Section 2.306 Site Specific Water Quality Study for Cl, SO_4 and TDS

Prepared for:

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1.0 INTRODUCTION

This report presents the documentation required in support of a third party rulemaking. The proposed rulemaking addresses the existing final permit limits for dissolved minerals in the NPDES permit (AR0001171) of Great Lakes Chemical Company (GLCC) central facility. The following documentation, required by Section 2.306 of the Arkansas Water Quality Standards (WQS), supports the proposal modifications to designated but non-existing and unattainable uses and associated water quality criteria. This report also addresses the requirements of the 1994 Administrative Guidance Document of the ADEQ, which clarifies the Section 2.306 documentation process.

In addition, this report provides documentation regarding the attainability of the domestic water supply uses from the perspective of the 40 CFR 131.10(g) rationale for use removal. The requirement for providing 40 CFR 131.10(g) documentation is to fulfill US EPA Region 6 requests for inclusion of use attainability information in the third party rule making process.

GLCC's central facility operates a bromine extraction and chemical facility in Union County, El Dorado, Arkansas (Figure 1). For the purpose of this report, three outfalls (002, 003, & 004) will be discussed and addressed. Outfalls 002 & 004 are storm water only outfalls that drain the northeastern and eastern portions of the facility via unnamed wet weather tributaries to Bayou de Loutre. Outfall 003 drains the western slopes of the facility and includes non-process waters as well as storm water. Outfalls 002, 003, & 004's discharge contains concentrations of chloride, sulfate, and total dissolved solids (TDS) that are in excess of the ecoregion based water quality criteria and/or stream based water quality criteria, and, in most cases, contains concentrations in excess of relevant secondary drinking water criteria. The primary report objectives are to:

- provide the required documentation to support a third-party rulemaking in accordance with Section 2.306 to remove the designated and unattainable domestic water supply use from two unnamed tributaries to Bayou de Loutre, Bayou de Loutre from headwaters to the mouth of Loutre Creek, and from unnamed tributaries of Little Cornie Bayou,

- propose site-specific water quality criteria for dissolved minerals (Cl, SO_4, and TDS) that

    - reflect the current discharge concentrations, (which have been reduced substantially from historical concentrations through facility upgrades to BMP's and spill control and containment),

    - account for recent reductions in mineral concentrations related to site improvements, and

    - are shown to support the designated seasonal fishery use and the supporting biotic communities to maintain that use.

This report provides conclusions and recommendations (Section 2.0), a summary of the site's background (Section 3.0), the physical, chemical, and biological characteristics of tributaries that receive permitted discharges from the outfalls (Section 4.0), and mass balance modeling results (Section 5.0). A review of alternatives for removal of dissolved minerals to meet ecoregion criteria is provided in Section 6.0. Attainability of the domestic water supply use of the respected unnamed tributaries is also discussed in Section 6.0. Section 7.0 provides the citation for documents referenced in this report.

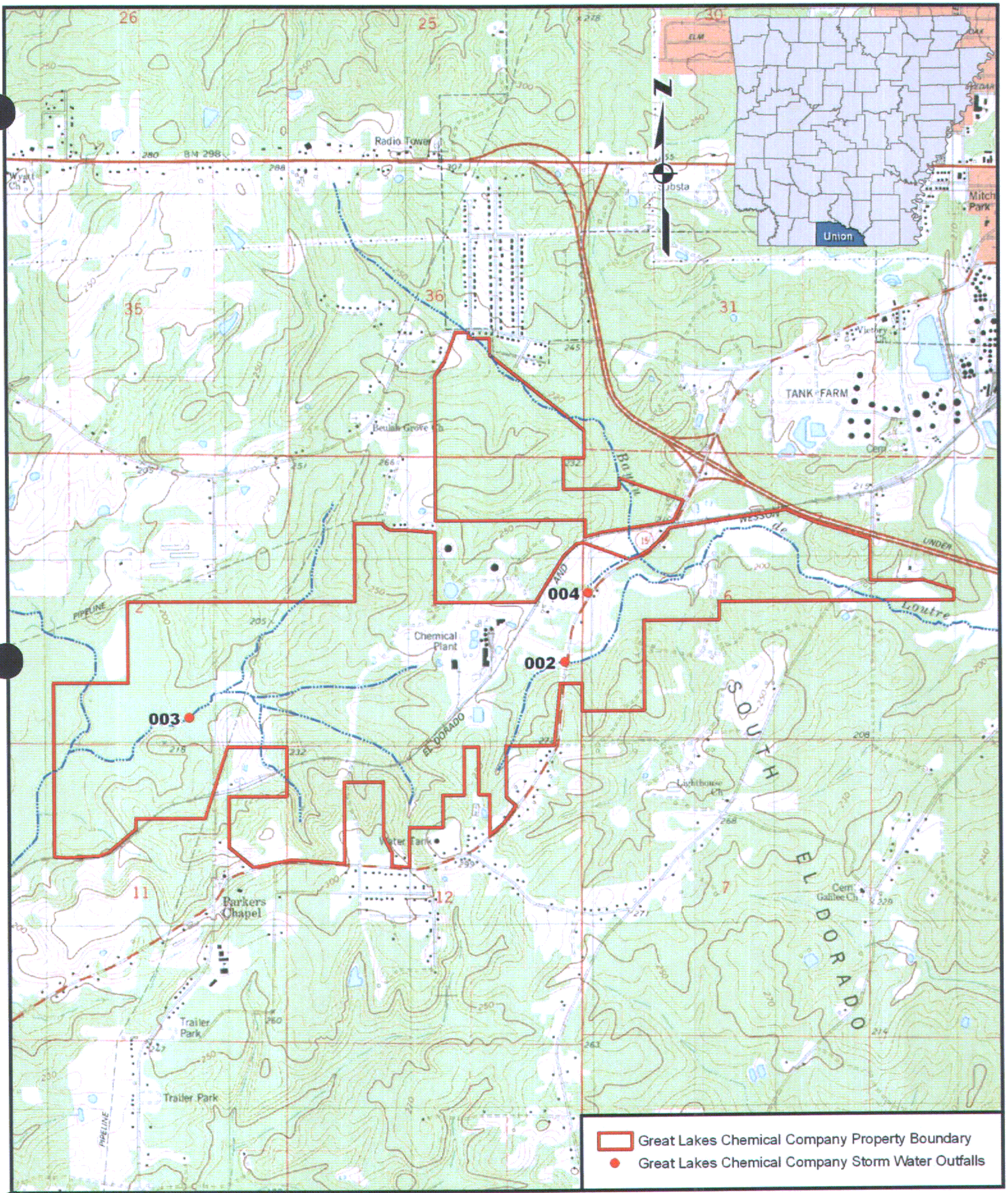

Figure 1. Great Lakes Chemical Company facility boundary and storm water outfall locations for 3rd party rule making.

2.0 Significant Findings and Recommendations

2.1 Significant Findings

The following findings are based on the information developed as part of the documentation in support of the proposed rule making and as directed by the aquatic life field survey study plan (Appendix A).

1. The facility manages water discharges under the NPDES permit AR0001171.
2. The NPDES permit storm water discharges have final dissolved mineral limitations based on least disturbed ecoregion reference water quality criteria.
3. The historical and existing discharges, exceed the water quality based Gulf Coastal Ecoregion mineral criteria.
4. The facility maintains a Storm Water Pollution Prevention Plan and a Spill Prevention Control and Countermeasure Plan.
5. The watershed into which each storm water discharge occurs is limited in size, ranging from 0.078 to 1.24 square miles.
6. The watershed sizes and resulting hydrologic characteristics are primarily responsible for the use attainment and govern biotic community development.
7. Although variable, each of the unnamed tributaries into which the storm water outfalls discharge maintains the designated aquatic life use, including a seasonal fishing use.
8. According to Arkansas state resource agencies the domestic water supply use is not an existing use, nor is it an attainable use.
9. The proposed modifications for the Little Cornie Bayou water shed do not impact the existing water quality standards for Louisiana. and
10. Modification to the mineral criteria will not preclude the attainment of the other designated and attainable uses.

2.2 Recommendations

Based on the documentation presented herein, it is recommended that the designated domestic water supply use be removed from:

1. Unnamed tributary into which Outfall 002 discharges,
2. Unnamed tributary into which Outfall 004 discharges,
3. Bayou de Loutre from the mouth of UT004 to the mouth of Loutre Creek,
4. Unnamed tributary into which Outfall 003 discharges, and
5. Unnamed tributary of Little Cornie Bayou from the mouth of UT003 downstream to its confluence with Little Cornie Bayou.

In addition, an increase in the water quality criteria for chloride (Cl), sulfate (SO_4), and total dissolved solids (TDS) for UT002 and UT003, an increase in the water quality criteria for Cl and TDS for UT004, an increase in the water quality criteria for Cl and TDS for UTLCB, and an increase in the water quality criteria for Cl and SO_4 in Little Cornie Bayou (LCB) is recommended. Tables 2.1 and 2.2 summarize the recommended changes:

Table 2.1. Summary of Proposed WQS Modifications for Bayou de Loutre watershed.

UT002 - unnamed tributary to Bayou de Loutre	**UT004 - unnamed tributary to Bayou de Loutre**	**Bayou de Loutre from mouth of Outfall 004 tributary downstream to the mouth of Loutre Creek**
Remove Designated Domestic Water Supply Use	Remove Designated Domestic Water Supply Use	Remove Designated Domestic Water Supply Use
Amend ecoregion dissolved minerals criteria:	**Amend ecoregion dissolved minerals criteria:**	**Amend stream ecoregion dissolved minerals criteria:**
Chloride from 14 mg/L to 65 mg/L; Sulfate from 31mg/L to 35 mg/L, and TDS from 123 mg/L to 141mg/L	Chloride from 14 mg/L to 239 mg/L and TDS from 123 mg/L to 324 mg/L	Chloride from 250 mg/L to 278 mg/L.

Table 2.2. Summary of proposed WQS Modifications for Little Cornie Bayou watershed.

UT003 - unnamed tributary to an unnamed tributary of Little Cornie Bayou	**UTLCB-2 – unnamed tributary of Little Cornie Bayou to Little Cornie Bayou**	**Little Cornie Bayou – to the Arkansas / Louisiana state line**
Remove Designated Domestic Water Supply Use	Remove Designated Domestic Water Supply Use	No Change
Amend ecoregion dissolved minerals criteria:	**Amend ecoregion dissolved minerals criteria:**	**Amend stream dissolved minerals criteria:**
Chloride from 14 mg/L to 538 mg/L; Sulfate from 31 mg/L to 35 mg/L, and TDS from 123 mg/L to 519 mg/L	Chloride from 14 mg/L to 305 mg/L and TDS from 123 to 325 mg/L	Chloride from 200 mg/L to 215 mg/L and Sulfate from 20 mg/L to 25 mg/L

3.0 BACKGROUND

3.1 Introduction

The GLCC central facility operates a bromine extraction facility in Union County on the south side of El Dorado, Arkansas. The facility has two outfalls that consist of storm water only (Outfalls 002 & 004) and one outfall (Outfall 003) that consist of primarily storm water but also includes non-process water (e.g. non-contact cooling water, boiler blow down, freeze protection, etc.). The discharges from these outfalls all discharge into unnamed wet weather tributaries. Outfalls 002 and 004 discharge into unnamed tributaries of Bayou de Loutre (Figure 2), while Outfall 003 discharges into an unnamed tributary of an unnamed tributary of Little Cornie Bayou (Figure 3).

The Arkansas Water Quality Standards - Regulation No. 2 (WQS) allows modification of water quality standards under various conditions. Specifically, Section 2.306 of the WQS (1998) allows the removal of a designated use other than a fishable or swimmable use, and for establishment of less stringent water quality criteria without affecting fishable or swimmable uses. This project report documents the information required to amend Reg. 2 through third party rulemaking. The study areas are shown above in Figure 1.

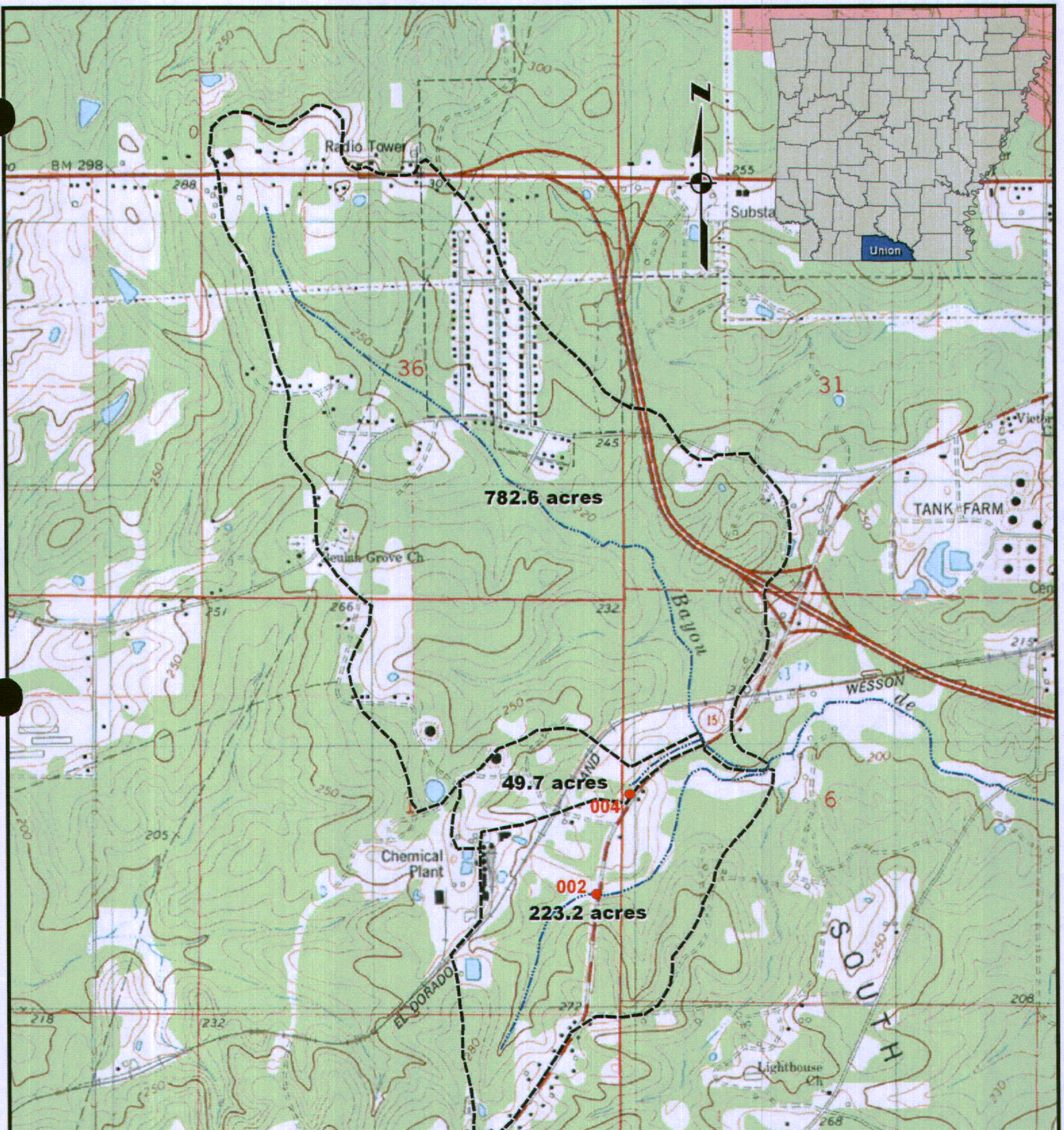

Figure 2. Watershed deleniation of Bayou De Loutre and Great Lakes Chemical Company storm water discharges as evaluated for the Great Lakes Chemical Company section 2.306 aquatic life field study. June 2005.

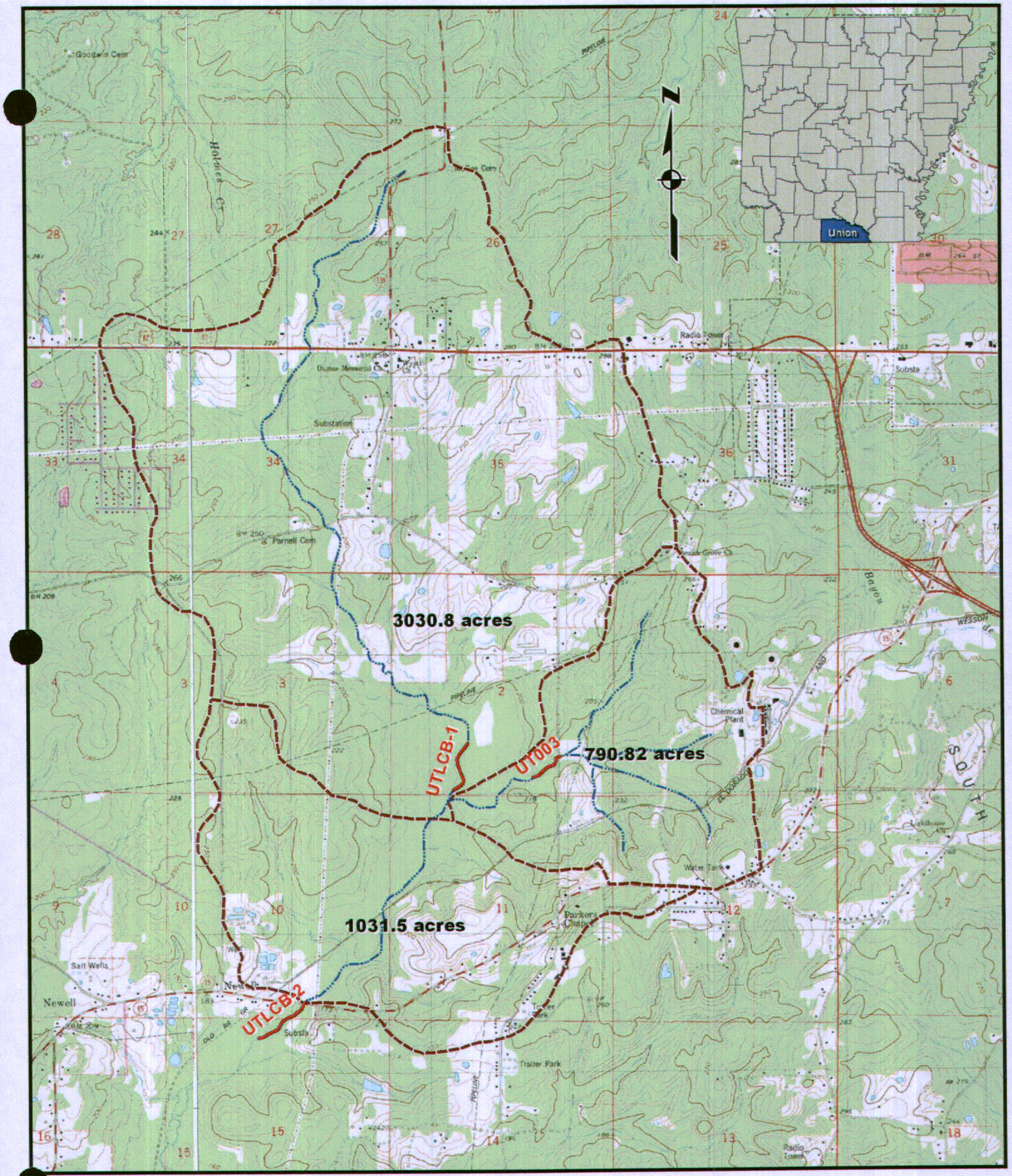

Figure 3. Watershed deleniation of unnamed tributary of Little Cornie Bayou and stream reaches evaluated for the Great Lakes Chemical Company section 2.306 aquatic life field study. June 2005.

3.2 Designated Uses

The designated uses for UT002, UT004, UT003, and UTLCB-2 are those listed in the WQS for Gulf Coastal Plain streams with watersheds less than 10 mi^2. The designated uses for Bayou de Loutre and Little Cornie Bayou are those listed in the WQS for Gulf Coastal Plain Streams with watershed greater the 10 mi^2. The designated uses for all streams are listed below. They are as follows:

Unnamed Tributary to Bayou de Loutre (UT004)

- Secondary Contact Recreation,
- Seasonal Gulf Coastal Fishery,
- Domestic Water Supply,
- Industrial Water Supply, and
- Agricultural Water Supply.

Unnamed Tributary to Bayou de Loutre (UT002)

- Secondary Contact Recreation,
- Seasonal Gulf Coastal Fishery,
- Domestic Water Supply,
- Industrial Water Supply, and
- Agricultural Water Supply.

Bayou de Loutre above mouth of Loutre Creek

- Secondary Contact Recreation,
- Seasonal & Perennial Gulf Coastal Fishery,
- Domestic Water Supply,
- Industrial Water Supply, and
- Agricultural Water Supply.

Unnamed Tributary to the UT Little Cornie Bayou (UT003)

- Secondary Contact Recreation,
- Seasonal Gulf Coastal Fishery,
- Domestic Water Supply,
- Industrial Water Supply, and
- Agricultural Water Supply.

Unnamed Tributary of Little Cornie Bayou (UTLCB-2)

- Secondary Contact Recreation,
- Seasonal Gulf Coastal Fishery,
- Domestic Water Supply,
- Industrial Water Supply, and
- Agricultural Water Supply.

Little Cornie Bayou

- Secondary Contact Recreation,
- Perennial Gulf Coastal Fishery,
- Domestic Water Supply,
- Industrial Water Supply, and
- Agricultural Water Supply.

3.3 Domestic Water Supply Use

Based upon documentation provided by the Arkansas Department of Health and Human services (ADHHS), UT002, UT004, UT003, UTLCB-2 below UT003, or Bayou de Loutre is neither an existing or planned public water supply source. In addition, the Arkansas Natural Resources Commission (ANRC) has documented that the removal of the designated domestic water supply use from these water sources does not conflict with the Arkansas Water Plan. The letters from the ADHHS and ASWCC are provided in Appendix B.

3.4 Effluent Characteristics

Tables 3.1, 3.2, & 3.3 present the effluent characteristics of Outfalls 002, 003, and 004, respectively. This data represents all available recent data. Documentation for the 95th percentile value is presented in Section 5.0. The percentile concentration values represent statistically calculated values based on methodologies outlined in *Statistical Methods for Environmental Pollution Monitoring* (Gilbert, 1987) which will be discussed in detail in Section 5.2.2. Details of the facility and outfall specific data upon which the outfalls were characterized is provided in Appendix C.

Table 3.1. Outfall 002 Discharge Statistics (monthly maximums) POR January 2000 through September 2005.

Statistic	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
(Data Characterization)	N=66	N=65	N=19
Maximum	1436	869	1376
Minimum	1.30	3.00	3.40
Average	230	78.9	544
95th percentile	1029	380	1376
Median	90.5	25.7	429

Table 3.2. Outfall 003 Discharge Statistics (monthly maximums) POR January 2000 through September 2005.

Statistic	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
(Data Characterization)	N=72	N=72	N=22
Maximum	5437	197	3699
Minimum	13.0	4.00	96.0
Average	489	35.4	684
95th percentile	2374	95.8	2079
Median	178	28.0	443

Table 3.3. Outfall 004 Discharge Statistics (monthly maximums). POR January 2000 through September 2005.

Statistic	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
(Data Characterization)	N=66	N=65	N=19
Maximum	2625	147	2881
Minimum	6.00	4.60	160
Average	314	23.5	700
95th percentile	1702	63.7	1932
Median	59.0	17.3	350

* includes statistical outliers

3.5 Description of Pollution Prevention Practices

Each outfall (002, 003, & 004) is addressed specifically in the facility's Spill Prevention Control and Countermeasures (SPCC) and Storm Water Pollution Prevention Plan (SWPPP) plans (GBMc, 2002). The following sections generally describe the potential pollution sources and best management practices (BMP's) at each outfall implemented to reduce contamination of storm water and prevent spill release. GLCC has installed pollution prevention practices at the facility designed to reduce the potential of storm water contamination and to prevent spills from entering waters of the state (i.e., UT002, UT003, & UT004).

3.5.1 Outfall 002

The NPDES Outfall 002 drainage basin includes the eastern portions of the facility. Areas of industrial activity that drain to Outfall 002 include the chlorine railcar loading/unloading area, southern portion of the Hertz/Penske vehicle maintenance area, old COPT area, old tail brine area, and the eastern portion of the railroad loading/unloading area. Table 3.4 summarizes the potential storm water pollution sources present in the Outfall 002 drainage basin.

Table 3 4. Potential storm water pollution sources in the Outfall 002 drainage basin.

Source Description and Map Reference	Pollutant Material
Chlorine loading/unloading area	COD
Trailer parking area south of Hertz/Penske	TSS, Oil and Grease
Old COPT area	TSS
Old tail brine pond area	TSS
Eastern portion of the railroad loading/unloading area	COD, Oil and Grease, TPH, TOC,

Specific BMP's at Outfall 002 are detailed in the facilities SPCC and SWPPP plans. However, GLCC Central maintains good housekeeping, a preventive maintenance program, spill prevention and response procedures, inspections, employee training, and record keeping and reporting at each outfall covered under their SPCC and SWPPP plans. In addition to these general BMP's, Outfall 002 has a retention basin into which storm water flow can be diverted prior to discharge via Outfall 002 should the need arise. Discharge through Outfall 002 is controlled on an as needed basis and can be discontinued if ever needed.

Based on the assessment of the structural and non-structural controls for the Outfall 002 drainage area, the existing procedures appear to be adequate for minimizing potential storm water contamination.

3.5.2 Outfall 003

The NPDES Outfall 003 drainage basin is the largest of the GLCC Central drainage basin areas. It includes non-process runoff from the facility production areas. These areas include:

1) Bromine Tower
2) Fine Chemicals
3) Alkyl Bromides
4) Bromated Organic Chemicals (BOC)
5) Sodium hydrosulfide (NAHS)
6) Groundwater Treatment
7) Tetrabromo-bisphenal A (IOB)
8) Organic Chemical Processing (OCP)
9) Calcium & Hydrogen bromides (CaBr/HBr)
10) Tetrabrom Carbonate Oligomers (TCO)
11) Bromine Recovery Unit
12) Process Water Area
13) Packaging and Shipping Area
14) Spray Dryer Area

NPDES Outfall 003 also receives runoff from the western portion of the railroad loading/unloading area, the maintenance building, the hazardous waste storage area, the north and south landfill, the solid waste landfill, gasoline vehicle fueling station, the paint contractor area, the Milam and Systems contractor areas, and the Feed Mill. Discussion of activities and storage areas within the Outfall 003 drainage basin can be found in the facilities SPCC and SWPPP plans.

BMP's at Outfall 003 include good housekeeping, a preventive maintenance program, spill prevention and response procedures, inspections, employee training, and record keeping and reporting. Outfall 003 also has a sump system designed to capture first flush waters and to serve as tertiary spill containment should primary and secondary controls (sumps) fail or be overwhelmed. Should primary and secondary systems fail (or be over whelmed), the west side sump in designed and operated to collect and pump any non-permitted discharge and/or process wastewater to the central waste water treatment system for treatment and injection to the deep well injection system on an as needed basis. Specific BMP's can be found in the facilities SPCC and SWPPP plans.

Based on the assessment of the structural and non-structural controls for the Outfall 003 drainage area, the existing procedures appear to be adequate for minimizing potential storm water contamination.

3.5.3 Outfall 004

The NPDES Outfall 004 drainage basin includes the northeastern portions of the facility. Areas of industrial activity that drain to Outfall 004 include the GLCC Central facility entrance, the Hertz/Penske vehicle maintenance area, and the supply room area. There are other areas that contribute storm water to Outfall 004 that would not necessarily be considered areas of industrial activity. These areas include office buildings, parking areas, the research and development laboratory, and the guardhouse. These areas would contribute minimal pollutant material to NPDES Outfall 004. Table 3.5 summarizes the potential storm water pollution sources present in the Outfall 004 drainage basin.

Table 3.5 Potential storm water pollution sources in the Outfall 004 drainage basin.

Source Description and Map Reference	**Pollutant Material**
GLCC-Central facility entrance (AA-1)	TSS, Oil and Grease
Northern portion of the Hertz/Penske vehicle maintenance area	TSS, Oil and Grease
Store Room area	TSS, Oil and Grease
Car wash	TSS, Oil and Grease

BMP's at Outfall 004 include good housekeeping, a preventive maintenance program, spill prevention and response procedures, inspections, employee training, and record keeping and reporting. Specific BMP's can be found in the facilities SPCC and SWPPP plans.

Based on the assessment of the structural and non-structural controls for the Outfall 004 drainage area, the existing procedures appear to be adequate for minimizing potential storm water contamination.

3.6 Current NPDES Permit Status

3.6.1 NPDES Permit Compliance

GLCC's Central current NPDES permit (Permit No. AR0001171) was initially issued in December 2003 and became effective on January 1, 2004. The permit remains in effect until December 31, 2008.

3.6.1.1 Discharge and Monitoring Requirements

The effluent limitations for chloride, sulfate, and TDS are based on the maintenance of the designated, but not existing domestic water supply use for the unnamed tributaries of Bayou de Loutre (UT002 & UT004), and the unnamed tributary of Little Cornie Bayou (UT003). Tables 3.6, 3.7, & 3.8 summarize Outfall 002's, 003's, and 004's daily maximum and monthly average limits for chloride, sulfate, and TDS. In addition, the following tables provide final discharge limitation and monitoring requirements for Outfalls 002, 003, & 004.

Table 3.6. Final Discharge Limitations for GLCC Central Outfall 002.

Effluent Characteristic	Monthly Average	Daily Maximum	Frequency of Analysis
Flow (MGD)	N/A	NA	Daily**
Chloride (mg/L)	129	193.5	Once per month**
Total Organic Carbon (mg/L)	N/A	35	Once per month**
Total Purgeable Halocarbons (mg/L)	N/A	0.1	Once per quarter**
Sulfate (mg/L)	250	375	Once per month**
Total Dissolved Solids (mg/L)	500	750	Once per month**
Oil and Grease (mg/L)	10	15	Once per month**
pH (SU)	*	*	Once per day**
*pH shall not be less than 6.0 standard units nor greater that 9.0 standard units **When discharging			

Table 3.7. Final Discharge Limitations for GLCC Central Outfall 003.

Effluent Characteristic	Monthly Average	Daily Maximum	Frequency of Analysis
Flow (MGD)	N/A	NA	Daily**
Chloride (mg/L)	31	46.5	Once per month**
Total Organic Carbon (mg/L)	N/A	35	Once per month**
Total Purgeable Halocarbons (mg/L)	N/A	0.1	Once per quarter**
Sulfate (mg/L)	66	99	Once per month**
Total Dissolved Solids (mg/L)	201	302	Once per month**
Oil and Grease (mg/L)	10	15	Once per month**
Temperature (°F)	N/A	86.0	Once per day**
pH (SU)	*	*	Once per day**
*pH shall not be less than 6.0 standard units nor greater that 9.0 standard units **When discharging			

Table 3.8. Final Discharge Limitations for GLCC Central Outfall 004.

Effluent Characteristic	Monthly Average	Daily Maximum	Frequency of Analysis
Flow (MGD)	N/A	NA	Daily**
Chloride (mg/L)	98	147	Once per month**
Total Organic Carbon (mg/L)	N/A	35	Once per month**
Total Purgeable Halocarbons (mg/L)	N/A	0.1	Once per quarter**
Sulfate (mg/L)	Report	Report	Once per month**
Total Dissolved Solids (mg/L)	500	750	Once per month**
Oil and Grease (mg/L)	10	15	Once per month**
pH (SU)	*	*	Once per day**
*pH shall not be less than 6.0 standard units nor greater that 9.0 standard units **When discharging			

3.6.2 Toxicity Testing

Outfalls 002 and 004 are storm water discharges and not subject to routine whole effluent toxicity testing. However, acute testing was completed on storm flows to both Outfall 002 and 004 using a 100% effluent as the critical dilution. These tests were completed in March 2006 and are provided in Attachment D-1. Both tests passed, demonstrating no mortality to either test organism when exposed in 100% storm water effluent. There is no information to indicate that either storm water effluent has ever exhibited toxicity.

Chronic toxicity tests have been completed on Outfall 003 on a quarterly basis since the current permit was issued in December 2003. A summary of the results of the chronic biomonitoring is provided in Appendix D-2. The chronic testing completed over the last 2 years requires testing using a two tiered critical dilution (100% and 45%). This approach was approved by ADEQ in recognition of the small watershed size. This approach reflects the seasonal nature of the discharge and accounts for the flows present during the spring seasonal period. Figure 4 depicts the results of the Outfall 003 chronic tests indicating that no significant lethality has been demonstrated in the Outfall 003 discharge since the chronic testing was initiated.

Prior to the current permit chronic biomonitoring requirement, acute biomonitoring has been completed on discharges through Outfall 003 for several years, with a variety of results. During the previous permit cycle, recurrent acute toxicity at the 100% critical dilution indicated sporadic test failures at a frequency sufficient to require a toxicity reduction evaluation (TRE). The TRE was completed in an effort to determine the cause(s) of the sporadic biomonitoring tests failures.

Multiple toxicity identification evaluations (TIE) indicated non-polar organics (and pH) to have been the cause for the historical tests failures. These findings and the findings of CAO investigations related to TOC and pH (GBMc, 2004--CAP Report. CAO LIS02-081 for Outfall 003 GLCC) excursions led to improvements of internal spill control and management policies and procedures. These general house keeping and process control modifications resulted in improved storm water discharges and resulted in the current sequence of biomonitoring tests that pass the required endpoints and has eliminated the TOC and pH excursions in discharges through Outfall 003.

The monitoring program implemented during the Outfall 003 investigation demonstrated that the dissolved minerals were not contributors to the permit excursions or the sporadic biomonitoring test failures exhibited by discharges through Outfall 003. In fact, during the TIE investigations, manipulations were completed to specifically address the potential that dissolved minerals were responsible for the biomonitoring failures. These efforts clearly exonerated dissolved minerals as a contributing factor to permit failures.

The results of the TRE investigation were submitted to ADEQ along with proposed schedule for compliance (GBMc, 2001). Subsequently, Outfall 003 has maintained compliance with the TOC and pH permit requirements.

In all the activities related to the TRE efforts, dissolved minerals were never demonstrated to be the cause of the biomonitoring failures or the source of the TOC and pH permit excursions

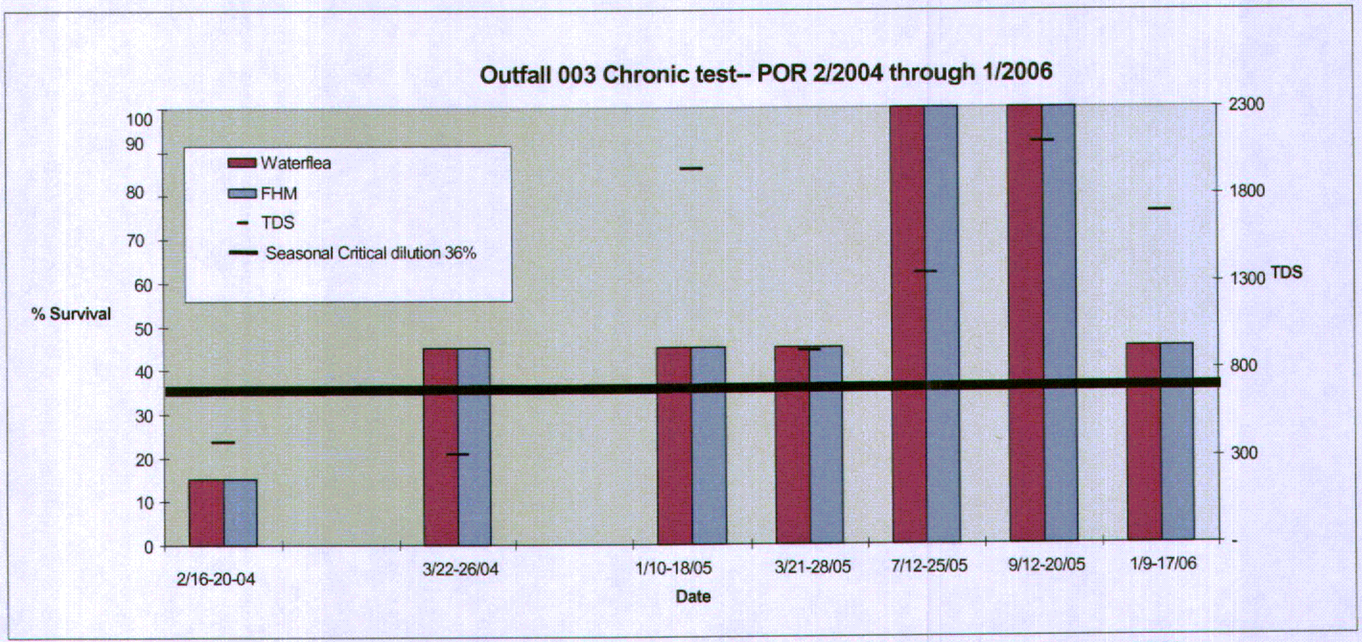

Figure 4. Summary of chronic lethality toxicity test results. GLCC Outfall 003. POR Jan 2004 to January 2006.

In summary, current whole effluent toxicity does not indicate effluent discharged through 003 is toxic at appropriate critical dilutions and there is no evidence to implicate dissolved minerals as the source of historical WET test failures.

4.0 AQUATIC LIFE FIELD STUDY

4.1 Introduction

The objective of the aquatic life field study was to document whether the designated aquatic life uses were being maintained in stream segments downstream existing discharges from the GLCC Central Facility on Highway 15, south of El Dorado in Union County, Arkansas (Figures 5 & 6). The following stream segments were assessed during this study: unnamed tributaries of Bayou de Loutre (UT002 and UT004) (Figure 5), unnamed tributary of an unnamed tributary of Little Cornie Bayou (UT003), Unnamed tributary of Little Cornie Bayou below the confluence of UT003 (UTLCB-2), and unnamed tributary of Little Cornie Bayou above the confluence of UT003 (UTLCB-1) (Figure 6). The watersheds of the unnamed tributaries at the sampling locations vary in size; Table 4.1 provides watershed sizes for the respected locations.

Table 4.1. Study Reach Watershed sizes.

Study Reach	Watershed Size
UT002	0.349 sq. miles
UT004	0.078 sq. miles
UT003	1.24 sq. miles
UTLCB-1	4.74 sq. miles
UTLCB-2	7.58 sq. miles

Based on locations and watershed sizes, each of the unnamed tributaries are designated as having a seasonal Gulf Coastal Fishery use in the Arkansas Water Quality standards.

To accomplish the objective, the aquatic life field study included evaluations of the habitat conditions, water quality, aquatic macroinvertebrate community, and fish community assemblages. Studies reaches for the aquatic life field study are as follows:

- Reach UT002,
- Reach UT004,
- Reach UT003,
- Reach UTLCB-1, and
- Reach UTLCB-2.

The evaluations were conducted during April and May, 2005. The results of this evaluation are provided in this section. Details of aquatic life field survey are provided in Appendix E and site photos are provided in Appendix F.

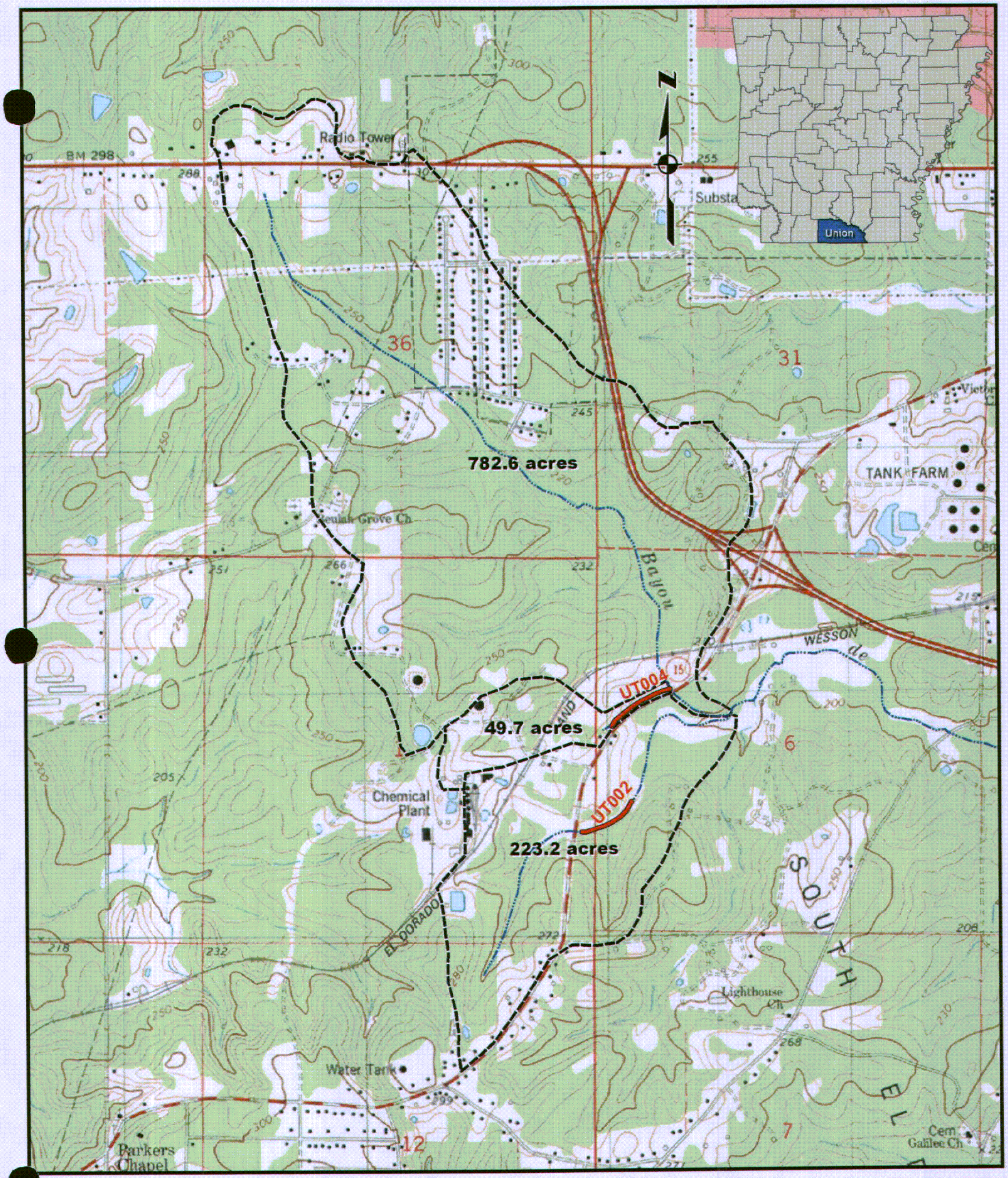

Figure 5. Bayou De Loutre stream reaches evaluated for Great Lakes Chemical Company Section 2.306 aquatic life field study. June 2005.

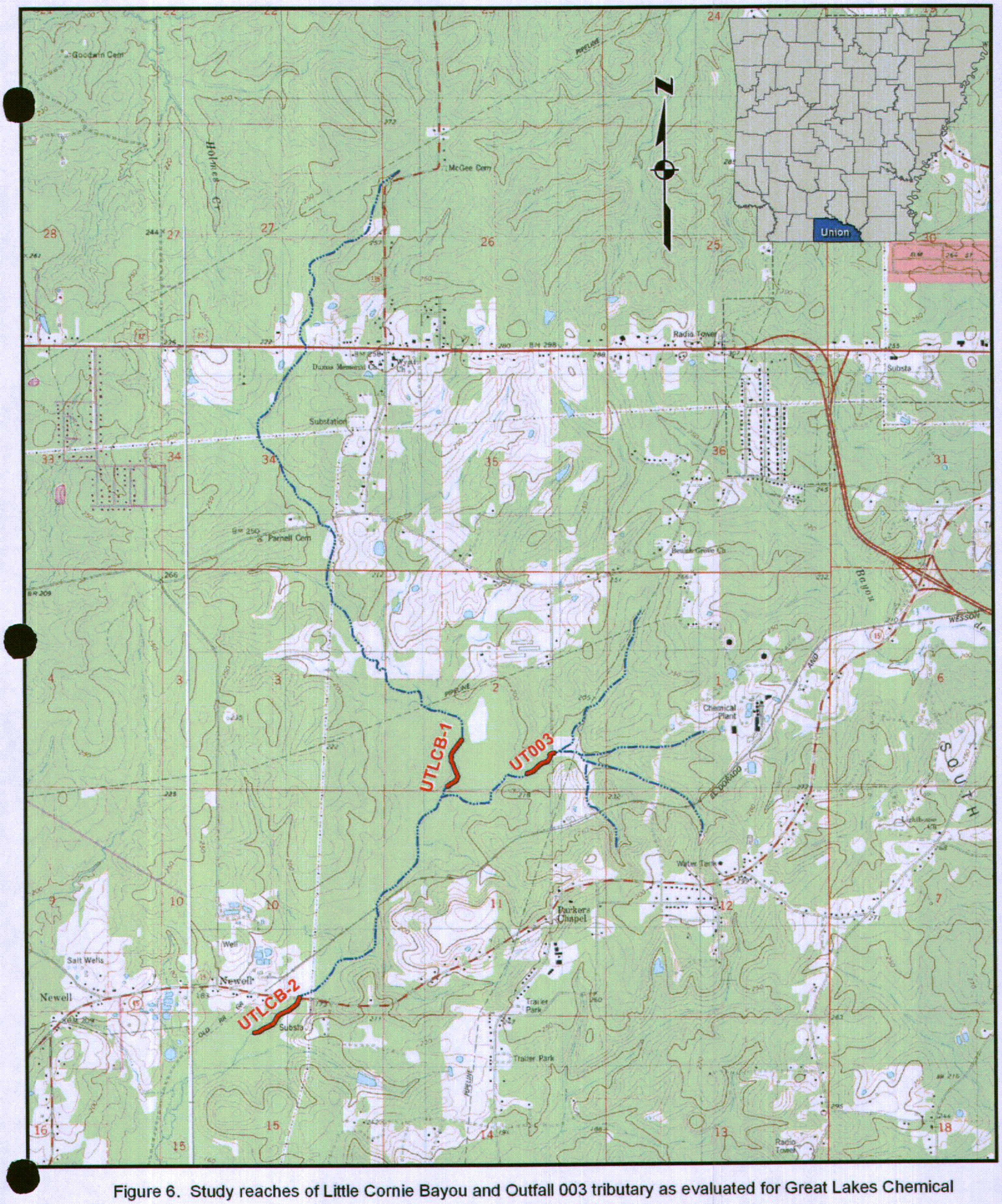

Figure 6. Study reaches of Little Cornie Bayou and Outfall 003 tributary as evaluated for Great Lakes Chemical Company section 2.306 aquatic life field study. June 2005.

4.2 Habitat Characterization

4.2.1 Introduction

Physical habitat in streams includes all those physical attributes that influence or provide sustenance to biological attributes, both botanical and zoological, within the stream. Stream physical habitat varies naturally, as do biological characteristics; thus, habitat conditions differ even in the absence of point and anthropogenic non-point disturbance. Within a given ecoregion, stream drainage area, stream gradient and the geology are likely to be strong natural determinants of many aspects of stream habitat, because of their influence on discharge, flood stage, and stream energy (both static and kinetic). Kaufmann (1993) identified seven general physical habitat attributes important in influencing stream ecology and the maintenance of biological integrity:

1) channel dimensions,
2) channel gradient,
3) channel substrate size and type,
4) habitat complexity and cover,
5) riparian vegetation cover and structure,
6) anthropogenic alterations, and
7) channel-riparian interaction.

Land use activities can directly or indirectly alter any and/or all of these attributes. Nevertheless, the trends for each attribute will naturally vary with stream size (drainage area) and overall gradient. The relationships of specific physical habitat measurements described in this section to these seven attributes are discussed by Kaufmann (1993). Although they are actually biological measures, aquatic macrophytes, riparian vegetation, instream habitat and canopy cover are included in this and other physical habitat assessments because of their role in habitat structure and light inputs

The objectives of a habitat characterization are to:

1) assess the availability and quality of habitat for the development and maintenance of benthic invertebrate and fish communities, and
2) evaluate the role of habitat quality in relation to the attainment of designated uses and biological integrity.

There are three main headings for the components of the physical habitat characterization each with several categories. Measurements for each of the components (14 categories total) are recorded on copies of a two-page field form entitled Stream Habitat Assessment (Semi-Quantitative), and include:

1) Channel Morphology
    a) Reach Length Determination
    b) Riffle-Pool Sequence
    c) Depth and Width Regime

2) Instream Structure
    a) Epifaunal substrate
    b) Instream Habitat
    c) Substrate Characterization
    d) Sediment Deposition
    e) Aquatic Macrophytes and Periphyton

3) Riparian Characteristics
    a) Canopy Cover
    b) Bank Stability and slope
    c) Vegetative Protection
    d) Riparian Vegetative Zone Width

Field physical habitat measurements from a field habitat characterization are used in conjunction with water chemistry, temperature, macroinvertebrate and vertebrate (typically fish) community analyses, and other data sources to determine the status of the target streams attainment of designated uses and the water quality required to maintain those uses.

These procedures are intended for evaluating physical habitat in wadeable streams, but may be adapted for use in larger streams as necessary. The field procedures applied to this characterization are most efficiently applied during low flow conditions and during times when terrestrial vegetation is active, but can also be applied during spring seasonal conditions with higher base flows. This collection of procedures is designed for monitoring applications where robust, quantitative or semi-quantitative descriptions of habitat are desired. This semi-quantitative habitat procedure is usually used in conjunction with the *General Physical Habitat Characterization* and the *Qualitative Habitat Assessment* to provide a detailed view of the streams habitat condition.

The habitat characterization protocol provided herein differs from other rapid habitat assessment approaches (e.g., Plafkin et al., 1989, Rankin, 1995) by employing a, systematic spatial sampling that minimizes bias in the placement and positioning of measurements. Measures are taken over defined channel areas and these sampling areas are placed systematically at spacing that is proportional to the length of the entire study reach. This systematic sampling design provides resolution appropriate to the length of the study reach. The habitat assessment protocol summarized in this SOP is based on those of USEPA in their EMAP and RBP procedures (Lazorchak, 1998 and Barbour, 1999), USGS NAWQA program (Fitzpatrick, 1998) and Missouri Department of Natural Resources ESP (Sarver, 2000).

The procedures are employed on a sampling reach of length equal to 20 times the bankfull width. The semi-quantitative habitat sampling reach length should coincide as much as possible with that of the fish and macroinvertebrate collection reaches. Measurements are taken in each of 10 sub-reaches, which are systematically placed, at intervals equal to approximately one tenth (1/10) the length of the represented study reach. Measurements and observations for each habitat characteristic are made in each of the sub-reaches as the assessment team moves along the stream channel. An average or total of the scores for each of the 10 sub-reaches is then calculated resulting in a mean value for each characteristic for the entire reach.

4.2.2 Methods

The habitat assessment was conducted within (or to the extent possible) the stream reach from which the benthic and fish communities are to be characterized. The physical habitat was characterized from measurements and observations of stream attributes made within 10 sub-reaches. The team assessing habitat moved along the stream channel (near the thalwag) observing habitat characteristics within each sub-reach. A description of and the rational for measuring each of the attributes are provided below. The details of how these attributes are recorded/evaluated are also described below in the following sections.

4.2.2.1 Channel Morphology

Channel morphology (or geomorphology) is a characterization of the shape of the stream channel including measurements and/or visual estimates of channel dimensions and riffle-pool sequences, i.e. a measure of the amount of riffles, runs and pools that occur in a given reach.

The channel observed includes that portion of the stream between the base flow wetted area and the top of the normal high water channel often referred to as the bankfull stage (Figure 7). The "bankfull" or "active" channel is defined as the channel that is filled by moderate-sized flood events that typically occur every one or two years. Such flow levels are on the verge of entering the flood plain and are believed to control channel dimensions in most streams.

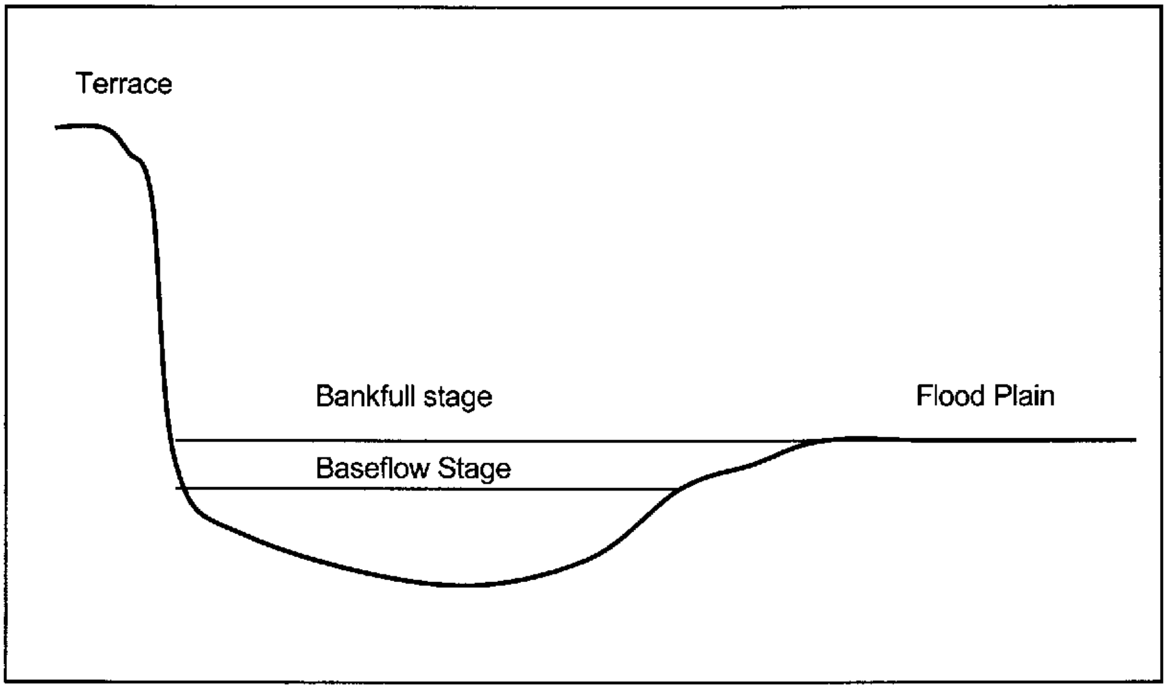

Figure 7. Stream channel depicting bankfull stage.

