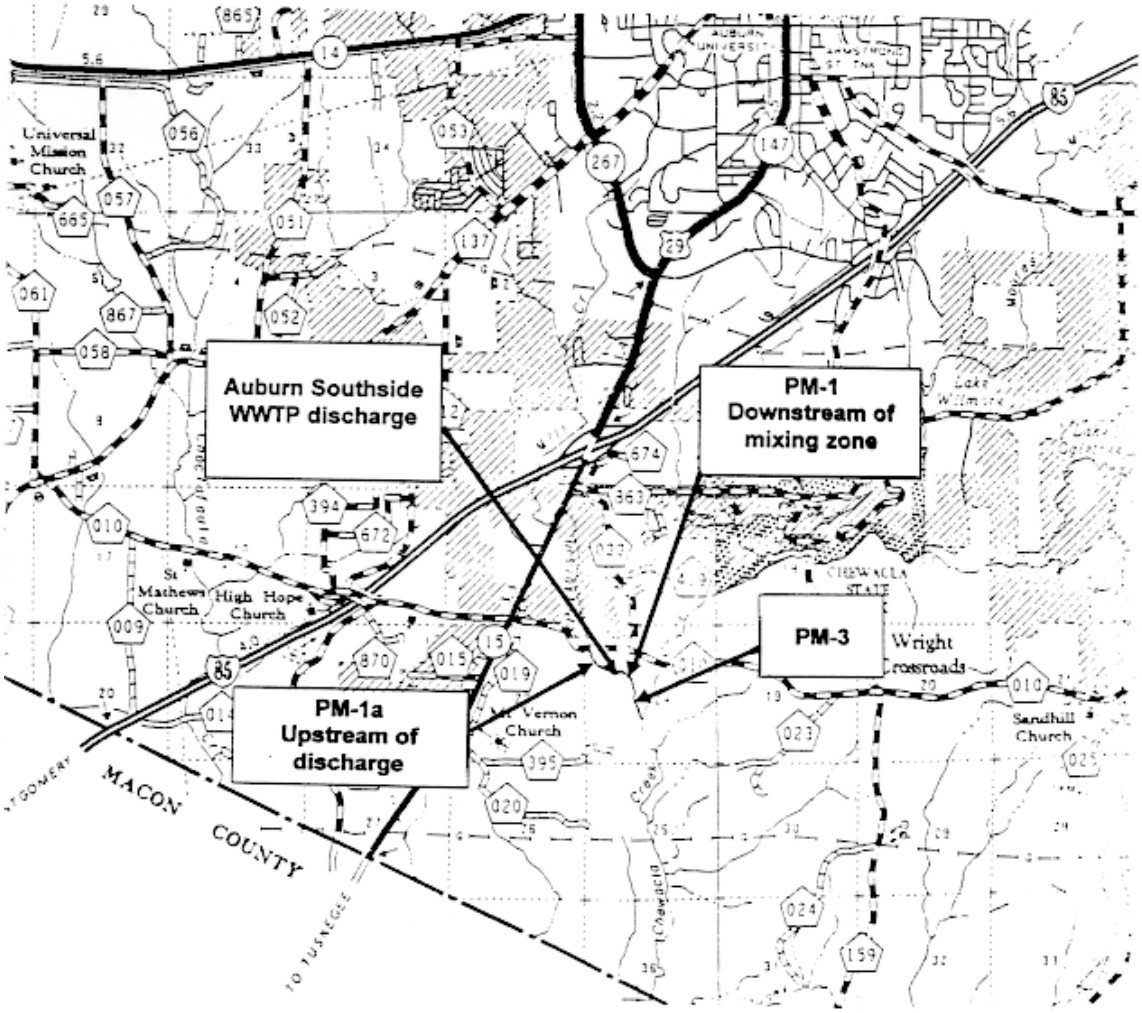

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Figure 2
Field Parameters

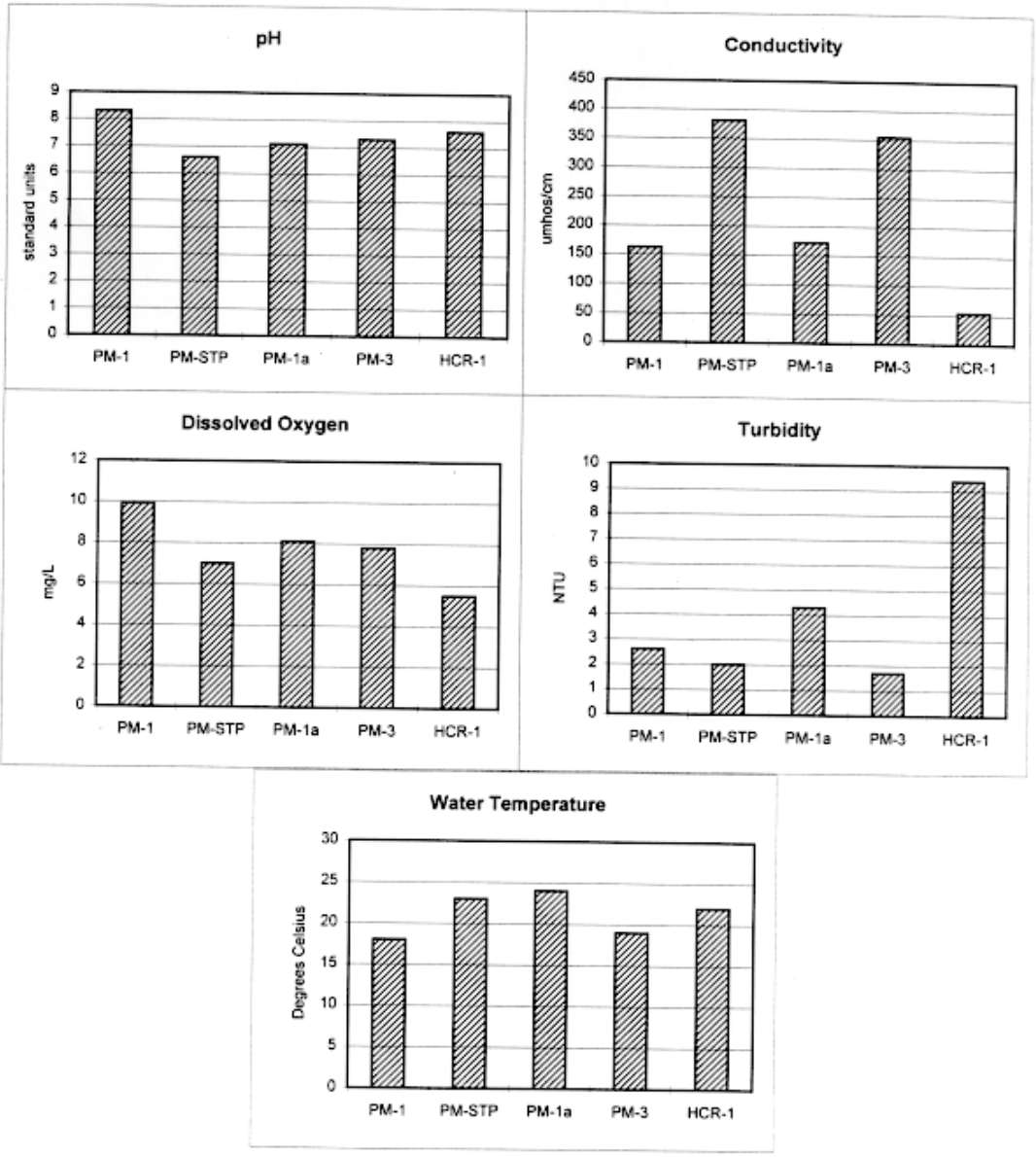

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Figure 3
Individual Metrics

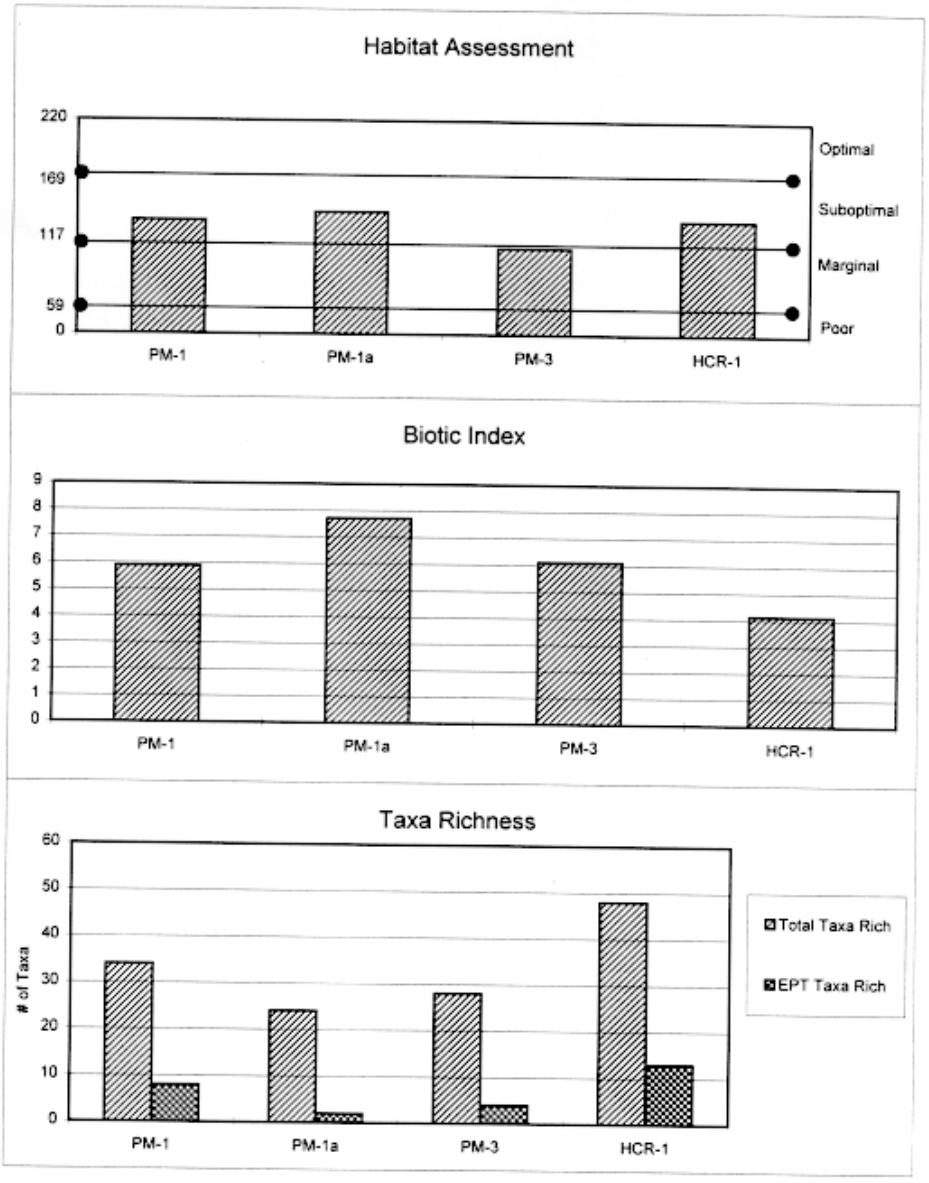

Figure 4
Total Number of Organisms

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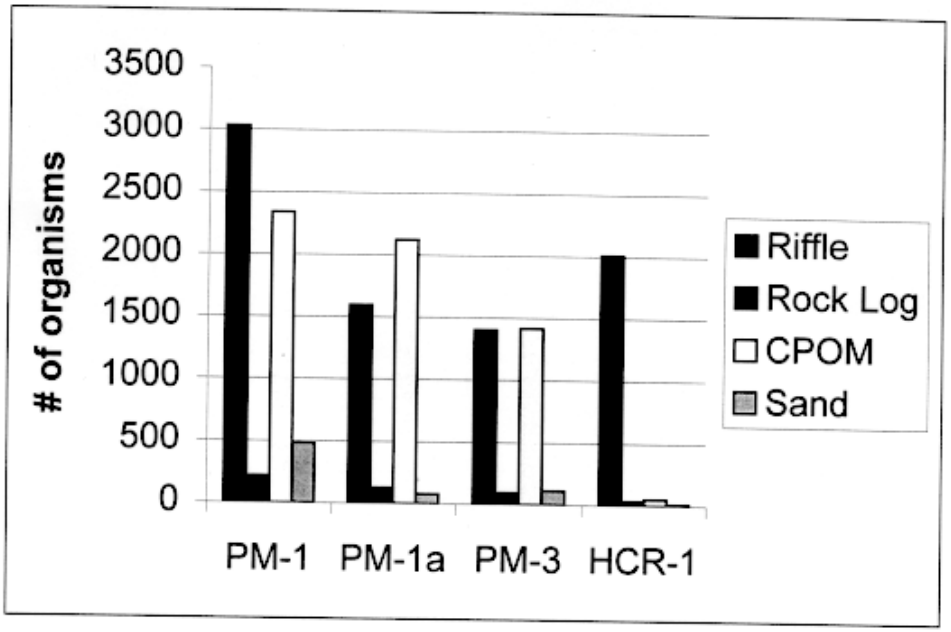

	Stations			
	PM-1	PM-1a	PM-3	HCR-1
Riffle	3030	1596	1404	2010
Rock Log	218	128	95	34
CPOM	2340	2124	1416	50