1) Reach Length Determination

First, bankfull depth (depth from stream bottom in thalwag to bankfull stage on the bank) was identified in at least two separate riffles (or alternatively runs in streams not exhibiting riffle morphology) in each study reach. Then bankfull depth and width was determined from 5 stream transects and recorded on the record sheet. Transect locations was selected to include each prominent morphology type represented in the stream. Bankfull depths were measured to the nearest 1/10 foot and bankfull widths were measured to the nearest foot using a wading rod and tape measure, respectively. An average of the 5 bankfull widths was then calculated and multiplied times 20 to arrive at the total reach length for assessment. This total length was then divided by ten to determine the length of each of the ten sub-reaches. Analysis of the first sub-reach began at the head of a given stream morphology (i.e. riffle, run or pool).

2) Riffle-Pool Sequence

Stream morphology refers to the abundance and placement (sequencing) of riffles, runs, and pools in a stream system. This sequencing is an indicator of a streams hydrological regime and stability as well as a determinant of its potential to sustain diverse aquatic communities. Beginning at the head of a morphological type (riffle, run or pool) the length of each morphological type in the stream reach was measured using a tape measure and recorded on the record sheet. The sequence of each morphological type was depicted on the record sheet using the provided notations so as to create a map to the location of each riffle, run or pool. The resulting measurements provided a quantitative measure of the percent of the study reach representing each stream morphological type (i.e. 40% riffle, 30% run, 30% pool, etc).

3) Depth and Width Regime

The average stream depth and width were estimated in riffles and pools in each sub-reach. Depths were measured along a transect, similar to that depicted in Figure 8, in a representative section of each riffle and pool in the sub-reach. Depths were generally taken in the thalwag (deepest area in stream channel) and approximately half way between the thalwag and the left and right banks. An estimated average depth for riffles and pools occurring in a sub-reach was derived from the cross-sectional depth measurements and recorded on the record sheet to the nearest 1/10 foot. Once completed for all 10 sub-reaches this provided an accurate semi-quantitative measurements of riffle and pool average depth and depth variability across the entire stream reach.

Stream wetted widths were measured along a transect, in a representative section of each riffle and pool in the sub-reach. An estimated average width for each morphological type in a sub-reach was recorded on the record sheet to the nearest foot. Once completed for all 10 sub-reaches this provided accurate semi-quantitative measurements of riffle and pool widths across the entire stream reach.

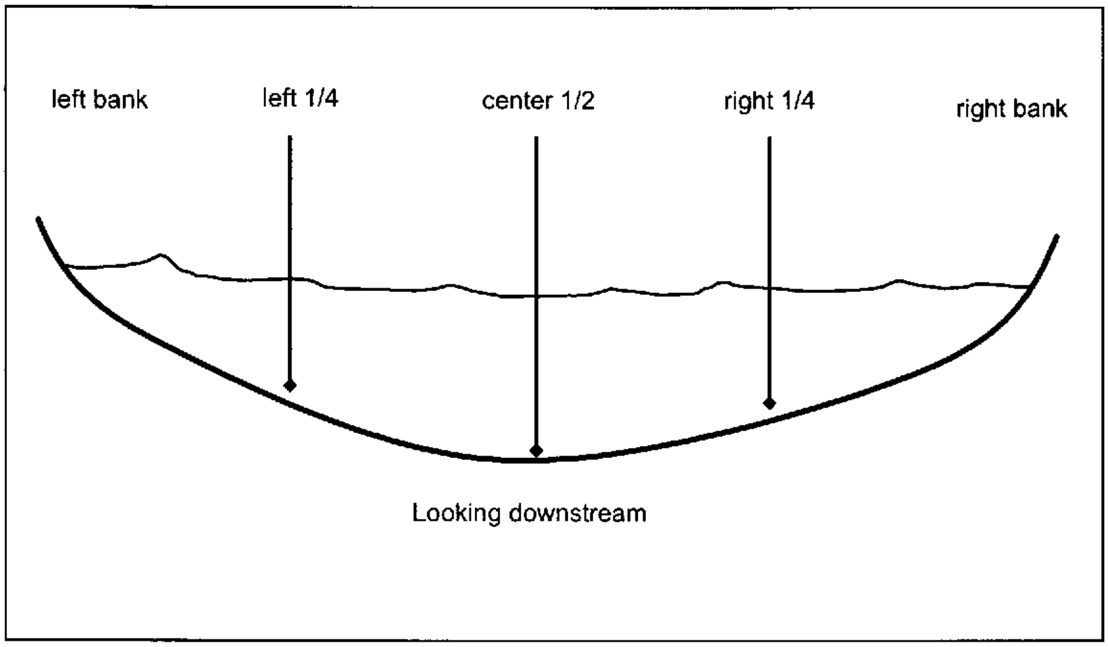

Figure 8. Approximate position of measurements across transect.

4.2.2.2 Instream Structure

Instream structure describes the characteristics of the stream within the wetted perimeter that makes up the habitat suitable for colonization of aquatic biota. This includes information about natural substrates (gravel, boulders, etc), aquatic plants and algae and debris that has been washed into or fallen into the stream, such as logs, leaves, etc. A stream capable of sustaining diverse aquatic communities will contain a variety of instream structure including some that is permanent and some that is mobile during high flow events.

1) Epifaunal Substrate (Macroinvertebrates)

Epifaunal substrate refers to the area on the bottom of the stream (entire wetted perimeter) where macroinvertebrates inhabit. This attribute is scored as a percentage of the stream bottom in a sub-reach which contains substrates suitable for macroinvertebrate colonization. Scoring for this attribute should rely heavily on the stability of the substrate, the size of the interstitial spaces, and the cleanliness (not covered in thick algae or sediment deposits) of the substrate. Cobbles and coarse gravel will score higher percentages as they contain larger interstitial spaces for colonization, while sand and silt would score lower since they provide little spaces. In addition, root wads along the bank would score higher as they are more stable features than would depositional areas or small woody debris.

2) Instream Habitat (Fish)

Instream habitat refers to the habitat features within the wetted perimeter of the stream sub-reach which are available for fish colonization. This attribute is scored as the percentage of the stream bottom (wetted perimeter) in a sub-reach which is covered with fish habitat. As with the epifaunal substrate attribute substrates composed of cobbles, coarse gravels and boulders score higher for fish cover as they provide better spaces for colonization. Other habitats that score high are large woody debris (individual logs with diameter >4 inches or complex woody structures composed of rootwads, logs, or limbs with diameter of 1.5 ft. or greater)and undercut banks. While habitats that score lower are those such as depositional areas, leaf packs, and fine sediments or sand.

3) Substrate Characterization

The dominant stream substrate size classification for riffles and pools within each sub-reach will be recorded on the record sheet. Only substrates within the wetted perimeter are evaluated. This information will be used to characterize the similarities and or differences in substrate structure and complexity in the riffles and pools of the study reach as it relates to the development and maintenance of the systems biological integrity.

Particle are classified into one of the size classes listed on the Semi-Quantitative Habitat Assessment Field Form based on the size of the intermediate axis (median dimension) of its length, width, and depth. This "median" dimension is the sieve size through which the particle can pass.

Bedrock	smooth or rough
Boulder	>25 cm
Cobble	6-25 cm
Coarse Gravel	1.6 – 6 cm
Fine Gravel	0.2 – 1.6 cm
Sand	<0.2 cm
Silt/Mud/Clay	fine, not gritty

Notations are made for unusual substrates such as concrete or asphalt and denote these artificial substrates as "other" and describe them in the comments section of the field data form. Code and describe other artificial (such as large appliances, tires, car bodies, etc.) substrates in the same manner.

4) Sediment Deposition

The sediment deposition attribute refers to the amount of stream bottom (in the wetted perimeter) that is covered by fine sediments and/or particulate organic matter. This attribute is scored as a percentage of the bottom in each sub-reach which is covered by such loose materials.

5) Aquatic Macrophytes and Periphyton Coverage

An estimate of the percentage of area covered by macrophytes and periphyton in a sub-reach is made and recorded both for riffles and pools. Macrophytes refers to aquatic plants that grow in the stream (both emergent and submerged), and periphyton refers to algae that grows on fixed surfaces. This attribute helps biologists determine stream productivity from a nutrient enrichment perspective and also for the availability of food sources for aquatic biota.

4.2.2.3 Riparian Characteristics

The riparian area includes the area from the stream bank in a direction away from the stream into the upland areas. It is these stream-side riparian zones that ultimately help shape the stream and provide organic material as nutrients to the aquatic system. A well developed riparian area protects stream banks form erosion, provides shading, inputs nutrients, provides materials as habitat (instream structure) and filters run-off entering the stream. In the absence of well developed riparian zones the stream is more impacted by encroaching land-uses.

1) Canopy Cover

Canopy cover (percent stream shading) over the stream was determined for each of the sub-reaches. Estimates of cover are made by looking into the canopy over the stream channel. Estimates were made from mid-channel and each quarter channel to determine the average percent canopy cover for the width of the stream in the sub-reach. Percent canopy at each measurement point was estimated visually.

2) Bank Stability and Slope

Bank stability is an important attribute that is an indication of a stream reaches overall hydrologic equilibrium. A bank's stability also determines its ability to provide stable habitat for biota and its propensity to release large sediment yields to the stream, which ultimately cause high turbidity and deposition in downstream reaches. The right and left banks are classified according to the following categories:

Score 9-10 = Stable, little evidence of erosion, < 5% bank eroding
Score 6-8 = Moderately stable, some evidence of new erosion, 5-29% bank eroding
Score 3-5 = Moderately unstable, obvious new erosion, 30-59% bank eroding
Score 1-2 = Unstable, most of bank actively eroding, 60-100% bank eroding

Banks composed of sands and gravels are much less stable than banks composed of silt/mud/clay or cobbles. The density of well rooted (more permanent) vegetation and root structure also help to improve a banks stability.

Average bank slope (in degrees) in a sub-reach, was recorded for each bank (left and right). Bank slope affects the stability of a bank and is an indicator of past erosion. A gentle slope may average 30° while a steep or undercut bank may average 90° or 100°, respectively.

3) Vegetative Protection

Bank vegetative protection was measured as a percent of the bank surface area which is covered by stable riparian vegetation and their associated roots in a sub-reach. Each bank (right and left) was assessed separately and the value recorded on the record sheet. Banks was assessed from the edge of the water to the top of the first terrace or normal top of bank.

4) Riparian Vegetative Zone Width

Riparian zone with encompasses the area from the top of the normal stream bank outwards into the upland area. The broader the riparian vegetative zone width the more protected the stream banks are from alteration, the fewer pollutants will enter the stream from run-off, and the more available food sources there are to be deposited into the stream from the surrounding forest. Riparian zone width is scored for each bank in a sub-reach according to the following scale:

Score 9-10 = Riparian Zone Width > 18 meters
Score 6-8 = Riparian Zone Width 18 - 12 meters
Score 3-5 = Riparian Zone Width 11 - 6 meters
Score 1-2 = Riparian Zone Width < 6 meters

4.2.3 Scoring and Analysis of Habitat Assessment Data

Scores from the Semi-Quantitative Habitat Assessment was utilized in two different ways. First, data collected for each attribute (assessment category) was used independently to describe the study reach collectively. This method results in information such as: average riffle depth, average pool width, %riffle in entire reach, average bank stability, average (median) substrate size class in pools and riffles, mean %canopy cover, etc. Second, the data collected during the assessment was used in conjunction with the Qualitative Habitat Assessment procedure to score each of the ten "qualitative" indices with near quantitative accuracy (semi-quantitative). A combination of the two methodologies was incorporated into this intensive aquatic biota field study. The following sections outline the scoring of the qualitative habitat indices using the semi-quantitative data.

1) Epifaunal Substrate/Available Fish Cover

Average values from semi-quantitative categories 4 (Epifaunal Substrate) and 5 (Instream habitat) are combined into an overall average percent coverage and used to score this metric.

The following table presents the scoring criteria:

Rank	**Optimal**	**Sub-Optimal**	**Marginal**	**Poor**
% Coverage	>70%	40%-70%	20%-39%	<20%
Score	20 -16	15 -11	10 - 6	5 - 1

2) Pool Substrate Characterization

Using the Substrate Characterization data from the semi-quantitative assessment (category 6) and the aquatic vegetation assessment (category 9) the following table may be used to score this metric.

Rank	**Optimal**		**Sub-Optimal**	**Marginal**	**Poor**
Substrate	Cobble or Gravel		Sand/Silt/Clay	Sand/Silt/Clay	Bedrock or Clay Only
Macrophytes Present	Yes	No	Yes	No	No
Score	20 - 18	17 - 16	15 - 11	10 - 6	5 - 1

3) Pool Variability

Semi-Quantitative categories 2 (Riffle-Pool Sequence) and 3 (Depth and Width regime) are used to help score this metric. Use the following table to determine pool variability.

Pool Characteristic	Large-Deep	Large-Shallow	Small-Deep	Small-Shallow
Size	Length ≥ Width	Length ≥ Width	Length < Width	Length < Width
Depth	≥3.2 feet	< 3.2 feet	≥3.2 feet	< 3.2 feet

An equal balance of all four pool types achieves higher scores. A prevalence of shallow pools scores lower.

4) Channel Alteration

Scored from visual assessment of entire reach. Not aided by semi-quantitative attributes.

5) Sediment Deposition

Reach average percent bottom affected by deposition (from category 8) is used directly to score this metric.

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Bottom Affected	<5%	5%-30%	31%-50%	>50%
Score	20 -16	15 -11	10 - 6	5 - 1

Utilize the lower end of each scale to represent reaches where recent sediment bar formation is evident.

6) Channel Sinuosity (replacement for Frequency of Riffles)

This metric is assessed separately from the semi-quantitative data. It can be estimated in the field, measured during a longitudinal survey or calculated from current aerial photographs.

7) Channel Flow Status

Scored from visual assessment of entire reach. Not aided by semi-quantitative attributes.

8) Bank Stability

The average bank stability score for each represented bank from the semi-quantitative assessment (category 11) is directly applied to the qualitative assessment scoring for this metric (i.e. an average reach score of 8 for the right bank and 7 for the left bank gets transferred directly to the qualitative score sheet as such.)

9) Vegetative Protection

Reach average percent bank protected (from category 12 of the semi-quantitative record sheet) is used directly to score this metric for the right and left bank.

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Protected	>90%	70% - 90%	50% - 69%	<50%
Score	20 -16	15 -11	10 - 6	5 - 1

10) Riparian Vegetative Zone Width

The average riparian zone width score for each represented bank from the semi-quantitative assessment (category 13) is directly applied to the qualitative assessment scoring for this metric (i.e. an average reach score of 8 for the right bank and 7 for the left bank gets transferred directly to the qualitative score sheet as such.)

4.2.4 Results and Discussion

4.2.4.1 Habitat Quality

The field study was initiated on April 27, 2005, but due to spring storms that elevated stream levels above base flow conditions, the completion of the aquatic life field characterization was delayed till May 24, 2005.

A summary of the physical attributes of all stations where physical data was collected is presented in Table 4.2. All of the study reaches were generally characteristic of seasonal wet-weather tributaries with small watersheds. The watershed size and resulting perennial nature of the stream reaches limited the development of the biotic communities and naturally limit the attainable uses.

The study reaches of the largest watersheds (i.e. UTLCB-2) in the study reflected typical Gulf Coastal Plain streams with small watersheds. Field sheets and the raw habitat data are provided in Appendix E.

Table 4.2. Habitat characteristics of study reaches during seasonal flow conditions. Bayou de Loutre and Little Cornie Bayou watersheds. GLCC Section 2.036 . 3rd party rule making. 2005.

	Bayou de Loutre		Little Cornie Bayou		
Observation	UT002	UT004	UT003	UTLCB-1	UTLCB-2
Date	4/27/2005	4/27/2005	4/27/2005	5/23/2005	5/24/2005
General Stream Characteristics:					
Upstream Watershed Size, mi^2	0.349	0.078	1.24	4.74	7 58
Total Habitat Reach Length, ft	154	112	180	250	412
Average Bankfull Width, ft	7.7	5.6	9.0	12.5	20.6
Average Bankfull Depth, ft[1]	1.7	1 1	NA	NA	NA
Average Velocity, fps	0.08	NA	0.87	0.01	NA
Flow, cfs	0.03	NA	3.62	0.02	NA
Morphology Regime					
% Pool	78	72	44	81	100
% Riffle	22	8 9	NA	NA	NA
% Run	0	19	56	19	NA
Depth and Width Regime					
Average Riffle Depth, ft.	0.2	0.1	NA	NA	NA
Average Riffle Wetted Width, ft	2.4	1.7	NA	NA	NA
Average Pool Depth, ft.	0.6	0 6	1.2	0.8	1.9
Average Pool Wetted Width, ft	5.2	4.7	7.3	10.2	19.3
Instream Habitat (Percent Stable Habitat)					
Epifaunal Substrate, Macroinvertebrates	26	33	46	32	33
Instream Cover, Fish	19	29	45	31	51
Substrate Characterization (Dominate Substrate)					
Riffle	fine gravel	sand	NA	NA	NA
Pool	sand	sand	Sand	silt/clay	silt/clay
Sediment Deposition					
Average Percent of Bottom Affected	7	54	66	47	72
Aquatic Macrophytes and Periphyton (Percent Coverage)					
Riffle Macrophytes	0	0	NA	NA	NA
Riffle Periphyton	0	0	NA	NA	NA
Pool Macrophytes	0	1.5	0	0	0
Pool Periphyton	0	0	0	0	0
Canopy Cover (Percent Stream Shading)					
Stream Shading	83	59	90	86	70
Bank Stability and Slope					
Average Left Bank Stability	mod stable	mod. stable	mod. Stable	mod. stable	mod. stable
Average Left Bank Slope (degrees)	76	52	47	74	55
Average Right Bank Stability	mod. unstable	mod. stable	mod. Stable	mod. stable	stable
Average Right Bank Slope (degrees)	74	53	54	84	59
Bank Vegetative Protection					
Average Left Bank Protection (percent)	50	33	20	36	55
Average Right Bank Protection (percent)	44	28	21	41	70
Riparian Vegetative Zone Width					
Left Bank Riparian Width, meters	12 - 18	> 18	> 18	> 18	> 18
Right Bank Riparian Width, meters	> 18	> 18	> 18	> 18	> 18

[1] Average bankfull depth is calculated on riffles only

Reach UT002

The water shed of Outfall 002 tributary at the mouth of Bayou De Loutre is less than 0.5 sq. miles and above the actual Outfall 002 discharge location the watershed is less than 0.2 sq. mile. The watershed of the 002 unnamed tributary is comprised equally of wooded areas, a wetland complex and areas within the GLCC facility. The majority of the Outfall 002 tributary receives storm flows from areas off the facility and storm flows from the adjacent unregulated watershed also flows into the unnamed tributary. The lower reaches of the 002 unnamed tributary forms a large wetland complex as other unnamed tributaries converge with Bayou de Loutre in the same vicinity (Figure 5).

The study Reach UT002 was comprised approximately 75% shallow pools and 25% riffles (site photos F-1 and F-2 in Appendix F). The remaining small stream segments above this study reach are channels that direct storm water sheet flow from facility areas around Outfall 002 and the adjacent highway right-of-way.

The study reach, as determined by a distance equal to 20 times the bank full width, was 154 feet. The average wetted riffle depth and width was 0.2 ft and 2.4 ft, respectively. The average wetted pool depth and width was 0.6 ft and 5.2 ft, respectively. The average velocity and flow recorded at this station were 0.08 fps and 0.03 cfs, respectively (Table 4.2). The average bankfull width (the point at which the stream enters its active floodplain) was measured at 7.7 ft.

Instream habitat (fish cover) was limited and composed mostly of logs and woody debris, but only covering approximately 20% of the area surveyed. The epifaunal substrate (macroinvertebrates habitat) was also limited and covered only approximately 25% of the area surveyed. The Instream substrate composed mostly of fine gravel in the riffle/runs and sand in the pools. Stream shading (canopy) along the reach was good at 83%. Bank slope was approximately 75° and bank stability ranged from moderately unstable to moderately stable. Bank vegetative protection covered approximately 45 -50% of the reach, while riparian vegetative zone averaged 12 to >18 meters.

Reach UT - 004

The water shed of Outfall 004 tributary at the mouth of Bayou De Loutre is less than one-tenth of a square mile. Unlike the 002 watershed, the majority of the entire UT004 water shed lies above the actual Outfall 004 discharge location (Figure 5). The majority of the UT004 watershed is comprised of wooded areas, however some areas receive storm flows from GLCC facility bone-yard and the corporate office complex. (GBMc, 2005 SWPPP)

UT004 sampling reach had very limited wetted habitat. The limited wetted area limits the biotic community develop potential and the prevents the attainment of several designated uses. The study reach of UT004 included 112 feet (20 times the bank full width of 5.6 ft) and was composed of approximately 70% shallow pools and 30% riffle/runs (F-3 and F-4 in Appendix F). The remaining stream segments above this station are small storm water runoff areas and were dry. The average wetted riffle depth and width was 0.1 ft and 1.7 ft, respectively. The average wetted pool depth and width was 0.6 ft and 4.7 ft, respectively. Due to very low water conditions, no flow was detected at reach UT004 and only intermittent pools connected by small channels of water were sampled. The average bankfull width was measured at 5.6 ft. The reach UT004 termination is a wetland complex (Figure's F-5 and F-6 in Appendix F).

Instream habitat (fish cover) and epifaunal substrate (macroinvertebrates habitat) both covered approximately 30% of the area surveyed. However, the habitat was limited due to the small area of wetted stream. Silts and sediment dominated UT004 substrate comprising approximately 55% of the inorganic substrates. Stream shading (i.e. canopy) along the reach was ample at 59%. Bank slope was approximately 50° and bank stability fell into the moderately stable category. Bank vegetative protection was low and covered only 30% of the reach. However, the riparian vegetative zone averaged more than18 meters.

Reach UT003

The water shed of Outfall 003 tributary at the mouth of the unnamed tributary to Little Cornie Bayou is approximately 1.25 sq. miles. The watershed above Outfall 003 study reach includes several unnamed tributaries that receive storm water runoff from areas other than areas of industrial activity within the property boundary of the GLCC facility (Figure 1). The majority of the UT003 watershed is comprised of wooded areas, however some areas receive storm flows from areas of industrial activity within the GLCC facility (GBMc, 2005 SWPPP). The point that UT003 tributary joins the unnamed tributary of Little Cornie Bayou (UTLCB-1), the watershed ratio is approximately 1:4, Outfall 003 tributary to UTLCB-1.

The study reach included an area of multiple shallow flow channels with no clearly defined primary stream channel (Appendix F: photos F-7 and F-8). The UT003 stream segment was flowing into a wooded flat and transitioning into a wetland complex as it met the unnamed tributary of Little Cornie Bayou (Appendix F: F-9). Reach UT003 was composed of approximately 45% shallow pools and 55% runs (Appendix E). Reach UT003 was made up of runs and pools only, no true riffles were found along the surveyed reach. The average wetted pool depth and width was 1.2 ft and 7.3 ft, respectively. The average velocity and flow recorded at this station were 0.87 fps and 3.62 cfs, respectively. The average bankfull width was measured at 9.0 ft. The remaining stream segments above this station are storm water runoff areas and were intermittent with shallow pools separated by areas of dry stream segments.

Instream habitat (fish cover) and epifaunal substrate (macroinvertebrates habitat) covered approximately 30% of the area surveyed. Sediments dominated the UT003 substrate where approximately 65% of the bottom was affected. Stream shading (canopy) along the reach was scored at 90%, the highest of any reach evaluated, reflecting the natural surroundings of the study reach. Bank slope was approximately 50° and bank stability fell into the moderately stable category. Bank vegetative protection was low and covered approximately 20% of the reach. However, the riparian vegetative zone was good and averaged greater than 18 meters.

Reach UTLCB-1

The water shed of the unnamed tributary of Little Cornie Bayou at the upstream study reach (UTLCB-1) is approximately 4.75 square miles (Figure 6). The watershed is predominately wooded with little contributions from urban storm water runoff. A small percentage of the watershed is cleared for pasture and there are poultry houses within the immediate watershed.

The study reach (UTLCB-1) was 250 feet (20 times the bank full channel width). Reach UTLCB-1 was composed of approximately 80% pools and 20% runs no riffles were found along the study reach (Appendix photos F-10 and F-11). The average wetted pool depth and width was less that 1 foot (0.8 ft) and 10.2 ft, respectively. There was little instream flow. The average velocity and flow recorded at this study reach were 0.01 fps and 0.02 cfs, respectively. The average bankfull width was measured at 12.5 ft.

Instream habitat (fish cover) and epifaunal substrate (macroinvertebrates habitat) both covered approximately 30% of the area surveyed. While adequate to maintain the respective communities, the available habitat limited the development potential. The habitat was not limited due to outside influences but was a function of stream size and the complexity of stream channel development given the small water shed size.

The dominate Instream substrate was silt/clay, with clays exposed in the runs and silts accumulated in the pool areas. Stream canopy along the study reach approximated 90%. Bank slope was approximately 75° for the left bank and placed bank stability into the moderately stable category. The right bank slope was approximately 85° and bank stability fell into the moderately stable category. Bank vegetative protection covered between 55% and 70%, while the riparian vegetative zone was greater than18 meters.

Reach UTLCB-2

The water shed of the unnamed tributary of Little Cornie Bayou at the down stream study reach (UTLCB-2) is approximately 7.58 square miles, almost double the size of the upstream study reach (Figure 3). The watershed is predominately wooded with little contributions from urban storm water runoff. Like the immediate watershed of the upstream reach, a small percentage of the watershed is cleared for pasture and there are poultry houses within the immediate watershed. In addition, there is limited contributions from other industrial activities within the watershed that could contribute to the mineral loading in the unnamed tributary of little Cornie Bayou.

The study reach UTLCB-2 (2,412 feet) was composed of 100% pools (Appendix F: F-12 to F-15). Reach UTLCB-2 was unique among the study reaches in that the reach was a single extended long pool. The reach is dominated by beaver dams and the downstream control was a beaver dam with maximum height greater than 6 ft. The average wetted pool depth in the upper end of the pool (which comprised 100% of the study reach) was 1.9 ft and the average pool width was 19.3 ft, respectively. Due to the pool/backwater characteristics created as a result of the beaver dam, flow was not detected at UTLCB-2.

Instream habitat (fish cover) within the study reach scored high (51% stable habitat), while epifaunal substrate (macroinvertebrates habitat) scored lower at 33% and was more characteristic of the other study reaches. The dominate Instream substrate was silt/clay. Thick deposits of sediment dominated the pool substrate and affected 72% of the bottom surface area with in the reach evaluated. Stream canopy (70%) was less that that encountered at either of the other 2 study reaches. Bank slope was between approximately 55° and 60° on both banks. Bank stability was characterized as moderately stable and the stable. Bank vegetative protection was high and scored between 55% and 70%, the highest of any stream reach. Like the other reaches within the watershed, the stream side riparian vegetative zone was greater than 18 meters, reflecting the woodland dominated floodplain.

4.2.4.2 Habitat Potential

A qualitative assessment of the habitat potential at 4 of the 5 study reaches (UT002, UT003, UTLCB-1, and UTLCB-2) evaluated during the aquatic life field assessment placed the surveyed reaches in the lower end of the sub-optimal category with mean scores of 13.2, 11.5, 13.2, and 13.3, respectively (Table 4.3). The assessment of habitat potential of UT004 placed it the marginal category with a score of 10.4 (Table 4.3). This qualitative assessment classifies the habitat potential of each study reach as having the potential for supporting an expected level of community development and is based on pre-selected habitat requirements. Differences in the scores between the individual reaches were reflected most significantly by differences in pool variability, channel alteration, sediment deposition, and channel flow status.

The results of the qualitative habitat assessment indicate sub-optional habitat for fish and macroinvertebrates at stations UTLCB-1, UTLCB-2, and UT002. Stations UT003 and UT004, also sub-marginal, scored lower and close to the marginal supporting category for fish and macroinvertebrate habitat due to small watershed size, reduced flow, and alterations to the channel. The individual scoring forms are provided in Appendix E.

Table 4.3. Summary of the qualitative habitat potential of study reaches evaluated during the aquatic life field studies completed in support of the GLCC 3rd party rulemaking. April and May 2005.

	Reach				
Parameters	**UT002**	**UT004**	**UT003**	**UTLCB-1**	**UTLCB-2**
1. Epifaunal Substrate	9	10	13	11	11
2. Pool Substrate	15	11	13	10	8
3. Pool Variability	10	8	10	10	16
4. Channel Alteration	16	12	8	18	17
5. Sediment Deposition	19	9	9	11	6
6. Channel Sinuosity	11	11	12	15	11
7. Channel Flow Status	16	8	14	17	18
8. Bank Stability					
Left Bank	8	7	7	8	8
Right Bank	5	6	7	8	9
9. Vegetative Protection					
Left Bank	4	2	2	3	4
Right Bank	3	2	2	3	7
10. Riparian Vegetative Zone Width					
Left Bank	7	9	9	9	9
Right Bank	9	9	9	9	9
Score (Total)	132	104	115	132	133
Score Average	13 2	10.4	11.5	13.2	13.3
Ranking	S	M	S	S	S

Ranking	Range
Optimal (O)	16-20
Sub-optimal (S)	11-15
Marginal (M)	6-10
Poor (P)	0-5

4.2.5 Habitat Conclusions

The habitat evaluation indicated that:

1. The habitat of the individual unnamed tributaries support biotic communities during seasonal periods of the year as a result of periodic discharge of storm water from the GLCC facility. These communities may not be supported in the absence of the storm flows.

2. The marginal habitat and limited enduring pool habitat in the ephemeral wet-weather tributaries (UT002, UT004, and UT003) limits the development and maintenance of the benthic macroinvertebrate community and the fish community assemblages that would otherwise be representative of a typical Gulf Coastal stream.

3. The water quality of the existing storm water flows from the GLCC facility does not appear to inhibit the development of the macroinvertebrate and/or fish communities in fact, the existing communities may not be sustained if the storm flows were not directed into the respective drainages.

4. The habitat potential of the wet weather tributaries are being met to the extent possible given the watershed size , and

5. The contribution of the storm water flows from the GLCC facility likely enhances the biotic community development of the small watersheds into which they discharge.

4.3 Water Quality

4.3.1 Chemical Characteristics

This section presents the methods and results of the water quality characterization for *in-situ* and minerals analysis in the unnamed tributaries of Bayou de Loutre (UT002 and UT004) and the unnamed tributary of the unnamed tributary of Little Cornie Bayou (UT003), as well as the unnamed tributary of Little Cornie Bayou upstream of UT003 (UTLCB-1) and the unnamed tributary of Little Cornie Bayou downstream of UT003 (UTLCB-2). The analytical methods used followed procedures outlined in Standard Methods for the Examination of Water and Wastewater and appropriate EPA published methods.

4.3.2 Methods

The water quality analysis was conducted during April and May of 2005 to document Instream conditions that existed during the aquatic life field survey and biotic characterization. Water quality analyses consisted of *in-situ* measurements and grab samples for laboratory analysis of chloride, sulfate, and TDS. *In-situ* measurements for water temperature, dissolved oxygen (DO), and specific conductance were measured using a YSI Model 85 digital meter. The pH was measured using an Orion model 230A pH meter that was calibrated using the standard two point method. Turbidity was measured using a Hach 2100P turbidimeter. Grab samples of ambient surface waters were collected and preserved on ice for laboratory analysis of chloride, sulfate, and TDS. All field meters were calibrated the morning prior to use in the field. Calibration records, analytical results and chain of custodies are provided in Appendix B.

4.3.3 Results and Discussion

The *in-situ* water quality data is presented in Table 4.4. DO ranged from 3.5 mg/L to 7.5 mg/L in the study reaches. The pH ranged from 5.6 s.u. to 6.9 s.u. in the five reaches evaluated. Specific conductivity was a magnitude higher in the UT004 study reach than the other sampling reaches (4293 µmhos compared to a range of 127 - 495 µmhos for all other study reaches). The elevated specific conductance was likely residuals from an Outfall 004 discharge. The analytical results of surface grab samples indicated that the chloride and TDS concentrations were also higher at UT004 than at any other study reach evaluated.

Table 4.4. Water quality data measured/sampled in April and May 2005.

	Bayou de Loutre Watershed		Little Cornie Bayou Watershed		
Parameter	**UT002**	**UT004**	**UT003**	**UTLCB-1**	**UTLCB-2**
Field Crew	SKH/BJP/REM/JBB				
Date	**4/27/2005**	**4/27/2005**	**4/27/2005**	**5/23/2005**	**5/24/2005**
Time	755	1140	1505	1640	1010
Temperature, C°	14.9	16.5	17.4	21.8	25.3
Dissolved Oxygen, mg/L	7.5	3.5	7.5	3.5	2.8
Specific Conductance, uS	475	4293	495	127	53.0
pH, su	6.5	5.6	6.4	6.9	6.6
Turbidity, ntu	12.7	21.2	17.0	42.1	29.2
Total Dissolved Solids, mg/L	280	2000	300	140	220
Chloride, mg/L	79	1200	100	12	62
Sulfate, mg/L	12	11	15	4.4	21

The TDS concentrations of all study reaches exceeded the Gulf Coastal ecoregion standard of 123 mg/L, including the background reference reach (UTLCB-1). The chloride criteria (14 mg/L) was exceeded in 4 of the 5 reaches evaluated. However, the sulfate ecoregion criteria of 31 mg/L was not exceeded in any other ambient surface water samples tested. However, UT004 was the only sample found to exceed the drinking water standard for TDS (500mg/l) and the chloride standard (250mg/L).

4.3.4 Conclusions

1) The *in-situ* parameters measured during the study indicate that water quality supports the attainment of the designated aquatic life use and the development and maintenance of the biological integrity in the stream segments as supported by available habitat.

2) The upstream reference condition was found to exceed the existing Gulf Coastal ecoregion criteria for TDS (123mg/L) without the influence of any permitted point source discharge.

3) Despite the increased TDS and chloride concentrations in the ephemeral storm water tributaries, biotic communities were not precluded, and

4) The water quality of stream reaches into which the target outfalls discharge appear to be dominated by the discharge during and immediately subsequent to storm events. However, in addition to the facility storm water, each of the tributaries receives storm flows from the adjacent watersheds and road side ditches. These ancillary storm contributions serve to further reduce the dissolved mineral concentrations contributed by the site waters prior to reaching Bayou de Loutre. This mixing of site and non-site waters maintains the biotic uses to the extent the habitat condition allows.

4.4 Benthic Macroinvertebrate Community

4.4.1 Introduction

The development of benthic macroinvertebrate community diversity reflects the combination of habitat availability, and the long term exposure to physical and chemical properties of the water in which it develops and lives. The presence and diversity the benthic macroinvertebrate community reflects a water body's biological integrity. The benthic community assemblage was characterized during the aquatic life field survey.

As discussed in Section 4.1, the watersheds of UT002, and UT004 (Bayou de Loutre watershed) and UT003 (Little Cornie Bayou Watershed) are very small. The GLCC facility is located on a watershed divide with storm water flowing eastward through Outfall 002 and storm flow north and east through Outfall 004. Storm flows off the western portion of the facility flow through Outfall 003 westward into the Little Cornie Bayou watershed.

As characterized in the habitat characterization (Section 4.2), the receiving streams are dominated by seasonal storm flows with limited permanently wetted habitat during the dry season. These restricted habitats and seasonally wetted stream corridors limit the potential for aquatic life community development.

4.4.2 Methods

An assessment of the benthic macroinvertebrate community was performed using rapid bioassessment (RBA) techniques as detailed in ADEQ, 1988. The methods were modified to sample in pool habitats. As indicated in Section 1.2, five sampling stations associated with the discharges were evaluated. Reach UT002 is down stream of GLCC Outfall 002 on an unnamed tributary to Bayou De Loutre. Reach UT004 is down stream of GLCC Outfall 004 on an unnamed tributary to Bayou de Loutre. Reach UT002 and UT004 are separate wet weather tributaries to Bayou de Loutre. The UT004 enters Bayou de Loutre upstream of the UT002, (Figure 5). The point at which the wet weather tributaries flow into Bayou de Loutre is an extensive wetland area with limited defined stream channel morphology (Figure 5). The down stream reaches of Bayou de Loutre have been characterized previously as part of other regulatory actions to set site specific temperature criteria (GBM^c, 2001). This information demonstrated that the designated use of seasonal fisheries and the aquatic life community required to support that use were maintained by the discharges into Bayou de Loutre.

Macroinvertebrates were sampled using a Turtox Indestructible® dip net. Each station was sampled for three minutes according to the RBA protocol. The three minute sample period included time spent actively sampling the selected microhabitat and did not include time moving from microhabitat to microhabitat and/or sorting large debris particles from the sample to be processed.

Each sample was placed in a bucket and condensed using multiple washings into a standard #30 sieve. The samples were preserved in the field and transported to the lab for further processing, sub-sampling, identification and enumeration. In the lab, each of the field preserved samples were sub-sampled at random, placed on a grid, white sorting tray from which the macroinvertebrates sub-sample was collected. The white tray, with a 10 X 10 grid, was used to randomly select a 100 organism sub-sample from the qualitatively collected benthic sample. Numbered grids were selected at random, from which all insects were collected and ultimately identified. Collections from individual grids continued until 100 organisms were collected. The 100 organism sub-samples were preserved in Kaylee's solution or 70% ethanol as a voucher for verification. The remainder of the original sample was concentrated, large particles removed, preserved in Kaylee's 'solution and retained as a voucher for the sample picking techniques used. These voucher samples will be held at GBM^{c} for a period of 24 months or until the project is completed. After project completion the samples may be contributed to a university zoological collection.

The macroinvertebrate assemblages from each station were analyzed according to several benthic community biometrics. These include richness (number of different taxa), EPT richness (number of different taxa represented in the orders Ephemeroptera, Plecoptera, and Trichoptera), and species diversity as determined by the Shannon-Wiener diversity Index. The analysis also included the seven biometrics used by the State of Arkansas (ADPCE, 1988) in their RBA scoring system. This scoring system places a value (1 to 4, 1=excessive differences, 4=no differences) on each of the seven biometrics to achieve a final mean score. The field data sheets and biometric score forms are provided in Appendix C.

4.4.3 Results and Discussion

4.4.3.1 Overview

The taxonomic richness was similar in all unnamed tributaries into which the storm water outfalls discharge, regardless of size. Although each watershed is very small and according to the water quality standards, not expected to maintain a fishery (ADEQ, 2001), each maintained a developed benthic community. The species diversity was greatest (3.68) at the downstream most station on the unnamed tributary of Little Cornie Bayou (UTLCB-2), and lowest (2.82) from the UT002 downstream of the Outfall 002. The range of taxonomic richness varied from a low of 14 to a maximum of 21 taxa (Table 4.5). Table 4.6 provides a summary of the benthic assemblage for all study reaches.

In comparing the unnamed tributaries (UT002, UT003 and UT004) to the background study reach (UTLCB-1), all had taxa richness equal to or greater than the upstream community despite being a fraction of the watershed size. The benthic community development was less diverse in the outfall tributaries, but not significantly so. Also, there were some minor differences in the ordinal group assemblage when compared to the upstream condition, this to is likely a reflection of the watershed size and the resulting enduring pool habitat in UTLCB-2

Another factor limiting the benthic community development is the transition from a storm water channel into an extensive wetland complex at each of the discharge reaches (UT002, UT003, and UT004), when compared to the incised stream channel with a maintained pool/rifle/run complex in the upstream study reach (UTLCB-1).

The benthic community within the down stream reach (UTLCB-2) was significantly different as a result of the extensive beaver activity that ponded water for long segments of the unnamed tributary to Little Cornie Bayou.

The benthic functional assemblage reflected the effect of the changes in hydrology caused by the beaver ponding. The dominant functional feeding group changed from predators at UTLCB-1 to collectors at UTLCB-2 and the gathering collectors dominated the increase. This active "gathering mode" is required in pooled habitat more so that the "filtering mode" in flowing waters. A summary of the benthic macroinvertebrate community assemblages of the storm water discharge tributaries and the unnamed tributary of Little Cornie Bayou as collected during the spring seasonal aquatic field study is presented in Table 4.6. Figure 9 provides a comparison of the function feeding assemblages of each study reach. The following sections provide a brief description of the benthic assemblage at each study reach.

Table 4.5. Macroinvertebrate community metric analysis for the receiving streams of GLCC storm water discharges, Union Co. AR., April & May 2005

PARAMETER	**Watershed**	**Bayou de Loutre**		**Little Cornie Bayou**		
COMMUNITY MEASURES	**REACH**	**UT002**	**UT004**	**UT003**	**UTLCB-1**	**UTCB-2**
Total number of Taxa (Richness)		16	14	19	15	21
EPT Richness		--	--	--	2	3
EPT % Abundance		--	--	--	28	26
Diversity Indices (Shannon-Wiener)		2.82	3.14	3.06	3.07	3.68
Total % of 5 Dominant Taxa		66	59	71	73	59
PERCENTAGE OF THE 4 DOMINANT ORDINAL GROUPS						
Annelida		6	14	--	--	--
Coleoptera		--	--	18	11	--
Crustacea		44	28	33	40	33
Diptera		28	51	26	--	13
Ephemeroptera		--	--	--	--	25
Hemiptera		--	--	15	14	10
Odonata		16	--	--	--	--
Tricoptera		--	--	--	23	--
FUNCTIONAL FEEDING ASSEMBLAGES %						
Shredders		15	13	13	13	7
Scrapers		--	--	--	--	--
Filterers		4	13	11	6	15
Collectors		43	37	24	31	44
Predators		38	35	51	50	34
Biometric Score*:		**3.0**		**2.5**		**3.16**

Table 4.6. Macroinvertebrate community assemblage collected from GLCC storm water watersheds in Union Co. AR. April & May 2005

Watershed		**Bayou de Loutre**		**Little Cornie Bayou**		
Taxa/Station I.D.	**Trophic Group**	**UTA-002**	**UTA-004**	**UT LCB-1**	**UTA -003**	**UTLCB-2**
COLUMBOLLA						
Poduridae	PR	2	--	--	--	--
ANNELIDA						
Oligochaeta	GC	6	14	3	--	--
Hirudidae	PA	--	--	--	1	--
PELECYPODA						
Corbicula	FC	--	5	--	5	--
CRUSTACEA						
Cambarinae	SH	7	5	13	10	7
Amphipoda	GC	5	13	19		16
Isopoda	GC	31	10	4	26	3
Palaemonetes	FC	--	--	4	--	9
EPHEMEROPTERA						
Caenis	GC	--	--	5	--	17
Callibaetis	GC	--	--	--	--	9
ODONATA						
Argia	PR	--	--	--	--	1
Calopteryx	PR	--	--	--	2	--
Corduligaster	PR	14	--	--	1	--
Enallagma	PR		--	--	--	5
Gomphus	PR	2	--	--	--	--
Neurocordulia	PR	--	--	--	--	1
Perithemis	PR	--	--	--	--	1
HEMIPTERA						
Belostoma	PR	--	--	--	--	1
Corixidae	PR	--	--	12	16	8
Notonecta	PR	--	--	2	--	--
Ranatra	PR	--	--	--	--	2
MEGALOPTERA						
Chauliodes	PR	--	--	--	--	1
Sialis	PR	--	--	--	--	2
TRICHOPTERA						
Agapetus	FC	--	--	--	--	--
Cheumatopsyche	PR	--	--	23	--	2
COLEOPTERA						
Dineutis (larvae)	PR	--	--	3	2	--
Haliplidae	SH	--	--	--	4	--
Stelemis	PR	4	--	--	2	--
Thermonectus	PR	--	--	1	1	--
Trophisteruns		--	1	1	--	--
Uvarus	PR	--	--	6	11	7

Watershed		**Bayou de Loutre**		**Little Cornie Bayou**		
Taxa/Station I.D.	**Trophic Group**	**UTA-002**	**UTA-004**	**UT LCB-1**	**UTA -003**	**UTLCB-2**
DIPTERA						
Bittacomorpha	SH	7	1	--	--	--
Probezzia	GC	--	--	--	--	1
Chironominae	FC	2	8	2	6	6
Tanypodinae	PR	6	13	3	2	--
Tanytarsini	PR	4	5	--	2	--
Chaborous	GC	--	--	--	--	1
Hemerodromia	PR	1	6	--	8	--
Hexatoma	PR	4	8	--	8	6
Psycoda	PR	--	3	--	--	--
Simulium	FC	2	--	--	1	--
Tipula	SH	1	7	--	1	--
Sum of Percentages		**100**	**100**	**100**	**100**	**100**
Total Abundance:		**98**	**99**	**101**	**109**	**106**
Species Richness:		**16**	**14**	**15**	**19**	**21**
Shannon-Wiener Diversity Index		**2.82**	**3.14**	**3.07**	**3.06**	**3.68**

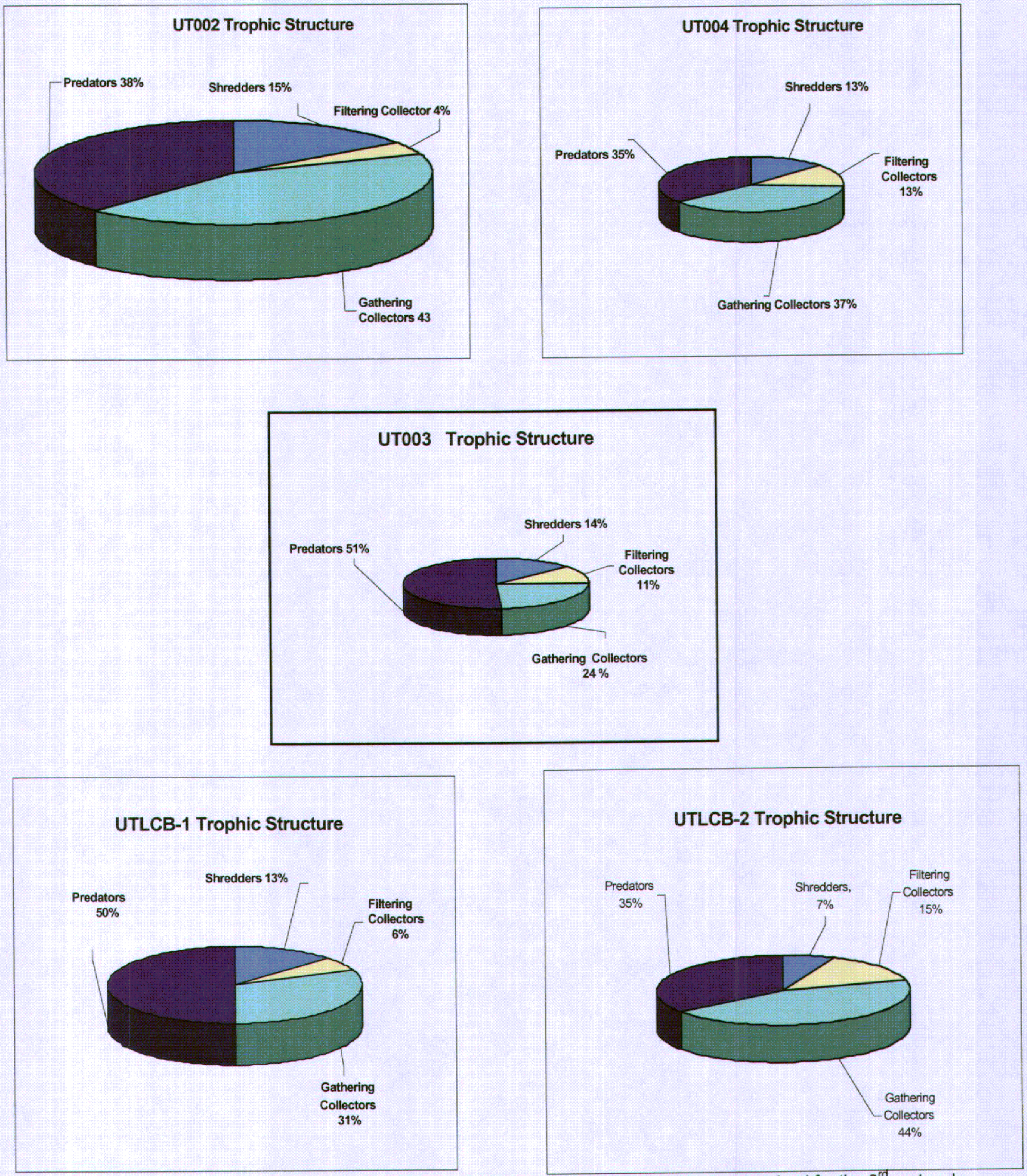

Figure 9. Comparison of functional feeding assemblages of the benthic communities as characterized for the 3rd party rule making in relation to the discharges from GLCC. April & May 2005.

4.4.3.2 Reach UTA 002

The discharges from Outfall 002 do not preclude the maintenance of the benthic community of the UT002. The UT002 benthic community was dominated by Crustaceans (isopods and crayfish). Although this reach had the largest number of taxa than any other discharge reach, UT002 had the lowest diversity index as a result of the dominance of the isopod population. These taxa are shredders and common inhabitants where the primary energy source is allochthonous (deposited into streams from outside the water column) and not produced within the water column (e.g. algae, and attached submergent vegetation). These organisms are primary consumers and act to process coarse organic particulate matter (e.g. leaf litter) into fine particulate organic matter (FPOC) that other aquatic organisms (filterers) can process. The second dominant taxa was the dragonfly, *Cordulasgaster*, a predator. This dragonfly is one of the largest dragonflies found in Arkansas, and are typically found in very small watersheds with some ground water (spring) influence. *Cordulasgaster* is considered an indicator of good water quality and unlike most dragonflies over-winter as an immature nymph during 2 winter cycles rather than a single winter cycle and therefore are exposed to long term water quality conditions.

4.4.3.3 Reach UT004

The discharges from Outfall 004 do not preclude the maintenance of the benthic community of the UT004. Although the watershed of UT004 is extremely small, a benthic community was maintained. There was no individual taxa collected from UT004 that was not also collected from some other study reach.

In fact, the invertebrate community of Reach UT004 had the second highest diversity, even greater than the upstream reference reach (UTLCB-1), despite having the smallest watershed evaluated and the lowest taxonomic richness. The increased diversity resulted from the fact that no single benthic taxa dominated the benthic assemblage.

Like UT002, the UT004 benthic community was collectively characterized by Crustacea followed by the order Diptera (true flies) and Annelida (aquatic worms). Unique to the benthic community of UT004, there was no clear sub-dominant ordinal group, six orders each approximated 10 percent of the community.

4.4.3.4 Reach UT003

The discharges from Outfall 003 do not preclude the maintenance of the benthic community of the UT003. The benthic invertebrate community of Reach UT003 had the second greatest taxonomic richness, second only to the downstream most reach. Like the previous study reaches, the outfall 003 tributary was also dominated by Crustacea and Diptera, which combined for 59% of the community identified. In contrast to other study reaches, the trophic structure of community was dominated by predators belonging to the orders Hemiptera (true bugs) and Coleoptera (beetles). The benthic community of UT003 was found to be most similar to the upstream reach UTLCB-1.

4.4.3.5 Reach UTLCB-1

The benthic invertebrate community of Reach UTLCB-1 was determined to be maintained at a level typical of the other reaches evaluated despite the watershed size being several times larger than those of the discharge tributaries. Although this reach served as an un-impacted reference condition, UTLCB-1 had the next to the lowest taxonomic richness, second only to the UT004 community.

The primary difference appears to be the presences of EPT taxa (insects belonging to the insect orders Ephemeroptera, Plecoptera, and Trichoptera), in the community and not in the benthic assemblages of the outfall communities. The EPT richness accounted for almost 1/3 of the assemblage and replaced Diptera as the co-dominate ordinal group, along with Crustacea (the dominate order in the other study reaches.

4.4.3.6 Reach UTLCB-2

The benthic invertebrate community of Reach UTLCB-2 demonstrates the greatest taxonomic richness and the highest community diversity of any reach evaluated. The benthic community of Reach UTLCB-2 reflected the development resulting from permanently wetted habitats and reflect a more typical gulf Coastal benthic assemblage that includes a wide diversity and ordinal assemblage including numerous insect orders.

There was more difference between the UTLCB-1 and UTLCB-2 benthic communities that there were between any of the effluent tributaries and the UTLCB-1 reference reach. This difference was driven by the difference in habitats between the up/downstream habitats.

4.4.3.7 Biometric Score Comparisons

Although there were some specific taxonomic differences in the species collected, the biometric scores calculated for the comparison of the assemblages collected were 3.0, 2.5 and 3.2, indicating only minimal differences between the benthic community assemblages. The most notable difference between the representative communities upstream and downstream in UTLCB-1 and UTLCB-2 is in their trophic structure (Figure 9).

4.4.4 Conclusions

The following conclusions are based on the analysis of the macroinvertebrate community assemblages from the study reaches evaluated in association with the storm water discharges from GLCC Corporation.

1) The macroinvertebrate community is being maintained downstream of the effluent discharges, as is the designated aquatic life use.

2) All tributaries which receive discharge through the storm water outfalls from the GLCC facility were found to maintain benthic communities similar in form and function to the upstream reference condition represented by the unnamed tributary to Little Cornie Bayou.

3) The biological integrity of Bayou de Loutre and the unnamed tributary to Little Cornie Bayou is being supported by the existing discharge conditions.

4) The macroinvertebrate communities observed at all study reaches are similar in the development of taxonomic diversity despite having watersheds that are considerably smaller than the reference utilized.

5) Biometric comparisons indicate that are minimal differences in the benthic

communities.

6) The community structure (form and function) demonstrated minimal differences which could be attributed to differences in physical conditions (watershed sizes) of the stream reach evaluated.

7) The macroinvertebrate communities observed in the storm water tributaries to Bayou de Loutre are similar in structure and composition to those characterized by Gulf Coastal Plain ecoregion for small watersheds; however the complexity of the community was limited when compared to least disturbed streams. and

8) The minimal differences actually reflect an improved benthic community at UTLCB-2 downstream when compared to UTLCB-1. The improvement is likely a response to increased flow and the improved habitat diversity indicated in the qualitative habitat assessment.

4.5 Fish Community

4.5.1 Introduction

The fish community supported in a stream is in direct response to available habitat, food sources, and water quality of that particular stream. The presence of a certain level of species richness and diversity along with a community structure similar to that expected in typical streams of an ecoregion are indicators of aquatic ecosystem health.

The objective of the fish community characterization is to collect and identify a representative sample of all except very rare species in the assemblage reflective of the relative abundance within the community. Backpack electrofishing equipment is used as the principal sampling gear supplemented by block netting and seining in habitats where flow, substrate and structure affect the capture of fish species. Other methods of fish sampling may be implemented when conditions are not adequate for backpack eletrofishing or seining; these may include, using boat electrofishing equipment and/or hook and line sampling equipment. Usually 2–4 team members will make up the sampling team involved in collecting the aquatic vertebrates.

Major factors that influence collecting include flows, water depth, instream obstructions, water turbidity, temperature and conductivity. The primary tool utilized in the fish collections will be a Smith-Root backpack electroshocker. However, seines and block nets may be utilized as necessary to adequately characterize a sampling reach. The shocker is equipped with an automated timing mechanism which records the amount of time that electricity is actually being applied, or "pedal down time" (PDT).

Sampling fish species to determine their proportionate abundance will be conducted after all water quality parameters and/or samples are collected but prior to the collection of the macroinvertebrate sample and habitat data.

Shocked fish were captured with hand held dip nets and held in buckets while the sampling continued. The entire stream width within the sampling reach will be sampled. PDT time will continue for not less than 30 minutes unless the wetted habitat of any reach limits the PDT. In addition to the PDT, the total collection time will be recorded.

Unless specified in a project specific sampling analysis plan (SAP), there will not be a maximum time limit for the collection period, however the collections may be terminated when in the opinion of the principal investigator determines that a representative collection has been obtained. Sampling information is recorded on the Fish Community Collection Form, general comments (perceived fishing efficiency, missed fish, and gear operation suggestions) will be recorded on the lines provided on this form.

An effort to search for and collect fish will be completed at all reaches, even if the stream is extremely small, and it appears that sampling may not collect any specimens. If no specimens are collected, the "NONE COLLECTED" field on the Fish Collection Form will be completed. Provide an explanation in the comments section of the form.

4.5.2 Methods

An assessment of the fish community in UT002, UT003, UT004, UTLCB-1, and UTLCB-2 was performed. During the spring of 2005, each reach was sampled using a Smith-Root backpack electroshocker. The shocker includes an automated timing mechanism which records the amount of time that electricity is actually being applied, or "pedal down time" (PDT).

Shocked fish were captured with hand held dip nets and held in buckets while the sampling continued. At the end of each sampling effort fish from both reaches were preserved in formalin for later identification in the lab. Fish identifications were made according to the Fishes of Arkansas (Robison, 1988) and The Fishes of Missouri (Pflieger, 1975) to species level where possible.

The fish collections at each reach were compared according to several biometrics including: species richness (number of taxa); sunfish richness; species diversity; abundance; dominant family groups; percent of tolerant species; trophic structure; percent of hybrids; percent of diseased fish; and key and indicator species as listed in Reg. No. 2. In addition, the fish community was assessed using a Biocriteria method developed by ADEQ. This Biocriteria uses a scoring system by which the assemblage collected is compared to a reference stream in the same ecoregion using eight different metrics. The metric scores are totaled and the resulting sum is used to assess if a stream reach is in support of its assigned designated uses.

4.5.3 Results and Discussion

4.5.3.1 Overview

Despite watersheds that ranged from 0.078 to less than 1.25 square miles, 2 of the 3 three storm water effluent tributaries (UT002 and UT003) were found to maintain a limited Gulf Coastal Ecoregion fish community assemblage. The very small watershed of UT004 (less than one-tenth of a square mile) limited the fish community development even during the spring seasonal flow period. The fish community of the other two discharge tributaries supported a limited fish community and did not seen to be related to the size of the watershed, in that the fish community of UT002 was more developed that that of the UT003 tributary.

The stream channel of UT002 was more developed, and was more confined into a single stream channel than that of UT003 which was multi-channeled with sheet flow through oak flats, making sampling UT002 more effective and probably contributed to the differences indicated between the fish communities of UT002 and UT003. Despite these differences both of these discharge tributaries provided habitat for numerous key and indicator fish species for the Gulf Coastal plain ecoregion as stipulated in Reg. 2 (ADEQ, 2001).

Although there were some differences above and below the mouth of the UT003 tributary, the fish communities of the UTLCB were not precluded by the discharge from Outfall 003. The pool conditions that persisted in the downstream reach limited collection success. However, like other reaches evaluated, there were numerous key and indicator fish species collected within the Reach UTLCB-2. The species diversity was greatest (3.47) at the upstream reference reach of Little Cornie Bayou (UTLCB-1), and lowest from the UT004 downstream of the Outfall 004. Table 4.7 provides a comparison of community metrics used to compare fish community development. Table 4.8 provides a summary of fish collected from each study reach.

4.5.3.2 Reach UT002

Despite a watershed size of less than one-half square mile, the historical Outfall 002 discharge maintains a limited Gulf Coastal Ecoregion fish assemblage in the receiving stream (UT002). One-half of the species collected from UT002 (7 of 14) were listed as a key and indicator species for Gulf Coastal ecoregion fish communities. A total of 104 fish representing 14 species were collected during the 31.1 minute PDT sampling effort at UT002. The "Key and Indicator" species collected at UT002 were represented by seven of the possible 12 species for the Gulf Coastal Ecoregion.

This equates to a relative fish abundance of 3.34 fish/minute of PDT. The fish community had a taxa richness of 14 and a Shannon-Wiener diversity index of 2.92. The three dominant family groups were Poeciliidae (28.8%), Centrarchidae (22.1%), and Catostomidae (22.1%).

Trophic structure was dominated by insectivores (93.3%) with a small percentage of piscivores (5.77%) and omnivores (0.96%). Table 4.7 provides all the fish community structural analysis. With respect to pollution tolerance, intermediate species had the highest representation at 79.8% followed by pollution tolerant species at 20.2%.

A biometric scoring system was used to evaluate the fish community as it is compared to a least disturbed Gulf Coastal stream. The watershed size and watershed condition of UT002 scored low when compared to those streams used by ADEQ in the biocriteria development. However, more importantly, UT002 scored higher than that of the upstream reference site on the unnamed tributary of Little Cornie Bayou (UTLCB-1).

The biometric assessment resulted in a total of 12 points at UT002, while total of 10 points at UTLCB-1 (upstream) out of 32 possible points. These would be considered as low scores when compared to an ecoregion least disturbed reference site. The low scores for UT002 reflect the absence of sensitive, catfishes, darters, and key species rarity, as well as an over abundance of sunfish representatives and low species diversity within the study reach.

4.5.3.3 Reach UT004

The watershed at the mouth of UT004 is less than 0.1 square mile. This very small watershed does not maintain enduring pools outside storm event activity. The discharge through Outfall 004 is transported to Bayou de Loutre via an unnamed ditch that is not indicated on a 7.5 minute USGS quad map, even as an ephemeral drainage. Although there was water present during the time of sample collections, there was no measurable flow and pools were very shallow and the ditch channel averaged less than 1ft in width. Although sampling was completed in the drainage ditch, the wet weather tributary provides little habitat for fish community development. Outside periods of storm flow, there is no evidence of enduring pools, even during the seasonal wet weather period. The temporary nature of the available wetted habitat is reflected in the benthic community assemblage (See Section 4.4.3.3).

Due to the very limited sampling reach and availability of wetted habitat, only 11 fish were collected during the 8.1 minute PDT sampling effort at UT004. This is a relative fish abundance of 1.36 fish/minute of PDT. Only one species, mosquito fish (*Gambusia affinis*), was collected at UT004. The mosquito fish is a relative invasive fish and is typically one of the first species to populate a wet weather tributary like UT004. Its trophic structure is insectivore and its tolerance level is intermediate. Table 4.7 depicts the fish collection at UT004.

Table 4.7. Comparison of fish community assemblages as collected from study reaches during aquatic life field assessment for GLCC 3rd party rule making, El Dorado, AR. April & May 2005.

Scientific Name	Common Name	UT002	UT004	UT003	UTLCB-1	UTLCB-2
		4/27/2005	4/27/2005	4/27/2005	5/23/2005	5/24/2005
CYPRINIDAE						
Lythrurus umbratilis[1]	redfin shiner	--	--	--	5	--
Notemigonus crysoleucas	golden shiner	1	--	--	3	--
Semotilus atromaculatus	creek chub	--	--	--	1	--
CATOSTOMIDAE						
Erimyzon oblongus[2]	creek chubsucker	23	--	--	1	--
POECILIIDAE						
Gambusia affinis	mosquitofish	30	11	2	37	11
CYPRINODONTIDAE						
Fundulus olivaceus	blackspotted topminnow	--	--	1	37	2
ESOCIDAE						
Esox americanus[1]	grass pickerel	6	--	5	38	7
APHREDODERIDAE						
Aphredoderus sayanus[2]	pirate perch	2	--	4	34	4
ICTALURIDAE						
Ameiurus natalis[1]	yellow bullhead	1	--	2	7	1
Ameiurus melas	black bullhead	1	--	1	--	--
CENTRARCHIDAE						
Lepomis cyanellus	green sunfish	19	--	2	9	5
Lepomis gulosus[1]	warmouth	2	--	1	14	7
Lepomis punctatus[2]	spotted sunfish	--	--	--	6	--
Lepomis macrochirus	bluegill sunfish	--	--	--	44	2
Lepomis megalotis	longear sunfish	2	--	1	10	6
Centrarchus macropterus[2]	flier	--	--	--	1	--
Micropterus salmoides	largemouth bass	--	--	--	--	1
ELASSOMATIDAE						
Elassoma zonatum[2]	banded pigmy sunfish	4	--	--	9	4
PERCIDAE						
Etheostoma gracile[1]	slough darter	5	--	--	10	1
Etheostoma parvipinne	goldstriped darter	7	--	--	--	--
Etheostoma chlorosomum	bluntnose darter	1	--	--	1	--
Total No. Taxa Collected		14	1	9	18	12
Total Fish Collected		104	11	19	267	51
Level of Effort (Minutes) PDT[3]		31.1	8.1	28.8	48.6	52.7
Catch per Minute, PDT		3.34	1.36	0.66	5.49	0.97
Shannon-Wiever Diversity Index		2.92	0.00	2.90	3.47	3.23

[1] Typical Gulf Coastal Ecoregion Key Species

[2] Typical Gulf Coastal Ecoregion Indicator Species

[3] Pedal Down Time

Table 4.8. Comparison of fish community metrics for study reaches as evaluated during aquatic life field assessment for GLCC 3rd party rule making, El Dorado, AR. April & May 2005

Parameter	UT002	UT004	UT003	UTLCB-1	UTLCB-2
COMMUNITY MEASURES					
Richness (Total Number of Taxa)	14	1	9	18	12
Darter Richness (Number of Taxa)	3	--	--	2	1
Sunfish Richness (Number of Taxa)	3	--	3	6	5
% Pollution Tolerant Species	20.2	--	21.1	7.5	11.8
% Pollution Intermediate Species	79.8	100	78.9	92.5	88.2
% Pollution Intolerant Species	--	--	--	--	--
% Diseased	1.0	--	--	0.7	--
Number of Key & Indicator Species (Taxa)*	7.0	--	4.0	10.0	6.0
Number of Key & Indicator Species (Individuals)	43.0	--	12.0	125.0	24.0
% Key & Indicator Species	41.3	--	63.2	46.8	47.0
Diversity Indices (Shannon-Wiever)	2.92	--	2.90	3.47	3.23
Abundance, fish collected/minute	3.34	1.36	0.66	5.49	0.97
TROPHIC STRUCTURE					
% Herbivores	--	--	--	--	--
% Omnivores	0.96	--	--	1.50	--
% Insectivores	93.3	100.0	73.7	84.3	84.3
% Piscivores	5.77	--	26.32	14.23	15.69
PERCENT OF 5 DOMINANT FAMILY GROUPS					
Centrarchidae	22.1	--	23.5	31.5	41.2
Poeciliidae	28.8	100.0	11.8	13.9	21.6
Catostomidae	22.1	--	--	--	--
Aphredoderidae	--	--	23.5	12.7	7.8
Percidae	12.5	--	--	--	--
Cyprinodontidae	--	--	5.9	13.9	--
Cyprinidae	--	--	--	--	--
Ictaluridae	--	--	5.9	--	--
Elassomatidae	--	--	--	--	7.8
Esocidae	5.8	--	29.4	14.2	13.7
Total % of 5 Dominant Groups	91.3	100.0	100.0	86.1	92.2

* Total of 12 key and indicator species possible.

The biometric assessment resulted in a total of 6 points at UT004. The low scores are due to a very limited sampling reach reflective of the very small watershed size, and fish cover availability.

4.5.3.4 Reach UT003

Despite the small watershed size, (1.25 sq. miles), the UT003 (and the historical discharges through Outfall 003) was found to maintain a limited Gulf Coastal fish community. A total of 19 fish were collected during the 28.8 minute PDT sampling effort at UT003. This equates to a relative fish abundance of 0.66 fish/minute of PDT. Even though numerical abundance of individual fish were low, the overall fish community was represented with a taxa richness of 9 and a Shannon-Wiener diversity index of 2.90. The low fish count may have been attributed to the development of multiple shallow stream channels as UT003 enters into the wetland complex and the unnamed tributary to UTLCB. The UT003 stream reach was braided and very shallow in places with very little fish habitat available. The dominate family species were Esocidae (29.4%), Centrarchidae (23.5%), and Aphredoderidae (23.5%).

UT003 fish community trophic structure was dominated by insectivores (73.7%) followed by piscivores at 26.3%. Table 4.8 provides the list of fish community structural analysis for the study reach. Fish tolerance was very similar to UT002, where intermediate species had the highest representation at 78.9% followed by pollution tolerant species at 21.1%. The "Key and Indicator" species were represented by 4 or 25% of the total possible number of species (12).

The biometric assessment resulted in a total of 10 points at UT003, equaling the total (10 points) at UTLCB-1 (upstream reference site) out of 32 possible points. The low scores when compared to a least disturbed reference, are a result of sensitive, catfishes, darters, and key species rarity, as well as an over abundance of sunfish representatives and low species diversity through out the study reaches.

4.5.3.5 Reach UTLCB-1

The observed fish community is typical of that expected in similar habitat and watershed size in the Gulf Coastal Ecoregion. A total of 267 fish were collected during the 48.6 minute PDT sampling effort at UTLCB-1. This equates to a relative fish abundance of 5.49 fish/minute of PDT. The fish community at UTLCB-1 a taxa richness of 18 and a Shannon-Wiener diversity index of 2.47. Table 4.6 provides a complete list of fish species collected at UTLCB-1. The Centrarchidae family had the highest taxa richness (6) and the highest percent of total individuals collected (31.5%) of all family groups. Esocidae, Cyprinodontidae, Poeciliidae, and Aphredoderidae all followed closely together at 14.2%, 13.9%, 13.9%, & 12.7%, respectively. Table 4.7 summarizes the fish species collected at UT003

UTLCB-1's fish community trophic structure was dominated by insectivores (84.3%). Piscivores represented 14.2%, while omnivores represented 1.5%. Fish tolerance at UTLCB-1 was represented by intermediate species at 92.5% followed by pollution tolerant species at 7.5%. The "Key & Indicator" species was represented by 10 of the possible 12 species for the Gulf Coastal Ecoregion.

The biometric assessment resulted in a total of 10 points at UTLCB-1 (upstream reference site) out of 32 possible points. The low scores when compared to a least disturbed reference, are a result of sensitive, catfishes, darters, and key species rarity, as well as an over abundance of sunfish representatives and low species diversity through out the study reaches. Table 4.8 provides the fish community structural analysis.

4.5.3.6 Reach UTLCB-2

A total of 51 fish were collected during the 52.7 minute PDT sampling effort at UTLCB-2. This equates to a relative fish abundance of 0.97 fish/minute of PDT. The fish community at UTLCB-2 had a taxa richness of 12 and a Shannon-Wiener diversity index of 3.23. A summary of the fish species collected at UTLCB-2 is provided in Table 4.7. The Centrarchidae family had the highest Taxa Richness (5) and the highest percent of total individuals collected (41.2%) of all family groups. The study reach's fish community trophic structure was dominated by insectivores (84.3%) followed by piscivores at 15.7%. Characteristics of the fish community structural analysis for UTLCB-2 are provided in Table 4.8. 88.2% of the community fell under the intermediate category for fish tolerance. Additionally, 6 of the possible 12 "Key and Indicator" species for the Gulf Coastal Ecoregion were collected.

The biometric assessment resulted in a total of 10 points at UTLCB-2, equaling the total (10 points) at UTLCB-1 (upstream reference site) out of 32 possible points. The low scores when compared to a least disturbed reference, are a result of sensitive, catfishes, darters, and key species rarity, as well as an over abundance of sunfish representatives and low species diversity through out the study reaches.

Due to larger stream channel, deeper water conditions, and low water clarity at UTLCB-2, fish collections were more difficult and provided fewer fish. However, collected species does indicate a potentially normal Gulf Coastal Ecoregion fish community.

4.5.4 Conclusions

Based on the results of the fish collections completed during the spring steady state conditions that existed during 2005, the following conclusions are provided:

1) Although all study reaches and specifically of the permitted storm water outfall receiving streams are not expected to maintain typical gulf Coastal fisheries due to very small watersheds, all but one were found to maintain a seasonal Gulf Coastal fish assemblage.
2) The very small watershed (and the intermittent nature of the storm flows) of UT004 precludes the maintenance of the Gulf coastal seasonal fish community assemblage However, this is a water quantity issue and not a water quality issue. The water quality was not preclusive of fish when sufficient wetted habitat is available.
3) The UT002 and UT003 study reaches provided habitat and maintained representative components of a Gulf Coastal fish community including multiple key and indicator fish species.
4) It does not appear that the historical discharges to the study reaches precluded the attainable level of fish community development.

4.6 Summary

Based on the aquatic life field study, the designated aquatic life use and the biological integrity of UT002, UT004, UT003, and UTLCB-2 is maintained downstream of the discharges from the GLCC Company's central facility. In addition, the historical mineral concentrations discharged from the permitted storm water outfalls have not precluded the maintenance of the designated and attainable uses as allowed by the existing habitat

5.0 EXISTING LOADINGS OF DISSOLVED MINERALS

5.1 Chloride, Sulfate, & TDS Water Quality Criteria

The existing ecoregion based chloride, sulfate, and TDS water quality criteria for UT002, UT003, and UT004, and UTLCB-2 are 14 mg/L, 31 mg/L and 123 mg/L, respectively. The existing stream based chloride, sulfate, and TDS water quality criteria for Bayou de Loutre above Gum Creek are 250 mg/L, 90 mg/L, and 500 mg/L, respectively. The existing stream based chloride, sulfate, and TDS water quality criteria for Little Cornie Bayou (LCB) are 200 mg/L, 20 mg/L, and 500 mg/L, respectively. Utilizing the appropriate flows and background concentrations provided in the WQS and the Continuous Planning Process (CPP), the discharge via Outfalls 002, 003, & 004 from the GLCC Central facility will not maintain the majority of the existing ecoregion dissolved minerals criteria in the unnamed tributaries of Bayou de Loutre (UT002 & UT004), the unnamed tributary of the unnamed tributary of Little Cornie Bayou (UT003), or the unnamed tributary of Little Cornie Bayou (UTLCB-2). Additionally, discharge via Outfalls 002, 003, & 004 from the GLCC Central facility will not maintain the majority of the existing stream dissolved minerals criteria in Bayou de Loutre above the mouth of Loutre Creek, or in Little Cornie Bayou (LCB). In addition to ecoregion water quality criteria (UT002, UT003, UT004, & UTLCB-2) and stream based water quality criteria for Bayou de Loutre above Loutre Creek, and Little Cornie Bayou (LCB), the domestic water supply use designation for UT002, UT003, UT004, UTLCB-2, LCB, and Bayou de Loutre above Loutre Creek results in a numeric criterion of 250 mg/L, 250 mg/L and 500 mg/L for chloride, sulfate and TDS, respectively. As discussed in Sections 3.2 and 3.3, the domestic water supply use is a designated, but not an existing use for UT002, UT003, UT004, UTLCB-2, LCB, or Bayou de Loutre above Loutre Creek. Additionally, there are no plans to utilize any of the aforementioned water bodies as a domestic water supply use.

In order to determine appropriate chloride, sulfate, and TDS criteria for UT002, UT003, and the section of Bayou de Loutre downstream to the mouth of Loutre Creek; appropriate chloride and TDS criteria for UT004 and UTLCB-2; appropriate chloride and sulfate criteria for LCB; appropriate sulfate and TDS for the sections of Bayou de Loutre; and the appropriate chloride for Bayou de Loutre from the mouth of UT002 to the confluence of Loutre Creek, mass balances calculations were developed as described in the following sections.

5.2 Mass Balance

The following mass balance equation was used to calculate instream waste concentrations (IWC) for chloride, sulfate, and TDS:

$$IWC = [(Qb \times Cb) + (Qe \times Ce)] / (Qb + Qe)$$

Where:

Qb = The background flow of the receiving stream
Cb = The background concentration of chloride, sulfate or TDS in the receiving stream
Qe = The discharge flow of the effluent
Ce = The effluent concentration of chloride, sulfate or TDS

5.2.1 Methods

The procedure for evaluating Instream concentrations and developing permit limits for dissolved minerals can be found in *ADEQ Discharge Permit, Toxic Control Implementation Procedure* in Arkansas' 1995 Continuing Planning Process (CPP). The value used for the background concentration of chloride (5 mg/L), sulfate (13 mg/L), and TDS (67 mg/L) was the mean concentration for the Gulf Coastal Plain Ecoregion. The background values are listed in the CPP in Attachment XII, *Mineral Permitting Strategy*, for streams in the Gulf Coastal Plain with a 7Q-10 of less than 100 cfs. A background flow of 4 cfs was used in each stream, as allowed for determining instream mineral concentrations in the WQS. Effluent concentrations for chloride, sulfate, and TDS were derived from historical maximum monthly concentrations from January 2000 through September 2005 (chloride & sulfate) and January 2004 through September 2005 (TDS). Instream concentrations were calculated for UT002, UT003, UT004, UTLCB-2, LCB, Bayou de Loutre from the mouth of UT002 to the mouth of Loutre Creek,

5.2.2 Instream Waste Concentration (IWC) Computations

The Gulf Coastal Plain ecoregion background concentrations for chloride, sulfate, and TDS are 5 mg/L, 13 mg/L, and 67 mg/L, respectively (Table 5.1). Flow values used for the IWC computations is the facility's reported highest monthly average flow for a period from January 2004 through October 2005 from each outfall (Outfall's 002, 004, & 003). The flow value used in the computations as the discharge flow at each outfall was selected as directed by Section D of *ADEQ Discharge Permit, Toxic Control Implementation Procedure* in the CPP. The effluent Concentrations used for chloride, sulfate, and TDS were the 95th percentile of its respective data set. One of two different 95th percentile calculations were used, either according to a parametric (the data set was normally distributed) statistical technique or according to a non-parametric (the data set was not normally distributed) statistical technique, as outlined in *Statistical Methods for Environmental Pollution Monitoring* (Gilbert, 1987). A frequency histogram was prepared for each data set to characterize its distribution. Computations for pertinent minerals at each outfall and their respective techniques are presented below. A schematic depiction of the 95th percentile contributions of the respective mineral and the effluent flow from each source utilized in the development of predicted instream waste concentration and the proposed water quality standard modification for each stream segment is provided in Appendix C.

5.2.2.1 IWC Computations for UT004

Due to the distribution of the available data for the individual dissolved minerals components, IWC computations for chloride at UT004 utilized the non-parametric statistical technique, while the computations for sulfate and TDS utilized a parametric statistical technique. The calculated IWC for sulfate at UT004 proved to be lower than the current ecoregion based water quality criteria and therefore, sulfate concentrations at Outfall 004 does not show any instream reasonable potential to exceed the current ecoregion criteria at this time. No change in the water quality criteria for sulfate at UT004 is being proposed at this time. Frequency histograms for chloride showed the data set is not normally distributed, while the histogram for TDS indicated a normal distribution (Appendix C). The following calculations were used to determine the IWC for each relevant mineral at UT004.

Chloride:

$k = p(n=1)$

where: k = the ranked order number from the mineral data set (values of k that are not integers are interpolated for using the two values that k falls between).
p = desired percentile
n = number of data points

This method returns k values of 63.65 for chloride. The chloride data set has an n = 66. Therefore, the value in the data set ranked as "63.65" for chloride and TDS was 1702 mg/L. These "ranked" values are equal to the 95th percentile. Flow values used in the following calculations (0.414 MGD or 0.64 cfs) is the reported highest monthly average flow for a period from January 2004 through October 2005 at Outfall 004. Utilizing all the aforementioned data the IWC is calculated below. The summary of the mass balance data inputs are provided in Table 5.3 for UT004.

TDS:
$X_P = \bar{x} + (Z_p * s)$

where:
X_P = desired percentile
$\bar{x}$ = sample mean of the mineral data set
Z_p = statistical "look up value" for the standard normal distribution of the desired percentile
s = standard deviation of the mineral data set

This method returns Z_p values of 1.64 for the 95th percentile, a standard deviation of the TDS data set of 749, and a sample mean value for the TDS data set is 700. This data returned a 95th percentile value of TDS data set of 1932 mg/L. Flow values used in the following calculations (0.414 MGD or 0.64 cfs) are the reported highest monthly average flows for a period from January 2004 through October 2005 at Outfall 004. Utilizing all the aforementioned data, the IWC is calculated below. The summary of the mass balance data inputs are provided in Table 5.3 for UT004.

$IWC_{chloride}$ =
[(4.0 cfs x 5.0 mg/L) + (0.64 cfs x 1702 mg/L)] / (4.0 cfs + 0.64 cfs) = 239 mg/L

IWC_{TDS} =
[(4.0 cfs x 67 mg/L) + (0.64 cfs x 1932 mg/L)] / (4.0 cfs + 0.64 cfs) = 324 mg/L

Table 5.1. Instream Waste Concentration (IWC) Calculation for UT004.

Parameters	Chloride	TDS
Ce, mg/L (projected 95th%tile)	1,702	1,932
Cb, mg/L	5.0	67
Qe, cfs	0.64	0.64
Qb, cfs	4.0	4.0
Projected IWC (mg/L)	239	324

5.2.2.2 IWC Computations for UT002

IWC computations for chloride, sulfate, and TDS at UT002 were calculated using the non-parametric statistical technique. The frequency histograms for chloride, sulfate, and TDS all showed a data set that was not normally distributed (Appendix C). The following calculations were used to determine the IWC for each mineral at UT002.

k = p(n=1)

where: k = the ranked order number from the mineral data set (values of k that are not integers are interpolated for using the two values that k falls between).
p = desired percentile
n = number of data points

This method returns k values of 63.65 for chloride, 62.70 for sulfate, and 19.0 for TDS. The chloride data set has an n = 66, the sulfate data set has an n = 65, and the TDS data set has an n = 19. Therefore, the values ranked in the data set as "63.65", "62.70", & "19.0" for chloride, sulfate, and TDS was 1,029 mg/L, 372 mg/L, and 1376 mg/L, respectively. These "ranked" values are equal to the 95th percentile. Flow values used in the following calculations (0.154 MGD or 0.24 cfs) is the reported highest monthly average flow for a period from January 2004 through October 2005 at Outfall 002. Utilizing all the aforementioned data the IWC is calculated below. The summary of the mass balance data inputs are provided in Table 5.1 for UT002.

$IWC_{chloride}$ =
[(4.0 cfs x 5.0 mg/L) + (0.24 cfs x 1029 mg/L)] / (4.0 cfs + 0.24 cfs) = 63 mg/L, say 65 mg/L

$IWC_{sulfate}$ =
[(4.0 cfs x 13 mg/L) + (0.24 cfs x 380 mg/L)] / (4.0 cfs + 0.24 cfs) = 33.8 mg/L, say 35 mg/L

IWC_{TDS} =
[(4.0 cfs x 67 mg/L) + (0.24 cfs x 1376 mg/L)] / (4.0 cfs + 0.24 cfs) = 141 mg/L

Table 5.2. Instream Waste Concentration (IWC) Calculation for UT002.

Parameters	Chloride	Sulfate	TDS
Ce, mg/L (projected 95th%tile)	1029	380	1376
Cb, mg/L	5.0	13	67
Qe, cfs	0.24	0.24	0.24
Qb, cfs	4.0	4.0	4.0
Projected IWC (mg/L)	63.0	33.8	141

5.2.2.3 IWC Computations for Bayou de Loutre (from the mouth of UT004 to the confluence of Loutre Creek)

IWC computations for chloride, sulfate, and TDS at Bayou de Loutre from the mouth of UT002 to the confluence of Loutre Creek were preformed utilizing the previously calculated IWCs and flows from UT004 & UT002 (above), and Bayou de Loutre background flow (4 cfs) for each respective mineral.

The following calculations were used to determine the IWC for chloride in this section of Bayou de Loutre. This method returns "effluent concentration" of 1,519 mg/L for chloride. "Effluent flow" values are the combined flows form Outfall 002 & Outfall 004's reported highest monthly average flow for a period from January 2004 through October 2005. The resulting "effluent flow" value used in the IWC computations was 0.88 cfs. Utilizing all the aforementioned data the IWC is calculated below:

$IWC_{chloride}$ =
[(4.0 cfs x 5.0 mg/L) + (0.88 cfs x 1519 mg/L)] / (4.0 cfs + 0.88 cfs) = 278 mg/L

Table 5.3. Instream Waste Concentration (IWC) Calculation for chloride on Bayou de Loutre (from the mouth of UT004 to the confluence of Loutre Creek).

Parameters	Chloride
Ce, mg/L	1519
Cb, mg/L	5.0
Qe, cfs	0 88
Qb, cfs	4.0
Projected IWC (mg/L)	278

While the calculated IWC for chloride indicated higher concentrations than the current stream based water quality criteria for this section of Bayou de Loutre, the calculated IWC for sulfate and TDS proved to be lower than the current stream based water quality criteria and demonstrates no reasonable potential to exceed the existing criteria at this time. Therefore, no change in the water quality criteria for sulfate or TDS in this section of Bayou de Loutre is being proposed.

5.2.2.4 IWC Computations for UT003

IWC computations for chloride and sulfate at UT003 utilized the non-parametric statistical technique, while the computations for TDS required a parametric statistical technique. The frequency histograms for chloride, sulfate, and TDS demonstrated the chloride and sulfate data set is not normally distributed and the TDS data set is normally distributed (Appendix C). The following calculations were used to determine the IWC for each mineral at UT002.

Chloride & Sulfate:

$k = p(n=1)$

where: k = the ranked order number from the mineral data set (values of k that are not integers are interpolated for using the two values that k falls between).
p = desired percentile
n = number of data points

This method returns k values of 69.35 for chloride and sulfate. Both the chloride and sulfate data sets has an n = 72. Therefore, the value in the data set ranked as "69.35" for chloride and sulfate was 2374 mg/L and 96 mg/L, respectively. These "ranked" values are equal to the 95th percentile. Flow values used in the following calculations (0.747 MGD or 1.16 cfs) is the reported highest monthly average flow for a period from January 2004 through October 2005 at Outfall 003. Utilizing all the aforementioned data the IWC is calculated below. The summary of the mass balance data inputs are provided in Table 5.2 for UT003.

TDS:

$X_P = \overline{x} + (Z_p * s)$

where: X_P = desired percentile
$\overline{x}$ = sample mean of the mineral data set
Z_p = statistical "look up value" for the standard normal distribution of the desired percentile
s = standard deviation of the mineral data set

This method returns Z_p values of 1.64 for the 95th percentile, a standard deviation of the TDS data set of 848, and a sample mean value for the TDS data set is 684. This data returned a 95th percentile value of TDS data set of 2079 mg/L. Flow values used in the following calculations (0.747 MGD or 1.16 cfs) is the reported highest monthly average flow for a period from January 2004 through October 2005 at Outfall 003. Utilizing all the aforementioned data the IWC is calculated below. The summary of the mass balance data inputs are provided in Table 5.2 for UT003.

$IWC_{chloride}$ =
[(4.0 cfs x 5.0 mg/L) + (1.16 cfs x 2374 mg/L)] / (4.0 cfs + 1.16 cfs) = 538 mg/L

$IWC_{sulfate}$ =
[(4.0 cfs x 13 mg/L) + (1.16 cfs x 95.8 mg/L)] / (4.0 cfs + 1.16 cfs) = 31.6 mg/L, say 35 mg/L

IWC_{TDS} =
[(4.0 cfs x 67 mg/L) + (1.16 cfs x 2079 mg/L)] / (4.0 cfs + 1.16 cfs) = 519 mg/L

Table 5.4. Instream Waste Concentration (IWC) Calculation for UT003. Great Lakes Chemical Company.

Parameters	Chloride	Sulfate	TDS
Ce, mg/L (projected 95th%tile)	2,374	95.8	2,079
Cb, mg/L	5.0	13	67
Qe, cfs	1.16	1.16	1.16
Qb, cfs	4.0	4.0	4.0
Projected IWC (mg/L)	538	31.6	519

5.2.2.5 IWC Computations for UTLCB-2

IWC computations for chloride, sulfate, and TDS at UTLCB-2 were preformed utilizing the previously calculated IWCs and flows from UT003 (above) as the "effluent concentration" and "effluent flows" for each respective mineral. The following calculations were used to determine the IWC for each relevant mineral at UTLCB-2.

This method returns "effluent concentration" of 538 and 519 for chloride and TDS, respectively. "Effluent flow" values are the combined flows from UT003 background flow (4 cfs) and Outfall 003's reported highest monthly average flow for a period from January 2004 through October 2005. The resulting "effluent flow" value used in the IWC computations was 5.16 cfs. Utilizing all the aforementioned data the IWC is calculated below.

$IWC_{chloride}$ =
[(4.0 cfs x 5.0 mg/L) + (5.16 cfs x 538 mg/L)] / (4.0 cfs + 5.16 cfs) = 305 mg/L

IWC_{TDS} =
[(4.0 cfs x 67 mg/L) + (5.16 cfs x 519 mg/L)] / (4.0 cfs + 5.16 cfs) = 322 mg/L, say 325mg/L.

Table 5.5. Instream Waste Concentration (IWC) Calculation for UTLCB-2.

Parameters	Chloride	TDS
Ce, mg/L (UT003's IWC)	538	519
Cb, mg/L	5.0	67
Qe, cfs	5.16	5.16
Qb, cfs	4.0	4.0
Projected IWC (mg/L)	305	322

While the calculated IWC for chloride and TDS indicated higher concentrations than the current ecoregion based water quality criteria for UTLCB, the calculated IWC for sulfate proved to be lower than the current ecoregion based water quality criteria and shows no reasonable potential to exceed the water quality based criteria at this time. Therefore, no change in the water quality criteria for sulfate at UTLCB-2 is being requested at this time.

5.2.2.6 IWC Computations for Little Cornie Bayou

IWC computations for chloride, sulfate, and TDS at LCB were preformed utilizing the previously calculated IWCs and flows from UTLCB-2 (above) as the "effluent concentration" and "effluent flows" for each respective mineral. The following calculations were used to determine the IWC for each relevant mineral in Little Cornie Bayou (LCB) for the section form the mouth of the unnamed tributary (UTLCB-2) to the Arkansas State line.

This method returns "effluent concentration" of 305 and 23.5 for chloride and sulfate, respectively. "Effluent flow" values are the combined flows form UT003 background flow (4 cfs), UTLCB-2 background flow (4 cfs), and Outfall 003's reported highest monthly average flow for a period from January 2004 through October 2005. The resulting "effluent flow" value used in the IWC computations was 9.16 cfs. Utilizing all the aforementioned data the IWC is calculated below.

$IWC_{chloride}$ =
[(4.0 cfs x 5.0 mg/L) + (9.16 cfs x 305 mg/L)] / (4.0 cfs + 9.16 cfs) = 214 mg/L, say 215 mg/L

$IWC_{sulfate}$ =
[(4.0 cfs x 13 mg/L) + (9.16 cfs x 23.5 mg/L)] / (4.0 cfs + 9.16 cfs) = 20.3 mg/L, say 25 mg/L.

Table 5.6. Instream Waste Concentration (IWC) Calculation for LCB.

Parameters	Chloride	Sulfate
Ce, mg/L (UTLCB-2's IWC)	305	23.5
Cb, mg/L	5.0	13
Qe, cfs	9.16	9.16
Qb, cfs	4.0	4.0
Projected IWC (mg/L)	214	20.3

While the calculated IWC for chloride indicated higher concentrations than the current stream based water quality criteria for LCB, the calculated IWC for sulfate and TDS was equal to or lower than the current stream based water quality criterion (20 mg/L and 500 mg/L, respectively) and shows no reasonable potential at this time to exceed the existing water quality criteria. No change in the water quality criteria for sulfate or TDS for this reach of Little Cornie Bayou are being requested at this time.

5.3 Compliance with LA standards for dissolved minerals.

Based on information as presented in the Louisiana WQS, the water quality criteria for unnamed streams in the Little Cornie Bayou watershed are 250 mg/L, 250 mg/L, and 500 mg/L for chloride, sulfate, and TDS, respectively and the critical flow is considered as a long tem average flow. Since the above computations indicate that the IWC all remain below the existing mineral criteria, there should be no impact to waters of the state of Louisiana.

6.0 ALTERNATIVE ANALYSES

This section summarizes the analyses of alternatives for the GLCC's central facility to maintain the WQS for UT002, UT003, UT004, UTLCB-2, and LCB. As seen in Section 5.0, the discharges from GLCC's central facility maintains protective criteria related to the existing uses; however, it does exceed the ecoregion standard criteria for chloride, sulfate, and TDS (UT002 & UT003), chloride and TDS (UT004 & UTLCB-2), and the stream standard criteria for chloride and sulfate (LCB). In addition, the current concentration of respective dissolved minerals is projected to cause Instream exceedances under critical flow conditions.

Six alternatives were identified to address designated uses and the protective criteria for chloride, sulfate, and TDS (as needed). They are as follows:

1) no action,
2) no discharge,
3) hydrograph controlled release,
4) treatment
5) source reduction/Pollution Prevention
6) Water Quality Standards modification.

6.1 No Action

This alternative would maintain the current discharge situation. Respective mineral effluent concentrations would exceed the permit limits established to maintain the designated but non-existing, domestic water supply use. In addition, it is projected that Instream exceedences of the ecoregion based and/or stream based chloride, sulfate, and TDS criteria will occur under critical conditions. For these reasons, this alternative is not considered to be feasible.

6.2 No Discharge

The no discharge alternative is not economically feasible. Although the GLCC Central facility practices deep-well injection of process wastewaters, the cost and added volume of deep-well injection of surface storm water runoff, non-contact cooling water boiler blowdown and cooling tower overflows would ultimately make it economically infeasible to continue operations.

GLCC employs approximately 559 workers (536 employees plus 23 full time on site contractors) with an annual payroll estimated at approximately $45.6 million. In addition, GLCC pays approximately $5 million in local and state taxes. GLCC is a significant employer in Union County. This alternative would require the cessation of operations at GLCC facilities, an action which would greatly affect the local economy.

This alternative is considered infeasible due to the socioeconomic effects to the local area should the GLCC facilities close.

6.3 Hydrograph Controlled Release (HCR)

The feasibility of a HCR was examined as an alternative for minimizing the impact of GLCC Central discharges with mineral concentrations that exceed the current ecoregion criteria. In this situation, an HCR system would not achieve compliance with the ecoregion based dissolved minerals water quality criterion because the hydrology of the unnamed tributaries is dictated by limited watershed size (the largest is less than 3 square miles) at the Outfall locations. An analyses of the flows required to attain the existing water quality criteria demonstrates that a storm event equal to a 1 in 10 year event would be required to generate the flow in Bayou de Loutre to create sufficient instream flows with ecoregion background mineral concentrations to allow compliance with the existing instream criteria in the unnamed tributaries.

In addition, as described in Section 3.5, the discharge through Outfalls 002 and 004 are storm water only, and discharge only in response to storm events. There is no capacity to implement a HCR system to capture the storm water from these discharges and then meter the discharge of the contained storm water only during subsequent events.

6.4 Treatment

EPA has no Best Available Technology (BAT) for removal of chloride, sulfate, or TDS from waste streams. While ion exchange (anion) and reverse osmosis treatment technologies exist, these methods currently are not cost effective on a large scale and are not typically recommended for treatment of storm waters prior to discharge. Also, the concentrated reject streams generated from such processes present their own unique set of potential environmental risks which can be much greater than the treated wastewater and/or storm waters from which the minerals were extracted. In addition this advanced treatment places large burdens on the cost effectiveness of the facility and goods produced.

The technical limitations and uncertain environmental effects of concentrated waste streams generated from ion exchange and reverse osmosis treatment make the treatment alternative infeasible when other alternatives are considered.

6.5 Source Reduction/Pollution Prevention

The dissolved minerals in the storm water outfalls are primarily contributed from collected storm water from the site. The facility has completed site modifications and prevention activities to reduce storm water contamination as discussed in Section 3.5. As provided in Section 3.5, the facility also maintains SWPPP and SPCC plans for routine control and management of storm water.

6.6 WQS Modifications

Discussions concerning the WQS Modification alternative are contained in the following sections.

6.6.1 Designated Uses

As discussed in Section 3.2, the following designated uses have been assigned to UT002, UT003, UT004, and UTLCB-2 in the AWQS.

Secondary Contact Recreation,
Seasonal Gulf Coastal Fishery,
Domestic Water Supply,
Industrial Water Supply, and
Agricultural Water Supply.

6.6.2 Existing Uses

The documented existing fishery use in the unnamed tributaries of Bayou de Loutre (UT002 & UT004), the unnamed tributary of the unnamed tributary of Little Cornie Bayou (UT003), and the unnamed tributary of Little Cornie Bayou (UTLCB) is a Seasonal Gulf Coastal Fishery.

The primary contact recreation use was not documented as an existing use. The uses of agricultural and industrial water supply were also not documented as existing and may be limited due to water volume, but are not precluded due to water quality.

6.6.3 Attainability of the Domestic Water Supply Use

As previously noted based on the documentation provided by ADH, the unnamed tributaries of Bayou de Loutre (UT002 & UT004), the unnamed tributary of the unnamed tributary of Little Cornie Bayou (UT003), and the unnamed tributary of Little Cornie Bayou (UTLCB-2) is not existing or planned public water supply source. In addition, the ASWCC has documented that the removal of the designated domestic water supply use from the unnamed tributaries of Bayou de Loutre (UT002 & UT004), the unnamed tributary of the unnamed tributary of Little Cornie Bayou (UT003), and the unnamed tributary of Little Cornie Bayou (UTLCB-2) does not conflict with the Arkansas Water Plan.

In addition to an evaluation of the existing and planned use of UT002, UT004, UT003, & UTLCB-2 as a domestic water supply, the USEPA Region 6 has requested that information concerning the attainability of the domestic water supply use on the basis of the regulatory criteria contained at 40 CFR 131.10(g) be included in use removal request documentation. Review of the project documentation considering the 40 CFR 131.10(g) criteria demonstrates that removing the designated, but not existing domestic water supply use is appropriate because the use is not attainable based on two of the 40 CFR 131.10(g) criteria. The first of these is criterion No. 2, which states:

"Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met."

The respective watersheds at appropriate outfall locations are all less than 5 mi^2 in size, the streams is intermittent in nature and does not have consistent base flows required to supply the volume of water necessary for the development and operation of a domestic water supply. In addition, because of the intermittent nature of the discharge from GLCC Central facility's storm water outfalls the increased flow supplied sporadically through effluent discharge is not sufficient to compensate for the small watershed sizes. Neither the stream systems nor the discharges provide consistent flow volume required for feasible attainment of a domestic water supply use.

The second applicable 40 CFR 131.10 (g) criterion is No. 5, which states:

"Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses"

As can be seen in the documentation, the physical characteristics of the respective stream segments, which primarily consist of shallow pools and run areas, will not support intake and storage areas necessary for the development of a domestic water supply system. As such, the extensive physical modifications required to develop intake and storage areas would result in the removal of riparian habitat and modification of Gulf Coastal fisheries habitats. Such modifications would impact the existing aquatic life use.

Table 6.1. Summary of Proposed WQS Modifications for Bayou de Loutre watershed.

UT002 - unnamed tributary to Bayou de Loutre	**UT004 - unnamed tributary to Bayou de Loutre**	**Bayou de Loutre from mouth of Outfall 004 tributary downstream to the mouth of Loutre Creek**
Remove Designated Domestic Water Supply Use	Remove Designated Domestic Water Supply Use	Remove Designated Domestic Water Supply Use
Amend ecoregion dissolved minerals criteria:	Amend ecoregion dissolved minerals criteria:	Amend stream ecoregion, dissolved minerals criteria:
Chloride from 14 mg/L to 65mg/L; Sulfate from 31 mg/L to 35 mg/L, and TDS from 123 mg/L to 141mg/L	Chloride from 14 mg/L to 239 mg/L and TDS from 123 mg/L to 324 mg/L	Chloride from 250 mg/L to 278 mg/L.

Table 6.2. Summary of proposed WQS Modifications for Little Cornie Bayou Watershed.

UT003 - unnamed tributary to an unnamed tributary of Little Cornie Bayou	**UTLCB-2 – unnamed tributary of Little Cornie Bayou to Little Cornie Bayou**	**Little Cornie Bayou – to the Arkansas / Louisiana state line**
Remove Designated Domestic Water Supply Use	Remove Designated Domestic Water Supply Use	No Change
Amend ecoregion dissolved minerals criteria:	Amend ecoregion dissolved minerals criteria:	Amend stream dissolved minerals criteria:
Chloride from 14 mg/L to 538mg/L; Sulfate from 31 mg/L to 35 mg/L, and TDS from 123 mg/L to 519 mg/L	Chloride from 14 mg/L to 305mg/L and TDS from 123 to 325 mg/L	Chloride from 200 mg/L to 215mg/L and Sulfate from 20 mg/L to 25 mg/L

These proposed modifications are supported by the documentation which meets the requirements of AWQS Section 2.306 as clarified by the Administrative Guidance Document.

6.7 Summary of Alternative Assessment

Based on the information developed and presented above (with supporting details in Appendix), the selected alternative to achieve compliance with the dissolved minerals criteria is to prusue the 3rd party rule making to increase the instream criteria and modify the existing desiginated uses to reflect actual conditions and attaianble uses, which are not precluded by the proposed rulemaking. The proposed rulemaking supports the removal of the domestic water supply use for those stream reaches as depicted in Figures 10 and 11. The proposed 3rd party rule making supports the removal of the domestic water supply use from those stream reaches indicated in figures 10 and 11.

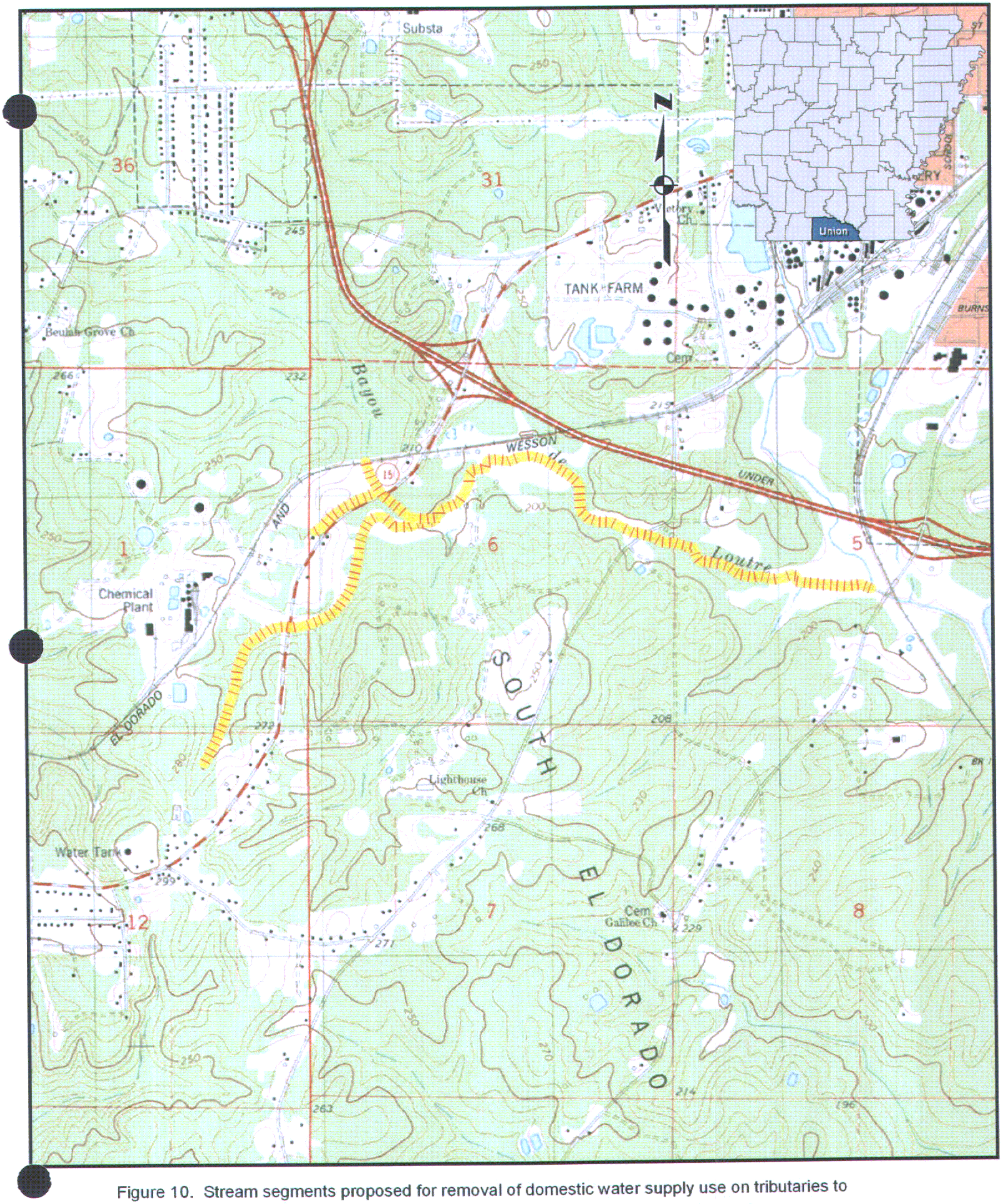

Figure 10. Stream segments proposed for removal of domestic water supply use on tributaries to Bayou De Loutre by Great Lakes Chemical Company 3rd party rule making.

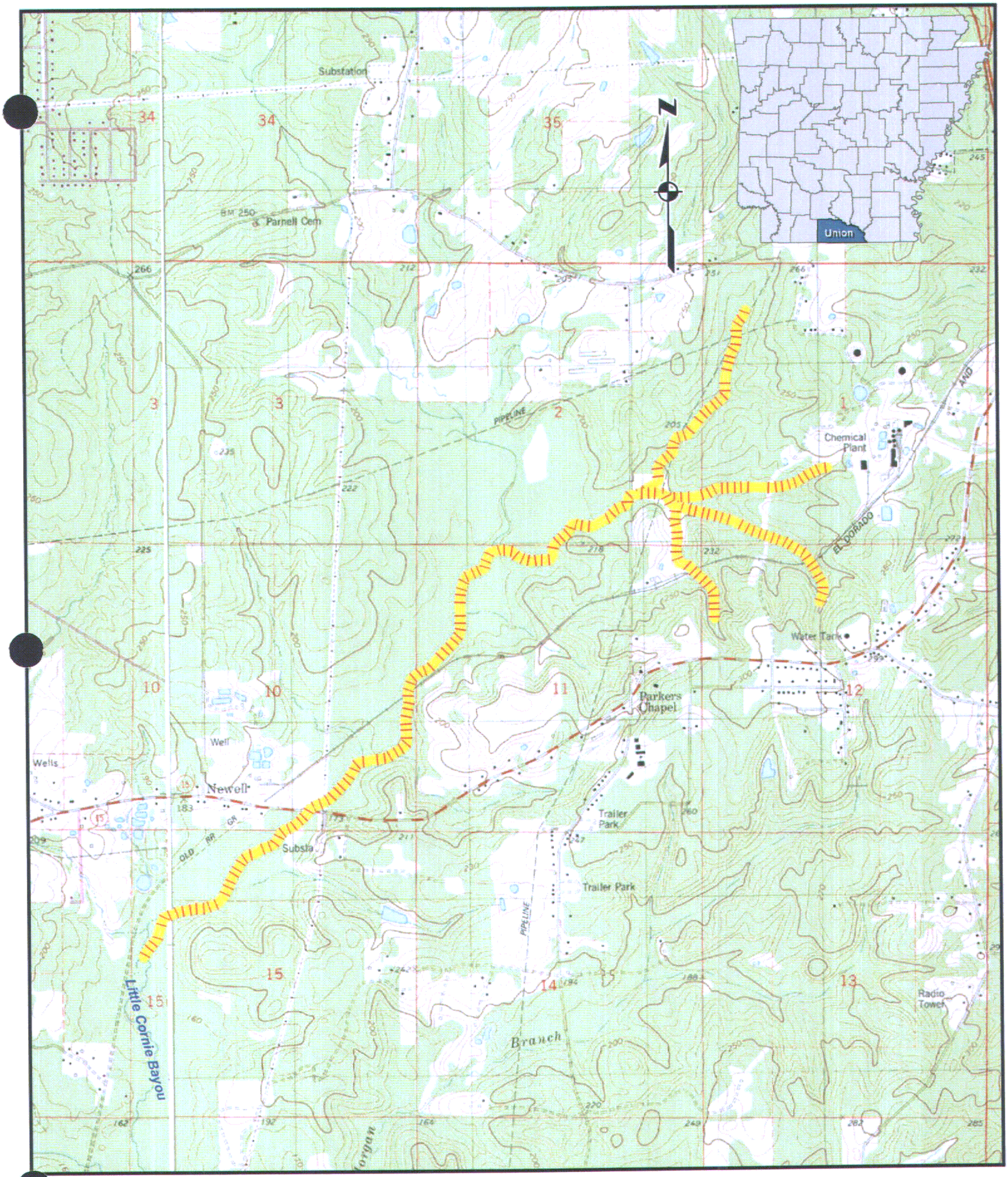

Figure 11. Stream segments proposed for removal of domestic water supply use from tributaries of Little Cornie Bayou through 3rd party rule making.