Sand	481	79	113	11

APPENDIX A

Toxicity Test Report

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
FIELD OPERATIONS DIVISION
ENVIRONMENTAL INDICATORS SECTION
BIOASSAY UNIT

TOXICITY TEST REPORT

1. GENERAL

NPDES PERMIT NO.: 0050237 DSN: 001 COUNTY: Lee
Facility Name: Auburn - Southside WWTP
Receiving Water: Parkerson Mill Creek Design Flow: ---
Test Type: 24-Hour Acute Screening. A chronic screening test was planned, but mortality was observed at 24h.
Test Id. #: 971118-02

Test Organism	Date/Time Started YYMMDD HHMM	Date/Time Ended YYMMDD HHMM	Control Validity (Acceptable/Unacceptable)
Ceriodaphnia dubia	971118 1614	971119 1450	Acceptable
Pimephales promelas	971118 1415	971119 1420	Acceptable

2A. SUMMARY OF RESULTS FOR SCREENING TEST

Test Org.	Effluent Conc.	Test Number (1) Surv	(1) Repro	(1) Grow	(2) Surv	(2) Repro	(2) Grow	(3) Surv	(3) Repro	(3) Grow	(4) Surv	(4) Repro	(4) Grow
C. d.	100%	FAIL	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----	-----
P. p.	100%	FAIL	N/A	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

3. LABORATORY ANALYSES OF UNDILUTED SAMPLES(S)

Sample Id.	pH su	Alkalinity mg/L as CaCO3	Hardness mg/L as CaCO3	Conductivity umhos/cm @ °C	TRC mg/L
971118-02	7.3	64	80	342 at 24.7	0.49

4. SAMPLE COLLECTION:

Were split samples collected?: no
Were samples collected as specified in NPDES Permit (Location and/or Type)? yes

Sample Id.	Sample(s) Collected YYMMDD HHMM to YYMMDD HHMM	Arrival Temp (°C)	Used in Test(s) YYMMDD to YYMMDD
971118-02	971117 1005 to 971118 0950	3	971118 to ---