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Appendix A

Section 2.306 [Formerly 4(g) Field Study Plan]

Section 2.306 [formerly 4(g)] Field Study Plan

Prepared for:

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DRAFT
April 13, 2005

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Attachment

1.0 Introduction

1.1 Background

A third-party rule making is being developed to address the existing final permit limits for dissolved minerals in the Great Lakes Chemical Company (GLCC) Central Facility's NPDES permit (AR0001171). The current interim permit limits are monitor and report only. During the interim period, these parameters have been demonstrated to exceed the final permit limitations.

Currently, the dissolved solids discharged through Outfall 002 (chloride, sulfate and TDS), Outfall 003 (chloride and sulfate) and Outfall 004 (chloride and TDS) will not consistently meet the final permit limits. Outfalls 002 and 004 are storm water discharges that drain the northeastern and eastern portions of the Central facility via unnamed tributaries into Bayou de Loutre. Outfall 003 drains the western slopes of the facility and includes non-process waters as well as storm water (Figure 1.1).

The final permit limits are scheduled to become effective on January 2007, unless they are modified through the third-party rule making provision of the Arkansas Water Quality Standards (Regulation No. 2). The current final dissolved mineral permit limits were developed and are being implemented to protect the designated but non-existing and unattainable drinking water uses through the application of criteria of 250 mg/L, 250mg/L, and 500 mg/L for chloride, sulfate and TDS, respectively.

The ADEQ recognizes that the application of the dissolved mineral criteria using long term average flows (rather than Q7-10 flows) do not necessarily preclude other designated uses (fishable/swimmable) and have provided for the application of long-term flows to determine site specific instream criteria once the drinking water uses are removed. This third-party rule making is accomplished through the application of Section 2.306 [formerly 4(g)] in Regulation No. 2.

1.2 Study Objective

The objective of the study plan is to complete the field documentation required to support a third-party rulemaking in accordance with Section 2.346 to remove the designated domestic water supply use and modifying the final permit limits for dissolved minerals that will allow maintenance of existing uses.

GLCC has developed and implemented best management practices (BMPs) to address and control storm water discharges and limit exposure of storm water. The facility is located on Highway 15 approximately one mile south of El Dorado, Arkansas (Figure 1.1) GLCC is authorized to discharge storm water and other non-process waters under National Pollutant Discharge Elimination System (NPDES) permit no. AR0001171. Due to the nature of Outfalls 002 and 004 (exclusively storm water), there is not a constant discharge. Outfall 003 generally discharges on a continuous basis and has non-process waters contributing to the effluent.

This Section 2.306 field study plan is focused on the waterbodies that receive discharges from these three outfalls. These water bodies are unnamed wet weather tributaries of Bayou de Loutre (Outfalls 002 & 004) and an unnamed tributary to Little Cornie Bayou (Outfall 003), (Figure 1.2).

The following sections provide the details of the field studies.

2.0 Quality Assurance/Quality Control

A complete and thorough Quality Assurance (QA) program with defined data quality objectives (DQO) is an essential part of any biological field study. The degree to which the study data meets the DQO dictates the quality and representativeness of the overall project.

2.1 Quality Control

The DQOs of this study are to attain data that meets the following quality control (QC) criteria:

1) Precision is a gauge of the ability of a measurement to be repeated acquiring similar results. The *in-situ* and analytical data will be checked for precision by use of duplicate samples at a minimum rate of 10%. An acceptable level of data precision will be based on the relative percent difference (RPD) between duplicate samples not to exceed 20%. The habitat, fish and macroinvertebrate portion of the study cannot be easily duplicated. Standard collection procedures will be used at each collection station to achieve the greatest degrees of reproducibility possible.
2) Representativeness is a gauge of the degree to which a measurement is representative of the true condition. Sampling reaches have been carefully selected as to best represent the conditions in that segment of the stream.
3) Comparability is a gauge of the ability of the resulting data to compare to data from similar measurements performed in the same study and in other studies. An effort to use standardized techniques based on EPA accepted methodologies was made to maximize comparability. Also, only experienced and trained personnel are performing the various measurements.
4) Completeness is a measure of the degrees of validity of the data collected. Completeness is evaluated by ongoing review of project data by team members to assure that all the necessary data will be collected and is reasonable.

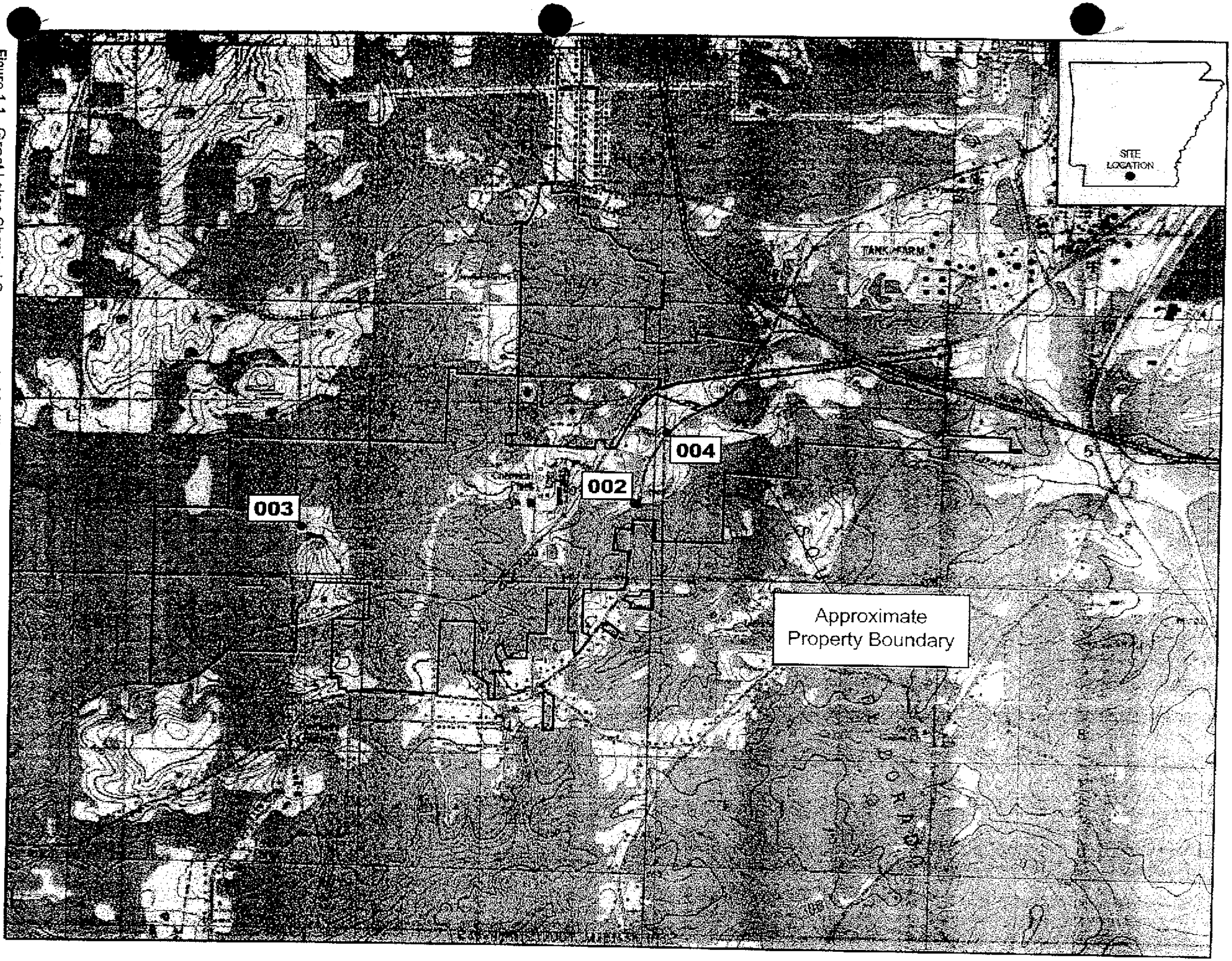

Figure 1.1. Great Lakes Chemical Company central facility & outfall locations.

April 13, 2005

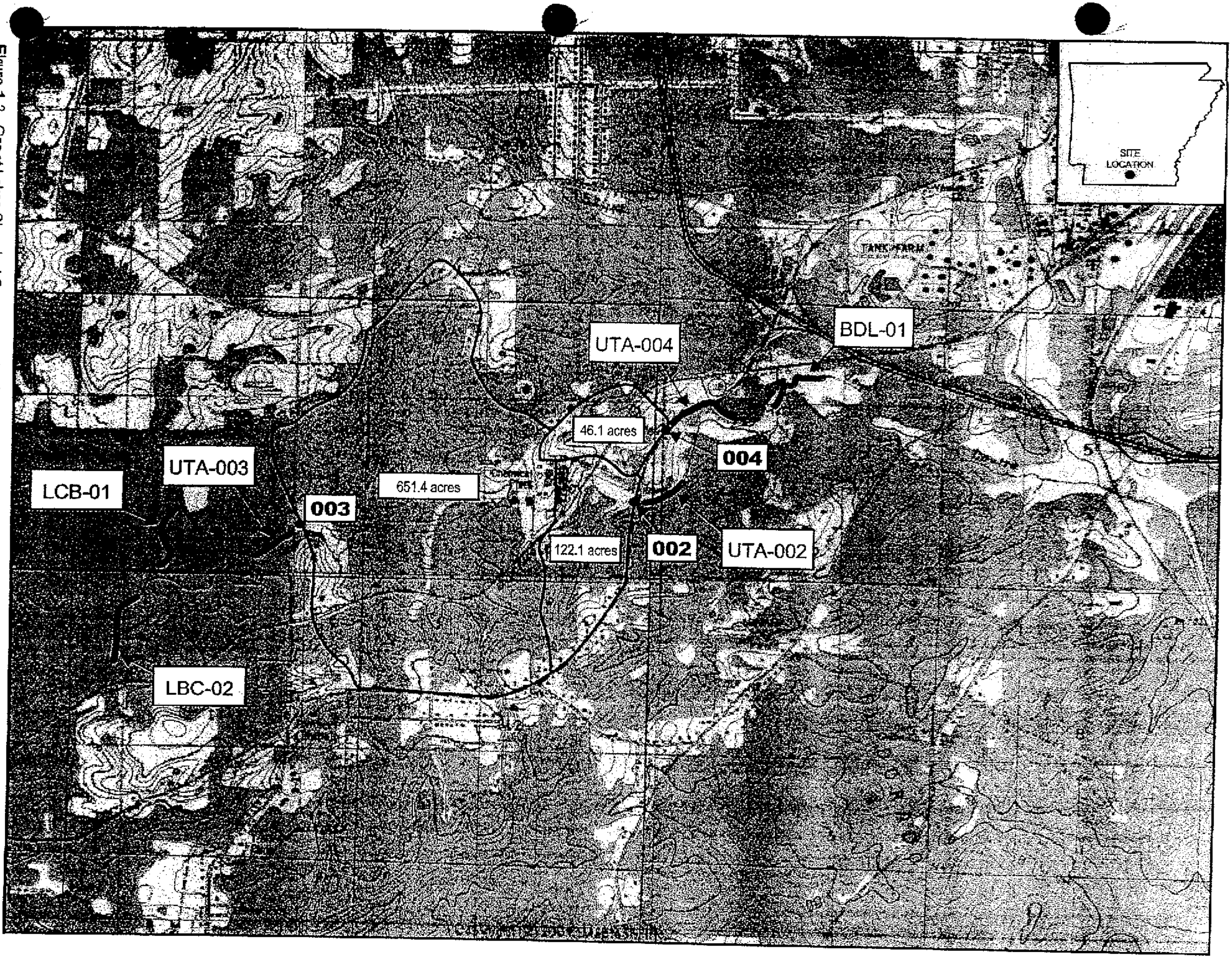

Figure 1.2. Great Lakes Chemical Company watershed boundaries, outfall locations & proposed study reaches.

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5) Accuracy is a gauge of the degree of agreement between the measured value and the real value. Proper instrument calibrations and reference solution checks assure accuracy of *in-situ* data. All field equipment will be utilized and calibrated according to manufacturer's directions. Calibrations will be conducted daily prior to use. If any equipment fails to conform to known QA/QC manufacturers' specifications, the equipment will be replaced with duplicate equipment that will meet the specifications. Accuracy for biological collections/assessments is not quantifiable, since the true value is not known.
6) A chain of custody will be executed whenever samples are to be transferred between separate entities (e.g., water quality samples).

2.2 Field Method QC

The quality of data collected during this study will be further assured by the following QC measures:

1) A Field Equipment Checklist will be maintained and followed for all field trips. Use of the checklist helps ensure that all field equipment and forms are prepared and available for use in the field.
2) All methodologies used during this study will be based on approved and widely accepted EPA methodologies. An effort is continuously made to keep abreast of the most current methodologies and to adjust our program so as to be more comparable, representative and accurate.
3) Field data sheets are designed for each type of measurement (i.e., *In-situ*, benthos, fish, habitat, etc.). Field sheets contain the necessary information along with space to note anomalies or variances from standard procedures.
4) Trained and experienced field biologists will conduct the study. All crucial team members hold college level degrees in biological sciences or related fields. Continuing education is encouraged through short courses, scientific journal review, conference attendance, and readings in current text and manuals to assure up-to-date knowledge of the field.
5) Fish and aquatic macroinvertebrates will be identified to the lowest taxonomic level practicable. Taxonomic references will be those widely accepted in the scientific community. Identification checks will be made randomly by the project manager or other senior level scientists to verify the accuracy and of the identifications. This check will occur at a rate of approximately 10%.
6) Where analyses are quantifiable EPA approved test methods will be utilized. In these quantifiable cases MDLs will be established and adhered to along with all pertinent QC procedures (i.e., blanks, controls, spikes, and spike duplicates).

2.3 Data Review and Validation

It is necessary to establish QC guidelines for reviewing, validating, and if necessary correcting data following its measurement and analysis in the field or laboratory. This is accomplished by following the steps listed below.

1) All field record sheets, taxonomic identifications, community metrics, and analytical results will be reviewed for precision, representativeness, comparability, completeness, and accuracy.
2) When data quality problems are discovered the project manager and/or the senior scientist will determine the level of the problem and the corrective action, if any, necessary to eliminate the problem.
3) Corrective actions will vary along with the type of QC problem and the degree of the problem. Corrective action for a duplicate sample returning an RPD greater than 20% might result in a repeat of the analysis or even a repeat of the sampling event. Corrective action for a field record sheet being incomplete would likely result in a team meeting to facilitate the missing parameters being filled in correctly.

2.4 QA/QC Checks Following Each Stream Visit

Following the conclusion of all activities at each sample reach, the sample team will review all completed data forms and sample labels for accuracy, completeness, and legibility, and will conduct a final inspection of samples collected. If information is missing from the forms or labels, the team leader will make any corrections prior to proceeding to the next sample reach. The team leader will initial all data forms after review. Other team members will inspect and clean sampling equipment, inventory field supplies, prepare samples for shipment or storage as needed.

3.0 Watershed Characterization

3.1 Study Reaches

The watershed of the unnamed tributaries originates within the property boundaries of the GLCC facility in Union County (Figure 1.2). As part of this 3rd party rulemaking, stream reaches on both Bayou de Loutre and Little Cornie Bayou and tributaries thereof will be evaluated. As indicated by Figure 1.2, the individual reaches will include:

1.	UTA 002	Unnamed tributary to Bayou de Loutre into which Outfall 002 discharges downstream of Hwy 15 but upstream of Bayou de Loutre;
2.	UTA004	Unnamed tributary to Bayou de Loutre into which Outfall 004 discharges but upstream of Bayou de Loutre;
3.	BDL01	Bayou de Loutre downstream of UTA 002 & 004;
4.	UTA 003	Unnamed tributary to Little Cornie Bayou into which Outfall 003 discharges and downstream of Feed Mill Road;
5.	LCB 01	Little Cornie Bayou upstream of UTA 003; and
6.	LCB 02	Little Cornie Bayou downstream of the mouth of UTA 003.

Physical, chemical, and biological data will be collected at each of these reaches in accordance with the following schedule.

3.2 Period of Study

Due to the limited watershed size (less than 10 square miles) and the nature of the respective discharges (exclusively or primarily storm water), data collection for the 3rd party rule making will occur during the spring seasonal period of the year during steady state flow conditions. It is currently proposed that field activities be completed during the last week of April or the first week of May.

4.0 Physical Habitat Characterization

4.1 Purpose

Physical habitat in streams includes all those physical attributes that influence or provide sustenance to biological attributes, both botanical and zoological, within the stream. Stream physical habitat varies naturally, as do biological characteristics; thus, habitat conditions differ even in the absence of point and anthropogenic non-point disturbance. Within a given ecoregion, stream drainage area, stream gradient and the geology are likely to be strong natural determinants of many aspects of stream habitat, because of their influence on discharge, flood stage, and stream energy (both static and kinetic). Kaufmann (1993) identified seven general physical habitat attributes important in influencing stream ecology and the maintenance of biological integrity:

1) channel dimensions,
2) channel gradient,
3) channel substrate size and type,
4) habitat complexity and cover,
5) riparian vegetation cover and structure,
6) anthropogenic alterations, and
7) channel - riparian interaction.

Land use activities can directly or indirectly alter any and/or all of these attributes. Nevertheless, the trends for each attribute will naturally vary with stream size (drainage area) and overall gradient. The relationships of specific physical habitat measurements described in this section to these seven attributes are discussed by Kaufmann (1993). Although they are actually biological measures, aquatic macrophytes, riparian vegetation, instream habitat and canopy cover are included in this and other physical habitat assessments because of their role in habitat structure and light inputs

The objectives of a habitat characterization are to:

1) assess the availability and quality of habitat for the development and maintenance of benthic invertebrate and fish communities, and
2) evaluate the role of habitat quality in relation to the attainment of designated uses and biological integrity.

There are three main headings for the components of the physical habitat characterization each with several categories. Measurements for each of the components (14 categories total) are recorded on copies of a two-page field form entitled Stream Habitat Assessment-Semi-Quantitative (Attachment A) and include:

1) Channel Morphology
   a) Reach Length Determination
   b) Riffle-Pool Sequence
   c) Depth and Width Regime
2) Instream Structure
   a) Epifaunal substrate
   b) Instream Habitat
   c) Substrate Characterization
   d) Embeddedness
   f) Sediment Deposition
   g) Aquatic Macrophytes and Periphyton
3) Riparian Characteristics
   a) Canopy Cover
   b) Bank Stability and slope
   c) Vegetative Protection
   d) Riparian Vegetative Zone Width
   e) Land-use Stream Impacts

Field physical habitat measurements from a field habitat characterization are used in conjunction with water chemistry, temperature, macroinvertebrate and vertebrate (typically fish) community analyses, and other data sources to determine the status of the target streams attainment of designated uses and the water quality required to maintain those uses.

These procedures are intended for evaluating physical habitat in wadeable streams. The field procedures will be applied during spring seasonal conditions with steady base flows. This semi-quantitative habitat procedure will be applied in conjunction with the *General Physical Habitat Characterization* and the *Qualitative Habitat Assessment* to provide a detailed view of the streams habitat condition.

The habitat characterization protocol differs from other rapid habitat assessment approaches (e.g., Plafkin et al., 1989, Rankin, 1995) by employing a, systematic spatial sampling that minimizes bias in the placement and positioning of measurements. Measures are taken over defined channel areas and these sampling areas are placed systematically at spacing that is proportional to the length of the entire study reach. This systematic sampling design provides resolution appropriate to the length of the study reach. The habitat assessment protocol is based on those of USEPA in their EMAP and RBP procedures (Barbour, 1999), USGS NAWQA program and Missouri

Department of Natural Resources ESP. The protocol is objective and repeatable and employs previously developed methods to produce repeatable measures of physical habitat in place of estimation techniques wherever possible.

Two people will complete the specified assessment, including stream flow. The actual time required to complete the habitat characterization at each monitoring location can vary considerably with channel characteristics.

The procedures are employed on a sampling reach of length equal to 20 times the bankfull width, or at least 100 yards of instream distance. The semi-quantitative habitat sampling reach length will include to the extent possible the fish and macroinvertebrate collection reaches. Measurements will be taken in each of 10 sub-reaches, which are systematically placed, at intervals equal to approximately one tenth (1/10) the length of the represented study reach. Measurements and observations for each habitat characteristic are made in each of the sub-reaches as the assessment team moves along the stream channel. An average or total of the scores for each of the 10 sub-reaches is then calculated resulting in a mean value for each characteristic for the entire reach.

4.2 Procedure

The habitat assessment will be conducted within (or to the extent possible) the stream reach from which the benthic and fish communities are to be characterized. The physical habitat will be characterized from measurements and observations of stream attributes made within 10 sub-reaches. The field team assessing habitat should move along the stream channel (near the thalwag) observing habitat characteristics within each sub-reach. A description of and the rational for measuring each of the attributes are provided below. The details of how these attributes are recorded/evaluated are also described in the GBM^c QAP.

4.2.1 Channel Morphology

Channel morphology (or geomorphology) is a characterization of the shape of the stream channel including measurements and/or visual estimates of channel dimensions and riffle-pool sequences (i.e., a measure of the amount of riffles, runs and pools that occur in a given reach).

The channel observed includes that portion of the stream between the base flow wetted area and the top of the normal high water channel often referred to as the bankfull stage (Figure 4.1) The "bankfull" or "active" channel is defined as the channel that is filled by moderate-sized flood events that typically occur every one or two years. Such flow levels are on the verge of entering the flood plain and are believed to control channel dimensions in most streams.

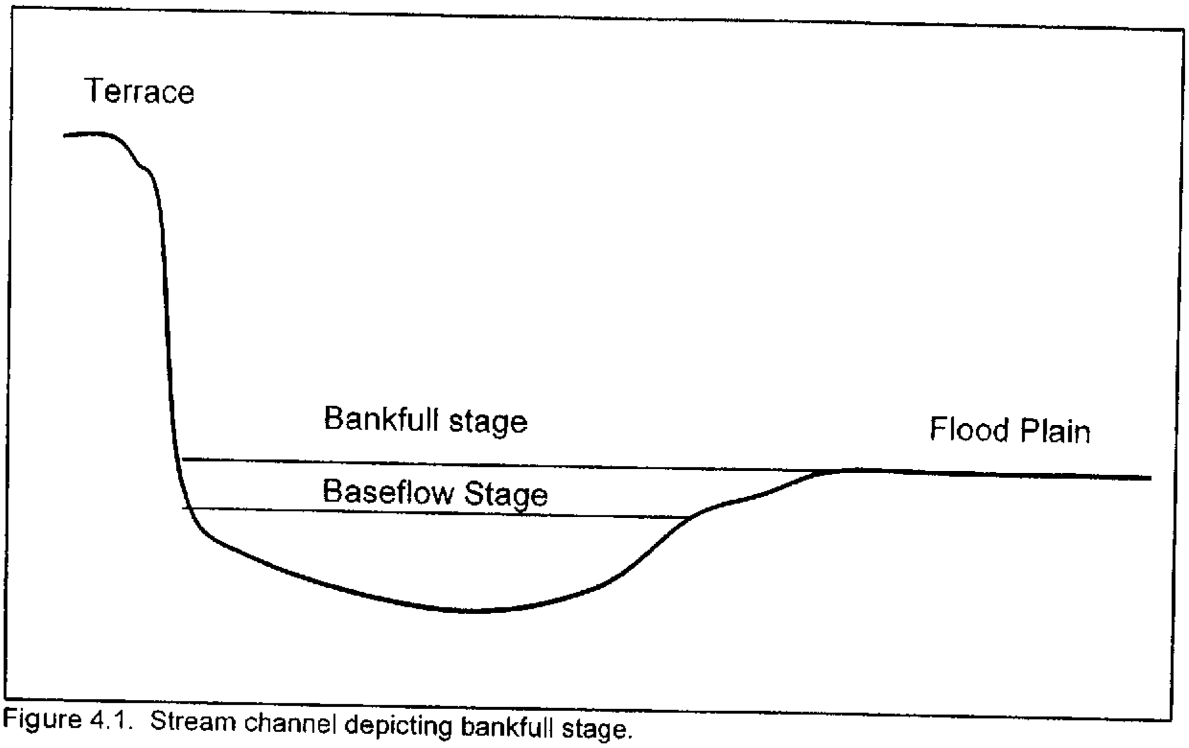

Figure 4.1. Stream channel depicting bankfull stage.

1) Reach Length Determination

First, bankfull depth (depth from stream bottom in thalwag to bankfull stage on the bank) is identified in at least two separate riffles (or alternatively runs in streams not exhibiting riffle morphology) in the study reach. Then bankfull depth and width is determined from five (5) stream transects and recorded on the record sheet. Transect locations should be selected to include each prominent morphology type represented in the stream. Bankfull depths are measured to the nearest 1/10 foot and bankfull widths are measured to the nearest foot using a wading rod and tape measure/range finder, respectively. An average of the 5 bankfull widths is then calculated and multiplied times 20 to arrive at the total reach length for assessment. This total length is then divided by ten to determine the length of each of the ten sub-reaches. Analysis of the first sub-reach should begin at the head of a given stream morphology (i.e., riffle, run or pool).

2) Riffle-Pool Sequence

Stream morphology refers to the abundance and placement (sequencing) of riffles, runs, and pools in a stream system. This sequencing is an indicator of a streams hydrological regime and stability as well as a determinant of its potential to sustain diverse aquatic communities. Beginning at the head of a morphological type (riffle, run or pool) the length of each morphological type in the stream reach should be measured using a range finder or tape measure and recorded on the record sheet. The sequence of each morphological type should be depicted on the record sheet using the provided notations so as to create a map to the location of each riffle, run or pool. The resulting measurements should provide a quantitative measure of the percent of the study reach representing each stream morphological type (i.e., 40% riffle, 30% run, 30% pool, etc.).

3) Depth and Width Regime

The average stream depth and width will be estimated in riffles (or runs in the absence of riffles) and pools in each sub-reach. Depths will be measured along a transect, similar to that depicted in Figure 4.2, in a representative section of each riffle and pool in the sub-reach. Depths are generally taken in the thalwag (deepest area in stream channel) and approximately half way between the thalwag and the left and right banks. An estimated average depth for riffles and pools occurring in a sub-reach is derived from the cross-sectional depth measurements and recorded on the record sheet to the nearest 1/10 foot. Once completed for all 10 sub-reaches this should provide accurate semi-quantitative measurements of riffle and pool average depth and depth variability across the entire stream reach.

Stream wetted widths will be measured along a transect, in a representative section of each riffle and pool in the sub-reach. An estimated average width for each morphological type in a sub-reach should be recorded on the record sheet to the nearest foot. Once completed for all 10 sub-reaches this should provide accurate semi-quantitative measurements of riffle and pool widths across the entire stream reach.

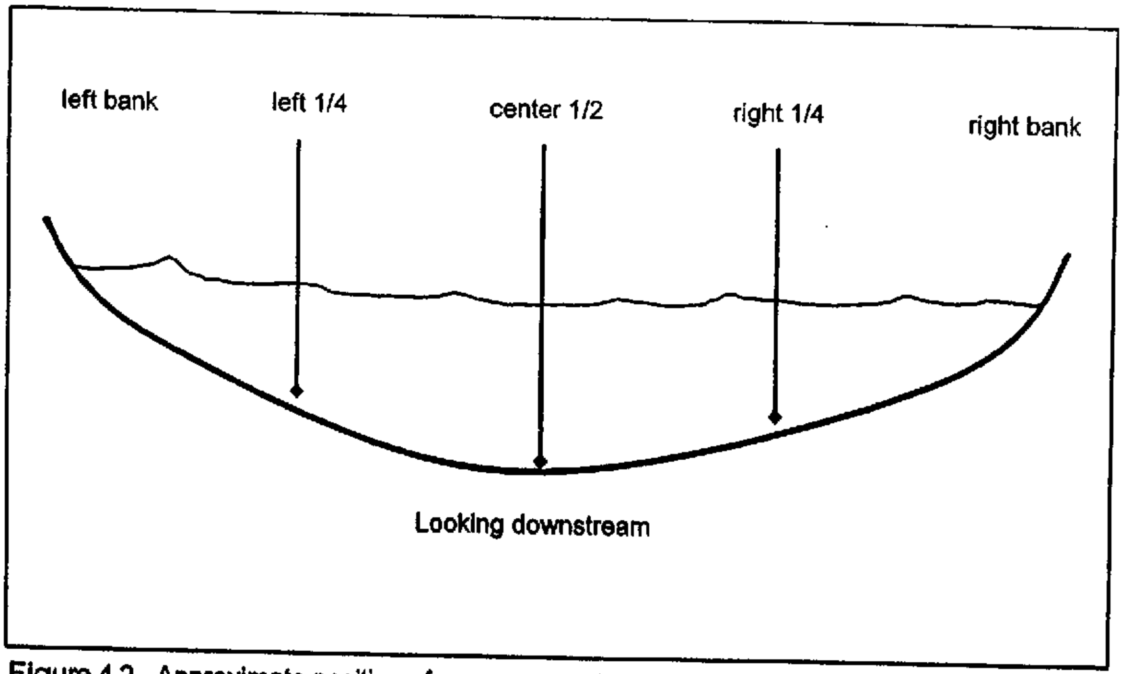

Figure 4.2. Approximate position of measurements across transect.

4.2.2 Instream Structure

Instream structure describes the characteristics of the stream within the wetted perimeter that makes up the habitat suitable for colonization of aquatic biota. This includes information about natural substrates (gravel, boulders, etc), aquatic plants and algae and debris that has been washed into or fallen into the stream, such as logs, leaves, etc. A stream capable of sustaining diverse aquatic communities will contain a variety of instream structure including some that is permanent and some that is mobile during high flow events.

4) Epifaunal Substrate (Macroinvertebrates)

Epifaunal substrate refers to the area on the bottom of the stream (entire wetted perimeter) where macroinvertebrates inhabit. This attribute is scored as a percentage of the stream bottom in a sub-reach which contains substrates suitable for macroinvertebrate colonization. Scoring for this attribute should rely heavily on the stability of the substrate, the size of the interstitial spaces, and the cleanliness (not covered in thick algae or sediment deposits) of the substrate. Cobbles and coarse gravel will score higher percentages as they contain larger interstitial spaces for colonization, while sand and silt would score lower since they provide little spaces. In addition, root wads along the bank would score higher as they are more stable features than would depositional areas or small woody debris.

5) Instream Habitat (Fish)

Instream habitat refers to the habitat features within the wetted perimeter of the stream sub-reach which are available for fish colonization. This attribute is scored as the percentage of the stream bottom (wetted perimeter) in a sub-reach which is covered with fish habitat. As with the epifaunal substrate attribute substrates composed of cobbles, coarse gravels and boulders score higher for fish cover as they provide better spaces for colonization. Other habitats that score high are large woody debris (individual logs with diameter >4 inches or complex woody structures composed of rootwads, logs, or limbs with diameter of 1.5 ft. or greater)and undercut banks. While habitats that score lower are those such as depositional areas, leaf packs, and fine sediments or sand.

6) Substrate Characterization

The dominant stream substrate size classification for riffles and pools within each sub-reach will be recorded on the record sheet. Only substrates within the wetted perimeter are evaluated. This information will be used to characterize the similarities and or differences in substrate structure and complexity in the riffles and pools of the study reach as it relates to the development and maintenance of the systems biological integrity.

Classify the particle into one of the size classes listed on the Semi-Quantitative Habitat Assessment Field Form based on the size of the intermediate axis (median dimension) of its length, width, and depth. This "median" dimension is the sieve size through which the particle can pass.

Bedrock	smooth or rough
Boulder	>25 cm
Cobble	6-25 cm
Coarse Gravel	1.6 – 6 cm
Fine Gravel	0.2 – 1.6 cm
Sand	<0.2 cm
Silt/Mud/Clay	fine, not gritty

Always make notations for unusual substrates such as concrete or asphalt and denote these artificial substrates as "other" and describe them in the comments section of the field data form. Code and describe other artificial (such as large appliances, tires, car bodies, etc.) substrates in the same manner.

7) Embeddedness

Embeddedness is the fraction of a particle's surface that is surrounded by (embedded in) sand or finer sediments on the stream bottom. By definition, the embeddedness of sand, silt, clay, and muck is 100 percent and the embeddedness of hardpan and bedrock is 0 percent.

For this attribute estimations are not made per sub-reach but for the entire stream reach as a whole. An estimation of the "percent embedded" is recorded for coarse riffle substrates in the study reach. This is accomplished by removing 12 pieces of cobble, gravel, or small boulders in at least two different riffles (three maximum) and recording the percent embedded for each. Percent embedded can be visually observed as the darkened portion of the coarse substrate that was buried in the streams fine bed material. If the darkened area covers half the coarse substrates height than the percent embedded is 50%, etc (Figure 4.3)

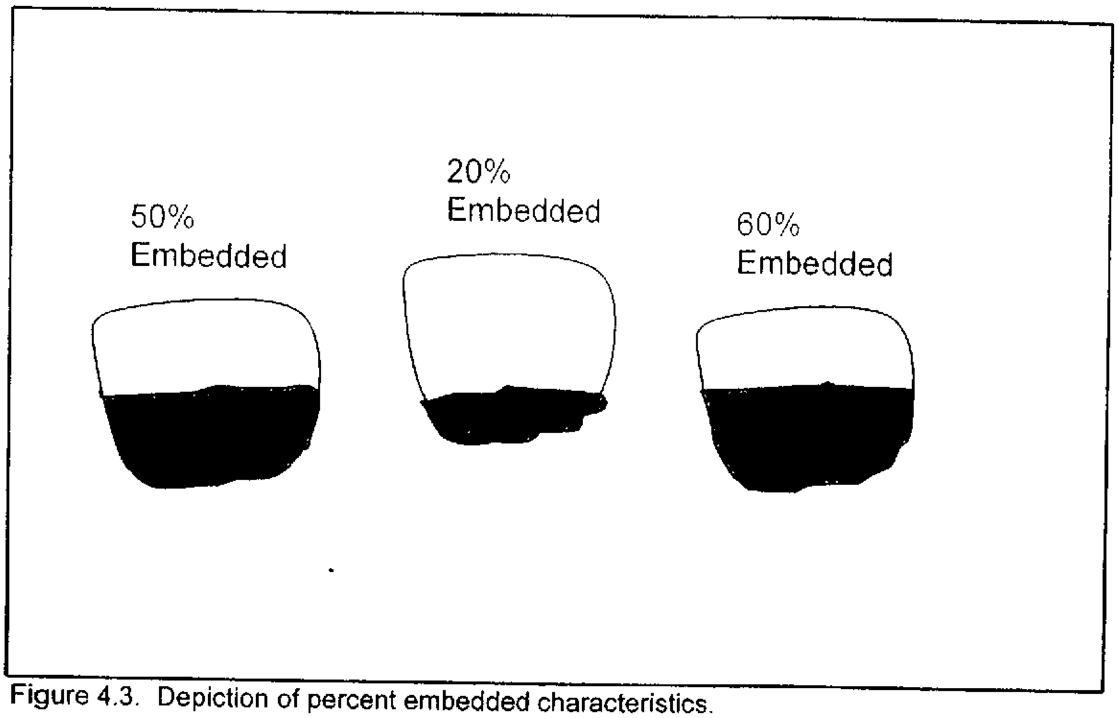

Figure 4.3. Depiction of percent embedded characteristics.

8) Sediment Deposition

The sediment deposition attribute refers to the amount of stream bottom (in the wetted perimeter) that is covered by fine sediments and/or particulate organic matter. This attribute is scored as a percentage of the bottom in each sub-reach which is covered by such loose materials.

9) Aquatic Macrophytes and Periphyton Coverage

An estimate of the percentage of area covered by macrophytes and periphyton in a sub-reach is made and recorded both for riffles and pools. Macrophytes refers to aquatic plants that grow in the stream (both emergent and submerged), and periphyton refers to algae that grows on fixed surfaces. This attribute helps biologists determine stream productivity from a nutrient enrichment perspective and also for the availability of food sources for aquatic biota.

4.2.4 Riparian Characteristics

The riparian area includes the area from the stream bank in a direction away from the stream into the upland areas. It is these stream-side riparian zones that ultimately help shape the stream and provide organic material as nutrients to the aquatic system. A well developed riparian area protects stream banks form erosion, provides shading, inputs nutrients, provides materials as habitat (instream structure) and filters run-off entering the stream. In the absence of well developed riparian zones the stream is more impacted by encroaching land-uses.

10) Canopy Cover

Canopy cover (percent stream shading) over the stream is determined for each of the sub-reaches. Estimates of cover are made by looking into the canopy over the stream channel. Estimates are made from mid-channel and each quarter channel to determine the average percent canopy cover for the width of the stream in the sub-reach. Percent canopy at each measurement point can be estimated visually or by use of a spherial densiometer.

11) Bank Stability and Slope

Bank stability is an important attribute that is an indication of a stream reaches overall hydrologic equilibrium. A bank's stability also determines its ability to provide stable habitat for biota and its propensity to release large sediment yields to the stream, which ultimately cause high turbidity and deposition in downstream reaches. The right and left banks are classified according to the following categories:

Score 9-10 = Stable, little evidence of erosion, < 5% bank eroding;
Score 6-8 = Moderately stable, some evidence of new erosion, 5-29% bank eroding;
Score 3-5 = Moderately unstable, obvious new erosion, 30-59% bank eroding;
Score 1-2 = Unstable, most of bank actively eroding, 60-100% bank eroding;

Banks composed of sands and gravels are much less stable than banks composed of silt/mud/clay or cobbles. The density of well rooted (more permanent) vegetation and root structure also help to improve a banks stability.

Average bank slope (in degrees) in a sub-reach, is recorded for each bank (left and right). Bank slope affects the stability of a bank and is an indicator of past erosion. A gentle slope may average 30° while a steep or undercut bank may average 90° or 100°, respectively.

12) Vegetative Protection

Bank vegetative protection is measured as a percent of the bank surface area which is covered by stable riparian vegetation and their associated roots in a sub-reach. Each bank (right and left) is assessed separately and the value recorded on the record sheet. Banks are assessed from the edge of the water to the top of the first terrace or normal top of bank.

13) Riparian Vegetative Zone Width

Riparian zone with encompasses the area from the top of the normal stream bank outwards into the upland area. The broader the riparian vegetative zone width the more protected the stream banks are from alteration, the fewer pollutants will enter the stream from run-off, and the more available food sources there are to be deposited into the stream from the surrounding forest. Riparian zone width is scored for each bank in a sub-reach according to the following scale:

Score 9-10 =	Riparian Zone Width > 18 meters
Score 6-8 =	Riparian Zone Width 18 - 12 meters
Score 3-5 =	Riparian Zone Width 11 - 6 meters
Score 1-2 =	Riparian Zone Width < 6 meters

14) Land-Use Stream Impacts

Significant Alteration of the land-uses in the immediate riparian area can have detrimental affects on the stream habitat and biota. Urban and agricultural activities are often considered the more prominent of those land-uses that may impact a stream. These impacts are assessed by indicting a specific land-use impact associated with a sub-reach (on either bank) on the record sheet and assigning a degree of impact score to the land-use. The following land-use categories and impact scoring system are provided:

Land-uses:
C = Cattle
R = Row Crops
U = Urban encroachment
I = Industrial Encroachment
O = Other (noted on field form)

Scoring:
0 = no land-use impacts
1 = minor impacts
2 = moderate impacts
3 = major impacts

4.3 Scoring and Analysis of Habitat Assessment Data

Scores from the Semi-Quantitative Habitat Assessment can be utilized in two different ways. First, data collected for each attribute (assessment category) can be used independently to describe the study reach collectively. This method results in information such as: average riffle depth, average pool width, %riffle in entire reach, average bank stability, average (median) substrate size class in pools and riffles, mean %canopy cover, etc. Second, the data collected during the assessment can be used in conjunction with the Qualitative Habitat Assessment procedure to score each of the ten "qualitative" indices with near quantitative accuracy (semi-quantitative). A combination of the two methodologies should be incorporated into all intensive aquatic biota field studies where habitat assessment accuracy and repeatability is critical. The following sections outline the scoring of the qualitative habitat indices using the semi-quantitative data.

4.3.1 High Gradient (riffle-pool stream complexes)

1) Epifaunal Substrate / Available Fish Cover

Average values from semi-quantitative categories 4 (Epifaunal Substrate) and 5 (Instream habitat) are combined into an overall average percent coverage and used to score this metric.

The following table presents the scoring criteria:

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Coverage	>70%	40%-70%	20%-39%	<20%
Score	20 -16	15 -11	10 - 6	5 - 1

2) Embeddedness

Reach average percent embedded (from category 7) is used directly to score this metric.

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Embedded	<25%	25%-50%	49%-75%	>75%
Score	20 -16	15 -11	10 - 6	5 - 1

3) Velocity / Depth Regime

Semi-Quantitative categories 2 (Riffle-Pool Sequence) and 3 (Depth and Width regime) along with flow and velocity data collected in the reach is used to score this metric. Use the following table to determine which regimes are present:

Rank	Slow-deep	Slow-shallow	Fast-deep	Fast-shallow
Velocity	<1 fps	<1 fps	>1 fps	>1 fps
Depth Regime	>1.6 feet	<1.6 feet	>1.6 feet	<1.6 feet
Typical Morphology	Deep pool	Shallow pool	run	riffle

If a reach has deep and shallow pools, and distinctive run and riffle morphology, then you have at least three regimes and possible all four regimes. Score each rank lower if shallow regimes are the missing regimes. Scoring is applied as per the following table.

Rank	Optimal	Sub-Optimal	Marginal	Poor
No. Regimes	Four regimes present	Three regimes present	Two regimes present	One regime present
Score	20 -16	15 -11	10 - 6	5 - 1

4) Channel Alteration

Scored from visual assessment of entire reach. Not aided by semi-quantitative attributes.

5) Sediment Deposition

Reach average percent bottom affected by deposition (from category 8) is used directly to score this metric.

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Bottom Affected	<5%	5%-30%	31%-50%	>50%
Score	20 -16	15 -11	10 - 6	5 - 1

Utilize the lower end of each scale to represent reaches where recent sediment bar formation is evident.

6) Frequency of Riffles

Using semi-quantitative category 3 (Depth and Width Regime) the average width of the stream is determined as the average of riffle and pool widths combined. Using category 2 (Riffle-Pool Sequence) the distance between riffles can be calculated using the sequencing notations and the morphological lengths. The table presented below should be used to develop scores for this metric.

Example: a reach with an average width of 18 feet, with 4 riffles separated by a 50 foot pool, a 20 foot run, and a 100 foot pool would result in an average distance between riffles of 57 feet. Therefore, the ratio = 57/18 = 3.2 and would rank as Optimal (score @ 18).

Rank	Optimal	Sub-Optimal	Marginal	Poor
Ratio (distance between riffles : stream width)	<7 : 1	7 – 15 : 1	16 -25 : 1	>25 : 1
Score	20 -16	15 -11	10 - 6	5 - 1

In continuous riffle streams the consistent placement of boulders and logs provides scores in the highest range of the optimal category.

7) Channel Flow Status

Scored from visual assessment of entire reach. Not aided by semi-quantitative attributes.

8) Bank Stability

The average bank stability score for each represented bank from the semi-quantitative assessment (category 11) is directly applied to the qualitative assessment scoring for this metric (i.e., an average reach score of 8 for the right bank and 7 for the left bank gets transferred directly to the qualitative score sheet as such.)

9) Vegetative Protection

Reach average percent bank protected (from category 12 of the semi-quantitative record sheet) is used directly to score this metric for the right and left bank.

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Protected	>90%	70% - 90%	50% - 69%	<50%
Score	20 -16	15 -11	10 - 6	5 - 1

10) Riparian Vegetative Zone Width

The average riparian zone width score for each represented bank from the semi-quantitative assessment (category 13) is directly applied to the qualitative assessment scoring for this metric (i.e., an average reach score of 8 for the right bank and 7 for the left bank gets transferred directly to the qualitative score sheet as such.)

4.3.2 Alternative Metrics for Low Gradient Streams (pool dominated complexes)

2) Pool Substrate Characterization (replacement for Embeddedness)

Using the Substrate Characterization data from the semi-quantitative assessment (category 6) and the aquatic vegetation assessment (category 9) the following table may be used to score this metric.

Rank	Optimal		Sub-Optimal	Marginal	Poor
Substrate	Cobble or Gravel		Sand/Silt/Clay	Sand/Silt/Clay	Bedrock or Clay Only
Macrophytes Present	Yes	No	Yes	No	No
Score	20 - 18	17 - 16	15 - 11	10 - 6	5 - 1

3) Pool Variability (replacement for Velocity/Depth Regime)

Semi-Quantitative categories 2 (Riffle-Pool Sequence) and 3 (Depth and Width regime) are used to help score this metric. Use the following table to determine pool variability.

Pool Characteristic	Large-Deep	Large-Shallow	Small-Deep	Small-Shallow
Size	Length ≥ Width	Length ≥ Width	Length < Width	Length < Width
Depth	≥3.2 feet	< 3.2 feet	≥3.2 feet	< 3.2 feet

An equal balance of all four pool types achieves higher scores. A prevalence of shallow pools scores lower.

6) Channel Sinuosity (replacement for Frequency of Riffles)

This metric is assessed separately from the semi-quantitative data. It can be estimated in the field, measured during a longitudinal survey or calculated from current aerial photographs.

5.0 Water Quality

During the field study, water quality will be documented through *in-situ* measurements and sampling for laboratory analyses at each of the study reaches as identified in Section 3.1. The following sections present the parameters and documentation methods.

5.1 *In-situ* Measurements

The following parameters will be monitored at each of the study reaches:

1) temperature, C°
2) dissolved oxygen, mg/L
3) conductivity, µS
4) pH, su and
5) flow, cfs

In accordance with Section 2.0 calibration will be performed and documented according to the manufacturer's recommendations. Details of the methods and procedures utilized are provided in Attachment A.

The *in-situ* measurements are recorded on the second page of the Field Data Form. Other information recorded on the Field Data Forms will include:

1) general station location information,
2) the field crew completing the assessment,
3) current hydrologic conditions,
4) antecedent moisture conditions, and
5) identification of the meters utilized.

5.2 Water Chemistry

Grab samples for laboratory analysis of chloride, sulfate and TDS will be collected at each sample reach at the same time as *in-situ* measurements are obtained. Analytical results from the laboratory will be retained for use in project documentation. The instream mineral concentrations will also be utilized in the development of the site specific water quality criteria for each discharge.

6.0 Benthic Macroinvertebrate Community

6.1 Introduction

The benthic macroinvertebrate protocol utilized in these field studies is intended to evaluate the biological integrity of wadeable streams for the purpose of detecting stresses on community structure, assessing the relative severity of these stresses, and determining the maintenance of the designated uses. The approach is based on the "Rapid Bioassessment Protocol III – Multi Habitat approach using an aquatic dip net as published by the U.S. Environmental Protection Agency (Barbour, M.I. et al., 1999) as adapted for use in pool dominated streams of the Gulf Coastal Plain Ecoregion. The details of the benthic characterization are provided in Section 9.0 of Attachment A.

The one-man protocol is the preferred macroinvertebrate collecting method for pool dominated streams (a second person can be used for water safety and to keep time and record information on the field forms). The U.S. Geological Survey utilizes the one-man approach for their National Water-Quality Assessment Program (NAWQA; Cuffney et al., 1993).

During this Project, the benthic community of the following reaches will be evaluated:

1.	UTA 002	Unnamed tributary to Bayou de Loutre into which Outfall 002 discharges downstream of Hwy 15 but upstream of Bayou de Loutre;
2.	UTA004	Unnamed tributary to Bayou de Loutre into which Outfall 004 discharges but upstream of Bayou de Loutre;
3.	BDL01	Bayou de Loutre downstream of confluence of UTA 002 & 004;
4.	UTA 003	Unnamed tributary to Little Cornie Bayou into which Outfall 003 discharges and downstream of Feed Mill Road;
5.	LCB 01	Little Cornie Bayou upstream of UTA 003; and
6.	LCB 02	Little Cornie Bayou downstream of the mouth of UTA 003.

6.2 Methods

Qualitative samples of the benthic macroinvertebrate assemblage will be collected over a predetermined period of time using an aquatic dip net and sampling all available microhabitats present within the stream reach.

Each station will be sampled for three minutes according to the RBA protocol. Each sample will be placed in a bucket and condensed with a series of washings through a series of sieves, the smallest of which will be a U.S. Standard #30 sieve.

6.3 Sample Processing

Random sub-samples of the concentrated sample will be then placed on a white sorting tray from which the macroinvertebrates will be removed. A 100 organism sub-sample will be randomly picked (according to the RBA procedures) from the tray and field identified to the lowest possible taxon.

The 100 organism sub-samples will be preserved in 70% ethanol or Kayles solution for lab verification of field identifications and as a voucher to be used if more detailed analysis becomes necessary. Laboratory verification will be accomplished using general keys including but not limited to Merritt & Cummings (1996), Pennak, (1989), and Unsinger (1963). In addition more taxa specific keys such as Mayflies of North and Central America (Edmunds et. al., 1976), Dragonflies of North America, (Needham & Westfall, 1975) or keys developed specifically for Arkansas may be utilized for the laboratory verification of the field identifications.

After the 100 organism random sample is collected, labeled and preserved, the larger debris items (e.g., leaves, sticks, rocks, etc.) in the collected sample will be examined for clinging benthic macroinvertebrates. Any organisms will be removed prior to the larger debris being discarded. The remainder of the original sample not utilized in the selection of the 100-organism sub-sample will be concentrated and retained as a voucher for the sample picking techniques used. The voucher samples will be preserved with 70% ethanol or Kayles solution. These voucher samples will be held at GBM^c for a period of 24 months following the conclusion of the third party rulemaking at which time the samples may be submitted to an academic zoological collection. The macroinvertebrate assemblages from each station will be analyzed according to several benthic community biometrics. These will include richness (number of different taxa), EPT richness (number of different taxa represented in the orders Ephemeroptera, Plecoptera, and Trichoptera), and species diversity as determined by the Shannon-Wiener Diversity Index.

The analysis will also include the seven biometrics used by the State of Arkansas (ADPCE, 1988) in their RBA scoring system. This scoring system places a value (1 to 4, 1 = excessive differences, 4 = no differences) on each of the seven biometrics to achieve a final mean score. The biometric scoring will indicate the impacts to a benthic community when compared to the benthic community of different reaches, to demonstrate effects of point and or non-point source contributions between reaches.

For each study site, a complete tabulation of taxa, numbers of individuals and their percent composition will be included on the two-page field data sheets – Benthic Macroinvertebrates. The first page of the two-page data form will include general information identifying the sample reach and investigators as well as site observations to include:

1) time sampled,
2) relative abundance of aquatic tropic level communities,
3) percent of major habitats sampled,
4) percent of specific microhabitats sampled, and
5) relative abundance of the ordinal groups observed during sample collection.

The second page provides for the listing of the taxa comprising the 100 organism sub-sample and the field identifications and the numbers of each. Also included on page 2 are the general reach identifiers and preliminary summary sections to be used in the application of selected biometric scoring criteria.

7.0 Fish Community

7.1 Introduction

The fish community supported in a stream is in direct response to available habitat, food sources, and water quality of that particular stream. The presence of a certain level of species richness and diversity along with a community structure similar to that expected in typical streams of the ecoregion are indicators of aquatic ecosystem health.

The objective of the fish community characterization is to collect and identify a representative sample of all except very rare species in the assemblage reflective of the relative abundance within the community assemblage. Backpack electrofishing equipment will be used as the principal sampling gear supplemented by block netting and seining in habitats where flow, substrate and structure affect capture of benthic species. All team personnel will be involved in collecting fish.

Although most of the receiving streams into which the discharges occur are a fraction of the 10 square mile threshold for perennial fish community maintenance, the fish community of the following reaches will be evaluated during this project:

1.	UTA 002	Unnamed tributary to Bayou de Loutre into which Outfall 002 discharges downstream of Hwy 15 but upstream of Bayou de Loutre;
2.	UTA004	Unnamed tributary to Bayou de Loutre into which Outfall 004 discharges but upstream of Bayou de Loutre;
3.	BDL01	Bayou de Loutre downstream of confluence of UTA 002 & 004;
4.	UTA 003	Unnamed tributary to Little Cornie Bayou into which Outfall 003 discharges and downstream of Feed Mill Road;
5.	LCB 01	Little Cornie Bayou upstream of UTA 003; and
6.	LCB 02	Little Cornie Bayou downstream of the mouth of UTA 003.

7.2 Methods

Major factors that influence collecting include flows, water depth, instream obstructions, water turbidity, temperature and conductivity. The primary tool utilized in the fish collections will be a Smith-Root backpack electroshocker. However, seines and block nets may be utilized as necessary to adequately characterize the reaches indicated.

Sampling fish species to determine their proportionate abundance will be conducted after all water quality parameters and/or samples are collected but prior to the collection of the benthic and habitat data as described in Sections 4 and 5.

Shocked fish will be captured with hand held dip nets and held in buckets while the sampling continues throughout the reach. The entire channel within the sampling reach will be sampled. Actual shocking time will continue for not less than 30 minutes unless the wetted habitat area of any reach is too small for 30 minutes of shocking time. The shocker is equipped with an automated timing mechanism which records the amount of time that electricity is actually being applied, or "pedal down time" (PDT). In addition to PDT, the total collection time will be recorded. There will not be a maximum time limit for the collection period, however the collections may be terminated when the principal investigator determines that additional collection time will not likely result in additional fish species. Sampling information will be recorded on the Field Data Sheets - Fish. General comments (perceived fishing efficiency, missed fish, and gear operation suggestions) will be recorded on the lines provided on the form.

An effort to search for and collect fish will be completed at all reaches, even if the stream is extremely small, and it appears that sampling may not collect any specimens.

7.3 Sample Processing

Following collection, each sample of fish from a reach will be preserved in formalin for later processing. Sample processing will involve tallying and identifying fish, examining individual specimens for external anomalies, preparing voucher specimens for taxonomic confirmation and archival at a museum.

For each study site, a complete tabulation of taxa, numbers of individuals and their percent composition will be included on the two-page Field Data Sheets – Fish. The first page of the two-page data form will include general information identifying the sample reach and investigators as well as site observations to include:

1) time sampled,
2) Pedal Down Time (PDT),
3) relative abundance of aquatic tropic level communities,
4) percent of major habitats sampled,
5) percent of specific microhabitats sampled, and
6) relative abundance and scoring of substrate.

Ultimately, the fish identification will be verified in the lab using keys in the Fishes of Arkansas (Robison and Buchanan, 1988) and the Fishes of Missouri (Pflieger, 1975) to species level where possible.

The fish collections at each reach will be compared according to several biometrics including: species richness (number of taxa); sunfish richness; species diversity; abundance; dominant ordinal groups; percent of tolerant species; trophic structure; percent of hybrids; percent of diseased fish; and key indicator species as listed in Regulation No. 2 of the ADEQ.

In addition, the fish assemblage will be evaluated utilizing the fish community biocriteria and a comparison to typical Gulf Coastal Ecoregion least disturbed streams. The fish community biocriteria scoring was developed by the ADEQ and uses eight metrics to determine use support status.

8.0 Field Study Schedule

The spring seasonal biotic characterizations will be completed during April/ May 2005. This period corresponds to the seasonal fishery period as stipulated in ADEQ seasonal fishery designation. Due to the storm water nature of the discharge and the small watershed size, a perennial fishery use does not apply to the unnamed tributaries into which the Outfalls 002, 003 and 004 discharge.

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1.0 pH Meter Calibration SOP

Purpose

This SOP describes the methods for calibration and use of the portable Orion® 200 series pH meters. Field forms used for meter calibration and measurement recording are attached to this SOP.

Procedure

Calibration

1. Be sure that the electrode (probe) is properly attached and that a good battery is installed.

2. Turn the meter on and check the read-out for any warning messages ("Low Bat.", etc.) If problems occur refer to the owners manual for help.

3. Record the proper information (date, time, etc.) on the Calibration Field Form (attached) or in a field logbook.

4. Remove the probe protection cap and place the probe in pH buffer solution 7.00 (yellow in color) submerging the end to ***at least 1 inch***. Allow the meter to adjust to the buffers pH for approximately 1 minute.

5. Press the "Cal" button on the meter to begin the calibration process. The display should read "calibration" and "P1" along with the pH reading.

6. When the meter has accepted the buffer it will beep and "ready" will be displayed. Press "Yes" to accept the value. Record this number on the pH Calibration Record sheet. The display should now read "P2" at the screen's bottom.

7. Remove the probe from the 7.00 buffer and rinse with distilled water to remove any excess buffer solution.

8. Place the probe in the second buffer solution, 4.01 (pink) or 10.01 (blue), whichever best brackets the expected pH range to be measured, and stir it gently.

9. When the meter has accepted the value it will beep and the "ready" sign will be displayed as in step 6 above. Press "Yes" to accept this value. Record this number on the pH Calibration Record sheet.

10. The display will immediately show the slope, a number that should be between 92% and 102%. Record this number on the pH Calibration Record sheet. If the slope is larger or smaller than this range the meter should be recalibrated.

11. A calibration check should be done once the meter is calibrated This is done simply by placing the probe in the pH 7.00 buffer solution and taking a reading. Record this reading on the pH Calibration Record form. If the reading is between 6.90 and 7.10 then the original calibration remains valid. If the measurement falls outside this range then the meter should be recalibrated.

12. Gently shake or rinse off excess liquid from the probe. The meter is now ready for use.

13. The pH meter should be calibrated once per day on days that it is used. The pH meter should have its calibration checked once for each sampling trip or once every 5 samples whichever is greater. This is done simply by placing the probe in the pH 7.00 buffer solution and taking a reading. Record this reading on the pH Calibration Record form. If the reading is between 6.90 and 7.10 then the original calibration remains valid. If the measurement falls outside this range then the meter should be recalibrated. Furthermore, if the battery or probe is ever disconnected from the meter during use, a new calibration would be required.

pH Measurements

1. Place the probe in the liquid to be analyzed and stir it gently. The probe should be submerged ***at least 1 inch*** into the liquid.

2. Allow the meter to stabilize on a reading (may take up to 4 minutes). The meter will respond with "ready" when it has properly stabilized. Record the reading. If the meter will not indicate "ready" after several minutes and the pH value displayed is not fluctuating greatly then a value may be recorded without the meter indicating "ready."

3. Be sure to turn off the meter when the final pH measurement has been taken and recorded.

Meter Maintenance/Storage

1. Store the meter in a safe dry place.

2. Keep the probe cover on the probe when not in use and between measurements.

3. A small piece of paper towel soaked in pH buffer 7.00 should be place in the bottom of the probe cover to keep the probe surface wetted with the buffer. The probe should **never** be allowed to dry out.

4. Use only "Low Maintenance Triode" ATC probes with the 200 series pH meters (model # 9107BN or equivalent.)

Quality Assurance/Quality Control

1. Meters are calibrated biweekly (at a minimum) to ensure proper function and accuracy.
2. Values measured during biweekly calibrations are compared between meters to verify accuracy.
3. Duplicate measurements should be taken at a rate of 10% (minimum) of samples analyzed.

2.0 Dissolved Oxygen (D.O.) Meter Calibration SOP

Purpose

This SOP describes the methods for calibration and use of the portable YSI Model 58 and Model 85 D.O. meters. Field forms used for meter calibration and measurement recording are attached to this SOP.

Procedure

Calibration

Model 58

1. Be sure that the oxygen probe is properly attached to the meter and that the end of the probe is affixed in storage bottle containing a piece of wet sponge or towel to keep the probe moist, and to provide a water-saturated air environment.

2. Turn the meter on and check the read-out for the "LOBAT" warning, and for the normally observed display readings. If problems occur refer to the owners manual for help.

3. Record the proper information (date, time, etc.) on the Dissolved Oxygen Calibration Record sheet or in a field logbook.

4. Set the D.O. meter to "ZERO" and use the "O2 ZERO" knob to adjust the display to 0.0. If the meter will not adjust to zero refer to the owners manual for guidance.

5. Perform a Calibration according to one of the following procedures:

   Winkler Titration (verification calibration)

   a) Fill a container with at least 500 mL distilled water (or tap water if distilled not available) and allow it to acclimate. It can be aerated overnight to achieve 100% oxygen saturation if desired.
   b) Fill each of two BOD bottles with the water from the container by gently submerging them into the container.
   c) Add one each of the HACH manganous sulfate and alkaline iodide-azide powder pillows to each bottle. Cap the bottles and invert them 15-20 times to mix the solution thoroughly.
   d) Allow the bottles to settle until a precipitate appears in the bottom half of the bottle. This will usually take 3-5 minutes.
   e) Add one HACH sulfamic acid powder pillow to each BOD bottle. Invert the bottles until all the precipitate has been dissolved.

f) Using a graduated cylinder measure and place 200 mL of the solution into a flask.
g) Add 1 mL of HACH starch indicator to the flask. The solution should turn black.
h) Using a burette filled with sodium thiosulfate (at room temperature) titrate the solution in the flask drop-wise until the solution turns clear.
i) Record the starting and ending volumes from the burette.
j) Repeat this titration (steps f-I) for a second flask filled with fresh solution.
k) Subtract ending volumes from starting volumes to arrive at the volume used for each titration. The volume used is equivalent to the dissolved oxygen content of the water in mg/L.
l) If the D.O. values from the two titrations differ by more than 5%RPD then the titrations should be repeated.
m) Remove the D.O probe from the storage bottle and place it in the container holding the water. It must be submerged at least 1 inch below the waters surface. Set the meter to the "0.1 mg/l" measurement mode.. Swirl the probe gently and slowly in the water.
n) Calibrate the meter to the average of the two dissolved oxygen measurements by turning the "O2 CALIB" knob until the display reads the corresponding D.O. concentration. Record the final calibrated value.

Air Calibration (Standard Calibration)

a) Set the meter to the temperature measurement mode ("TEMP...").
b) Record the temperature of the probe in the storage bottle on the record form or in a field logbook.
c) Refer to the attached table presenting Solubility of Oxygen in Water values (also on back of meter) and find the solubility of oxygen at the corresponding temperature.
d) Record the appropriate barometric pressure or altitude (use pressure when available).
e) Refer to the attached table presenting Calibration Values at Various Pressures and Altitudes (also on back of meter) and record the "CALIB VALUE" in % saturation at the corresponding pressure or altitude.
f) Using the solubility of oxygen value and the % saturation value as a decimal calculate the calibration value by multiplication (i.e. at an altitude Of 1413 ft. and a temperature of 20°C the calibration value would be 8.64 mg/L or 8.6 mg/L).
g) Set the meter to the D.O. measurement mode ("0.1 mg/l") and adjust the display using the "O2 CALIB" knob to read the calibration value as calculated.
h) Record the final calibrated value on the record form or in a field logbook.

Model 85

1. Turn on the meter and make sure the meter is in the D.O. mode (will display mg/L).

2. Wet the sponge in the calibration/storage chamber and insert the probe into the chamber.

3. Allow the D.O. and Temperature readings to stabilize (up to 15 minutes).

4. Press the up arrow and down arrow buttons simultaneously.

5. When prompted to do so, enter the local altitude in hundreds of feet by scrolling up or down with the up or down arrow buttons.

6. Press enter when the correct altitude is displayed. Base altitude on barometric pressure when possible, as it will have an affect on the calibration. See "Air Calibration" above for details.

7. When the percent reading is stable, press enter. Save will be displayed on the screen for a few seconds, then the meter will return to the normal operation mode.

NOTE: Each time either of the meters is turned off they should be recalibrated.

D.O. Measurements

Model 58 and 85

1. Set the meter to the D.O. measurement mode. Place the probe in the liquid to be analyzed and stir it gently and slowly to keep water passing over the probe membrane. The probe should be submerged ***at least 1 inch*** into the liquid.

2. Allow the meter to stabilize on a reading (should take less than one minute). Once the meter has stabilized record the reading.

3. If the meter will not stabilize check the probe for air bubbles. If bubbles are found shake the probe firmly but not violently a couple of times and re-measure. If problems still occur probe maintenance is necessary.

4. The meter should be placed in the "ZERO" mode between measurements to conserve battery life. Be sure to turn off the meter when the final D.O. measurement has been taken and recorded.

Meter Maintenance/Storage

1. Store the meter in a safe dry place.

2. Keep the probe cover on the probe when not in use and between measurements.

3. A small piece of sponge or paper towel soaked in clean water should be place in the bottom of the probe cover to keep the probe surface moist. The probe should **never** be allowed to dry out.

4. The probe membrane should be replaced at a minimum every 6 months or whenever the meter fails to perform to standard.

5. Use only YSI replacement parts and probes with the meter.

Quality Assurance/Quality Control

1. Meters are calibrated biweekly (at a minimum) to ensure proper function and accuracy.
2. Values measured during biweekly calibrations are compared between meters to verify accuracy.
3. Duplicate measurements should be taken at a rate of 10% (minimum) of samples analyzed.

3.0 Conductivity Meter Calibration and Measurement SOP

Purpose

This SOP describes the methods for calibration and use of portable YSI conductivity meters. Field forms used for meter calibration and measurement recording are attached to this SOP.

Procedure

Calibration

Calibration of YSI conductivity meters is performed by the manufacturer and is rarely needed. However, the accuracy of the meter should be monitored bi-weekly and before each use. The bi-weekly monitoring of accuracy should be recorded in the calibration log book, along with date/time performed and name of person performing task.

1. Turn the instrument on and allow it to complete its self test procedure.

2. Bi-weekly the instrument should be checked for accuracy using a standard of 80 uS/cm. The meter should be set to measure specific conductance. The steps listed below under "Conductivity Measurements" should be followed for checking conductivity accuracy. This standard check should be recorded in the calibration log book.

3. YSI conductivity meters are calibrated a minimum of once a year or when there is reason to believe the instrument is reading incorrectly (outside the range of 80±10 uS/cm during the accuracy check).

4. To calibrate, select a calibration solution, which is most similar to the sample you will be measuring. The following should serve as a guideline:

   for sea water choose a 50 mS/cm conductivity standard,
   for fresh water choose a 1 mS/cm conductivity standard, and
   for brackish water choose a 10 mS/cm conductivity standard.

5. Place at least 3 inches of solution in a clean glass beaker.

6. Insert the probe into the beaker deep enough to completely cover the oval shaped hole on the side of the probe. Do not rest the probe on the bottom of the container -- suspend it above the bottom at least 1/4 inch.

7. Allow at least 60 seconds for the temperature reading to become stable.

8. Move the probe vigorously from side to side to dislodge any air bubbles from the electrodes.

9. Press and release the up and down keys (Λ,V) at the same time. The CAL symbol will appear at the bottom left of the display to indicate that the instrument is now in Calibration Mode.

10. Use the up or down arrow key to adjust the reading on the display until it matches the value of the calibration solution you are using.

11. Once the display reads the exact value of the calibration solution being used press the ENTER key once. The word "SAVE" will flash across the display for a second indicating that the calibration has been accepted.

Conductivity Measurements

1. Press the "ON/OFF" button to turn the meter on. The meter will go through a self-test procedure, which will last for several seconds. The cell constant will be displayed when the self-test is finished. Consult the Operations Manual if an error is displayed during the self-test.

2. Select the mode of measurement on the meter by pressing and releasing the "MODE" button on the meter. GBM^C generally measures specific conductance in its field studies. The following are the modes of measurement capable of the YSI 30 meter:

   Conductivity - measurement of the conductive material in the liquid sample without regard to temperature. Displayed when the large numbers on the display will be followed by the respective units, and the temperature units will not be flashing.

   Specific Conductance - temperature compensated conductivity which automatically adjusts the reading to a calculated value which would have been read if the sample had been at 25°C. Displayed when the large numbers on the display will be followed by the respective units, and the temperature units will be flashing.

   Salinity - A calculation done by the instrument electronics, based upon the conductivity and temperature readings. Displayed when large numbers on the display will be followed by ppt.

3. Insert the probe into the solution being measured for conductivity, making sure that the probe is inserted deep enough to cover the hole located on its side. If possible,

refrain from touching any solid located in the solution, and hold the probe at least 1/4 inch from the bottom and sides of any container used to hold the sample. The probe should also be vigorously shaken in the solution to dislodge any air bubbles, which may be adhered.

NOTE: The YSI meters are factory calibrated, and retain the last calibration conducted. This means that once batteries are installed, or when the meter is turned on, you are ready to begin taking measurements.

Meter Maintenance/Storage

Always rinse the conductivity cell with clean water after each use.

Cleaning the conductivity cell

1. Dip the cell in cleaning solution of 1:1 isopropyl alcohol and 10N HCl, and agitate for two to three minutes.

2. Remove the cell from the cleaning solution.

3. Use a nylon brush to dislodge any contaminants from inside the electrode chamber.

4. Repeat steps one and two until the cell is completely clean. Rinse the cell thoroughly in deionized water.

5. Store the conductivity cell in the meter storage chamber.

Quality Assurance/Quality Control

1. Meters are calibrated biweekly (at a minimum) to ensure proper function and accuracy.
2. Values measured during biweekly calibrations are compared between meters to verify accuracy.
3. Duplicate measurements should be taken at a rate of 10% (minimum) of samples analyzed.

4.0 Temperature Measurement/Check SOP

Purpose

This SOP describes the methods for the measurement of temperature using the Orion MODEL 230 A pH meter, Hach MODEL 50050 pH meter, YSI MODEL 58 DO meter, YSI MODEL 30 conductivity meter, and YSI MODEL 85 combination meter. Field forms used for meter calibration and measurement recording are attached to this SOP.

Procedure

Accuracy Check for all Instruments

1. Insert the probe for the corresponding instrument into a container holding water, and allow the temperature reading to stabilize.
2. Record the temperature displayed on each respective instrument in the calibration log book along with date/time and individual performing the task.
3. Compare the actual temperature of the water measured with a certified calibrated thermometer to the temperature measured by the respective instruments.
4. If the temperature relative percent difference exceeds 20%, then do not use that particular meter for temperature analysis.

Temperature Measurement

Orion Model 230 A pH meter

1. Connect the combination pH/temperature electrode to the meter.
2. Turn the meter on, and allow it to go through its self-test.
3. Insert the probe into the solution to be measured.
4. The temperature read out is located in the lower left of the LCD on the meter.

HACH EC10 pH/mV/temperature meter

1. Connect the combination pH/temperature electrode to the meter.
2. Turn the meter on, and allow it to go through its self-test.
3. Insert the probe into the solution to be measured.
4. The temperature read out is located in the prompt line followed by ATC.

YSI Model 30 Conductivity meter and YSI Model 85 Combination meter

1. Turn the meter on.
2. Insert the probe into the solution to be measured.
3. The temperature read out is located in the lower right of the LCD on the meter.

YSI Model 58 Dissolved Oxygen meter

1. Turn the meter to temperature mode.
2. Insert the probe into the solution to be measured.
3. The temperature read out is located on the screen

Quality Assurance/Quality Control

1. Meters are calibrated biweekly (at a minimum) to ensure proper function and accuracy.
2. Values measured during biweekly calibrations are compared between meters to verify accuracy.
3. Duplicate measurements should be taken at a rate of 10% (minimum) of samples analyzed.

5.0 Flow Measurements SOP

Purpose

This SOP describes the procedure used in the determination of water flow, which is necessary for the calculation of water volume passing through a given water body.

No single method for measuring discharge is applicable to all types of stream channels. The preferred procedure for obtaining discharge data is based on "velocity-area" methods (e.g., Rantz and others, 1982; Linsley et al., 1982). For streams that are too small or too shallow to use the equipment required for the velocity-area procedure, two alternative procedures are presented.

Stream discharge is equal to the product of the mean current velocity and vertical cross sectional area of flowing water. Discharge measurements are critical for assessing pollutant loading and reaeration rates used for dissolved oxygen modeling, as well as, other characteristics that are very sensitive to stream flow differences. Discharge will be measured at a suitable location within the sample reach that is as close as possible to the location where chemical samples are collected so that these data correspond. Field data forms for recording measurements are attached to this SOP.

Procedure

Velocity Area Procedure

Because velocity and depth typically vary greatly across a stream, accuracy in field measurements is achieved by measuring the mean velocity and flow cross-sectional area of many increments across a channel. Each increment gives a subtotal of the stream discharge, and the whole is calculated as the sum of these parts.

A Marsh McBirney Model 201 Portable Water Current Meter will be used whenever conditions allow. The site selected for flow measurements will be chosen on the basis of the most uniform streambed cross-section. This facilitates the best measurements since non-uniform streambeds may cause errors in velocity and depth. Manmade structures (bridges and culverts) may be used as flow measurement sites, but are not ideal.

Discharge measurements are generally made at only one carefully chosen channel cross section within the sampling reach. It is important to choose a channel cross section that is as much like a canal as possible, void of obstructions, as this provides the best conditions for measuring discharge by the velocity-area method. Rocks and other obstructions may be removed to improve the cross-section before any measurements are made. However, because removing obstacles from one part of a cross-section affects adjacent water velocities, you must not change the cross-section once you commence collecting the set of velocity and depth measurements.

The procedure for obtaining depth and velocity measurements is outlined below:

1) Locate a cross-section of the stream channel for discharge determination that exhibits as many of these qualities as possible: Segment of stream above and below cross-section is straight, depths mostly greater than .5 feet, and velocities mostly greater than 0.5 feet/second. Do not measure discharge in a pool. Flow should be relatively uniform, with no eddies, backwaters, or excessive turbulence.

2) Stretch a tape measure across the stream perpendicular to its flow, with the "zero" end of the rod or tape on the left bank, as viewed when looking downstream. Tightly suspend the measuring tape across the stream, approximately one-foot above water level and secure at both ends.

3) Record the total wetted distance indicated by the tape from the left descending bank (LDB) to the right descending bank (RDB).

4) Attach the velocity meter probe to the calibrated wading rod that indicates depth and holds the flow probe at 60% depth. Check to ensure the meter is functioning properly and the correct calibration value is displayed. If necessary the meter and probe can be calibrated according to the instructions in the QA/QC section of this SOP (which is based on manufacturers recommendations).

5) Divide the total wetted stream width into equally sized intervals, generally one foot wide (minimum of ten measurement locations, but never less than 1/2 foot increments).

6) Stand downstream of the tape and to the side of the midpoint of the first interval (closest to the LDB).

7) Place the wading rod in the stream at the midpoint of the interval. Record the distance from the left bank (in feet) and the depth indicated on the wading rod (in tenths of a foot) on the Flow Measurement Form.

8) Stand downstream of the probe to avoid disrupting the stream flow. If the water depth is less than 3 ft., adjust the position of the probe on the wading rod so it is at 60% of the measured depth below the surface of the water (Meador et al., 1993). The probe is set at the 60% depth by adjusting the foot scale on the sliding rod with the tenth scale on the depth gauge rod. If the water depth is greater than 3 ft., take measurements at 20% and 80% of the depth from the water surface. The average of these two readings is considered the water velocity for the respective measurement point. To set the probe at the 20% depth, first multiply the water depth by two, then use the calculated number to line up the foot scale as with the

60% depth. The same method is used for the 80% depth, except the calculated value is the water depth divided by two.

9) Face the probe upstream at a right angle to the cross-section. Do not adjust the angle of the probe, even if local flow eddies hit at oblique angles to the cross-section.

10) Wait 20 seconds to allow the meter to equilibrate then measure the velocity. Record the value on the Flow Measurement Form. For the electromagnetic current meter (e.g., Marsh-McBirney), use the lowest time constant scale setting on the meter that provides stable readings.

11) Move to the midpoint of the next interval and repeat Steps 6 through 8. Continue until depth and velocity measurements have been recorded for all intervals.

12) Record the data from each measurement on the Discharge Flow Recording form.

Timed Filling Procedure

In channels too "small" for the velocity-area method, discharge can be determined directly by measuring the time it takes to fill a container of known volume. "Small" is defined as a channel so shallow that the current velocity probe cannot be placed in the water, or where the channel is broken up and irregular due to rocks and debris, and suitable cross-section for using the velocity area procedure is not available. This can be an extremely precise and accurate method, but requires a natural or constructed spillway of free-falling water. If obtaining data by this procedure will result in a lot of channel disturbance or stir up a lot of sediment, wait until after all biological and chemical measurements and sampling activities have been completed.

Choose a cross-section of the stream that contains one or more natural spillways or plunges that collectively include the entire stream flow. A temporary spillway can also be constructed using a portable V-notch weir, plastic sheeting, or other materials that are available onsite. Choose a location within the sampling reach that is narrow and easy to block when using a portable weir. Position the weir in the channel so that the entire flow of the stream is completely rerouted through its notch. Impound the flow with the weir, making sure that water is not flowing beneath or around the side of the weir. Use mud or stones and plastic sheeting to get a good waterproof seal. The notch must be high enough to create a small spillway as water flows over its sharp crest.

Make sure that the entire flow of the spillway is going into the bucket. Record the time it takes to fill a measured volume on the Field Measurement Form. Repeat the procedure five times. If the cross-section contains multiple spillways, you will need to do separate determinations for each spillway. If so, clearly indicate which time and volume data replicates should be averaged together for each spillway; use additional field measurement forms if necessary.

Neutrally-Buoyant Object Procedure

In streams too shallow to use the velocity-area method the neutrally-buoyant object method may be employed. This procedure involves measuring the time it takes a floating object to pass a known stream distance This is done using buoyant objects that float low in the water such as key limes, sticks, or small rubber balls. The following steps should always be followed to ensure accurate results.

1. Mark off on the stream bank the starting and ending points. These should be far enough apart to allow at least 10 seconds of drift time between them. Record the distance between the two points in feet to the nearest 0.1 foot.

2. Place the buoyant object in the water upstream of the starting point and begin timing on a stopwatch when the object reaches the start line.

3. Record the elapsed time till the object crosses the end line, in seconds to the nearest 0.1 seconds.

4. Repeat steps two and three at least three times to develop an average time of passage in seconds.

5. Average velocity is equal to distance divided by average elapsed time.

6. Measure cross sectional depths and width in the middle of the flow path to acquire a cross sectional wetted area. This can be used along with the average velocity to determine flow in cubic feet per second.

Observations and Calculations

Discharge is usually determined after collecting water chemistry samples. Although discharge is part of the physical habitat indicator, it is presented as a separate section.

Flow data will be recorded on the Discharge Flow Recording forms. Any additional observations will be recorded in field notebooks. Calculations will be performed using hand held calculators to determine flow volume in CFS. The calculated volume will be evaluated for reasonableness and may be repeated if there are questions regarding the flow accuracy. A sketch of the stream cross section should be added to the flow form, especially if there were critical conditions that may have impacted the flow measurement.

The following calculations are used to calculate flow/discharge:

a. Calculate Area (A) by multiplying Width (W) X Depth (D).
b. Calculate discharge (Q) by multiplying Velocity (V) by Area (A).
c. Calculate total Area (A) and Discharge (Q) in each respective column.

d. Calculate average Velocity (V) by dividing summed Discharge (Q) by summed area or by taking an average of each velocity measurement.

QA/QC Stream flow Current Velocity Meters

Field teams will be using an electromagnetic type meter (e.g., Marsh McBirney Model 201 D). General guidelines regarding performance checks and inspection of current meters are presented below. If required the operating manual for the specific meter will be referenced for information as necessary.

Periodically or prior to field studies, the meter is calibrated to a zero value using a bucket of quiescent water and the following routine. The probe is placed in the bucket and allowed to sit for 30 minutes with no disturbance. The velocity value obtained should be 0.0 ±0.1. The meter is adjusted to zero if the value is outside this range.

Duplicate flow measurements are taken for at least one in ten sites where flow is measured. A relative percent difference (RPD) is calculated, and must be less than 20% to be within control parameters. Any values exceeding 20% are investigated to determine the cause and the need for corrective action. When possible flow measurement values are compared to gauging station data or data from fixed flow meters as a QA check

6.0 General Physical Characterization SOP

Purpose

The physical characteristics of an entire watershed are important components of an overall biological assessment of an individual stream. Watershed features and uses have a great affect on the development of a stream morphology and its biota.

Physical characterization includes documentation of weather conditions before and during the survey, description of stream origin and type, flow status, watershed features (landuse, etc), instream morphological features, water observations, and sediment observations. These parameters provide a general overview of the stream system in which a study is occurring.

Procedure

A General Physical Characterization Field Form (attached) should be completed for each stream reach in a study. The information (apart form general headings) provided below is included on the field form. A brief explanation of how to complete the information under each parameter heading is provided below.

Parameter:

1. Stream Name
2. Latitude/Longitude
3. River Basin (basin the stream is a part of)
4. Weather Conditions

   Check the appropriate box for the current weather conditions and the weather conditions in the past 24 hours. If there is cloud cover provide an approximation of the percent coverage. Indicate if there has been significant rain in the past 7 days. Provide an estimate (or measure) of air temperature.

5. Stream Attributes

   Check the box indicating if the stream is perennial, intermittent, or tidal. Check if the stream is a coldwater habitat (trout) or a warmwater habitat (bass). Mark the correct stream geological origin (glacial, montane, swamp, etc.) Estimate or measure, on a topographic map, the catchment size and record on the field form.

6. Hydrology

Check the appropriate current flow status of the stream (low, moderate, high) and indicate if flow measurements will be taken.

7. Watershed Features

Check the appropriate boxes concerning dominant land uses (pasture, industrial, etc.) in the area of the stream. Mark appropriate boxes concerning potential non-point source (NPS) pollution contributions. Note watershed erosion evidence observed.

8. Instream Features

Assess what portion of the stream reach can be characterized by the three morphological types (riffle, run, pool). Make an effort to assess the entire reach accurately and rank each morphological type as a percentage of the whole reach (i.e. 30% riffle, 50% run, 20% pool). Complete this parameter by having each participating field biologist collaborate in the ratings. Have each collaborating biologist initial the field form in this section. Note if any channelization or dams are present.

9. Water/Observations

Assess the water for odors, turbidity, and surface sheen's and mark the appropriate descriptor listed on the field form.

10. Sediment/Observations

Assess the sediment for odor and deposits and mark the appropriate descriptor on the field form.

Make additional notes and observations for each category directly on the field form or provide a code to reference comments written in a separate field notebook.

7.0 Semi-Quantitative Habitat Assessment SOP

Purpose

Physical habitat in streams includes all those physical attributes that influence or provide sustenance to biological attributes, both botanical and zoological, within the stream. Stream physical habitat varies naturally, as do biological characteristics; thus, habitat conditions differ even in the absence of point and anthropogenic non-point disturbance. Within a given ecoregion, stream drainage area, stream gradient and the geology are likely to be strong natural determinants of many aspects of stream habitat, because of their influence on discharge, flood stage, and stream energy (both static and kinetic). Kaufmann (1993) identified seven general physical habitat attributes important in influencing stream ecology and the maintenance of biological integrity:

1) channel dimensions,
2) channel gradient,
3) channel substrate size and type,
4) habitat complexity and cover,
5) riparian vegetation cover and structure,
6) anthropogenic alterations, and
7) channel-riparian interaction.

Land use activities can directly or indirectly alter any and/or all of these attributes. Nevertheless, the trends for each attribute will naturally vary with stream size (drainage area) and overall gradient. The relationships of specific physical habitat measurements described in this section to these seven attributes are discussed by Kaufmann (1993). Although they are actually biological measures, aquatic macrophytes, riparian vegetation, in-stream habitat and canopy cover are included in this and other physical habitat assessments because of their role in habitat structure and light inputs

The objectives of a habitat characterization are to:

1) assess the availability and quality of habitat for the development and maintenance of benthic invertebrate and fish communities, and
2) evaluate the role of habitat quality in relation to the attainment of designated uses and biological integrity.

There are three main headings for the components of the physical habitat characterization each with several categories. Measurements for each of the components (14 categories total) are recorded on copies of a two-page field form entitled Stream Habitat Assessment (Semi-Quantitative), and include:

1) Channel Morphology
   a) Reach Length Determination
   b) Riffle-Pool Sequence
   c) Depth and Width Regime

2) In-Stream Structure
    a) Epifaunal substrate
    b) In-Stream Habitat
    c) Substrate Characterization
    d) Embeddedness
    e) Sediment Deposition
    f) Aquatic Macrophytes and Periphyton
3) Riparian Characteristics
    a) Canopy Cover
    b) Bank Stability and slope
    c) Vegetative Protection
    d) Riparian Vegetative Zone Width
    e) Land-use Stream Impacts

Field physical habitat measurements from a field habitat characterization are used in conjunction with water chemistry, temperature, macroinvertebrate and vertebrate (typically fish) community analyses, and other data sources to determine the status of the target streams attainment of designated uses and the water quality required to maintain those uses.

These procedures are intended for evaluating physical habitat in wadeable streams, but may be adapted for use in larger streams as necessary. The field procedures applied to this characterization are most efficiently applied during low flow conditions and during times when terrestrial vegetation is active, but can also be applied during spring seasonal conditions with higher base flows. This collection of procedures is designed for monitoring applications where robust, quantitative or semi-quantitative descriptions of habitat are desired. This semi-quantitative habitat procedure is usually used in conjunction with the *General Physical Habitat Characterization* and the *Qualitative Habitat Assessment* to provide a detailed view of the streams habitat condition.

The habitat characterization protocol provided herein differs from other rapid habitat assessment approaches (e.g., Plafkin et al., 1989, Rankin, 1995) by employing a, systematic spatial sampling that minimizes bias in the placement and positioning of measurements. Measures are taken over defined channel areas and these sampling areas are placed systematically at spacing that is proportional to the length of the entire study reach. This systematic sampling design provides resolution appropriate to the length of the study reach. The habitat assessment protocol summarized in this SOP is based on those of USEPA in their EMAP and RBP procedures (Lazorchak, 1998 and Barbour, 1999), USGS NAWQA program (Fitzpatrick, 1998) and Missouri Department of Natural Resources ESP (Sarver, 2000).

We strive to make the protocol objective and repeatable by using previously developed methods to produce repeatable measures of physical habitat in place of estimation techniques wherever possible.

Two people typically complete the specified assessment, including stream flow measurements, in about two hours of field time. However, the time required can vary considerably with channel characteristics.

The procedures are employed on a sampling reach of length equal to 20 times the bankfull width, or at least 100 yards of in-stream distance. The semi-quantitative habitat sampling reach length should coincide as much as possible with that of the fish and macroinvertebrate collection reaches. Measurements are taken in each of 10 sub-reaches, which are systematically placed, at intervals equal to approximately one tenth (1/10) the length of the represented study reach. Measurements and observations for each habitat characteristic are made in each of the sub-reaches as the assessment team moves along the stream channel. An average or total of the scores for each of the 10 sub-reaches is then calculated resulting in a mean value for each characteristic for the entire reach.

Procedure

The habitat assessment will be conducted within (or to the extent possible) the stream reach from which the benthic and fish communities are to be characterized. The physical habitat will be characterized from measurements and observations of stream attributes made within 10 sub-reaches. The team assessing habitat should move along the stream channel (near the thalwag) observing habitat characteristics within each sub-reach. A description of and the rational for measuring each of the attributes are provided below. The details of how these attributes are recorded/evaluated are also described below in the following sections.

Channel Morphology

Channel morphology (or geomorphology) is a characterization of the shape of the stream channel including measurements and/or visual estimates of channel dimensions and riffle-pool sequences. i.e. a measure of the amount of riffles, runs and pools that occur in a given reach.

The channel observed includes that portion of the stream between the base flow wetted area and the top of the normal high water channel often referred to as the bankfull stage (Figure 1.) The "bankfull" or "active" channel is defined as the channel that is filled by moderate-sized flood events that typically occur every one or two years. Such flow levels are on the verge of entering the flood plain and are believed to control channel dimensions in most streams.

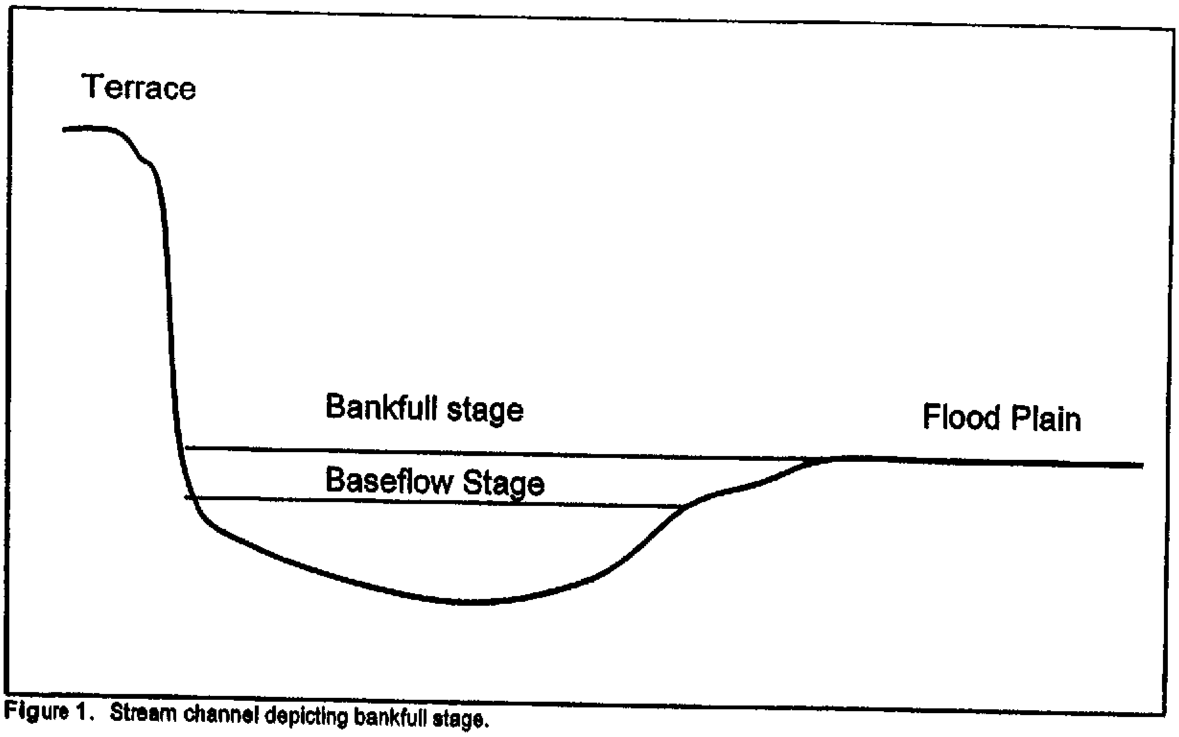

Figure 1. Stream channel depicting bankfull stage.

1) Reach Length Determination

First, bankfull depth (depth from stream bottom in thalwag to bankfull stage on the bank) is identified in at least two separate riffles (or alternatively runs in streams not exhibiting riffle morphology) in the study reach. Then bankfull depth and width is determined from 5 stream transects and recorded on the record sheet. Transect locations should be selected to include each prominent morphology type represented in the stream. Bankfull depths are measured to the nearest 1/10 foot and bankfull widths are measured to the nearest foot using a wading rod and tape measure/range finder, respectively. An average of the 5 bankfull widths is then calculated and multiplied times 20 to arrive at the total reach length for assessment. This total length is then divided by ten to determine the length of each of the ten sub-reaches. Analysis of the first sub-reach should begin at the head of a given stream morphology (i.e. riffle, run or pool).

2) Riffle-Pool Sequence

Stream morphology refers to the abundance and placement (sequencing) of riffles, runs, and pools in a stream system. This sequencing is an indicator of a streams hydrological regime and stability as well as a determinant of its potential to sustain diverse aquatic communities. Beginning at the head of a morphological type (riffle, run or pool) the length of each morphological type in the stream reach should be measured using a range finder or tape measure and recorded on the record sheet. The sequence of each morphological type should be depicted on the record sheet using the provided notations so as to create a map to the location of each riffle, run or pool. The resulting measurements should provide a quantitative measure of the percent of the study reach representing each stream morphological type (i.e. 40% riffle, 30% run, 30% pool, etc).

3) Depth and Width Regime

The average stream depth and width will be estimated in riffles (or runs in the absence of riffles) and pools in each sub-reach. Depths will be measured along a transect, similar to that depicted in Figure 2, in a representative section of each riffle and pool in the sub-reach. Depths are generally taken in the thalwag (deepest area in stream channel) and approximately half way between the thalwag and the left and right banks. An estimated average depth for riffles and pools occurring in a sub-reach is derived from the cross-sectional depth measurements and recorded on the record sheet to the nearest 1/10 foot. Once completed for all 10 sub-reaches this should provide accurate semi-quantitative measurements of riffle and pool average depth and depth variability across the entire stream reach.

Stream wetted widths will be measured along a transect, in a representative section of each riffle and pool in the sub-reach. An estimated average width for each morphological type in a sub-reach should be recorded on the record sheet to the nearest foot. Once completed for all 10 sub-reaches this should provide accurate semi-quantitative measurements of riffle and pool widths across the entire stream reach.

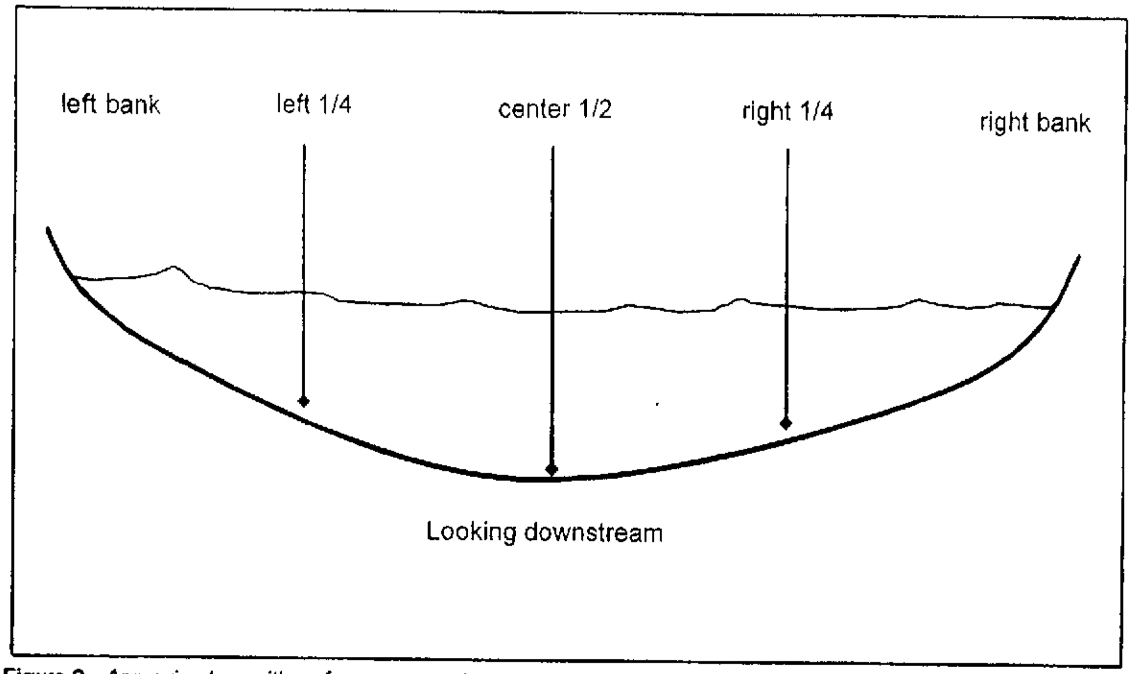

Figure 2. Approximate position of measurements across transect.

In-Stream Structure

In-stream structure describes the characteristics of the stream within the wetted perimeter that makes up the habitat suitable for colonization of aquatic biota. This includes information about natural substrates (gravel, boulders, etc), aquatic plants and algae and debris that has been washed into or fallen into the stream, such as logs, leaves, etc. A stream capable of sustaining diverse aquatic communities will contain a variety of in-stream structure including some that is permanent and some that is mobile during high flow events.

4) Epifaunal Substrate (Macroinvertebrates)

Epifaunal substrate refers to the area on the bottom of the stream (entire wetted perimeter) where macroinvertebrates inhabit. This attribute is scored as a percentage of the stream bottom in a sub-reach which contains substrates suitable for macroinvertebrate colonization. Scoring for this attribute should rely heavily on the stability of the substrate, the size of the interstitial spaces, and the cleanliness (not covered in thick algae or sediment deposits) of the substrate. Cobbles and coarse gravel will score higher percentages as they contain larger interstitial spaces for colonization, while sand and silt would score lower since they provide little spaces. In addition, root wads along the bank would score higher as they are more stable features than would depositional areas or small woody debris.

5) In-Stream Habitat (Fish)

In-stream habitat refers to the habitat features within the wetted perimeter of the stream sub-reach which are available for fish colonization. This attribute is scored as the percentage of the stream bottom (wetted perimeter) in a sub-reach which is covered with fish habitat. As with the epifaunal substrate attribute substrates composed of cobbles, coarse gravels and boulders score higher for fish cover as they provide better spaces for colonization. Other habitats that score high are large woody debris (individual logs with diameter >4 inches or complex woody structures composed of rootwads, logs, or limbs with diameter of 1.5 ft. or greater)and undercut banks. While habitats that score lower are those such as depositional areas, leaf packs, and fine sediments or sand.

6) Substrate Characterization

The dominant stream substrate size classification for riffles and pools within each sub-reach will be recorded on the record sheet. Only substrates within the wetted perimeter are evaluated. This information will be used to characterize the similarities and or differences in substrate structure and complexity in the riffles and pools of the study reach as it relates to the development and maintenance of the systems biological integrity.

Classify the particle into one of the size classes listed on the Semi-Quantitative Habitat Assessment Field Form based on the size of the intermediate axis (median dimension) of its length, width, and depth. This "median" dimension is the sieve size through which the particle can pass.

Bedrock	smooth or rough
Boulder	>25 cm
Cobble	6-25 cm
Coarse Gravel	1.6 – 6 cm
Fine Gravel	0.2 – 1.6 cm
Sand	<0.2 cm
Silt/Mud/Clay	fine, not gritty

Always make notations for unusual substrates such as concrete or asphalt and denote these artificial substrates as "other" and describe them in the comments section of the field data form. Code and describe other artificial (such as large appliances, tires, car bodies, etc.) substrates in the same manner.

7) Embeddedness

Embeddedness is the fraction of a particle's surface that is surrounded by (embedded in) sand or finer sediments on the stream bottom. By definition, the embeddedness of sand, silt, clay, and muck is 100 percent and the embeddedness of hardpan and bedrock is 0 percent.

For this attribute estimations are not made per sub-reach but for the entire stream reach as a whole. An estimation of the "percent embedded" is recorded for coarse riffle substrates in the study reach. This is accomplished by removing 12 pieces of cobble, gravel, or small boulders in at least two different riffles (three maximum) and recording the percent embedded for each. Percent embedded can be visually observed as the darkened portion of the coarse substrate that was buried in the streams fine bed material. If the darkened area covers half the coarse substrates height than the percent embedded is 50%, etc (Figure 3.)

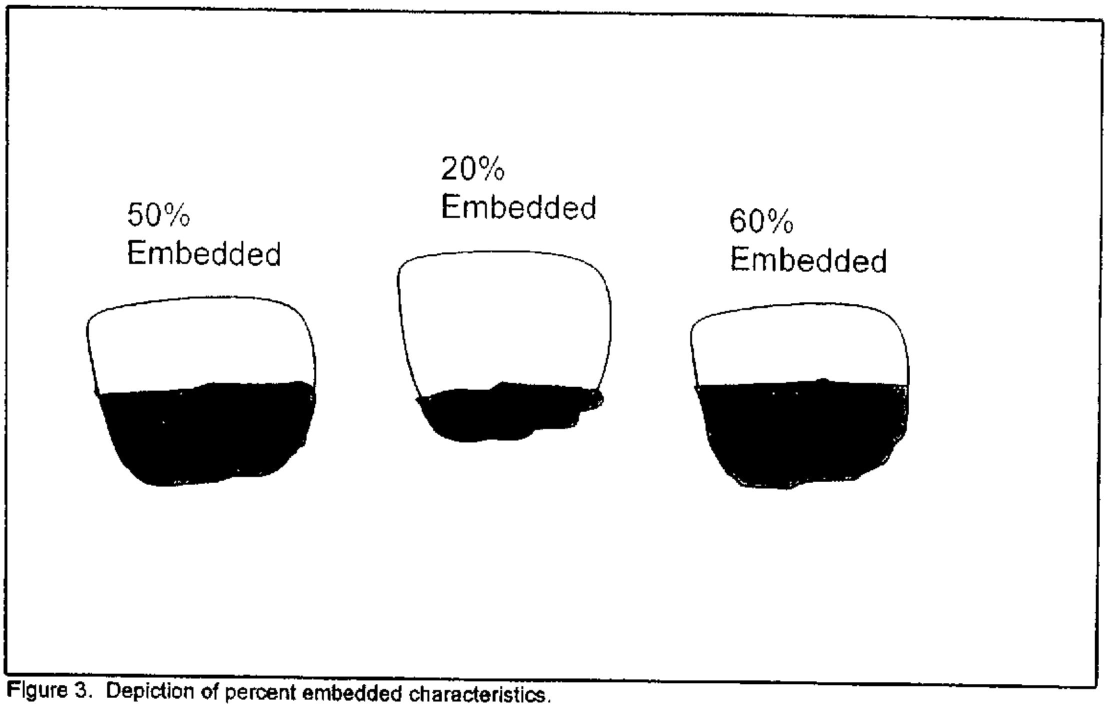

Figure 3. Depiction of percent embedded characteristics.

8) Sediment Deposition

The sediment deposition attribute refers to the amount of stream bottom (in the wetted perimeter) that is covered by fine sediments and/or particulate organic matter. This attribute is scored as a percentage of the bottom in each sub-reach which is covered by such loose materials.

9) Aquatic Macrophytes and Periphyton Coverage

An estimate of the percentage of area covered by macrophytes and periphyton in a sub-reach is made and recorded both for riffles and pools. Macrophytes refers to aquatic plants that grow in the stream (both emergent and submerged), and periphyton refers to algae that grows on fixed surfaces. This attribute helps biologists determine stream productivity from a nutrient enrichment perspective and also for the availability of food sources for aquatic biota.

Riparian Characteristics

The riparian area includes the area from the stream bank in a direction away from the stream into the upland areas. It is these stream-side riparian zones that ultimately help shape the stream and provide organic material as nutrients to the aquatic system. A well developed riparian area protects stream banks form erosion, provides shading, inputs nutrients, provides materials as habitat (in-stream structure) and filters run-off entering the stream. In the absence of well developed riparian zones the stream is more impacted by encroaching land-uses.

10) Canopy Cover

Canopy cover (percent stream shading) over the stream is determined for each of the sub-reaches. Estimates of cover are made by looking into the canopy over the stream channel. Estimates are made from mid-channel and each quarter channel to determine the average percent canopy cover for the width of the stream in the sub-reach. Percent canopy at each measurement point can be estimated visually or by use of a spherial densiometer.

11) Bank Stability and Slope

Bank stability is an important attribute that is an indication of a stream reaches overall hydrologic equilibrium. A bank's stability also determines its ability to provide stable habitat for biota and its propensity to release large sediment yields to the stream, which ultimately cause high turbidity and deposition in downstream reaches. The right and left banks are classified according to the following categories:

Score 9-10 = Stable, little evidence of erosion, < 5% bank eroding
Score 6-8 = Moderately stable, some evidence of new erosion, 5-29% bank eroding
Score 3-5 = Moderately unstable, obvious new erosion, 30-59% bank eroding
Score 1-2 = Unstable, most of bank actively eroding, 60-100% bank eroding

Banks composed of sands and gravels are much less stable than banks composed of silt/mud/clay or cobbles. The density of well rooted (more permanent) vegetation and root structure also help to improve a banks stability.

Average bank slope (in degrees) in a sub-reach, is recorded for each bank (left and right). Bank slope affects the stability of a bank and is an indicator of past erosion. A gentle slope may average 30° while a steep or undercut bank may average 90° or 100°, respectively.

12) Vegetative Protection

Bank vegetative protection is measured as a percent of the bank surface area which is covered by stable riparian vegetation and their associated roots in a sub-reach. Each bank (right and left) is assessed separately and the value recorded on the record sheet. Banks are assessed from the edge of the water to the top of the first terrace or normal top of bank.

13) Riparian Vegetative Zone Width

Riparian zone with encompasses the area from the top of the normal stream bank outwards into the upland area. The broader the riparian vegetative zone width the more protected the stream banks are from alteration, the fewer pollutants will enter the stream from run-off, and the more available food sources there are to be deposited into the stream from the surrounding forest. Riparian zone width is scored for each bank in a sub-reach according to the following scale:

Score 9-10 = Riparian Zone Width > 18 meters
Score 6-8 = Riparian Zone Width 18 - 12 meters
Score 3-5 = Riparian Zone Width 11 - 6 meters
Score 1-2 = Riparian Zone Width < 6 meters

14) Land-Use Stream Impacts

Significant Alteration of the land-uses in the immediate riparian area can have detrimental affects on the stream habitat and biota. Urban and agricultural activities are often considered the more prominent of those land-uses that may impact a stream. These impacts are assessed by indicting a specific land-use impact associated with a sub-reach (on either bank) on the record sheet and assigning a degree of impact score to the land-use. The following land-use categories and impact scoring system are provided:

Land-uses:
C = Cattle,
R = Row Crops,
U = Urban encroachment,
I = Industrial Encroachment, and
O = Other (noted on field form)

Scoring:
0 = no land-use impacts,
1 = minor impacts,
2 = moderate impacts, and
3 = major impacts

Scoring and Analysis of Habitat Assessment Data

Scores from the Semi-Quantitative Habitat Assessment can be utilized in two different ways. First, data collected for each attribute (assessment category) can be used independently to describe the study reach collectively. This method results in information such as: average riffle depth, average pool width, %riffle in entire reach, average bank stability, average (median) substrate size class in pools and riffles, mean %canopy cover, etc. Second, the data collected during the assessment can be used in conjunction with the Qualitative Habitat Assessment procedure to score each of the ten "qualitative" indices with near quantitative accuracy (semi-quantitative). A combination of the two methodologies should be incorporated into all intensive aquatic biota field studies where habitat assessment accuracy and repeatability is critical. The following sections outline the scoring of the qualitative habitat indices using the semi-quantitative data.

High Gradient (riffle-pool stream complexes)

1) Epifaunal Substrate / Available Fish Cover

Average values from semi-quantitative categories 4 (Epifaunal Substrate) and 5 (In-Stream habitat) are combined into an overall average percent coverage and used to score this metric.