5.CONTROL/DILUTION WATER

Carboy #	Preperation YYMMDD	Begin Use YYMMDD	Initial Water Chemistries pH (su)	Alkalinity (mg/L)	Hardness (mg/L)	Conductivity @ °C (umhos/cm)
C-4	971117	971118	8.2	69	70	153 at 22.6

PERMITTEE: Auburn - Southside WWTP NPDES #: 0050237 DSN: 001 TEST Id #: 971118-02

6. TOXICITY TEST INFORMATION

Test Organism	Organism Age	Organism Source	Org./Test Vessel	Replicates/Conc.
C.d.	<8h	ADEM In-house cultures	1	10
P.p.	<24h	ADEM In-house cultures	10	4

Test Organism	Temperature Range (°C)	D.O. Range (mg/L)	pH Range (su)	Light Intensity Average (ft-c)
C.d.	24.9 - 25.8	7.6 - 8.7	7.3 - 7.9	65
P.p.	24.5 - 24.9	3.9 - 8.7	7.3 - 7.3	60

7. FEEDING: Fed Daily

Brine Shrimp Fed 0.15 mL Suspension of Newly Hatched Larvae 2 Times Daily.
YCT Fed 0.15 mL Suspension Containing 1800 mg/L TSS Daily.
Algae Fed 0.15 mL Suspension Containing 3.3×10^7 Algal Cells/mL Daily.

8. REFERENCE TOXICANT TESTS

TOXICANT - Sodium Chloride (NaCl)

Test Organism	Test Date YYMMDD	Results LC50 (mg/L)	95% Confidence Interval (mg/L)
C.d.	971118	1945.00	1802.59/2098.66
P.p.	971119	7256.43	6995.63/7526.96

9. TEST CONDITION VARIABILITY

A. Deviations From Standard Test Conditions: Light intensity was not recorded on 971118. The P. promelas control organisms were loaded with a pipet that had been used to load another test. These deviations did not adversely affect the test results.

B. Test Solution Manipulations or Test Modifications

- ☐ Dechlorination
- ☐ Aeration during the test
- ☐ Aeration prior to test initiation or sample renewal
- ☐ Filtration
- ☐ pH adjustment
- ☒ NO sample modifications

PERMITTEE: Auburn - Southside WWTP NPDES #: 0050237 DSN: 001 TEST Id #: 971118-02

10A. ACUTE SCREENING TOXICITY TESTS RESULTS:

TEST ORGANISM: *Ceriodaphnia dubia* **ACUTE TOXICITY INDICATED? FAIL**

Solution Concentration (%)	% Survival
Control (0%)	100
100	0

STATISTICAL ANALYSES (Using Survival data as proportion surviving that is arc sine transformed):	COMMENTS:
☒ No Statistical Analysis Necessary	Acute mortality might be due to high chlorine concentration in the sample.

TEST ORGANISM: *Pimephales promelas* **ACUTE TOXICITY INDICATED? FAIL**

Solution Concentration (%)	% Survival
Control (0%)	100
100	25

STATISTICAL ANALYSES (Using Survival data as proportion surviving that is arc sine transformed):	COMMENTS:
Shapiro Wilk's Test (Normality) Test Statistic: 0.899 Critical Value: 0.749 (Parametric) Normally Distributed ☒ Yes (if test stat is > critical value) GOTO VARIANCE F-TEST ☐ No (if test stat is < critical value) GOTO WILCOXON RANK SUM TEST F-TEST – could not be run T-TEST t Statistic: 5.669 Critical t value: 1.94 Significant Difference ☒ YES (if t stat is > critical t) FAIL ☐ NO (if t stat is < critical t) PASS WILCOXON RANK SUM TEST or MODIFIED T-TEST Sample Rank Sum: 10.0 # of reps 4 Critical Rank Sum: 11.0 Significant Difference ☒ YES (if sample rank sum is < critical rank sum) FAIL ☐ NO (if sample rank sum is > critical critical rank sum) PASS	Acute mortality might be due to high chlorine concentration in the sample.

Signature: _____ Date: _____