The following table presents the scoring criteria:

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Coverage	>70%	40%-70%	20%-39%	<20%
Score	20 -16	15 -11	10 - 6	5 - 1

2) Embeddedness

Reach average percent embedded (from category 7) is used directly to score this metric.

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Embedded	<25%	25%-50%	49%-75%	>75%
Score	20 -16	15 -11	10 - 6	5 - 1

3) Velocity / Depth Regime

Semi-Quantitative categories 2 (Riffle-Pool Sequence) and 3 (Depth and Width regime) along with flow and velocity data collected in the reach is used to score this metric. Use the following table to determine which regimes are present:

Rank	Slow-deep	Slow-shallow	Fast deep	Fast shallow
Velocity	<1 fps	<1 fps	>1 fps	>1 fps
Depth Regime	>1.6 feet	<1.6 feet	>1.6 feet	<1.6 feet
Typical Morphology	Deep pool	Shallow pool	run	riffle

If a reach has deep and shallow pools, and distinctive run and riffle morphology, then you have at least three regimes and possible all four regimes. Score each rank lower if shallow regimes are the missing regimes. Scoring is applied as per the following table.

Rank	Optimal	Sub-Optimal	Marginal	Poor
No. Regimes	Four regimes present	Three regimes present	Two regimes present	One regime present
Score	20 -16	15 -11	10 - 6	5 - 1

4) Channel Alteration

Scored from visual assessment of entire reach. Not aided by semi-quantitative attributes.

5) Sediment Deposition

Reach average percent bottom affected by deposition (from category 8) is used directly to score this metric.

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Bottom Affected	<5%	5%-30%	31%-50%	>50%
Score	20 -16	15 -11	10 - 6	5 - 1

Utilize the lower end of each scale to represent reaches where recent sediment bar formation is evident.

6) Frequency of Riffles

Using semi-quantitative category 3 (Depth and Width Regime) the average width of the stream is determined as the average of riffle and pool widths combined. Using category 2 (Riffle-Pool Sequence) the distance between riffles can be calculated using the sequencing notations and the morphological lengths. The table presented below should be used to develop scores for this metric.

Example: a reach with an average width of 18 feet, with 4 riffles separated by a 50 foot pool, a 20 foot run, and a 100 foot pool would result in an average distance between riffles of 57 feet. Therefore, the ratio = 57/18 = 3.2 and would rank as Optimal (score @ 18).

Rank	Optimal	Sub-Optimal	Marginal	Poor
Ratio (distance between riffles : stream width)	<7 : 1	7 – 15 : 1	16 -25 : 1	>25 : 1
Score	20 -16	15 -11	10 - 6	5 - 1

In continuous riffle streams the consistent placement of boulders and logs provides scores in the highest range of the optimal category.

7) Channel Flow Status

Scored from visual assessment of entire reach. Not aided by semi-quantitative attributes.

8) Bank Stability

The average bank stability score for each represented bank from the semi-quantitative assessment (category 11) is directly applied to the qualitative assessment scoring for this metric (i.e. an average reach score of 8 for the right bank and 7 for the left bank gets transferred directly to the qualitative score sheet as such.)

9) Vegetative Protection

Reach average percent bank protected (from category 12 of the semi-quantitative record sheet) is used directly to score this metric for the right and left bank.

Rank	Optimal	Sub-Optimal	Marginal	Poor
% Protected	>90%	70% - 90%	50% - 69%	<50%
Score	20 -16	15 -11	10 - 6	5 - 1

10) Riparian Vegetative Zone Width

The average riparian zone width score for each represented bank from the semi-quantitative assessment (category 13) is directly applied to the qualitative assessment scoring for this metric (i.e. an average reach score of 8 for the right bank and 7 for the left bank gets transferred directly to the qualitative score sheet as such.)

Alternative Metrics for Low Gradient Streams (pool dominated complexes)

2) Pool Substrate Characterization (replacement for Embeddedness)

Using the Substrate Characterization data from the semi-quantitative assessment (category 6) and the aquatic vegetation assessment (category 9) the following table may be used to score this metric.

Rank	Optimal		Sub Optimal	Marginal	Poor
Substrate	Cobble or Gravel		Sand/Silt/Clay	Sand/Silt/Clay	Bedrock or Clay Only
Macrophytes Present	Yes	No	Yes	No	No
Score	20 - 18	17 - 16	15 - 11	10 - 6	5 - 1

3) Pool Variability (replacement for Velocity/Depth Regime)

Semi-Quantitative categories 2 (Riffle-Pool Sequence) and 3 (Depth and Width regime) are used to help score this metric. Use the following table to determine pool variability.

Pool Characteristic	Large Deep	Large Shallow	Small Deep	Small Shallow
Size	Length ≥ Width	Length ≥ Width	Length < Width	Length < Width
Depth	≥3.2 feet	< 3.2 feet	≥3.2 feet	< 3.2 feet

An equal balance of all four pool types achieves higher scores. A prevalence of shallow pools scores lower.

6) Channel Sinuosity (replacement for Frequency of Riffles)

This metric is assessed separately from the semi-quantitative data. It can be estimated in the field, measured during a longitudinal survey or calculated from current aerial photographs.

8.0 Qualitative Habitat Assessment (Habitat Potential) SOP

Purpose/Objective

After all other samples and field data have been collected, the field team conducts an overall habitat assessment of the stream, makes a general visual assessment of the stream, and performs a final check of the data forms and samples before leaving the stream site. The habitat assessment protocol used is adapted from EPA's "Rapid Bioassessment Protocols..." (Barbour et al, 1999), and has been refined from various applications across the country. The approach focuses on integrating information from specific parameters on the structure of the physical habitat.

The objective of the visual stream assessment is to record field team observations of catchment and stream characteristics that are useful for data validation, future data interpretation, ecological value assessment, development of associations, and verification of stressor data. The observations and impressions of field teams are extremely valuable. Thus, it is important that these observations about stream characteristics be recorded for future data interpretation and, validation. The assessment form is designed as a template for recording pertinent field observations. It is by no means comprehensive and any additional observations should be recorded in the Comments section of the form.

Based on the perception gained from collecting samples and measurements from throughout the sampling reach, the reach will be classified as either "Riffle/run" or "Pool/glide" prevalent based on visual impressions of the dominant habitat type. The prevalent habitat type will be based on which habitat type occupies the majority of the length of the sampling reach. A different field data form is completed depending upon the prevalent habitat type.

For each prevalent habitat type, ten characteristics (termed "parameters") of habitat are considered and evaluated as part of the rapid habitat assessment. These parameters are described below. Most of the parameters are evaluated similarly for both types of prevalent (Riffle/run and Pool/glide) habitats. In four cases, the same parameter is evaluated differently, or a different, but ecologically equivalent, parameter is evaluated in riffle/run prevalent streams versus pool/glide prevalent streams. Epifaunal substrates are evaluated differently in riffle/run and pool/glide prevalent streams. Substrate embeddedness is evaluated in riffle/run prevalent streams, while pool substrate composition is evaluated in pool/glide prevalent streams. The presence of four potential types of microhabitat types based on combinations of depth and current velocity is evaluated in riffle/run prevalent streams, while the presence of four potential types of pool microhabitat based on depth and area are evaluated in pool/glide prevalent streams. The frequency of riffles is evaluated in riffle/run prevalent streams, while channel sinuosity is evaluated in pool/glide prevalent streams.

Procedure

For each of the ten parameters, rate the overall quality of the sampling reach on a scale of 0 to 20. Scores for each parameter are recorded on the pool/glide or riffle/run version of the Qualitative Habitat Assessment Field Form. If the stream is classified as a pool/glide prevalent stream, record your scores for each parameter on the pool/glide version of the Qualitative Habitat Assessment Field Form. Transfer the scores assigned for each parameter to the box in the left-hand column of the form. Sum the scores for each parameter and record the total score in the box at the bottom of page 2 of the form. Divide the total score by ten to arrive at a reach average score.

The following parameters are used for the evaluation:

1. epifaunal substrate/available cover,
2. (a)embededdness, or
   (b)pool substrate characterization,
3. (a)velocity and depth regimens, or
   (b)pool variability,
4. channel alteration,
5. sediment deposition,
6. (a)frequency of riffles, or
   (b)channel sinuosity,
7. channel flow status,
8. bank stability,
9. vegetative protection, and
10. riparian vegetative zone width.

Each reach will be evaluated by two to four experienced field biologists who ranked each attribute independently and summed them for a total score. The scores were then averaged to produce the overall ranking. Calculated scores placed the reach into a habitat category of optimal (16-20), suboptimal (11-15), marginal (6-10), or poor (1-5). The distinction within the four (4) categories may be subjective. (e.g., a large patch of clear cut logging on a hill overlooking the stream would be rated high within the poor category [a rating of 5] while limited logging activity right on the stream bank would be rated low within the poor category [a rating of 1]). When assessing reach characteristics, the entire sampling reach is considered a third level evaluation.
Complete the assessment form after all other sampling and measurement activities have been completed. Take into account all observations the sampling team has made while at the site. The assessment includes the following components:

Parameter	**Description and Rationale**
1. Epifaunal Substrate/Available Cover	Essentially the amount of niche space or hard substrates (gravel, cobble) for macroinvertebrate colonization and the amount of available cover (logs, branches) for fish refugia. Numerous types of insect larvae attach themselves to rocks, logs, branches, or other submerged substrates. The greater the variety and number of available niches, and cover the greater the variety of insects and fishes in the stream. Rocky bottom areas are critical for maintaining a healthy variety of insects in most high gradient stream. Woody cover is critical in developing a well-balanced fish community. The abundance, distribution, and quality of substrate and other stable colonizing surfaces and cover (e.g., old logs, snags, and aquatic vegetation) maximize the potential for colonization by fish and insects.
2a. Embeddedness (high gradient)	The extent to which rocks (gravel, cobble, and boulders) are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish for shelter, spawning, and egg incubation is decreased. To estimate the percent of embeddedness, observe the amount of silt or finer sediments overlying and surrounding the rocks. If kicking does not dislodge the rocks or cobble, they may be greatly embedded. It is useful to observe the extent of the dark area on their underside of a few rocks.
2b. Pool Substrate Characterization (low gradient)	Gravel or firm vegetated pool substrates support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants. In addition, a stream that has a uniform substrate in its pools will support far fewer types of organisms than a stream that has a variety of substrate types.

3a. Velocity and Depth Regimens (high gradient)	There are four primary current and depth combinations: (1)slow-deep, (2)slow-shallow, (3)fast-deep, and (4)fast-shallow. The best streams in high gradient regions will have all four combinations present. The presence or availability of these four habitats relates to the ability of the stream to provide and maintain a stable aquatic environment. In general use a depth of 0.5 m to separate shallow from deep and a current velocity of 0.3 m/sec to separate fast from slow.
3b. Pool Variability (low gradient)	Rates the overall mixture of pool types found in streams, according to size and depth. The four basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream with many pool types will support a wide variety of aquatic species. Rivers with sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community. As a general guideline, consider a pool deep if it is greater than 1 m deep, and large if its length, width, or oblique dimension is greater than half the stream width.
4. Channel Alteration	Basically a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened or diverted into concrete channels, often for flood control purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when the stream runs through a concrete channel; when artificial embankments, rip-rap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams and bridges are present; and when other such changes have occurred.

5. Sediment Deposition	The amount of sediment that has accumulated and the changes that have occurred to the stream bottom as a result of the deposition. Deposition occurs from large-scale movement of sediment caused by watershed erosion. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of meanders that increase in size as the channel is diverted toward the outer bank) or shoals or result in the filling of pools. Increased sedimentation also results in increased deposition. Usually this is evident in areas that are obstructed by natural or man-made debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition create an unstable and continually changing environment that becomes unsuitable for many organisms.
6a. Frequency of Riffles (high gradient)	The sequence of riffles occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community. For areas where riffles are uncommon, a run/bend ratio can be used as a measure of sinuosity. A large degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle the high-energy flows that result from storms than are relatively straight streams.
6b. Channel Sinuosity (low gradient)	Evaluates the meandering or relative frequency of bends of for aquatic organisms, whereas straight stream segments are characterized by monotonous habitats that are prone to flooding. A high degree of sinuosity creates a variety of pools and reduces the energy from surges when the stream flow fluctuates. The absorption of this energy by bends protects the stream from excessive erosion and flooding. In "ox bow" streams of coastal areas and deltas, meanders are highly exaggerated and transient. Natural conditions are shifting channels and bends. Alteration of these streams is usually in the form of flow regulation and diversion.

7. Channel Flow Status	The degree to which the channel is filled with water. The flow status will change as the channel enlarges or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of useable substrate for aquatic organisms is limited.
8. Bank Stability	The stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are therefore considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil
9. Vegetative Protection	The amount of the stream bank and near-stream riparian area that is covered by vegetation. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This parameter supplies information on the ability of the bank to resist erosion, as well as some additional information on the uptake of nutrients by the plants, the control on instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap.
10. Riparian Vegetated Zone Width	The width of natural vegetation from the edge of the stream bank (riparian buffer zone). The riparian vegetative zone serves as a buffer zone to pollutants entering a stream from runoff, controls erosion, and provides stream habitat and nutrient input into the stream. A relatively undisturbed riparian zone reflects a healthy stream system; narrow, far less useful riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. The presence of "old fields" (i.e., a previously developed field allowed to convert to natural conditions) will rate higher than fields in continuous or periodic use. Paths and walkways in an otherwise undisturbed riparian zone may be judged to be Inconsequential to destruction of the riparian zone.

9.0 Benthic Macroinvertebrate Protocol SOP

Purpose

Benthic invertebrates inhabit the sediment or live on the bottom substrates of streams. The diversity and the presence of an expected level of benthic community reflects the maintenance of a systems biological integrity. Monitoring these assemblages is useful in assessing the status of the water body and detecting trends in ecological condition. Benthic communities respond to a wide array of stressors in different ways so that it is often possible to determine the type of stress that has affected a macroinvertebrate community (e.g., Klemm et al., 1990). Because many macroinvertebrates have relatively long life cycles of a year or more and are relatively immobile, macroinvertebrate community structure can be a function of present or past conditions. The benthic invertebrate community also reflects the effects of habitat availability, and the long-term exposure to physical and chemical properties of the water in which they develop and live.

The benthic macroinvertebrate protocol is intended to evaluate the biological integrity of wadeable streams for the purpose of detecting stresses on community structure, assessing the relative severity of these stresses, and determine the maintenance of the designated uses. The approach are based on the *Rapid Bioassessment Protocols for Wadeable Streams and Rivers* published by the U.S. Environmental Protection Agency (Barbour, 1999). Variations of the approach is utilized by the U.S. Geological Survey for their National Water-Quality Assessment Program (NAWQA; Cuffney et al., 1993) and by the EPA in their Environmental Monitoring and Assessment Program (EMAP, Lazorchak, 1998). The protocol requires only one person and is the preferred macroinvertebrate collecting method where habitat is variable (a second person can be used for water safety and to keep time and record information on the field forms). The methodology used by GBMc & Associates is a modification of the EPA "Multi-habitat Approach" (Barbour, 1999) designed to better assess pool dominated streams and riffle dominated streams using similar but different collection techniques. The approach can be generally considered a semi-quantitative methodology, in that there is some measure of abundance on a per sample basis and data is comparable to other collections.

Procedure

Pool Dominated Stream/Multihabitat Approach

An aquatic dip net is used to sample all available microhabitats present within the stream reach. Sampling is conducted using kicking, jabbing, and sweeping techniques. Kicking involves placing the net on the substrate and kicking the substrate upstream of the net allowing the dislodged invertebrates and debris to float into the net. Jabbing involves quick jabs of the net into submerged or exposed habitat types (macrophytes, root wads, branches, etc.) in an effort to dislodge invertebrates for capture. Sweeping entails sweeping the net through or above a habitat type to dislodge and capture invertebrates. Sweeping is often done above sandy and silty areas and root wads so as to capture as little debris as possible but still dislodge organisms. Sampling effort is timed on a stopwatch for a total of three minutes. Only time actually spent kicking, jabbing, or sweeping is allowed to accrue on the timer. The net is periodically emptied into a bucket for transport of the sample up and down the stream reach.

Riffle Dominated Stream

An aquatic dip net (generally the rectangular sort at least 16" wide) is used to sample the riffle habitat in a stream. The net is placed on the stream bottom and the substrate upstream of the net is vigorously kicked by the sampler to dislodge invertebrates allowing them to drift into the net. Sampling is conducted in this manner at different riffle locations throughout the study reach for a total kick time of 5 minutes. It may be useful to sweep the net through the dislodged and drifting debris in an effort to pick up as many invertebrates as possible. Kick time is monitored with a stop watch allowing time to accrue only during kicking and subsequent drift time. The net contents are placed in a bucket for holding after each riffle sample is collected.

Sample Processing

After collection, samples are initially sorted and concentrated using a series of U.S. standard sieves the smallest of which has a #30 mesh with an opening size of 600μm. Random sub-samples of the concentrated sample will be placed on a white sorting tray from which the macroinvertebrates will be removed. A 100 organism sub-sample will be randomly picked from the tray and field identified to the lowest possible taxon. A representative amount of the concentrated sample is picked to be sure that each type of debris (i.e. leafs, algal mats, sediment, etc.) have been checked for macroinvertebrates. The 100 organism sub-samples will be preserved in Kaylee's Solution (a fixative, 15 pts. ethanol, 6 pts. formalin, 1 pt. glacial acetic acid, 30 pts. deionized water) or 70% ethanol for lab verification of field identifications and as a voucher to be used if more detailed analysis becomes necessary. If the sample is placed in Kaylee's solution it is removed and placed in 70% ethanol within 7-days. Each sample is labeled inside with a waterproof label and outside with laboratory tape containing the following information:

- station I.D.,
- location (waterbody, county, state),
- project number,
- date/time,
- initials of collector, and
- collection method/duration.

After the 100 organism random sample is collected, labeled and preserved, the larger debris items (e.g. leaves, sticks, rocks etc.) in the collected sample will be examined for clinging benthic macroinvertebrates. Any organisms will be removed prior to the debris being discarded. The remainder of the original sample not utilized in the selection of the 100-organism sub-sample will be concentrated and retained as a voucher for the sample picking (sub-sampling) techniques used. The voucher samples will be preserved in either Kaylee's Solution or 70 % ethanol. Voucher samples will be held at GBM^c for a period of 24 months, from the conclusion of the study at which time the samples may be submitted to an academic zoological collection.

For each study site, a complete tabulation of taxa, numbers of individuals and their percent composition will be included on the Benthic Macroinvertebrates Field Data Form (attached). The first page of the form will include general information identifying the sample reach and investigators as well as site observations to include:

1. time sampled,
2. relative abundance of aquatic trophic level communities (periphyton, macrophytes, etc.),
3. percent of major habitats sampled,
4. percent of specific microhabitats sampled, and
5. relative abundance of the ordinal groups observed during sample collection.

The second page provides for the listing of the taxa comprising the 100 organism sub-sample and the field identifications and the numbers of each. Also included on page 2 are the general reach identifiers and preliminary summary sections to be used in the application of selected biometric scoring criteria.

All macroinvertebrate identifications shall be verified in the laboratory by experienced invertebrate biologists. Laboratory verification will be accomplished using general keys including but not limited to Merritt & Cummings, (1996); and Pennak, (1989). In addition more taxa specific keys such as Mayflies of North and Central America (Edmunds et, al, 1976), Dragonflies of North America, (Needham & Westfall, 1975) or species specific keys developed for a state or region will be utilized for the laboratory verification of the field identifications.

Community Biometric Analysis

The qualitative samples are used to taxonomically characterize the aquatic community, identify indicator taxa and determine relative abundance of taxa and ecological types. The macroinvertebrate assemblages from each station are analyzed according to several benthic community biometrics. These will include richness (number of different taxa), EPT richness (number of different taxa represented in the orders Ephemeroptera, Plecoptera, and Trichoptera), percentage of dominant ordinal groups, species diversity as determined by the Shannon-Wiener diversity Index, and functional feeding group assessment. The analysis may also include the seven biometrics used by the State of Arkansas (ADPC&E, 1988) in their RBA scoring system, as well as other state specific biotic indexes. The biometric scoring activity will indicate the impacts to a benthic community when compared to the benthic community of different reaches, to demonstrate effects of point and or non-point source contributions between reaches.

Alternative Sampling and Processing Methodologies

An alternative processing technique may be used for the macroinvertebrate samples collected using the preceding RBA protocols. This technique involves concentrating the entire sample in the field and preserving it for transport to the laboratory. No on-site picking occurs. Once in the lab the sample is further concentrated and sorted to size using standard sieves. The sample is then placed into white sorting trays. Every macroinvertebrate in the sample is picked out and placed in a sample container. Once the entire sample has been picked and all organisms are in a single container the macroinvertebrates are poured onto a gridded and numbered sorting tray and swirled to distribute them randomly and as evenly as possible throughout the tray. Random numbers are then drawn that correspond to a given grid. All of the macroinvertebrates found in that grid are then removed and tallied. This process continues until a sample of sufficient size has been achieved, usually 100, 200, or 300 macroinvertebrates. The final sample size is dependant on the level of random error that is acceptable in the study. The macroinvertebrates are then identified to the lowest taxonomic level possible and the assemblage is analyzed as outlined above.

In addition to the semi-quantitative sampling protocols described in the preceding sections other semi-quantitative and quantitative methodology may be utilized where circumstances require a more detailed and precise assessment of the macroinvertebrate community. Quantitative and semi-quantitative protocols utilize sampling devices where a known area of substrate is sampled (i.e. 1.0 ft^2, 0.1 m^2, etc) such as with a Surber Sampler or a Hester-Dendy , respectively. Quantitative techniques require processing of the entire sample collected to remove all macroinvertebrates captured. Macroinvertebrates are identified to the lowest possible taxonomic level, enumerated, and calculations of density per unit area are completed at varying taxonomic levels. Biometric analysis can then be completed using the same metrics as in the semi-quantitative assessment.

Quality Control

Field teams collecting macroinvertebrates are led by experienced aquatic biologists and ecologists. Field forms designed specifically for macroinvertebrate collection studies and set up to include all pertinent field data are completed for each sample site. All field forms are reviewed at the end of the study for completeness and accuracy. Identification of macroinvertebrates is verified in the laboratory by an experienced invertebrate biologist. Periodic spot checks to verify laboratory identifications are made by a qualified biologist on the team. Efforts are made to remain abreast of current research in macroinvertebrate biology and identification techniques through scientific journals and conferences. In addition, EPA document updates and new information on macroinvertebrate community assessment is tracked via the internet.

Macroinvertebrate duplicate samples are collected at one of ten study sites. In years where less than ten sites are sampled a minimum of one duplicate sample should be collected at a given site. Duplicate samples are treated the same way as the base sample for processing and identification. A similarity index is calculated for the duplicate and base samples. Index results indicating similarity less than 65% are considered out of control. In the case of an "out of control" condition the organism identifications will be assessed as will the collection techniques. Corrective action will be determined by the project manager and/or the senior biologist and could include adjustments to techniques or a re-sampling of the sites in question.

10.0 Fish Collection Protocol SOP

Purpose/Objective

The fish community supported in a stream is in direct response to available habitat, food sources, and water quality of that particular stream. The presence of a certain level of species richness and diversity along with a community structure similar to that expected in typical streams of a ecoregion are indicators of aquatic ecosystem health.

The objective of the fish community characterization is to collect and identify a representative sample of all except very rare species in the assemblage reflective of the relative abundance within the community. Backpack electrofishing equipment is used as the principal sampling gear supplemented by block netting and seining in habitats where flow, substrate and structure affect the capture of fish species. Other methods of fish sampling may be implemented when conditions are not adequate for backpack eletrofishing or seining; these may include, using boat electrofishing equipment and/or hook and line sampling equipment. Usually 2 – 4 team members will make up the sampling team involved in collecting the aquatic vertebrates.

Major factors that influence collecting include flows, water depth, in-stream obstructions, water turbidity, temperature and conductivity. The primary tool utilized in the fish collections will be a Smith-Root backpack electroshocker. However, seines and block nets may be utilized as necessary to adequately characterize a sampling reach. The shocker is equipped with an automated timing mechanism which records the amount of time that electricity is actually being applied, or "pedal down time" (PDT).

Sampling fish species to determine their proportionate abundance will be conducted after all water quality parameters and/or samples are collected but prior to the collection of the macroinvertebrate sample and habitat data.

Shocked fish were captured with hand held dip nets and held in buckets while the sampling continued. The entire stream width within the sampling reach will be sampled. PDT time will continue for not less than 30 minutes unless the wetted habitat of any reach limits the PDT. In addition to the PDT, the total collection time will be recorded.

Unless specified in a project specific sampling analysis plan (SAP), there will not be a maximum time limit for the collection period, however the collections may be terminated when in the opinion of the principal investigator determines that a representative collection has been obtained. Sampling information is recorded on the Fish Community Collection Form, general comments (perceived fishing efficiency, missed fish, and gear operation suggestions) will be recorded on the lines provided on this form.

An effort to search for and collect fish will be completed at all targeted reaches, even if the stream is extremely small, and it appears that sampling may not collect any specimens. If no specimens are collected, complete the "NONE COLLECTED" field on the Fish Collection Form. Provide an explanation in the comments section of the form.

Procedure

Electroshocking

The procedure to sample with the backpack electrofisher unit is presented below:

Initially a decision will have to be made on what type of current to be used, alternating current (AC) or direct current (DC). AC flows from the anode and the cathode with an alternating direction of current flow. This alternating flow of current causes the fish to have strong muscle contractions, resulting in immobilization. AC has the highest electrofishing sucsess rate but also poses the highest risk of permanent injury to the fish (particularly to larger specimens). DC is the direct flow of electrical current from the cathode to the anode. DC causes the fishes muscles to contract in such a way that the fish swim towards the anode probe. Muscle contractions occur until the fish is so close to the probe that the higher level of electricity stuns the fish. DC pulse length and duration can be adjusted with the shocking unit mode switches to more efficiently apply electricity that will draw fish to the probe without causing injury.

Make sure that the unit is full of properly mixed gas and oil (100:1), attach cathode (cable tail that drags behind operator, and anode (actual shocking probe with thumb switch to control electricity current)

Select the initial voltage based on the measured conductivity of the stream. For high conductivity water (300 - 1200 µS) use a voltage setting of 100 - 400 volts. For medium conductivity water (100 – 300 µS) use a voltage setting of 500 - 800 volts. For low conductivity water (10 – 100 µS) use a voltage setting of 900 - 1100 volts.

Select the initial frequency and/or wavelength based on the expected size of fish. Find a setting, using the number dial (1 – 16) and the letter dial (A – P), that will allow you to have maximum amperage output without overloading the unit, typically 0.7 – 1.9 amps. Start with a setting of I-6 and adjust letters then numbers to find your setting. A higher mode setting provides more amperage as does a higher voltage setting. Typical setting used by GBMc & Associates are I (5-7) and J (5-7) at a voltage of 100-300 volts.

Record the latitude and longitude of the starting location and the starting time for electrofishing. Start the electrofisher, place the generator on the 300VA position for full generator output, set the timer to zero, and depress the switch to begin fishing. Starting at the bottom of the reach, fish in an upstream direction. **Adjust voltage and waveform output according to sampling effectiveness and incidental mortality to specimens.** The backpack unit is equipped with an audio alarm that sounds when the output voltage exceeds 30 V. It also serves as an input current indicator for pulse cycles greater than 5Hz. It begins as a strong continuous tone and begins to beep slowly at currents of 1.25 amps. It beeps faster as input current increases. In case of an overload (in excess of 3 amps), the beep becomes very rapid and the overload indicator comes on. Release the anode switch and adjust voltage and waveform and continue fishing.

When fishing, slowly sweep the anode wand from side to side in the water in riffles and pools. Sample available cut-bank and snag habitat areas as well as riffles and pools. Move the wand in and out of large snags or deep cuts or release the electrode switch, move the wand away slightly, depress the switch again and sweep the wand away from the cover to draw fish out into open. In fast, shallow water, it may be more effective to use a seine or a couple of handheld nets as a block net; sweep the anode and fish downstream into the net.

In streams wider than can be effectively sampled during a single pass (generally 5 ft or more), it may be necessary to work from the midline of the stream channel to the banks. Be sure that deep, shallow, fast, slow, complex, and simple habitats are all sampled. In stretches with deep pools, fish the margins of the pool as much as possible, being extremely careful not to step into deep water.

One or two netters follow along beside or slightly behind the person operating the electrofisher (on the anode side). Each netter uses an insulated dip net to retrieve stunned individual fish, which are then deposited into a bucket carried by one of the netters for later processing

At the completion of electrofishing, note the PDT, total sampling time, the total distance sampled, and information obtained while sampling. Record this information on the Fish Collection Form or in a team member's field notebook.

Electrofishing Precautions

Because fishes and amphibians are collected using portable electrofishing units, safety procedures must be followed meticulously at all times. Primary responsibility for safety while electrofishing rests with the principal investigator. Electrofishing units have a high voltage output and may deliver a dangerous electrical shock. While electrofishing, avoid contact with the water unless sufficiently insulated against electrical shock. Use chest waders and rubber gloves to prevent the chance of electric shock
Avoid contact with the anode and cathode at all times due to the potential shock hazard. While electrofishing avoid reaching into the water. If it is necessary for a team member to reach into the water to pick up a fish or something that has been dropped, do so only after the electrical current has been interrupted and the anode is removed from the water. Do not resume electrofishing until all individuals are clear of the electroshock hazard. The electrofishing equipment is equipped with a 45° tilt switch that interrupts the current and may shut off the unit completely in the event the person carrying the unit falls. Do not make any modifications to the electrofishing unit that would bypass the unit's automatic shutoff features.

Electrofishing equipment will not be utilized near unprotected people, pets, or livestock. Activity will be discontinued during thunderstorms or heavy rain.

Seining

Seining may be used in conjunction with electrofishing to ensure sampling of those species which may otherwise be under presented by an electrofishing survey alone (e.g., darters, madtoms, and benthic cyprinids). Seining may also be used in sites where the stream is too deep for electrofishing to be conducted safely or in turbid, simple, soft-bottomed streams where it is more effective.

Depending on the particular use (block netting vs. active seining) and the habitat, different sizes of seines are used. In riffle habitats, the seine is held stationary while team members disturb the substrate immediately upstream of the net. In pools, the seine is pulled back and forth across the pool, using the shore and other natural habitat breaks as barriers, or pulled rapidly downstream through the pool and then swept toward the shore. Block nets may be used in very large pools to limit escape or as seines. Large nets are typically deployed parallel to the current and swept to shore.

Proceed upstream through the reach, allocating the seining effort among habitat areas (riffles and pools) so that the entire reach is sampled. Deposit fish collected by seining into a bucket for later processing. It is not necessary to segregate the fish collected via electroshocking or seining. However the number of seine hauls and the time expanded in seining will be recorded on the Fish Field Data Sheet. At the completion of sampling activities (electrofishing and/or seining), record the total fishing time on the Fish Field Data Sheets.

Sample Processing

Sample processing involves tallying and identifying fish, examining individual specimens for external anomalies, preparing voucher specimens for taxonomic confirmation and archival at GBM^c.

Unless otherwise specified in a project specific SAP, at the end of each sampling effort fish from the entire reach are preserved in formalin for identification in the lab. For each study site, a complete tabulation of taxa, numbers of individuals and their percent composition will be included on the 2 page Field Data Sheets – Fish (attached). The first page of the 2-page data form will include general information identifying the sample reach and investigators as well as site observations to include:

time sampled,
pedal down time (PDT),
relative abundance of aquatic trophic level communities,
percent of major habitats sampled,
percent of specific microhabitats sampled, and
relative abundance and scoring of substrate.

The second page provides for the listing of the taxa (field identification) and the numbers of each. Also included on page 2 are the general reach identifiers.
Ultimately, the fish identification will be verified in the lab using keys in the Fishes of Arkansas (Robison, 1988) and the Fishes of Missouri (Pflieger, 1975) to species level where possible.

The fish collections at each reach will be compared according to several biometrics which may include: species richness (number of taxa); sunfish richness; species diversity; abundance; dominant ordinal groups; percent of tolerant species; trophic structure; percent of hybrids; and percent of diseased fish. The analysis may also include the eight biometrics used by the State of Arkansas in their RBA scoring system. This scoring system places a value of 0, 2, or 4 on each of the eight biometrics to achieve a final mean score. The final mean score (0 to 32, 0-8=not supporting, 9-16=impaired, 17-24=generally supporting, 25-32=fully supporting) will indicate the impacts to a fish community when compared to the fish community of different reaches, to demonstrate effects of point and or non-point source contributions between reaches.

Sample Maintenance

At the conclusion of all identifications, all fish collections are placed in 40% - 50% isopropyl alcohol for permanent preservation. The fish collections are maintained at GBMc & Associates for a period of three years after the completion of the project. An archive list of all fish collections is on file at GBMc & Associates. After the three year time period is up preserved fish may be offered to a scholastic institution or museum, discarded in an appropriate manner, or remain in storage at GBMc & Associates.

Quality Control

Field teams collecting fish are led by experienced aquatic biologists. A team of qualified personnel using proven sampling techniques makes field collections. Sampling equipment is routinely inspected to maintain and ensure proper working order prior to a sampling trip. Adjustment in the field to the equipment and/or techniques can be made in the field by the sampling team to improve the collection results. All aspects of the fish collection are documented in team members' personal field books, as well as specific field forms. The field forms are designed specifically for fish collection studies and are set up to include all pertinent field data. Field forms are completed for each sample site. All field forms are reviewed at the end of the study for completeness and accuracy.

Identification of the collected fish starts in the field and is conducted by one or more experienced aquatic biologists that were involved in the collection effort. Field identifications are later verified in the laboratory by an experienced aquatic biologist. Laboratory identifications are then confirmed by a senior biologist to ensure completeness and accuracy. Efforts are made to remain abreast of current research in fisheries biology and identification techniques through scientific journals and conferences. In addition, EPA document updates and new information on fish assessment is tracked via the internet.

12.0 Sample Collection and Custody

Purpose

This SOP describes the materials and methods necessary for the routine collection of water and wastewater samples for the analysis of various conventional and unconventional pollutants. It also gives guidance for the completion of the COC forms necessary for each set of samples collected for laboratory analysis. This SOP provides general guidance and should not be substituted for a study specific work plan and/or Sampling and Analysis Plan.

Procedures

Sample Collection

1. Fill out an Equipment Checklist for each sampling trip, checking (✓) all the necessary gear for sample completion.

2. Clean sample bottles should be supplied by the laboratory or a reputable scientific supply company. Be sure to have an extra set of sample bottles on hand on each field trip.

3. Check all bottles prepared by the lab to ensure the proper analyses are covered with the correct type of preservation. (Table 1)

4. A duplicate sample for a given analyte shall be taken, 1 for every 10 samples collected. That is, a duplicate sample will be collected 10% of the time. A duplicate sample is simply a second sample taken from the same location immediately following the original sample. The duplicate sample serves as a quality control check for the sample sources (stream water, etc.) variability, and the sampling methodology repeatability.

5. A field blank shall be collected 10% of the time (1 in 10 samples) when metals or organic chemicals are being analyzed. A field blank is simply a sample bottle filled with deionized water (blank water) on-site at the study location to represent any potential contamination present at the site or in the sampling techniques.

6. A trip blank should be collected at the rate of 1 per 10 samples when metals or organic chemicals are being analyzed. A trip blank is a bottle filled in the lab with deionized water to verify blank water and sample bottle purity.

7. Use appropriate safety precautions while collecting the samples (i.e., wear latex gloves, Tyvek® suits, etc.) as necessary.

8. Place a label on the sample bottle, prior to collecting the samples, and record the following information on the label using a permanent marker (e.g., Sharpie®):

   a. sample identification,
   b. date of collection,
   c. time of collection,
   d. initials of collectors, and

    e. parameters to be analyzed (NH_3-N, Total Cu, etc.)

9. Fill one bottle per site completely, and place the cap securely on the bottle.

   When filling sample bottles be sure to choose a representative sample location which is accessible in a manner as to prevent bottom and/or attached solid materials from entering the sample bottle. Samples should be taken in flowing water where possible. Samples should be taken from below the water surface if depth allows.

10. Place the bottle in an ice filled ice chest to keep the sample cool (4°C±2). If the ice chest(s) will be shipped to a laboratory, ice should be placed in a plastic bag(s) to prevent possible sample contamination from melting.

11. Record sample information on the Field Data Form or in a field notebook, along with any pertinent observations. If available, record instantaneous flow at the time of sample collection. This is important if the samples are from an NPDES discharge or other regulatory monitored system.

12. If samples are to be composited according to flow (flow-weighted) the following protoccol should be followed:

    a) record a flow for each sample time on the COC form
    b) include compositing instructions on the COC form for laboratory use

13. Measure any necessary in-situ parameters (pH, temperature, dissolved oxygen, specific conductivity) and record on the appropriate field form or in a field notebook.

14. When sampling is complete a COC form should be completed.

15. Take note of sample holding times (Table 1) and make an effort to return samples to lab as soon as possible.

Chain of Custody (COC)

1. A COC form (attached) must be filled out for all samples submitted to the laboratory for analysis.

2. The COC form must be filled out with a ballpoint pen, and signed in the appropriate locations by each individual receiving the sample(s).

3. The following information ***must be completed*** on each COC form:

    a. company/facility,
    b. contact name,
    c. address,
    d. phone number,
    e. sample Id,
    f. sample description (where taken),
    g. date (from sample bottle),
    h. time (from sample bottle),

i. number of containers,
j. preservative,
k. parameters to analyze at lab,
l. sampler(s),
m. shipment method,
n. turnaround time required,
o. coc form completed by,
p. coc form checked by, and
q. relinquished by.

4. Each completed COC form shall be photocopied and the copy filed.

5. If shipping ice chests to a laboratory, the original COC form should be placed in a ziplock bag and then taped to the inside top of the ice chest for shipment.

6. At the lab the COC form will be received and signed. A copy of the COC form should be returned by the lab, along with the analysis results, when completed.

14.0 Turbidity Meter Calibration SOP

Purpose

This SOP describes the methods for calibration and use of the portable HACH Model 2100P Turbidimeter.

Calibration

Procedure

1. Prepare formazin 20, 100, and 800 NTU calibration dilutions immediately before calibrating. The solutions are made with a well mixed 4000 NTU stock solution and high quality dilution water (<0.5 NTU) as follows:

   Dilution water--Deionized water. The deionized water should have a turbidity reading <0.5 NTU.

   20 NTU--Add 0.5 mL stock solution to a 100 mL volumetric flask and bring to volume.
   100 NTU--Add 2.5 mL stock solution to a 100 mL volumetric flask and bring to volume.
   800 NTU--Add 20 mL stock solution to a 100mL volumetric flask and bring to volume.
   (The 4000 NTU solution is stable for up to a year, but dilutions deteriorate more rapidly.)

2. Use the same sample cuvette for each different dilution reading. Rinse the clean cuvette with dilution water three times; then fill to the line with dilution water.

3. Place the instrument on a flat surface. Then insert the sample cuvette into the cuvette compartment with the orientation mark on the cuvette aligned with the mark on the front of the compartment. Close the lid and press I/O.

4. Turn the signal average off by pressing the Signal Average key until off is indicated. Then press calibrate (CAL). CAL and S0 should be displayed on the screen along with the value for the S0 standard for the last calibration.

5. Press READ. After the count down is completed, the blank value will be displayed, then the display will advance to the next standard. Remove the sample cuvette. (In case of error, refer to manual.)

6. S1 and 20 NTU will be displayed on the screen.

7. Rinse the sample cuvette 3 times with the well mixed, 20 NTU standard. Then fill the cuvette to the line with the 20 NTU standard.

8. Clean the outside of the cuvette with a soft, lint-free cloth removing water spots and fingerprints. Then apply a thin film of silicone oil and spread the oil evenly over the outside surface with a soft cloth.

9. Insert the sample cuvette into the cuvette compartment with the orientation mark on the cuvette aligned with the mark on the front of the compartment.

10. Close the lid and press READ. After the count down is completed, the standard value will be displayed, then the display will advance to the next standard. Remove the sample cuvette.

11. Repeat steps 6 through 10 for the S2 and S3 samples (100 and 800 NTU, respectively.)

12. After S3 has been read, the display will show S0. Remove the sample cuvette. Press CAL to accept the calibration.

13. Once the calibration has been accepted, the instrument will automatically proceed to measurement mode.

    (If any errors occur during calibration, revert to manual for explanation.)

Calibration Verification

The 2100P Turbidimeter does not require calibration before every measurement. Gelex® Standards are used for routine calibration checks. Routine calibration checks should be performed bi-monthly. If the Gelex® standards read more than 5% from their recorded value, the meter should be recalibrated.

Procedure

Assigning values to the Gelex® standards

1. Calibrate the meter as described above.

2. Select the automatic range mode using the RANGE key.

3. Turn the signal average off by pressing the SIGNAL AVERAGE key until SIG AVG is not displayed on the screen.

4. Clean the outside of the Gelex® vile with a soft, lint-free cloth removing water spots and fingerprints. Then apply a thin film of silicone oil and spread the oil evenly over the outside surface with a soft cloth.

5. Insert the 0-10 NTU Gelex® standard into the cuvette compartment with the orientation mark on the vile aligned with the mark on the front of the compartment. Close the compartment lid.

6. Press READ and record the displayed value after the lamp signal is no longer displayed on the screen.

7. Remove the vile and mark the value on the band near the top of the vile with a permanent marker.

8. Repeat steps 3 through 6 for the other Gelex® standards.

9. The values for each Gelex® standard should be reassigned each time a new calibration is performed.

Checking meter calibration

1. The Gelex® standards should be used as a routine check for instrument calibration. If the standards do not read within 5% of the assigned value, the instrument should be recalibrated before use, and new values assigned to the Gelex® standards.

2. Place the instrument on a flat surface.

3. After turning the instrument on, select the automatic range mode using the RANGE key.

4. Turn the signal average off by pressing the SIGNAL AVERAGE key until SIG AVG is not displayed on the screen.

5. Clean the outside of the Gelex® vile with a soft, lint-free cloth removing water spots and fingerprints. Then apply a thin film of silicone oil and spread the oil evenly over the outside surface with a soft cloth.

6. Insert the 0-10 NTU Gelex® standard into the cuvette compartment with the orientation mark on the vile aligned with the mark on the front of the compartment. Close the compartment lid.

7. Press READ and record the displayed value after the lamp signal is no longer displayed on the screen.

8. Remove the vile and compare the value on the band near the top of the vile with the recorded value. If the recorded value is within 5% of the value marked on the vile, continue to step 8. Otherwise recalibrate the instrument.

9. Repeat steps 3 through 6 for the other Gelex® standards.

Turbidity Measurements

Procedure

1. Collect a representative sample of the liquid to be analyzed in a clean container. Rinse the clean sample cuvette three times with the sample water and fill to the line with sample, taking care to prevent the formation of air bubbles and not leave fingerprints on the sides of the cuvette.

2. Clean the outside of the cuvette with a soft, lint-free cloth removing water spots and fingerprints. Then apply a thin film of silicone oil and spread the oil evenly over the outside surface with a soft cloth.

3. Place the instrument on a flat surface and turn it on by pressing I/O.

4. Insert the sample cuvette into the cuvette compartment with the orientation mark on the cuvette aligned with the mark on the front of the compartment and close the lid.

5. Select automatic range by pressing the RANGE key until AUTO RNG is displayed.

6. Turn the signal average off by pressing the SIGNAL AVERAGE key until SIG AVG is not displayed on the screen.

7. Press READ and record the turbidity value after the lamp symbol is no longer displayed on the screen.

Meter Maintenance/Storage

1. Store the meter in the designated portable carrying case.

2. The meter should not be stored or left in a "dirty" condition.

3. The sample cuvette, silicone oil, and Gelex® standards should be stored in clean state in the proper boxes in the portable carrying case.

4. The 4000 NTU stock solution should be stored in a refrigerator at 5^0 C.

Quality Assurance/Quality Control

1. Meters are calibrated biweekly (at a minimum) to ensure proper function and accuracy.

2. Duplicate measurements should be taken at a rate of 10% (minimum) of samples analyzed.

Appendix B

Agency documentation

Arkansas Department
of Health and Human Services
Division of Health
Paul K. Halverson, DrPH, Director
Engineering Section – Environmental Health Branch – Center for Local Public Health
Postal Address P. O. Box 1437, Slot H-37 Little Rock, AR 72203-1437 1-501-661-2623 TDD: 1-800-234-4399
Physical Address for UPS or Fedex 4815 West Markham St., Slot H-37 Little Rock, AR 72205 Fax: 1-501-661-2032

December 6, 2005

Mr. Vince Blubaugh
GBMc & Associates
219 Brown Lane
Bryant, AR 72022

Re: Domestic Water Supply Determination
Unnamed Tributaries of Little Cornie Bayou and Bayou De Loutre
Union County, AR

Dear Mr. Blubaugh,

In response to your letter of October 27, 2005 regarding the above streams, please be advised that these water bodies are not currently used as a source of supply for a public water system, nor are we aware of their being considered for such use.

We have no information regarding their use as a private or individual water supply. By copy of this letter, if the County Sanitarian is aware of such use, he/she is requested to respond to you in writing.

Should you have any questions in this regard, feel free to contact our office. We apologize for the delay in responding.

Sincerely,

Bob Makin, P.E., Assistant Director
Engineering Section

Cc: Martin Maner, ADEQ Water Division
Union County Sanitarian

Arkansas Department of Health and Human Services

Division of Health

Paul K. Halverson, DrPH, Director

Engineering Section – Environmental Health Branch – Center for Local Public Health

Postal Address P. O. Box 1437, Slot H-37 Little Rock, AR 72203-1437 1-501-661-2623 TDD: 1-800-234-4399

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Sincerely,

Bob Makin, P.E., Assistant Director
Engineering Section

Cc: Martin Maner, ADEQ Water Division
Union County Sanitarian

Arkansas Natural Resources Commission

J. Randy Young, PE
Executive Director

101 East Capitol, Suite 350
Little Rock, Arkansas 72201
http://www.anrc.arkansas.gov/

Phone: (501) 682-1611
Fax: (501) 682-3991
E-mail: anrc@arkansas.gov

Mike Huckabee
Governor

November 8, 2005

Mr. Vince Blubaugh
Principal, CBM^c & Associates
219 Brown Lane
Bryant, Arkansas 72022

RE: Review and Comments
Removal of Designated Domestic Water Supply Use from Loutre Creek

Dear Mr. Blubaugh:

Thank you for the opportunity to review and comment on the removal of the Designated Domestic Water Supply Use from Loutre Creek near El Dorado in Union County, Arkansas. The downstream most coordinates for the reach under review are Latitude 33°11'33.08" and Longitude 92°40'42.39".

The removal of the Designated Domestic Water Supply Use from this reach of Loutre Creek would not conflict with the Arkansas State Water Plan. If you need any further assistance, or have any questions, please contact Steve Loop at (501)-682-3959.

Sincerely,

Earl T. Smith, P.E., Chief
Water Resources Division

219 Brown Lane Bryant, AR 72022 (501) 847-7077 (501) 847-7943 fax

GBM^c

May 31, 2006

Mr. Robert Hart, P.E.
Chief Engineer
Arkansas Department of Health
4815 West Markham Street
Little Rock, AR 72205-3867

Re: Domestic Water Supply Determination
GBM^c No. 2072-05-070 & 2160-05-070

Dear Mr. Hart:

GBM^c & Associates is developing documentation, pursuant to the Arkansas Water Quality Standards, to evaluate removal of the Designated Domestic Water Supply Uses from the upper reach of Bayou De Loutre down to its confluence with Gum Creek near El Dorado, Arkansas. Please see the attached map of the stream reach.

Pursuant to ADEQ policy, we are requesting a determination as to whether this reach of Bayou De Loutre has been approved, or is being considered for use, as a domestic water source.

Thank you for your attention to this request for information. If you have any questions or need additional information please contact me or Roland McDaniel at (501) 847-7077.

Respectfully submitted,
GBM^c & ASSOCIATES

Vince Blubaugh

Vince Blubaugh
Principal

Attachment: Figure 1 – Map of Bayou De Loutre

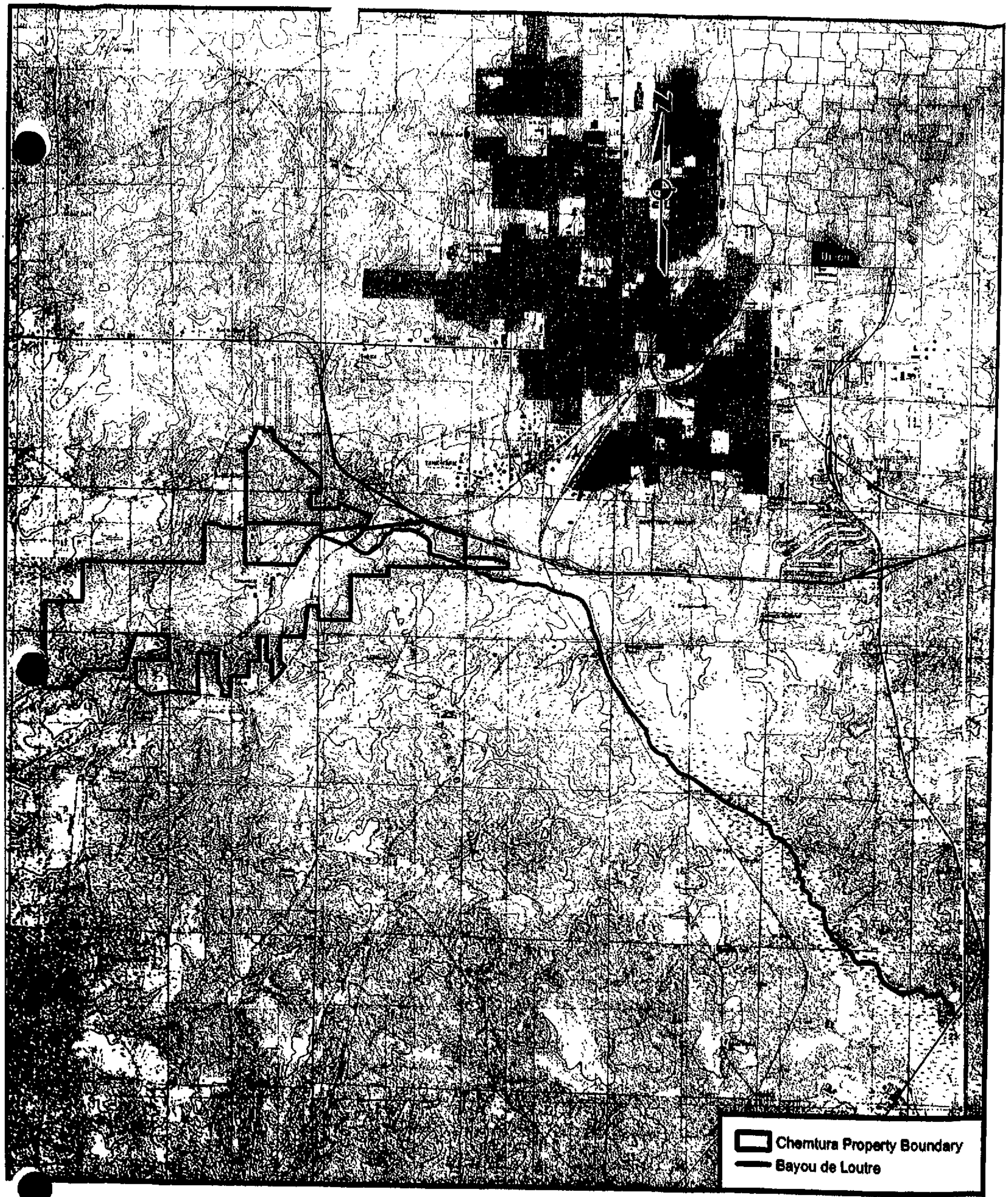


Figure 1. Bayou de Loutre downstream to the mouth of Gum Creek.

219 Brown Lane Bryant, AR 72022 (501) 847-7077 (501) 847-7943 fax

GBM^{c}

May 31, 2006

Mr. Earl T. Smith
Chief Water Management Division
Arkansas Soil and Water Conservation Commission
101 East Capital, Suite 350
Little Rock, AR 72201

Re: Domestic Water Supply Determination
GBM^{c} No. 2160-05-070 & 2072-05-070

Dear Mr. Smith:

GBM^{c} & Associates is developing documentation, pursuant to the Arkansas Water Quality Standards, to evaluate removal of the Designated Domestic Water Supply Use from the upper reach of Bayou De Loutre down to its confluence with Gum Creek near El Dorado. Please see attached map of the stream reach.

Pursuant to ADEQ policy, we are requesting a determination as to whether removal of the Designated Domestic Water Supply Uses from this portion of Bayou De Loutre.

Thank you for your attention to this request for information. If you have any questions or need additional information please contact me or Roland McDaniel at (501) 847-7077.

Respectfully submitted,
GBM^{c} & ASSOCIATES

Vince Blubaugh

Vince Blubaugh
Principal

Attachment: Figure 1 –Map of Bayou De Loutre

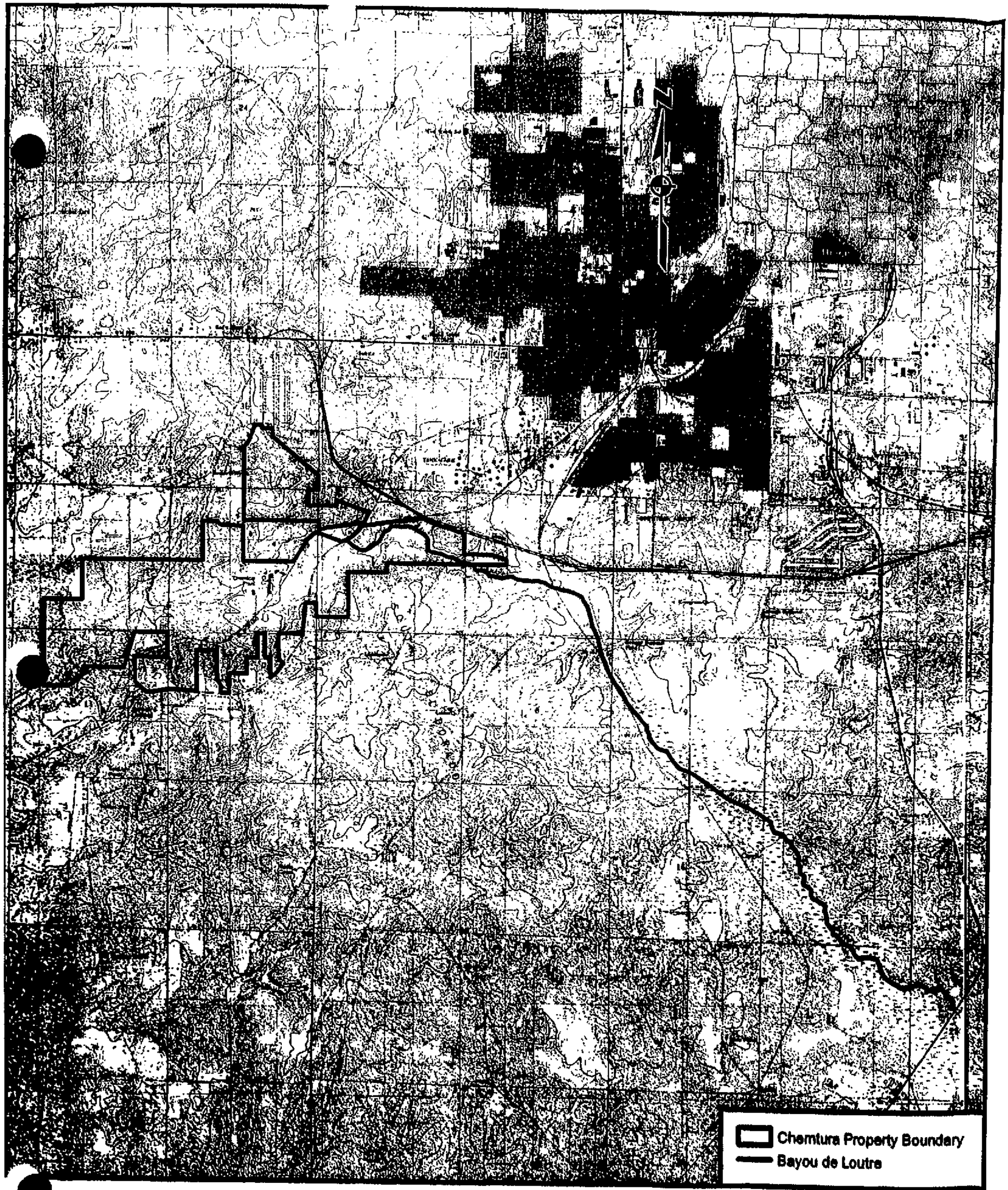


Figure 1. Bayou de Loutre downstream to the mouth of Gum Creek.

Appendix C

DMR and Outfall Specific Mineral Data with Statistical Assessment

FACILITY NAME (1):	GREAT LAKES CHEMICAL CORP-CENT	NPDES :	AR0001171			
FACILITY NAME (2):	RAL PLANT	LIMIT TYPE :	3 = INTERIM			
PIPE NUMBER :	002	SEASON NUM :	0			
REPORT DESIGNATOR :	A	PARAMETER CODE:	50050 = FLOW, IN CONDUIT OR THRU TREATMENT PLANT			
PIPE SET QUALIFIER :	9	MONITORING LOCATION :	1 = EFFLUENT GROSS VALUE			
MODIFICATION NUM :	0					
MONITORING PERIOD END DATE	DISCHARGE IND	MAXIMUM (MGD)	AVERAGE (MGD)	CONC MAXIMUM	CONC AVERAGE	CONC MINIMUM
31-Oct-05		0.043	0.025			
30-Sep-05		0.422	0.059			
31-Aug-05		0.297	0.154			
31-Jul-05		0.173	0.057			
30-Jun-05		0.054	0.021			
31-May-05		0.101	0.025			
30-Apr-05		0.475	0.051			
31-Mar-05		0.137	0.019			
28-Feb-05		0.113	0.018			
31-Jan-05		0.256	0.034			
31-Dec-04		0.262	0.036			
30-Nov-04		0.297	0.04			
31-Oct-04		0.416	0.119			
30-Sep-04	C = NO DISCHARGE					
31-Aug-04		0.095	0.045			
31-Jul-04		0.06	0.043			
30-Jun-04		0.22	0.048			
31-May-04		0.297	0.053			
30-Apr-04		1.1	0.059			
31-Mar-04		0.392	0.045			
29-Feb-04		0.232	0.069			
31-Jan-04		0.214	0.025			
Totals:		**MGD**		**cfs**		
	Average	**0.269**	**0.050**	**0.417**	**0.077**	
	Minimum	**0.043**	**0.018**	**0.067**	**0.028**	
	Maximum	**1.1**	**0.154**	**1.702**	**0.238**	

Summary of DMR values for Chloride, Sulfate, and TDS for GLCC-Central Outfall 002.
Period of Record January 2000 - September 2005

Date	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
1/8/00	587	500	
2/26/00	1407	56	
3/3/00	852	146	
4/7/00	305	150	
5/3/00	669	124	
6/3/00	150	30	
8/29/00	152	41	
9/9/00	233	293	
10/6/00	179	119	
11/4/00	1124	417	
12/13/00	134	25	
1/1/01	506	42	
2/9/01	93	75	
3/8/01	69	26	
4/12/01	59	49	
5/7/01	43	21	
6/4/01	15	15	
7/13/01	832	11	
8/31/01	709	224	
9/9/01	32	153	
10/6/01	125.3	26.1	
11/19/01	57.3	8.8	
12/6/01	163	14.6	
1/5/02	68	20	
2/5/02	134	16.8	
3/1/02	21	11	
3/17/02	115		
4/8/02	119	20	
5/2/02	49	6.7	
6/9/02	1436	8.9	
7/3/02	1.3	31.3	
8/16/02	80	19	

Summary of DMR values for Chloride, Sulfate, and TDS for GLCC-Central Outfall 002.
Period of Record January 2000 - September 2005

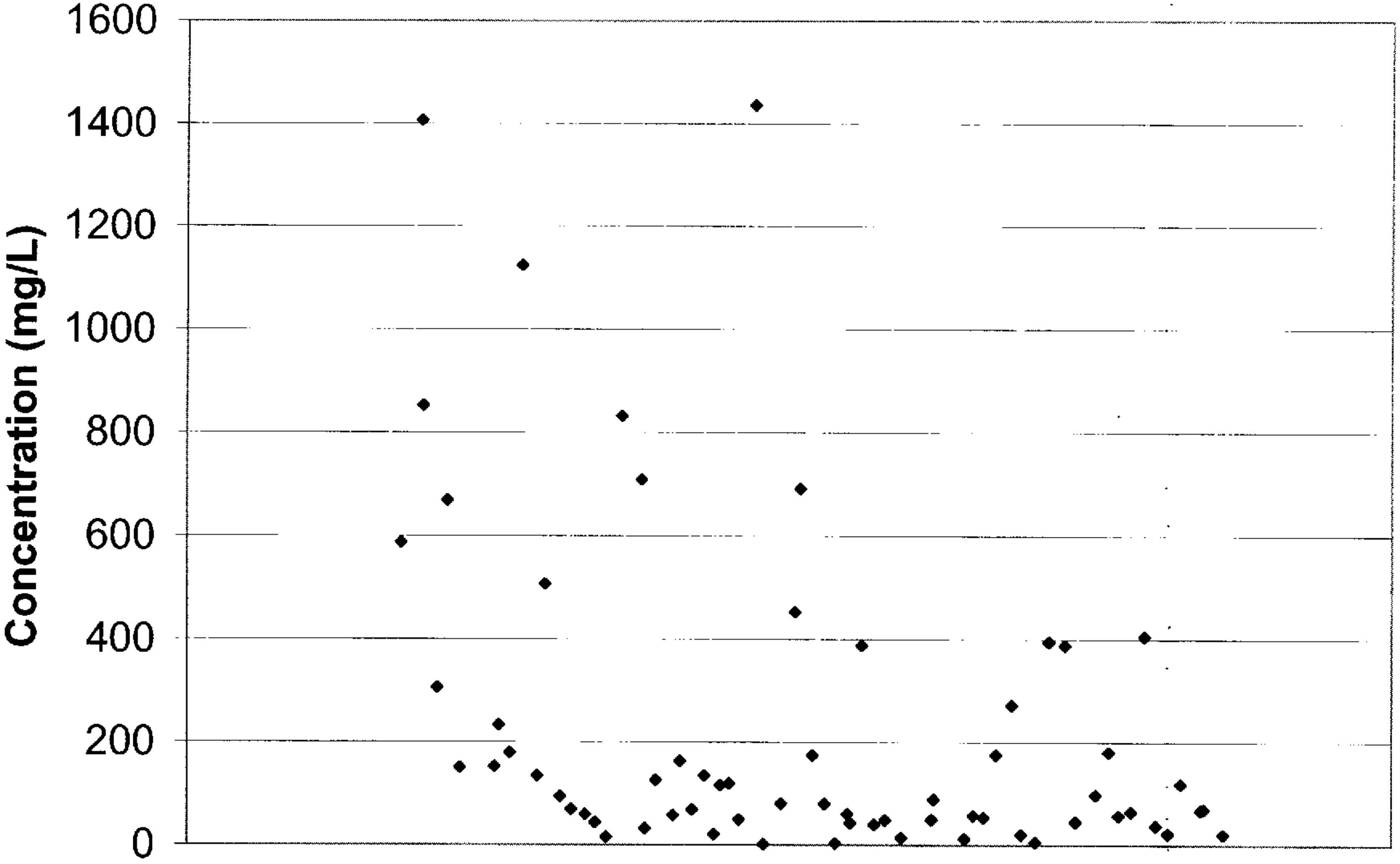
Date	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
9/20/02	452	173	
10/3/02	691	218	
11/3/02	174	105	
12/3/02	79	52	
12/30/02	3	3	
1/29/03	60	22	
2/5/03	42	15.5	
3/5/03	388	19	
4/6/03	39	11	
5/3/03	48	6.3	
6/12/03	14	19	
8/27/03	49	23	
9/1/03	88	211	
11/18/03	12	10	
12/9/03	57	137	
1/4/04	53	146	556
2/4/04	175	16	352
3/14/04	271	19	770
4/7/04	20	8	3
5/12/04	5	7	270
6/15/04	395	6	1239
7/25/04	388	869	1376
8/20/04	44.9	64.5	214
10/9/04	96.4	27.8	348
11/10/04	180	49	570
12/5/04	57	23	235
1/5/05	64	27	492
2/7/05	405	24	1086
3/7/05	37	9	326
4/6/05	22	7	186
5/8/05	118	12.5	522
6/26/05	67	38	429
7/3/05	69	27	1147
8/21/05	20.2	25.7	210
9/13/05	5333	72	11015
9/15/05	6961	59	13842

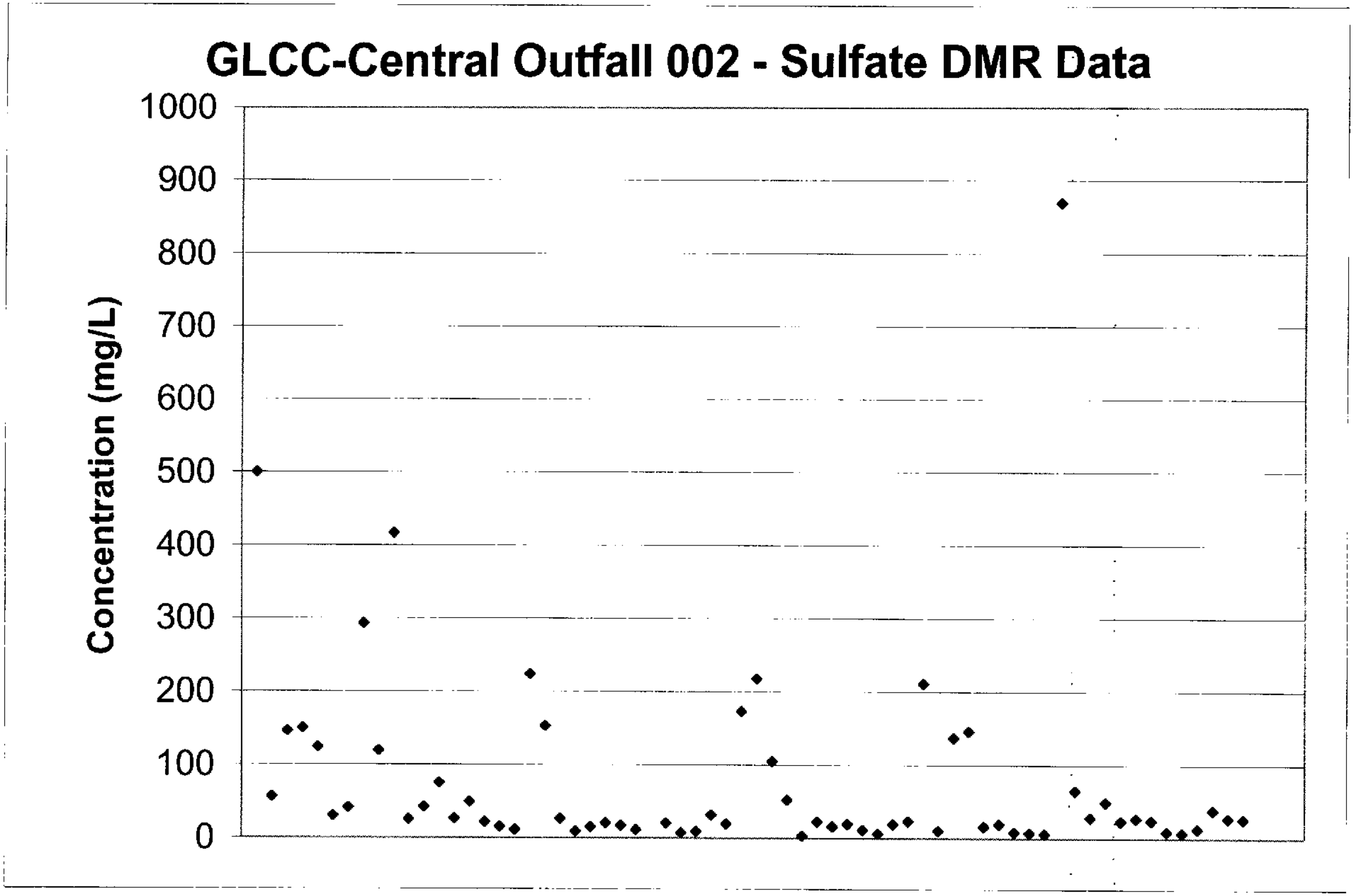
Summary of DMR values for Chloride, Sulfate, and TDS for GLCC-Central Outfall 002.
Period of Record January 2000 - September 2005

Date	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
Statistics	**Chlorides (mg/l)**	**Sulfate (mg/l)**	**TDS (mg/l)**
Data Characterization			
99th%tile	1417	633	1351
95th%tile	847	279	1253
average	230	78.9	544
maximum	1436	869	1376
minimum	1.30	3.00	3.40
median	90.5	25.7	429
count	66	65	19
standard deviation	321	138	397
CV	1.39	1.75	0.73
Pn	0.93	0.93	0.78
99%	0.99	0.99	0.99
95%	0.95	0.95	0.95
Z for 99 %tile	2.33	2.33	2.33
Z for 95 %tile	1.64	1.64	1.64
99% Value	**1436**	**869**	**1376**
95% Value	**1029**	**380**	**1376**
	ORDER STATS	**ORDER STATS**	**ORDER STATS**

	k	value	k	value	k	value
Order Stats (95)	63.65	**1029**	62.70	**380**	19	**1376**
Order Stats (99)	66.33	**1436**	65.34	**869**	19.8	**1376**

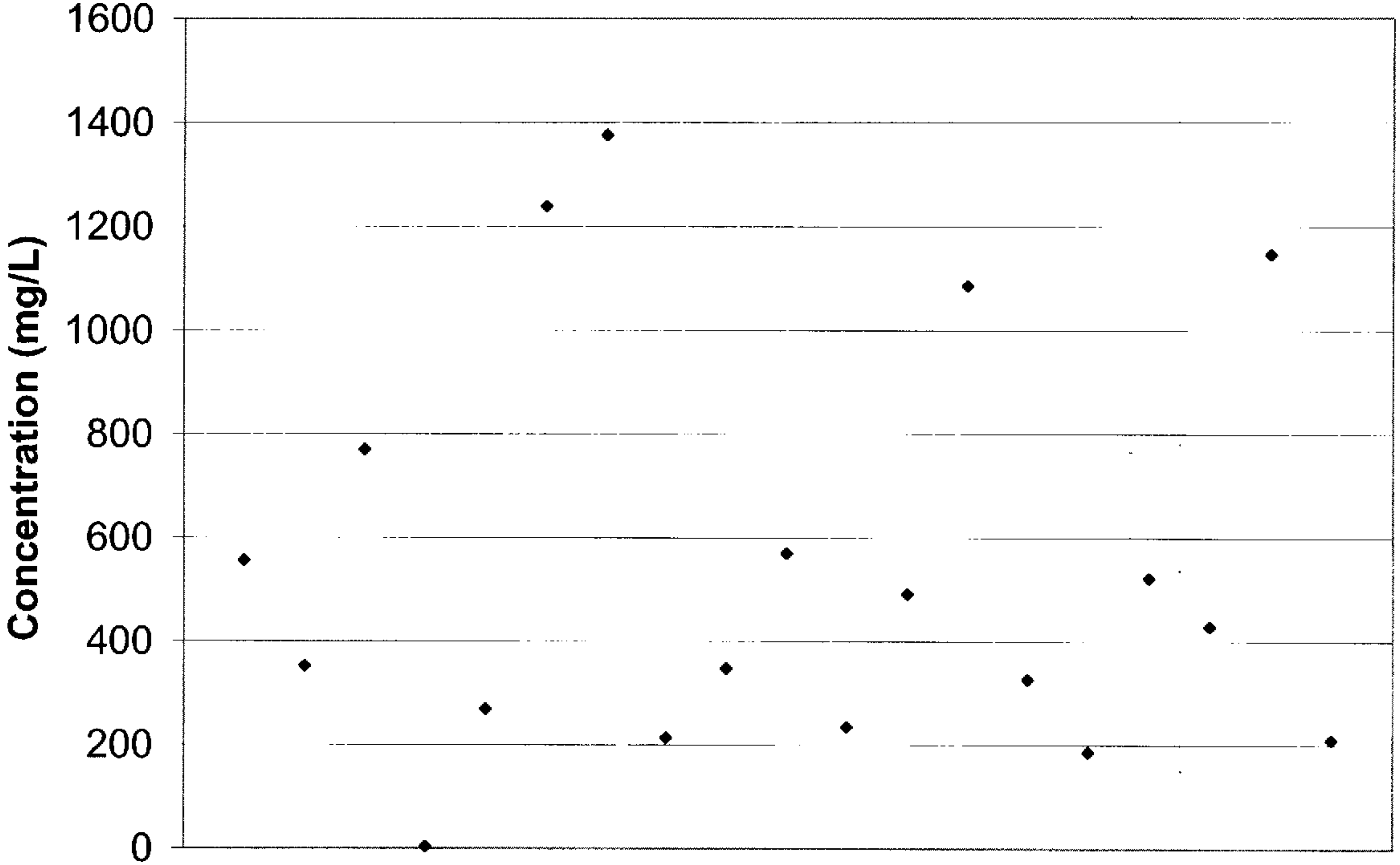
GLCC-Central Outfall 002 - Chloride DMR Data

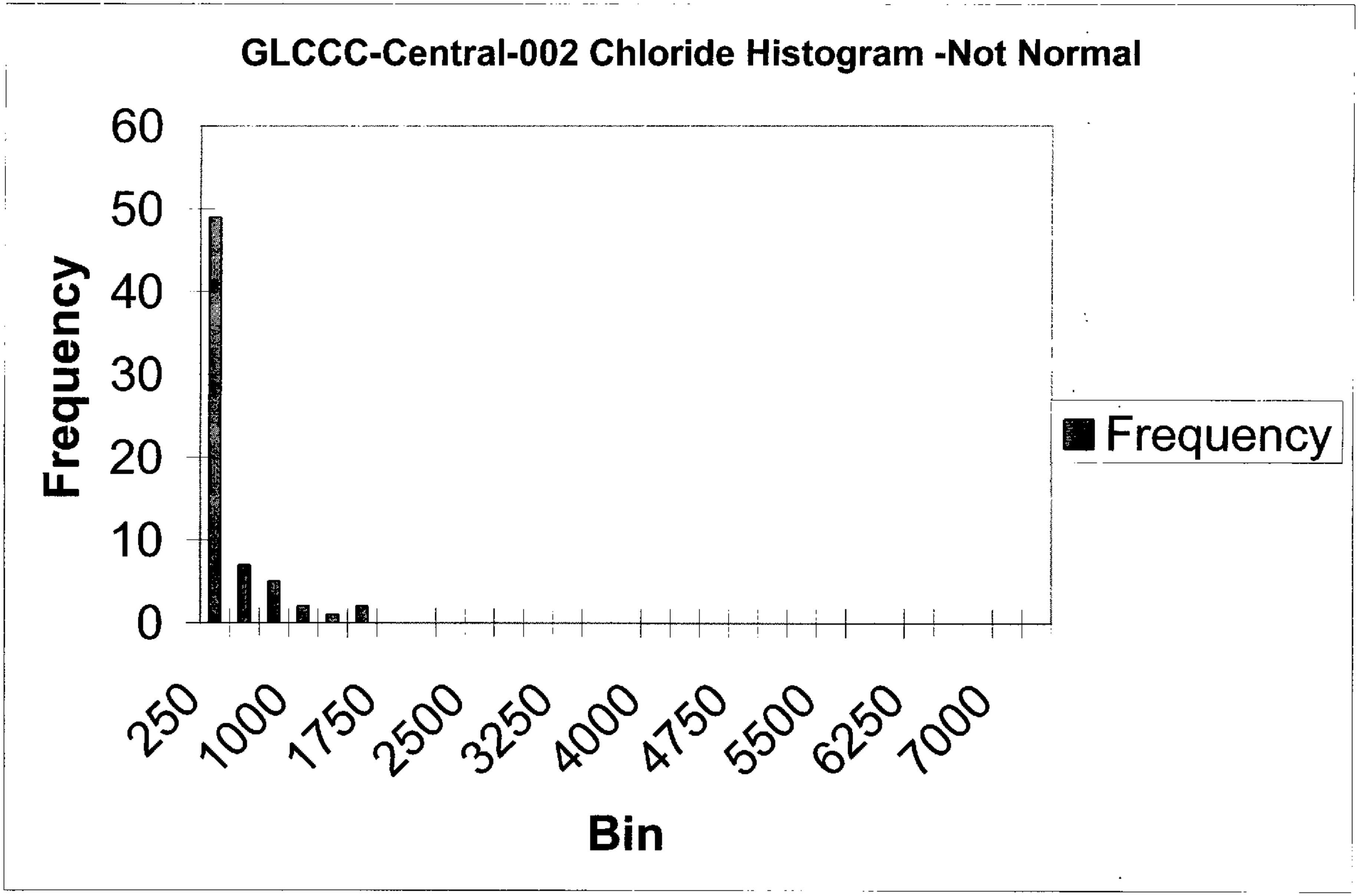




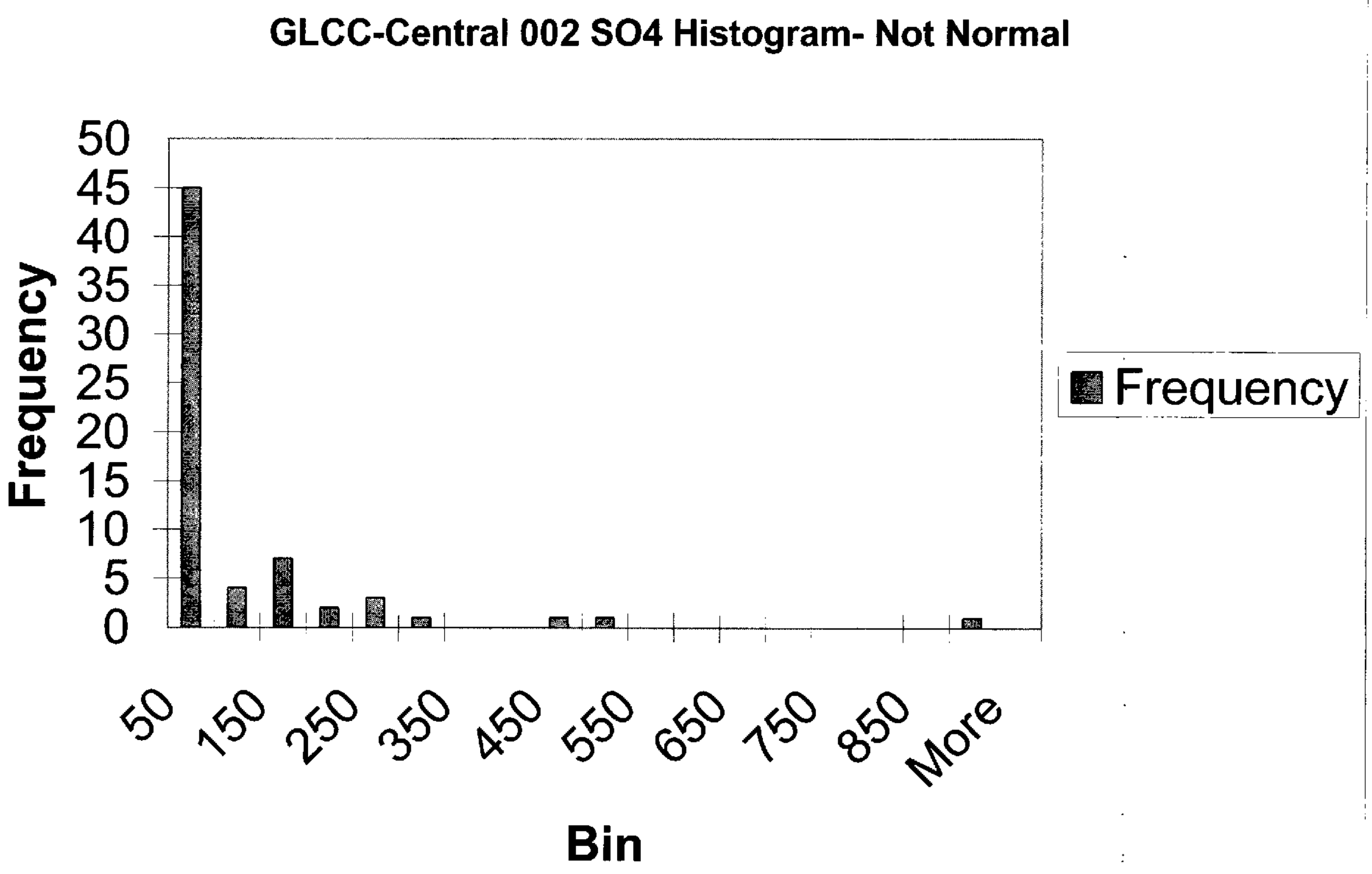
GLCC-Central Outfall 002 - Sulfate DMR Data

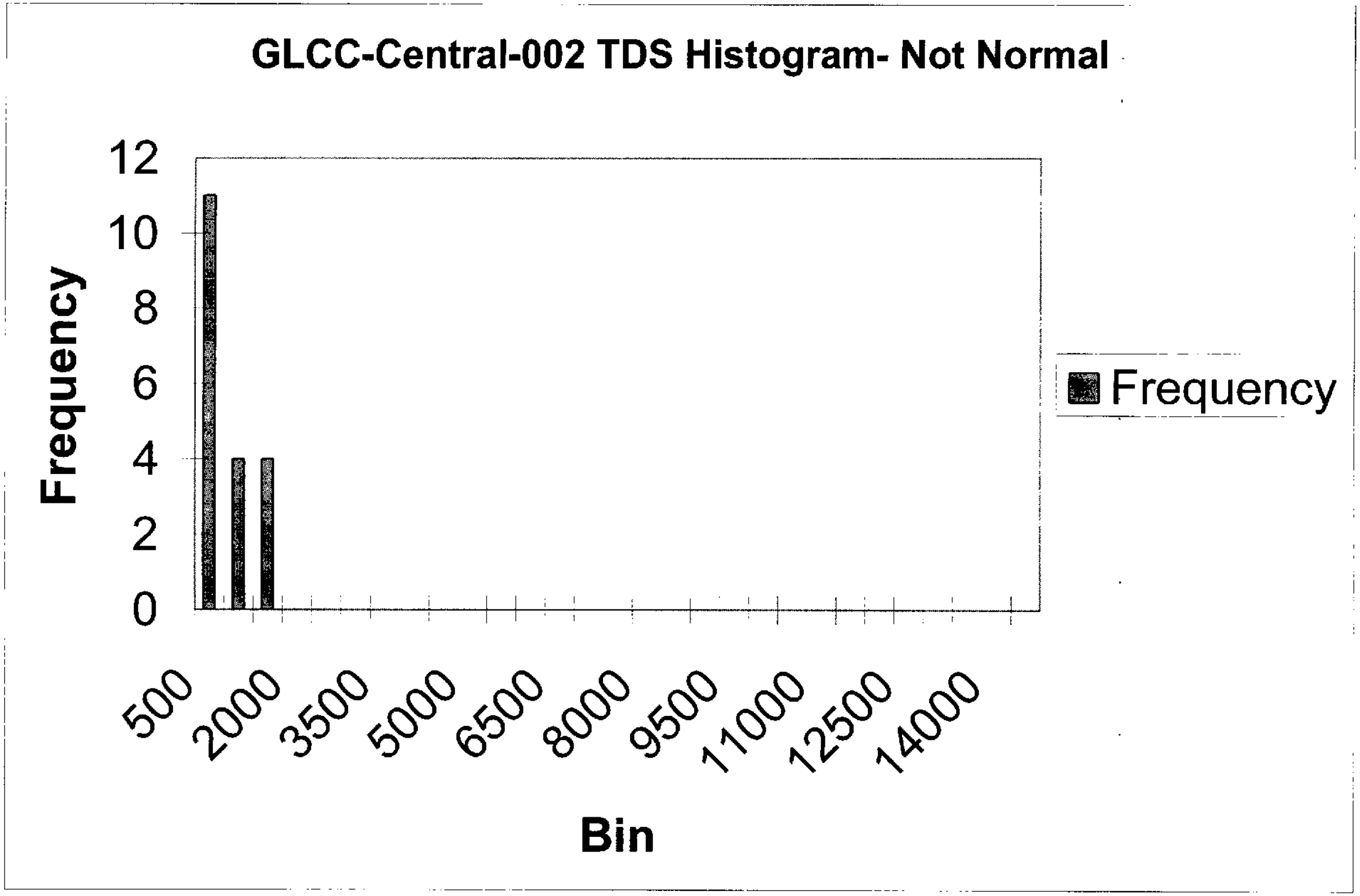
GLCC-Central Outfall 002 - TDS DMR Data





GLCCC-Central-002 Chloride Histogram -Not Normal
Frequency
60
50
40
30
20
10
0
250
1000
1750
2500
3250
4000
4750
5500
6250
7000
Bin
Frequency


GLCC-Central 002 SO4 Histogram- Not Normal
Frequency
50
45
40
35
30
25
20
15
10
5
0
50
150
250
350
450
550
650
750
850
More
Bin
Frequency



GLCC-Central-002 TDS Histogram- Not Normal

FACILITY NAME (1):	GREAT LAKES CHEMICAL CORP-CENT	NPDES :	AR0001171			
FACILITY NAME (2):	RAL PLANT	LIMIT TYPE :	3 = INTERIM			
PIPE NUMBER :	003	SEASON NUM :	0			
REPORT DESIGNATOR :	A	PARAMETER CODE:	50050 = FLOW, IN CONDUIT OR THRU TREATMENT PLANT			
PIPE SET QUALIFIER :	9	MONITORING LOCATION :	1 = EFFLUENT GROSS VALUE			
MODIFICATION NUM :	0					
MONITORING PERIOD END DATE	DISCHARGE IND	MAXIMUM (MGD)	AVERAGE (MGD)	CONC MAXIMUM	CONC AVERAGE	CONC MINIMUM
31-Oct-05		1.083	0.069			
30-Sep-05		3.843	0.416			
31-Aug-05		2.328	0.236			
31-Jul-05		1.57	0.283			
30-Jun-05		0.054	0.022			
31-May-05		0.92	0.137			
30-Apr-05		4.331	0.459			
31-Mar-05		1.245	0.174			
28-Feb-05		1.029	0.156			
31-Jan-05		2.328	0.313			
31-Dec-04		2.382	0.327			
30-Nov-04		2.707	0.359			
31-Oct-04		3.789	0.747			
30-Sep-04		1.245	0.1			
31-Aug-04		0.866	0.099			
31-Jul-04		0.542	0.197			
30-Jun-04		2.003	0.428			
31-May-04		2.707	0.391			
30-Apr-04		1.191	0.242			
31-Mar-04		3.573	0.406			
29-Feb-04		2.111	0.626			
31-Jan-04		1.95	0.408			
Totals:		MGD		cfs		
	Average	**1.991**	**0.300**	**3.080**	**0.464**	
	Minimum	**0.054**	**0.022**	**0.084**	**0.034**	
	Maximum	**4.331**	**0.747**	**6.701**	**1.156**	

Summary of DMR values for Chloride, Sulfate, and TDS for GLCC-Central Outfall 003.
Period of Record January 2000 - October 2005

Date	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
1/3/00	253	33	
2/18/00	581	43	
3/3/00	2789	67	
4/7/00	318	21	
5/3/00	370	93	
6/3/00	101	20	
7/22/00	1406	136	
8/11/00	5437	61	
8/29/00	1445	75	
9/9/00	[redacted]	7.3	
10/6/00	236	13	
11/2/00	4094	49	
12/13/00	50	11	
12/25/00	15	9	
1/1/01	436	40	
2/9/01	422	32	
3/9/01	261	56	
4/12/01	83	29	
5/7/01	72	12	
6/4/01	93	31	
7/13/01	359	30	
8/13/01	90.3	10.3	
9/9/01	47	35	
10/6/01	220	52.1	
11/26/01	198	27	
1/5/02	392	32	
2/5/02	107	62.1	
3/1/02	206	33	
3/17/02	44		
4/8/02	96	8	
5/2/02	1158	79	
6/9/02	232	34.3	
7/3/02	106	54	
8/14/02	2150	197	
9/19/02	552	101	
10/3/02	1213	79	
11/3/02	193	46	
12/3/02	259	35	
12/30/02	400	75	

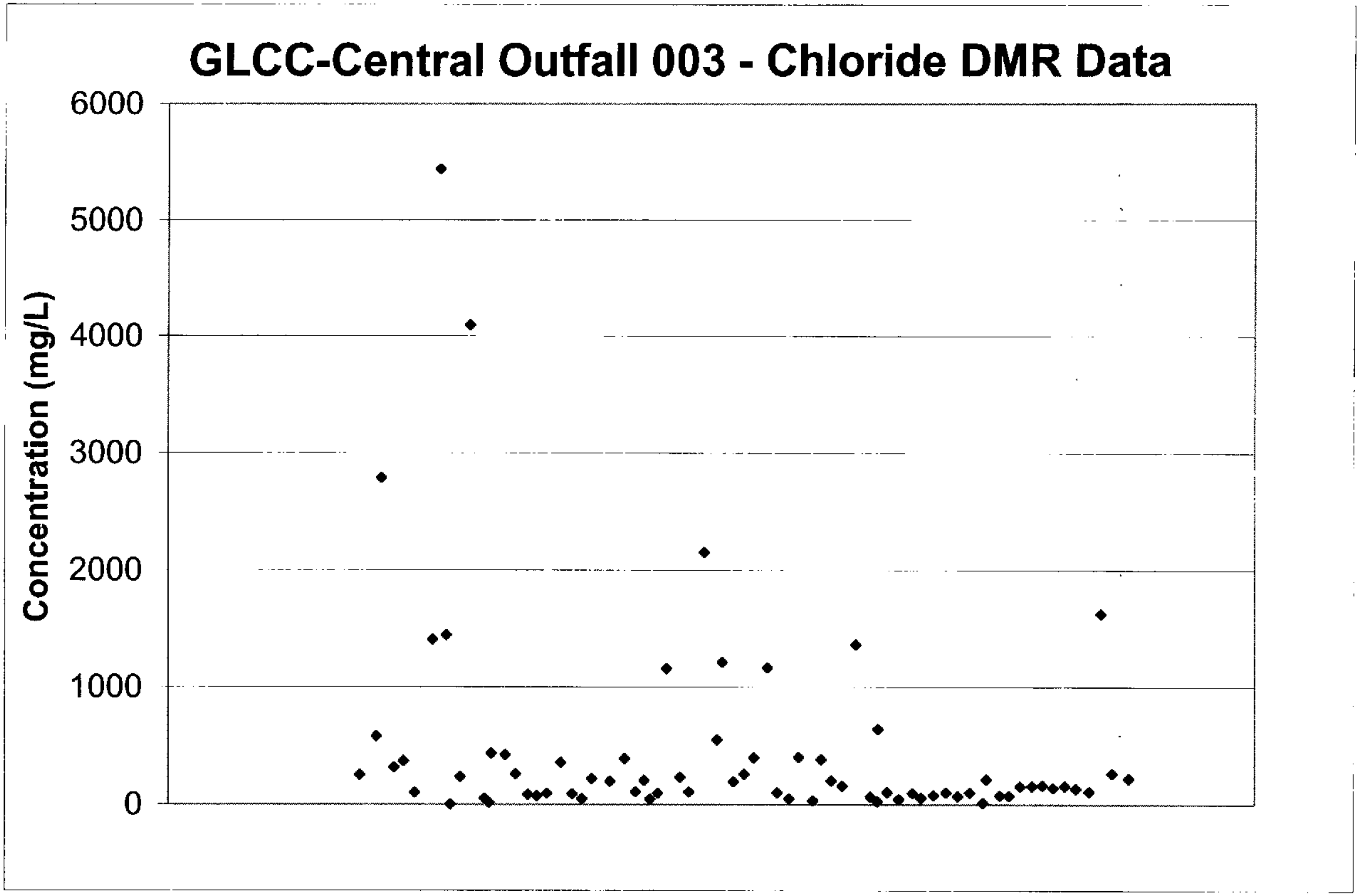
Summary of DMR values for Chloride, Sulfate, and TDS for GLCC-Central Outfall 003.
Period of Record January 2000 - October 2005

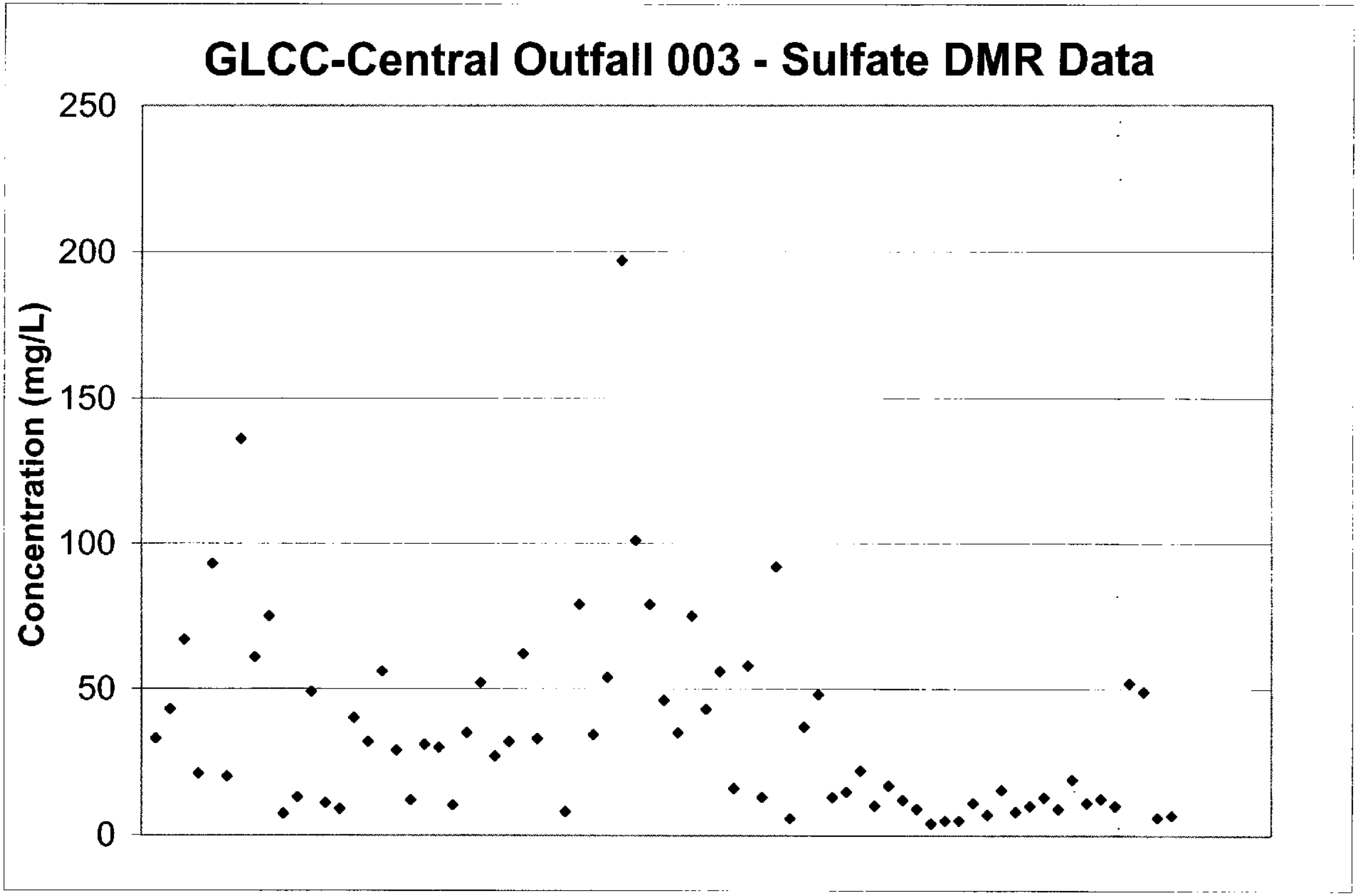
Date	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
2/5/03	1166	43	
3/5/03	100	56	
4/6/03	48	16	
5/3/03	403	58	
6/12/03	33	13	
7/5/03	385	92	
8/2/03	204	5.7	
9/1/03	159	37	
10/9/03	1364	48	
11/18/03	66	13	
12/7/03	25.3	14.8	
12/9/03	642	22	
1/4/04	104	10	343
2/4/04	42	17	635
3/14/04	95	12	206
4/7/04	56	9	395
5/11/04	78	4	302
6/15/04	102	5	330
7/17/04	69	5	271
8/19/04	100	11	441
9/24/04	13	7	96
10/4/04	213	15.5	658
11/10/04	75	8	266
12/5/04	74	10	409
1/5/05	155	13	474
2/7/05	156	9	608
3/7/05	163	19	3699
4/6/05	141	11	699
5/8/05	156	12.5	444
6/7/05	135	10	340
7/14/05	107	52	460
8/15/05	1624	49	2726
9/15/05	265	6	743
10/31/05	222	6.8	500

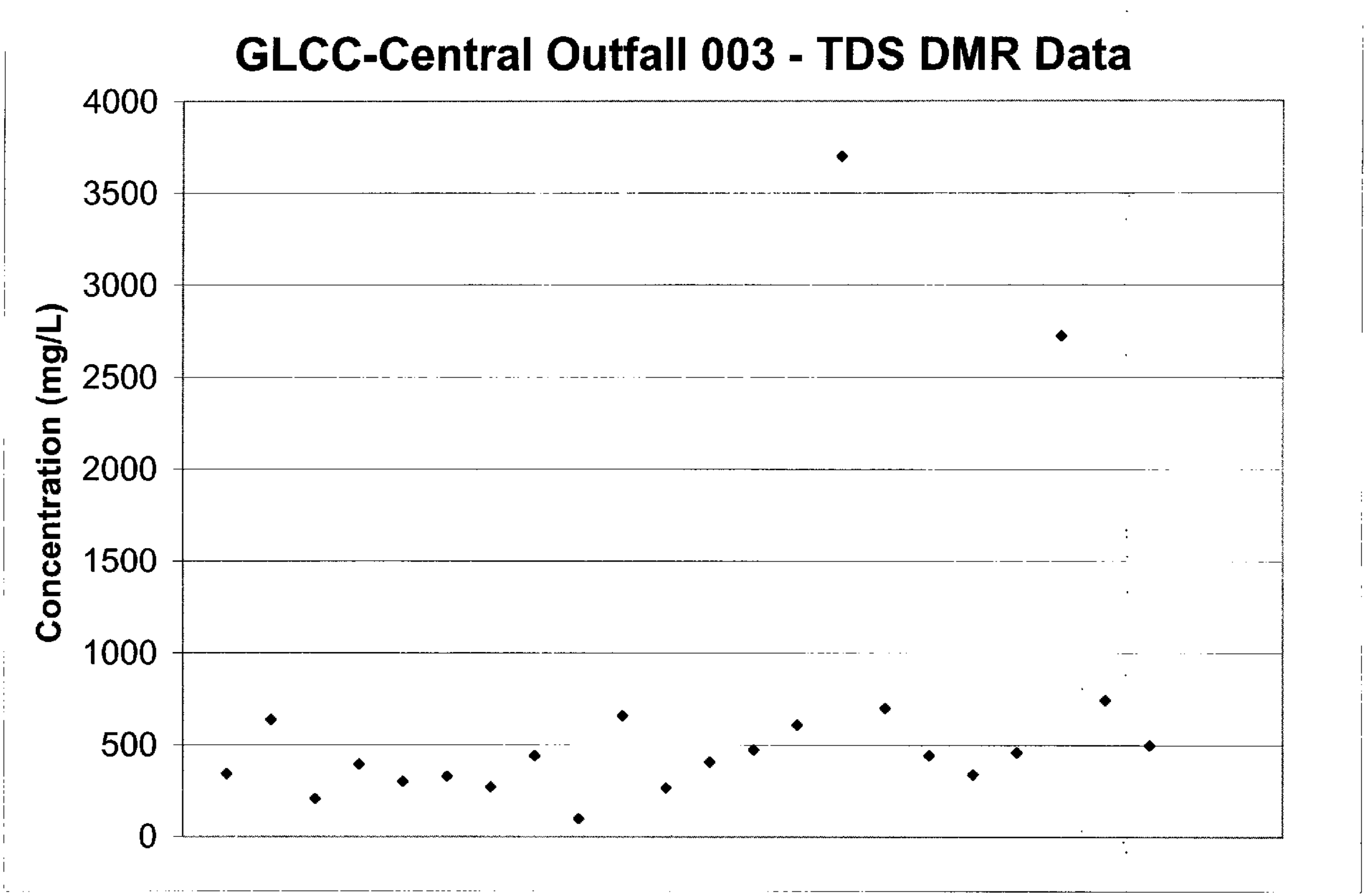
Summary of DMR values for Chloride, Sulfate, and TDS for GLCC-Central Outfall 003.
Period of Record January 2000 - October 2005

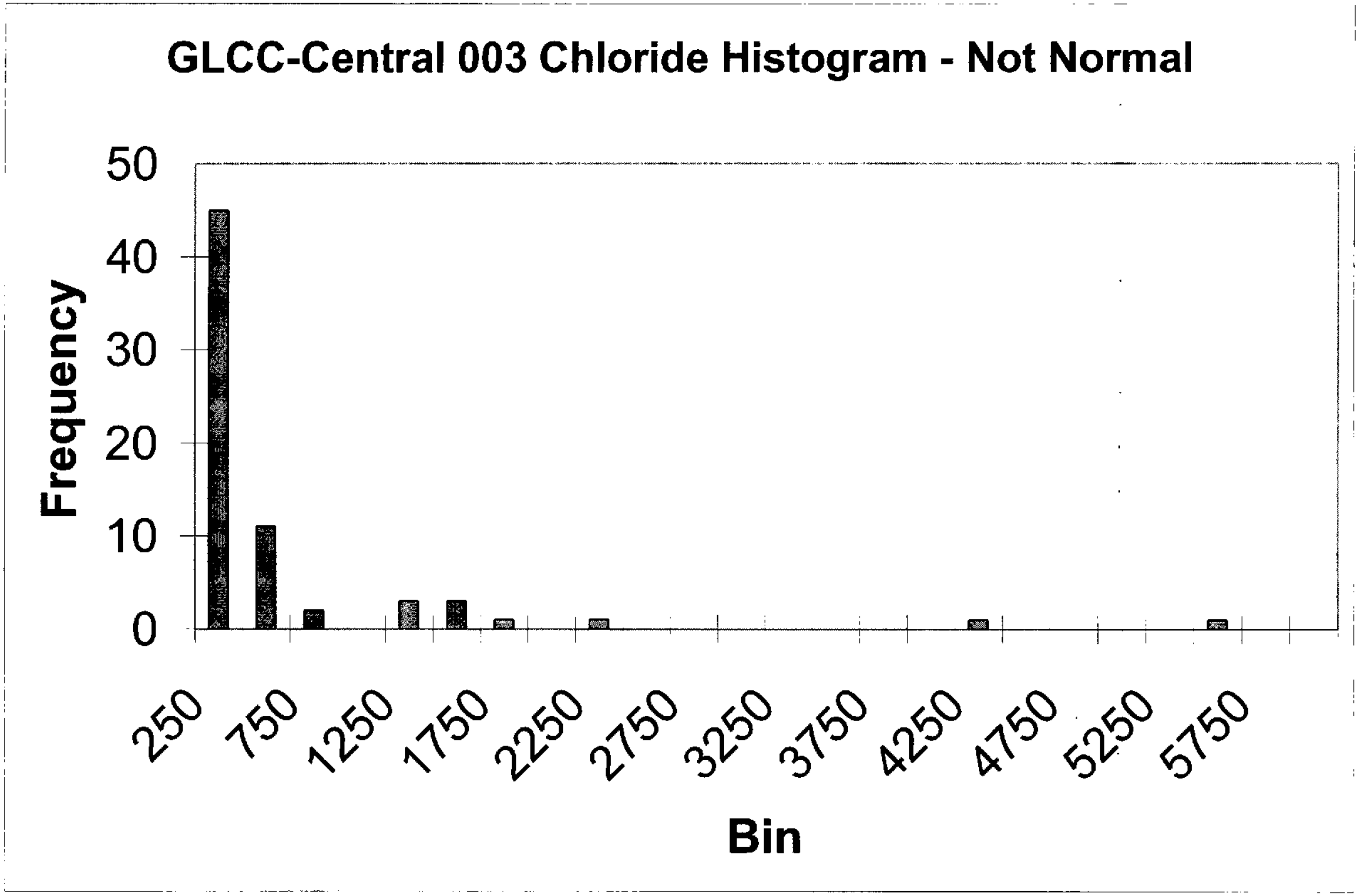
Date	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
Statistics	**Chlorides (mg/l)**	**Sulfate (mg/l)**	**TDS (mg/l)**
Data Characterization			
99th%tile	4483	154	3495
95th%tile	1861	92.5	2627
average	489	35.4	684
maximum	5437	197	3699
minimum	13.0	4.00	96.0
median	178	28.0	443
count	72	72	22
standard deviation	901	33.7	848
CV	1.84	0.95	1.24
Pn	0.94	0.94	0.81
99%	0.99	0.99	0.99
95%	0.95	0.95	0.95
Z for 99 %tile	2.33	2.33	2.33
Z for 95 %tile	1.64	1.64	1.64
99% Value	**5437**	**197**	**2657**
95% Value	**2374**	**95.8**	**2079**
	ORDER STATS	**ORDER STATS**	**NORMAL FORMULA**

	k	value	k	value
99%	72.27	**5437**	72.27	**197**
95%	69.35	**2374**	69.35	**96**
	639		8	
	63.9		0.8	
	223.65		2.8	
	2373.65		95.8	

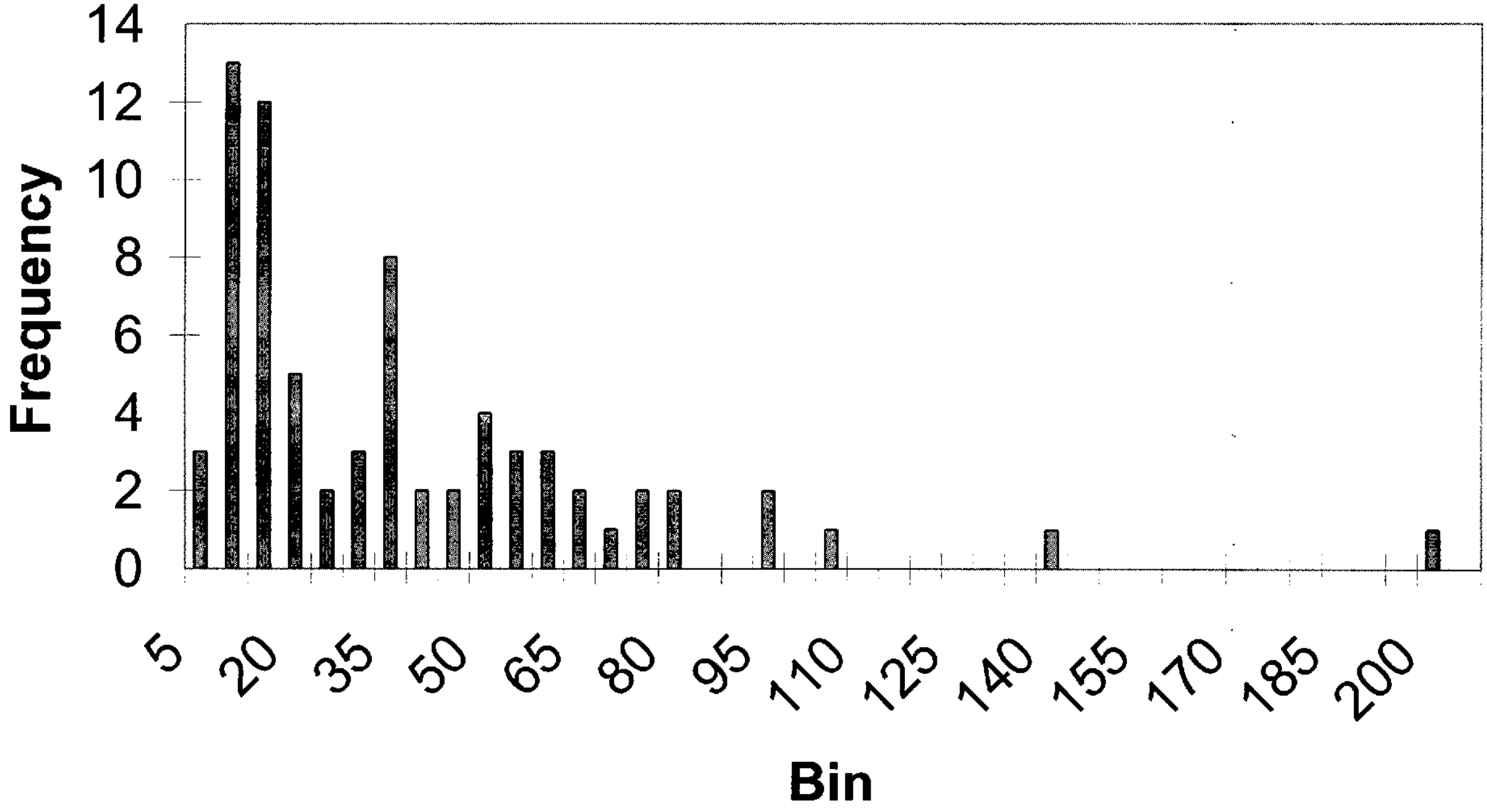

GLCC-Central Outfall 003 - Chloride DMR Data
Concentration (mg/L)
6000
5000
4000
3000
2000
1000
0

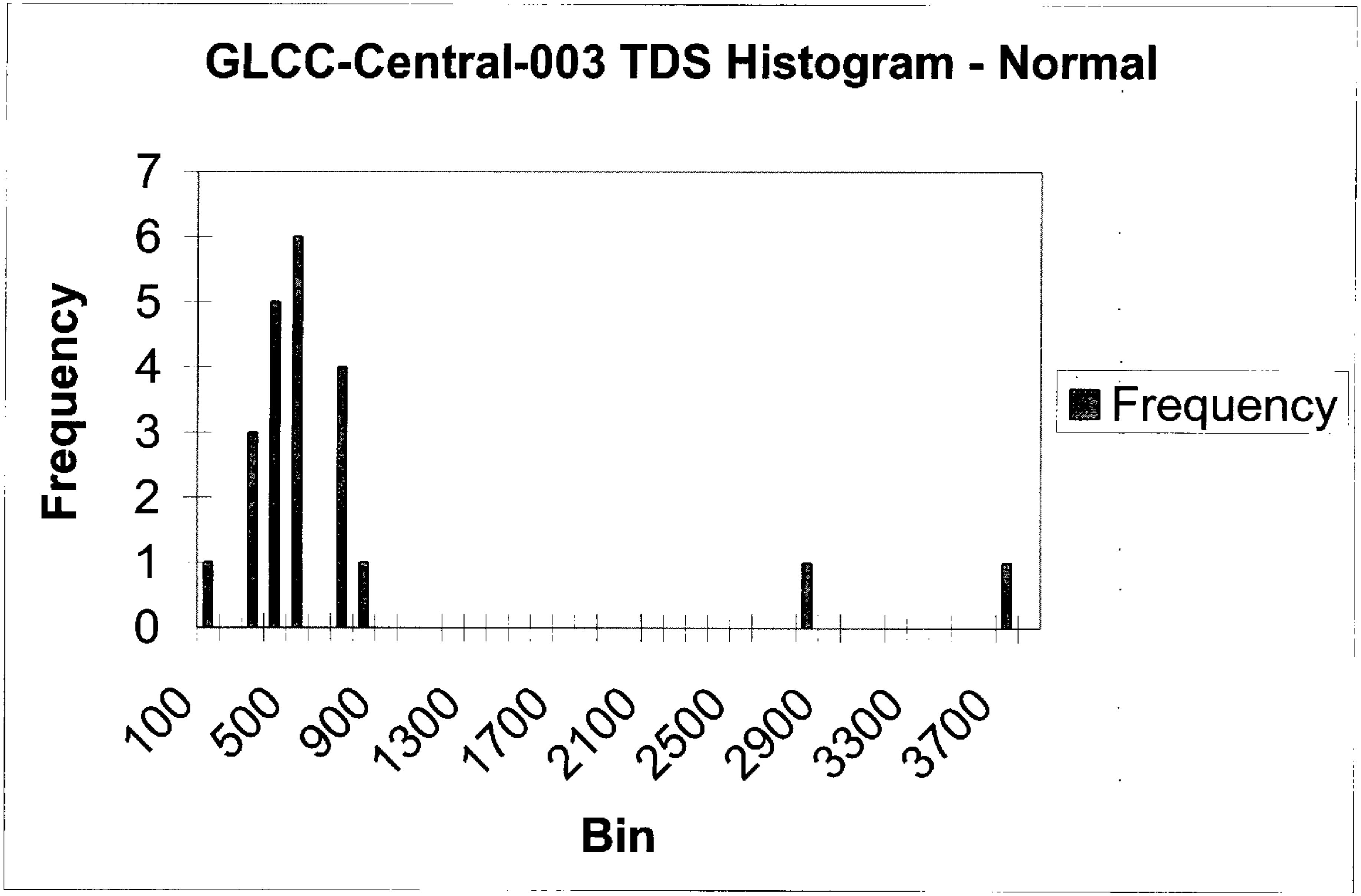

GLCC-Central Outfall 003 - Sulfate DMR Data
Concentration (mg/L)
250
200
150
100
50
0


GLCC-Central Outfall 003 - TDS DMR Data
Concentration (mg/L)
4000
3500
3000
2500
2000
1500
1000
500
0


GLCC-Central 003 Chloride Histogram - Not Normal

GLCC-Central-003 SO4 Histogram - Not Normal




GLCC-Central-003 TDS Histogram - Normal
Frequency
7
6
5
4
3
2
1
0
100
500
900
1300
1700
2100
2500
2900
3300
3700
Bin
▩ Frequency

FACILITY NAME (1):	GREAT LAKES CHEMICAL CORP-CENT	NPDES :	AR0001171			
FACILITY NAME (2):	RAL PLANT	LIMIT TYPE :	3 = INTERIM			
PIPE NUMBER :	004	SEASON NUM :	0			
REPORT DESIGNATOR :	A	PARAMETER CODE:	50050 = FLOW, IN CONDUIT OR THRU TREATMENT PLANT			
PIPE SET QUALIFIER :	9	MONITORING LOCATION :	1 = EFFLUENT GROSS VALUE			
MODIFICATION NUM :	0					
MONITORING PERIOD END DATE	DISCHARGE IND	MAXIMUM (MGD)	AVERAGE (MGD)	CONC MAXIMUM	CONC AVERAGE	CONC MINIMUM
31-Oct-05		0.36	0.36			
30-Sep-05		0.747	0.327			
31-Aug-05		0.387	0.24			
31-Jul-05		0.261	0.19			
30-Jun-05	C = NO DISCHARGE					
31-May-05		0.183	0.173			
30-Apr-05		0.72	0.108			
31-Mar-05		0.207	0.04			
28-Feb-05		0.171	0.026			
31-Jan-05		0.387	0.052			
31-Dec-04		0.396	0.054			
30-Nov-04		0.45	0.059			
31-Oct-04		0.63	0.21			
30-Sep-04		0.414	0.414			
31-Aug-04		0.144	0.022			
31-Jul-04		0.09	0.033			
30-Jun-04		0.333	0.085			
31-May-04		0.45	0.104			
30-Apr-04		0.198	0.063			
31-Mar-04		0.594	0.068			
29-Feb-04		0.351	0.104			
31-Jan-04		0.324	0.042			
Totals:		**MGD**		**cfs**		
	Average	**0.371**	**0.132**	**0.574**	**0.204**	
	Minimum	**0.090**	**0.022**	**0.139**	**0.034**	
	Maximum	**0.747**	**0.414**	**1.156**	**0.641**	

Summary of DMR values for Chloride, Sulfate, and TDS for GLCC-Central Outfall 004.
Period of Record January 2000 - October 2005

Date	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
1/3/00	72	19	
2/18/00	40	39	
3/3/00	367	28	
4/7/00	336	147	
5/3/00	41	46	
6/3/00	51	130	
9/24/00	33	16	
10/6/00	65	11	
11/4/00	83	25	
1/1/01	390	38	
2/9/01	781	40	
3/8/01	210	38	
4/12/01	44	20	
5/7/01	14	6	
6/4/01	31	16	
7/13/01	30	14	
8/13/01	21.8	4.6	
9/9/01	22	19	
10/11/01	9	11	
11/26/01	37	15	
12/6/01	38.2	9.1	
1/5/02	1470	30	
2/5/02	260	21.9	
3/1/02	1827	18	
3/17/02	209		
4/8/02	32.1	10.9	
5/2/02	33	13	
6/9/02	33	14.8	
7/3/02	63	15	
8/14/02	50	14	
9/19/02	45	12.9	
10/3/02	55	11	

Summary of DMR values for Chloride, Sulfate, and TDS for GLCC-Central Outfall 004.
Period of Record January 2000 - October 2005

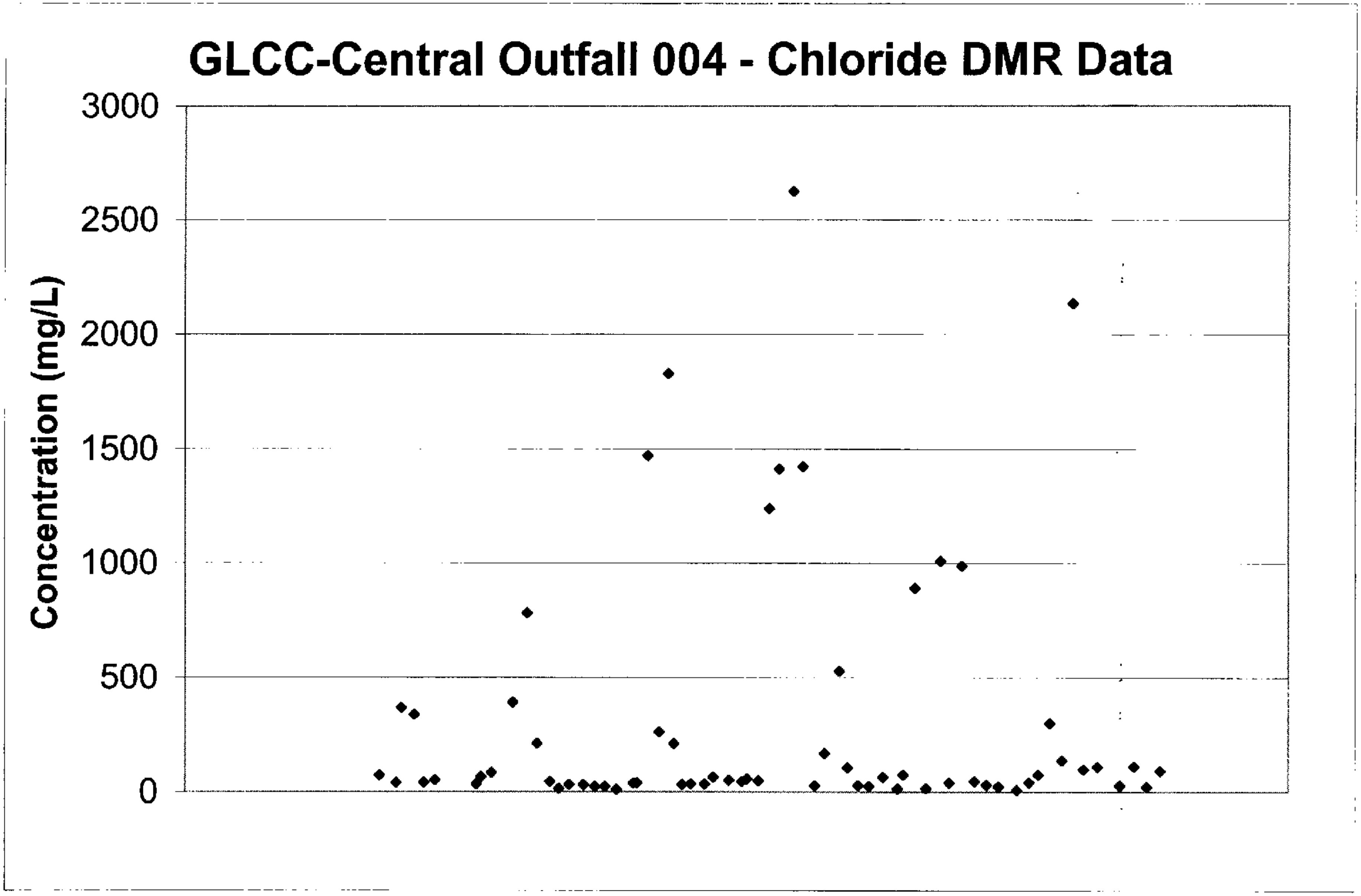
Date	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
11/3/02	48	9	
12/3/02	1239	19	
12/30/02	1411	15	
2/5/03	2625	17.3	
3/5/03	1422	18	
4/6/03	26	11	
5/3/03	167	8.2	
6/12/03	528	81	
7/5/03	104	56	
8/2/03	27	16	
9/1/03	23	11	
10/9/03	63	28	
11/18/03	12	8	
12/3/03	73	28	
1/4/04	890	22	1561
2/4/04	15	8	184
3/14/04	1009	18	2089
4/7/04	39	5	203
5/11/04	987	13	2881
6/15/04	45	18	
7/17/04	29	19	306
8/19/04	22	29	235
10/7/04	6	12	160
11/10/04	40	18	227
12/5/04	74	10	409
1/5/05	299	30	900
2/7/05	136	18	553
3/7/05	2136	41	1342
4/6/05	97	12	399
5/14/05	108	12.5	324
7/13/05	26	14	605
8/21/05	110	17.4	350
9/24/05	21.27	12.72	220
10/31/05	91	22	345

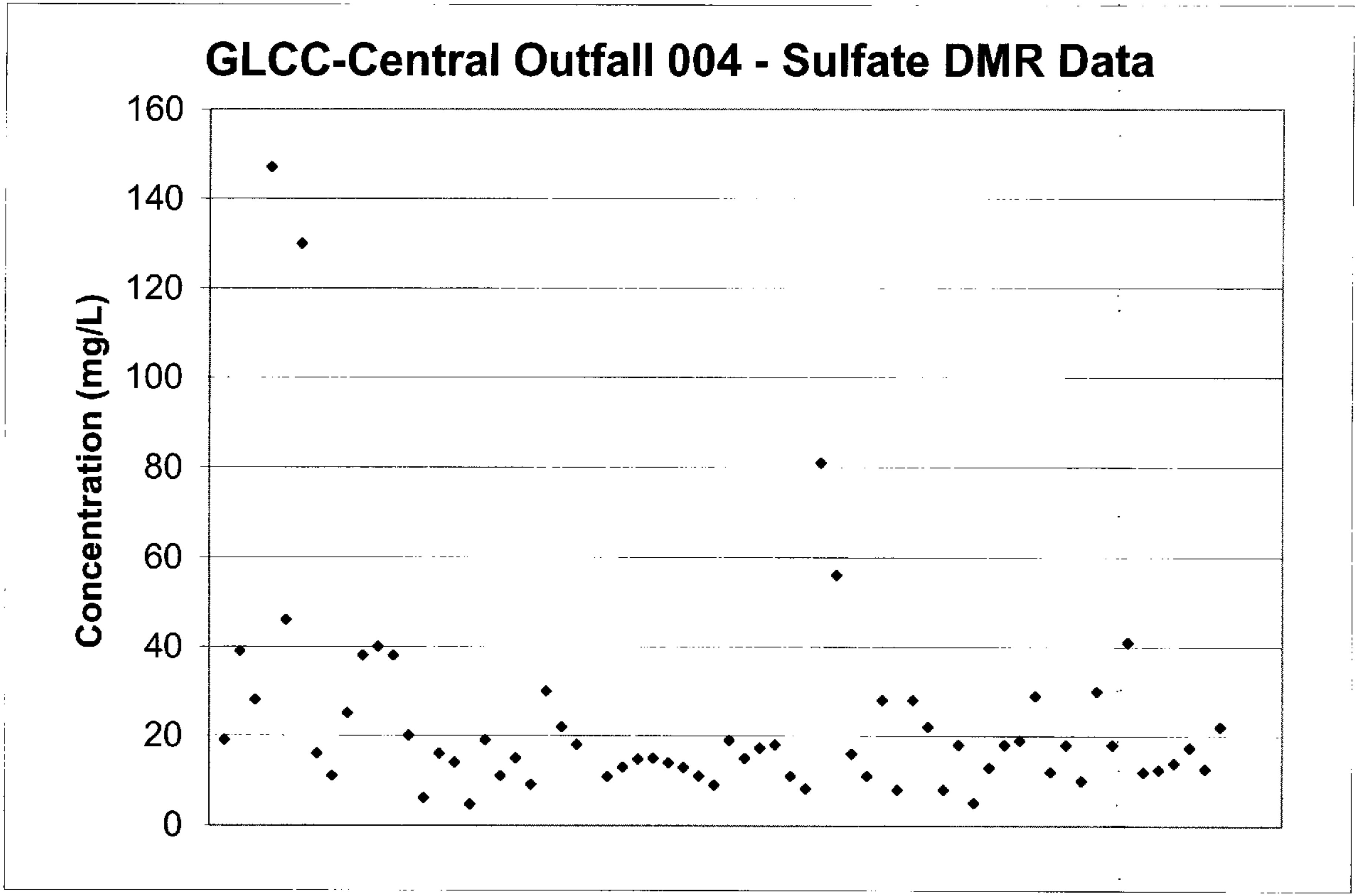
Summary of DMR values for Chloride, Sulfate, and TDS for GLCC-Central Outfall 004.
Period of Record January 2000 - October 2005

Date	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)
Statistics	**Chlorides (mg/l)**	**Sulfate (mg/l)**	**TDS (mg/l)**
Data Characterization			
99th%tile	2307	136	2738
95th%tile	1458	54.0	2168
average	314	23.5	700
maximum	2625	147	2881
minimum	6.00	4.60	160
median	59.0	17.3	350
count	66	65	19
standard deviation	561	24.4	749
CV	1.79	1.04	1.07
Pn	0.93	0.93	0.78
99%	0.99	0.99	0.99
95%	0.95	0.95	0.95
Z for 99 %tile	2.33	2.33	2.33
Z for 95 %tile	1.64	1.64	1.64
99% Value	**2625**	**80.3**	**2442.7**
95% Value	**1702**	**63.7**	**1932.1**
	ORDER STATS	**NORMAL FORMULA**	**NORMAL FORMULA**

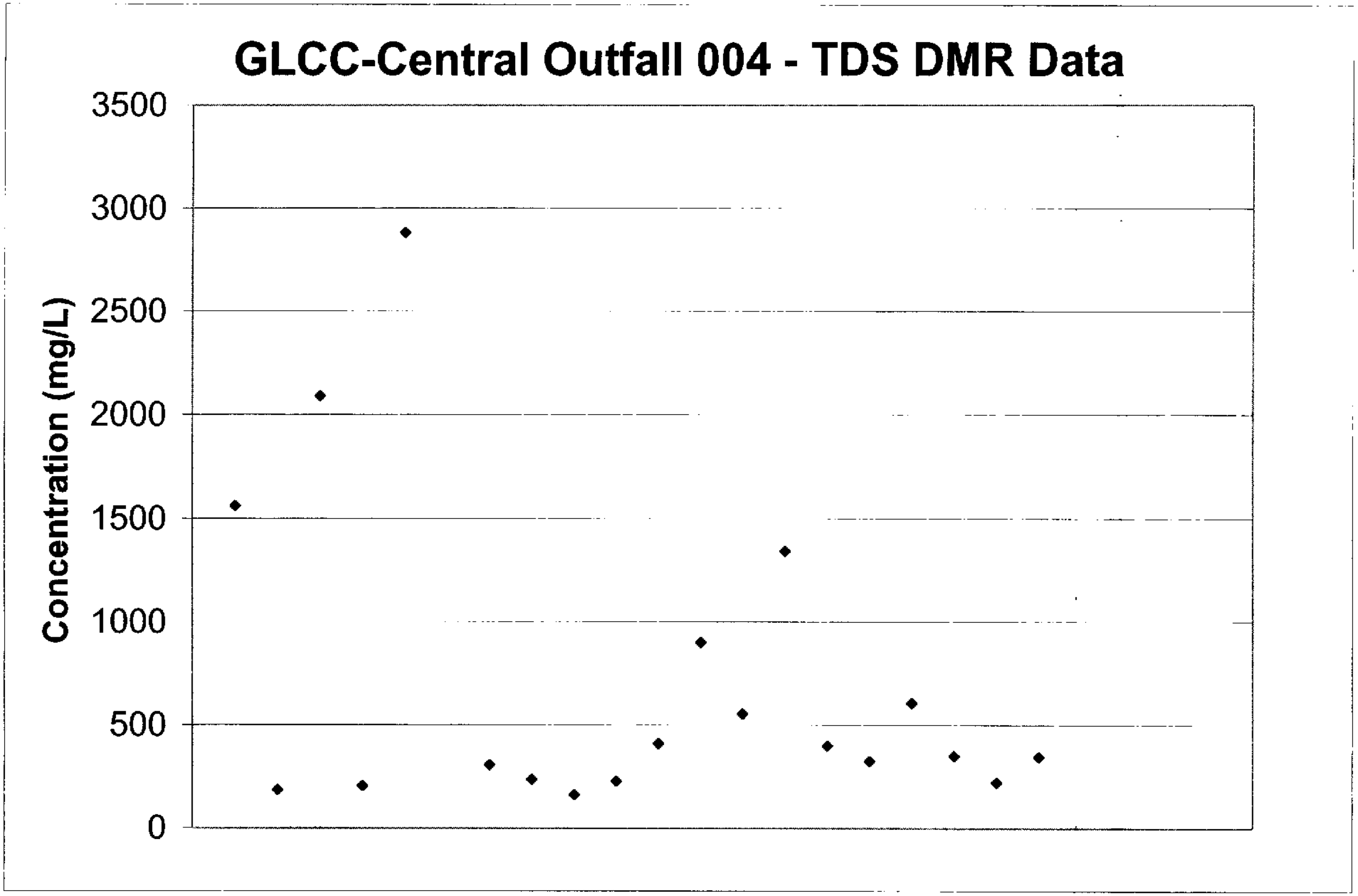
	k	value
99%	66.33	**2625**
95%	63.65	**1702**

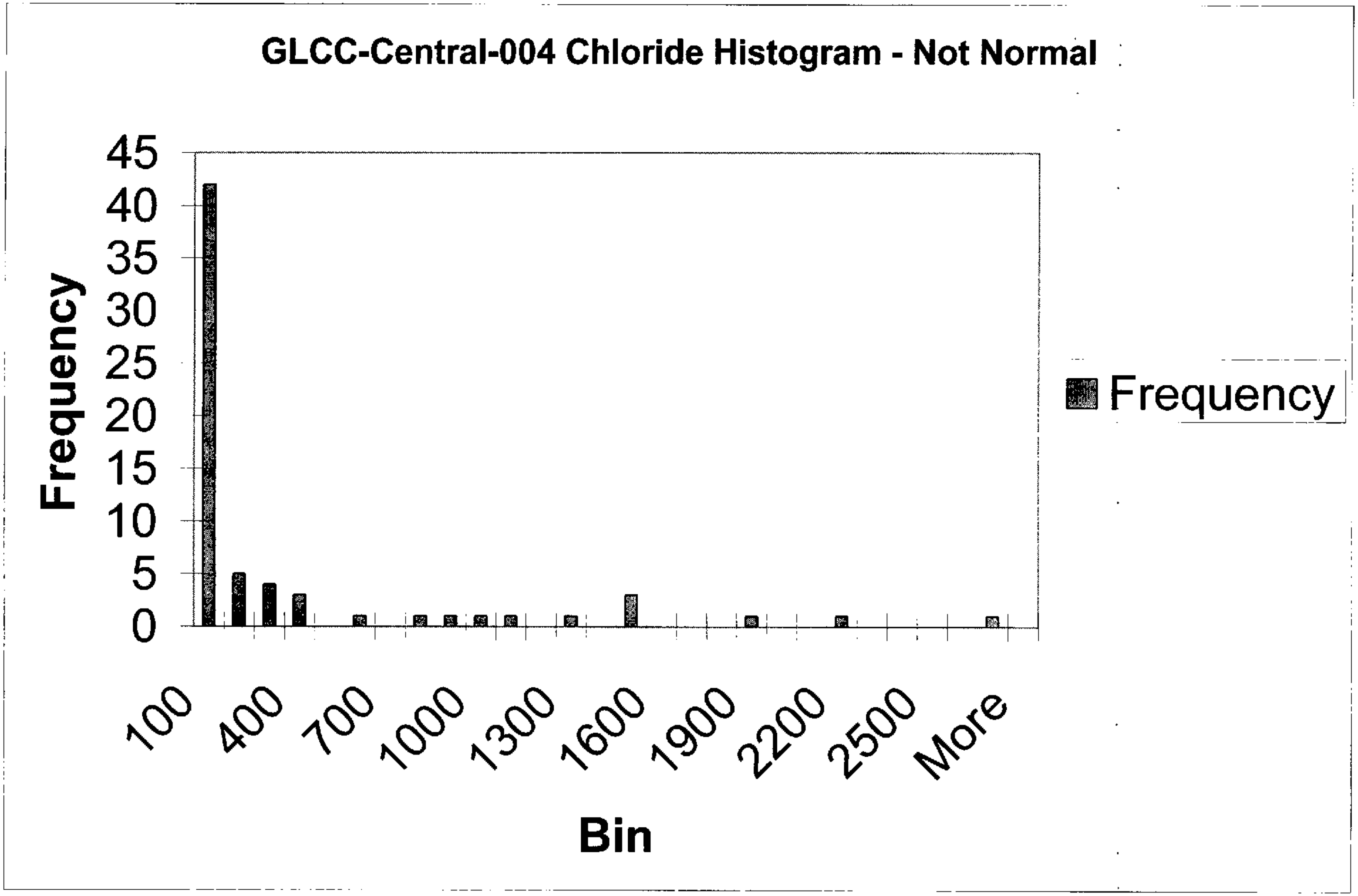
357
35.7
232.05
1702.05

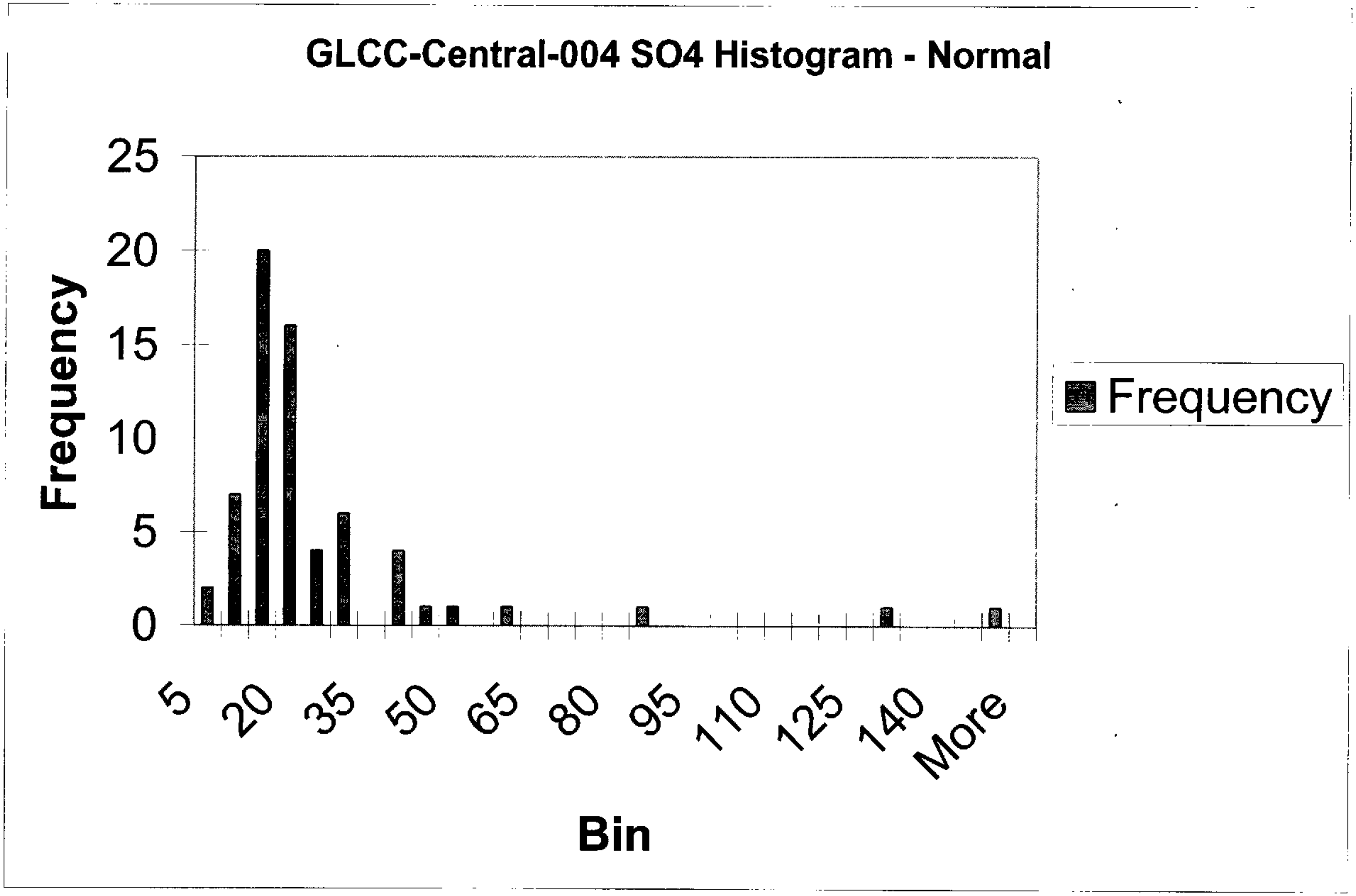

GLCC-Central Outfall 004 - Chloride DMR Data
Concentration (mg/L)
3000
2500
2000
1500
1000
500
0



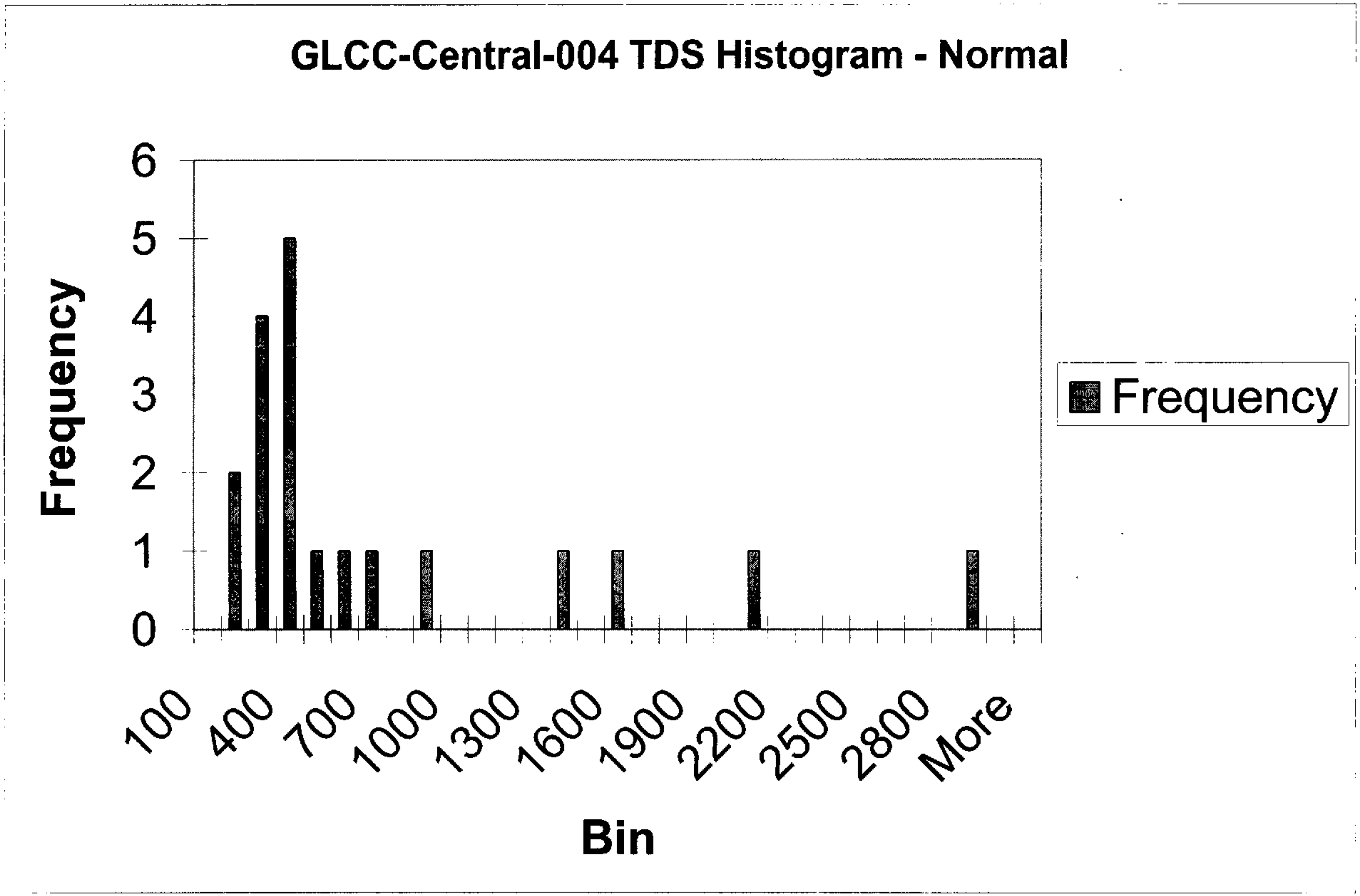
GLCC-Central Outfall 004 - Sulfate DMR Data


GLCC-Central Outfall 004 - TDS DMR Data
Concentration (mg/L)
3500
3000
2500
2000
1500
1000
500
0


GLCC-Central-004 Chloride Histogram - Not Normal



GLCC-Central-004 SO4 Histogram - Normal


GLCC-Central-004 TDS Histogram - Normal
Frequency
6
5
4
3
2
1
0
100
400
700
1000
1300
1600
1900
2200
2500
2800
More
Bin
Frequency

Bayou de Loutre / Loutre Creek IWC Calcs - Final

Chloride IWC	DISCHG. CONC (mg/L)	DISCHG. FLOW (cfs)	U/S CONC. (mg/L)	U/S FLOW (cfs)	TOTAL FLOW (cfs)	IWC (mg/L)
GLCC-Central - 004: 95th%tile	1702	0.64	5	4	4.64	239
Bayou de Loutre u/s of UT-002	1702	0.64	5	4	4.64	239
GLCC-Central - 002: 95th%tile	1029	0.24	5	4	4.24	63
Bayou de Loutre u/s of Loutre Creek	1519	0.88	5	4	4.88	278
Loutre Creek	503	4.06	5	4	8.06	256
Bayou de Loutre d/s of Loutre Creek	684	4.94	5	8	12.94	264
Bayou de Loutre d/s of City of ElDo - South	358	12.37	5	8	20.37	219
Bayou de Loutre d/s of Hwy 79	358	12.37	5	12	24.37	184

Sulfate IWC	DISCHG. CONC (mg/L)	DISCHG. FLOW (cfs)	U/S CONC. (mg/L)	U/S FLOW (cfs)	TOTAL FLOW (cfs)	IWC (mg/L)
GLCC-Central - 004: 95th%tile	63.7	0.64	13	4	4.64	20.0
Bayou de Loutre u/s of UT-002	63.7	0.64	13	4	4.64	20.0
GLCC-Central - 002: 95th%tile	380	0.24	13	4	4.24	33.8
Bayou de Loutre u/s of Loutre Creek	148	0.88	13	4	4.88	37.4
Loutre Creek	1967	4.06	13	4	8.06	997
Bayou de Loutre d/s of Loutre Creek	1643	4.94	13	8	12.94	635
Bayou de Loutre d/s of City of ElDo - South	702	12.37	13	8	20.37	431
Bayou de Loutre d/s of Hwy 79	702	12.37	13	12	24.37	363

TDS IWC	DISCHG. CONC (mg/L)	DISCHG. FLOW (cfs)	U/S CONC. (mg/L)	U/S FLOW (cfs)	TOTAL FLOW (cfs)	IWC (mg/L)
GLCC-Central - 004: 95th%tile	1932	0.64	67	4	4.64	324
Bayou de Loutre u/s of UT-002	1932	0.64	67	4	4.64	324
GLCC-Central - 002: 95th%tile	1376	0.24	67	4	4.24	141
Bayou de Loutre u/s of Loutre Creek	1780	0.88	67	4	4.88	376
Loutre Creek	3420	4.06	67	4	8.06	1756
Bayou de Loutre d/s of Loutre Creek	3128	4.94	67	8	12.94	1236
Bayou de Loutre d/s of City of ElDo - South	1548	12.37	67	8	20.37	966
Bayou de Loutre d/s of Hwy 79	1548	12.37	67	12	24.37	819

Mass Balance Calcs

Chloride

	Flow		Conc	Load	mixed conc
Source	cfs	mgd	mg/L	lb/day	
GLCC-Central - Outfall 002	0.24	0.15504	1029	1330.531574	
GLCC-Central - Outfall 004	0.64	0.41344	1702	5868.648499	
Totals	0.88	0.56848		7199.180074	**1518**

Chloride

	Flow		Conc	Load	mixed conc
Source	cfs	mgd	mg/L	lb/day	
GLCC-Central - Outfall 002	0.24	0.15504	1029	1330.531574	
GLCC-Central - Outfall 004	0.64	0.41344	1702	5868.648499	
Lion - Outfall 001	4.06	2.62276	504	11024.40447	
Totals	4.94	3.19124		18223.58455	**685**

Chloride

	Flow		Conc	Load	mixed conc
Source	cfs	mgd	mg/L	lb/day	
GLCC-Central - Outfall 002	0.24	0.15504	1029	1330.531574	
GLCC-Central - Outfall 004	0.64	0.41344	1702	5868.648499	
Lion - Outfall 001	4.06	2.62276	504	11024.40447	
City of ElDo - South	7.43	4.79978	142	5684.283458	
Totals	12.37	7.99102		23907.86801	**359**

Sulfate

	Flow		Conc	Load	mixed conc
Source	cfs	mgd	mg/L	lb/day	
GLCC-Central - Outfall 002	0.24	0.15504	380	491.352768	
GLCC-Central - Outfall 004	0.64	0.41344	63.7	219.6433075	
Totals	0.88	0.56848		710.9960755	**150**

Sulfate

	Flow		Conc	Load	mixed conc
Source	cfs	mgd	mg/L	lb/day	
GLCC-Central - Outfall 002	0.24	0.15504	380	491.352768	
GLCC-Central - Outfall 004	0.64	0.41344	63.7	219.6433075	
Lion - Outfall 001	4.06	2.62276	1967	43025.80079	
Totals	4.94	3.19124		43736.79687	**1643**

Sulfate

	Flow		Conc	Load	mixed conc
Source	cfs	mgd	mg/L	lb/day	
GLCC-Central - Outfall 002	0.24	0.15504	380	491.352768	
GLCC-Central - Outfall 004	0.64	0.41344	63.7	219.6433075	
Lion - Outfall 001	4.06	2.62276	1967	43025.80079	
City of ElDo - South	7.43	4.79978	76	3042.292555	
Totals	12.37	7.99102		46779.08942	**702**

Flow weighted Mixed Conc.

TDS

	Flow		Conc	Load	mixed conc
Source	cfs	mgd	mg/L	lb/day	
GLCC-Central - Outfall 002	0.24	0.15504	1376	1779.214234	
GLCC-Central - Outfall 004	0.64	0.41344	1932	6661.709107	
Totals	0.88	0.56848		8440.923341	**1780**

TDS

	Flow		Conc	Load	mixed conc
Source	cfs	mgd	mg/L	lb/day	
GLCC-Central - Outfall 002	0.24	0.15504	1376	1779.214234	
GLCC-Central - Outfall 004	0.64	0.41344	1932	6661.709107	
Lion - Outfall 001	4.06	2.62276	3420	74808.45893	
Totals	4.94	3.19124		83249.38227	**3128**

TDS

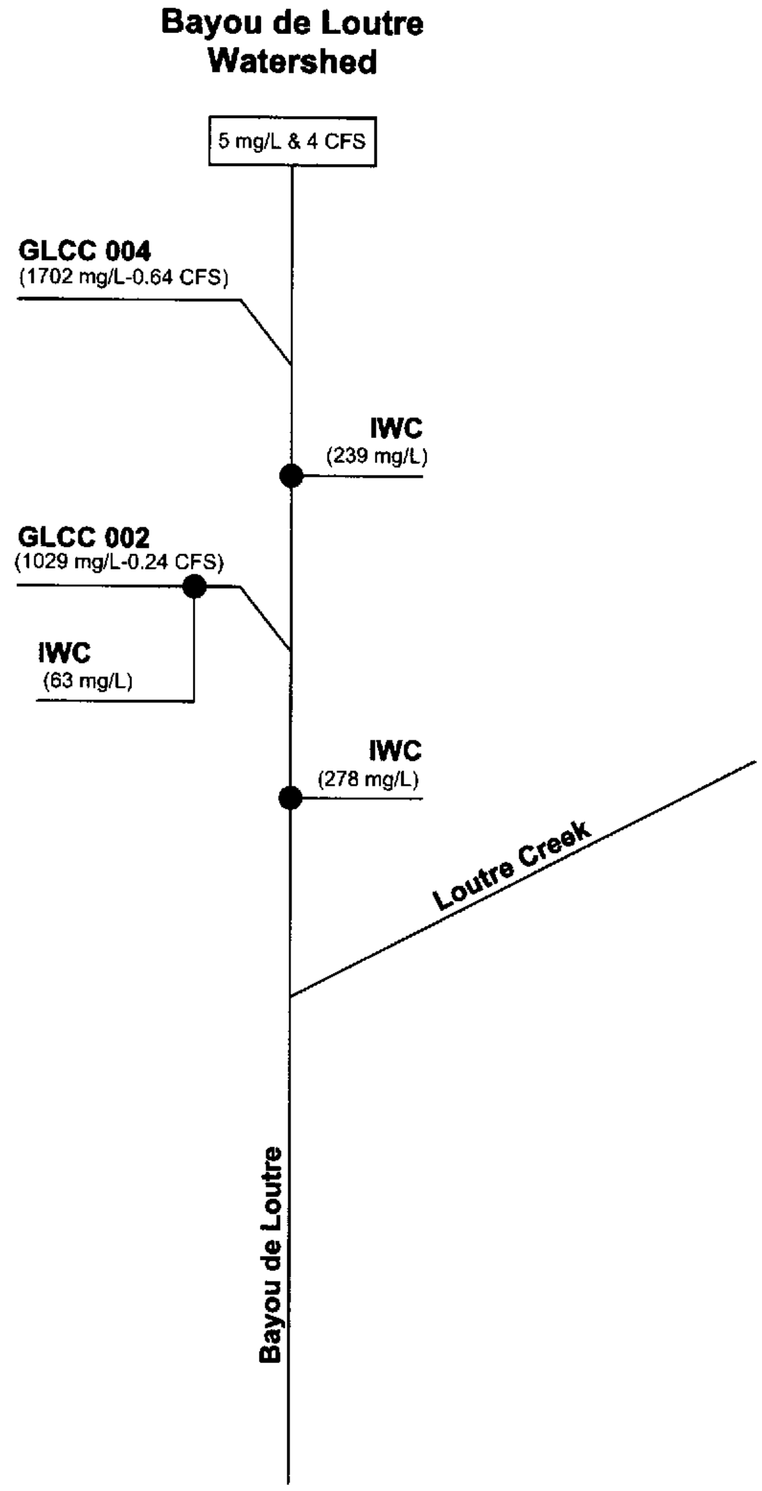
	Flow		Conc	Load	mixed conc
Source	cfs	mgd	mg/L	lb/day	
GLCC-Central - Outfall 002	0.24	0.15504	1376	1779.214234	
GLCC-Central - Outfall 004	0.64	0.41344	1932	6661.709107	
Lion - Outfall 001	4.06	2.62276	3420	74808.45893	
City of ElDo - South	7.43	4.79978	497	19894.9921	
Totals	12.37	7.99102		103144.3744	**1548**

Outfall 003 / Little Cornie Bayou - IWC Calcs - Final

Chloride IWC	**DISCHG. CONC (mg/L)**	**DISCHG. FLOW (cfs)**	**U/S CONC. (mg/L)**	**U/S FLOW (cfs)**	**TOTAL FLOW (cfs)**	**IWC (mg/L)**
UT-003	2374	1.16	5	4	5.16	538
UT-Little Cornie Bayou	538	5.16	5	4	9.16	305
Little Cornie Bayou	305	9.16	5	4	13.16	214

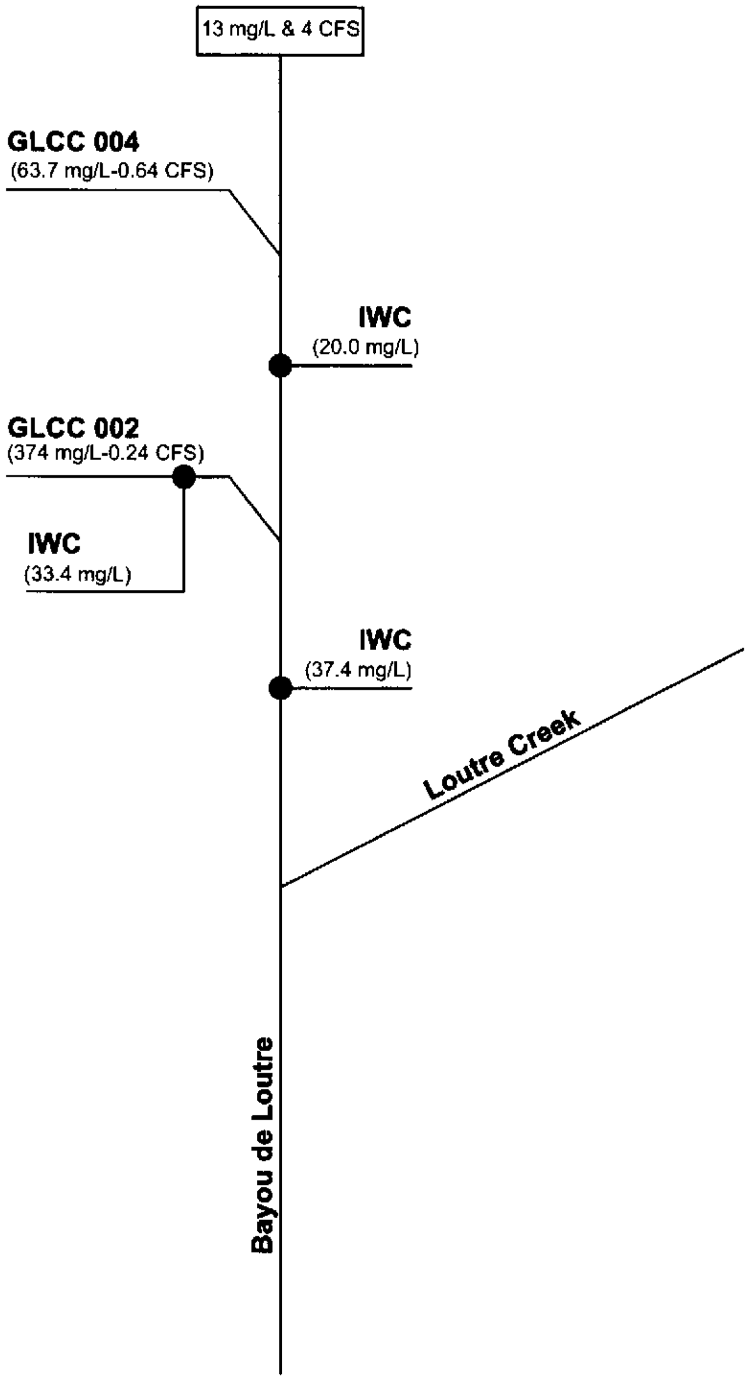
Sulfate IWC	**DISCHG. CONC (mg/L)**	**DISCHG. FLOW (cfs)**	**U/S CONC. (mg/L)**	**U/S FLOW (cfs)**	**TOTAL FLOW (cfs)**	**IWC (mg/L)**
UT-003	95.8	1.16	13	4	5.16	31.6
UT-Little Cornie Bayou	31.6	5.16	13	4	9.16	23.5
Little Cornie Bayou	23.5	9.16	13	4	13.16	20.3

TDS IWC	**DISCHG. CONC (mg/L)**	**DISCHG. FLOW (cfs)**	**U/S CONC. (mg/L)**	**U/S FLOW (cfs)**	**TOTAL FLOW (cfs)**	**IWC (mg/L)**
UT-003	2079	1.16	67	4	5.16	519
UT-Little Cornie Bayou	519	5.16	67	4	9.16	322
Little Cornie Bayou	322	9.16	67	4	13.16	244



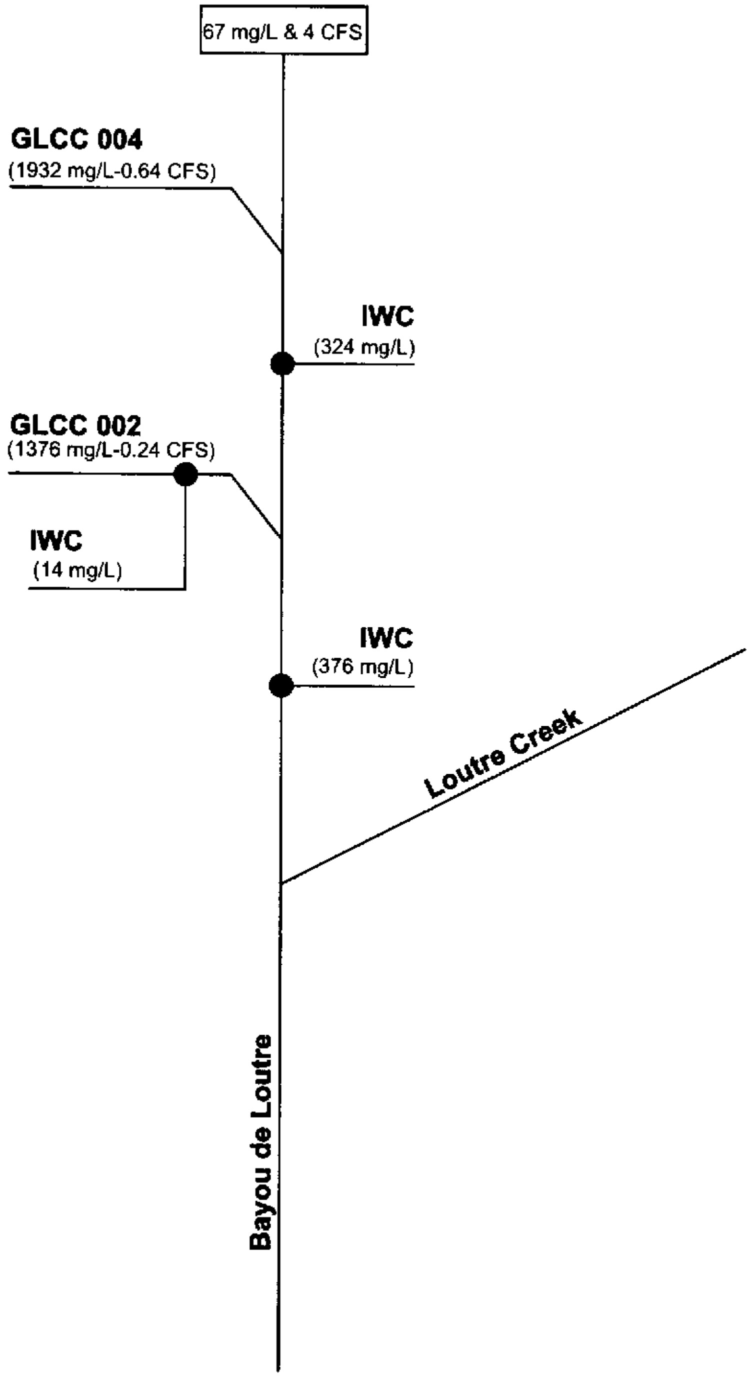
Schematic of Chloride discharges considered for Great Lakes Chemical Company-Central Facility 3rd party rule making indicating the instream waste concentration resulting from the 95 percentile of historical discharges, the mean maximum monthly flow and background flow of 4 CFS for Bayou de Loutre to the mouth of Loutre Creek.

Bayou de Loutre Watershed



Schematic of Sulfate discharges considered for Great Lakes Chemical Company-Central Facility 3rd party rule making indicating the instream waste concentration resulting from the 95 percentile of historical discharges, the mean maximum monthly flow and background flow of 4 CFS for Bayou de Loutre and to the mouth of Loutre Creek.

Bayou de Loutre Watershed



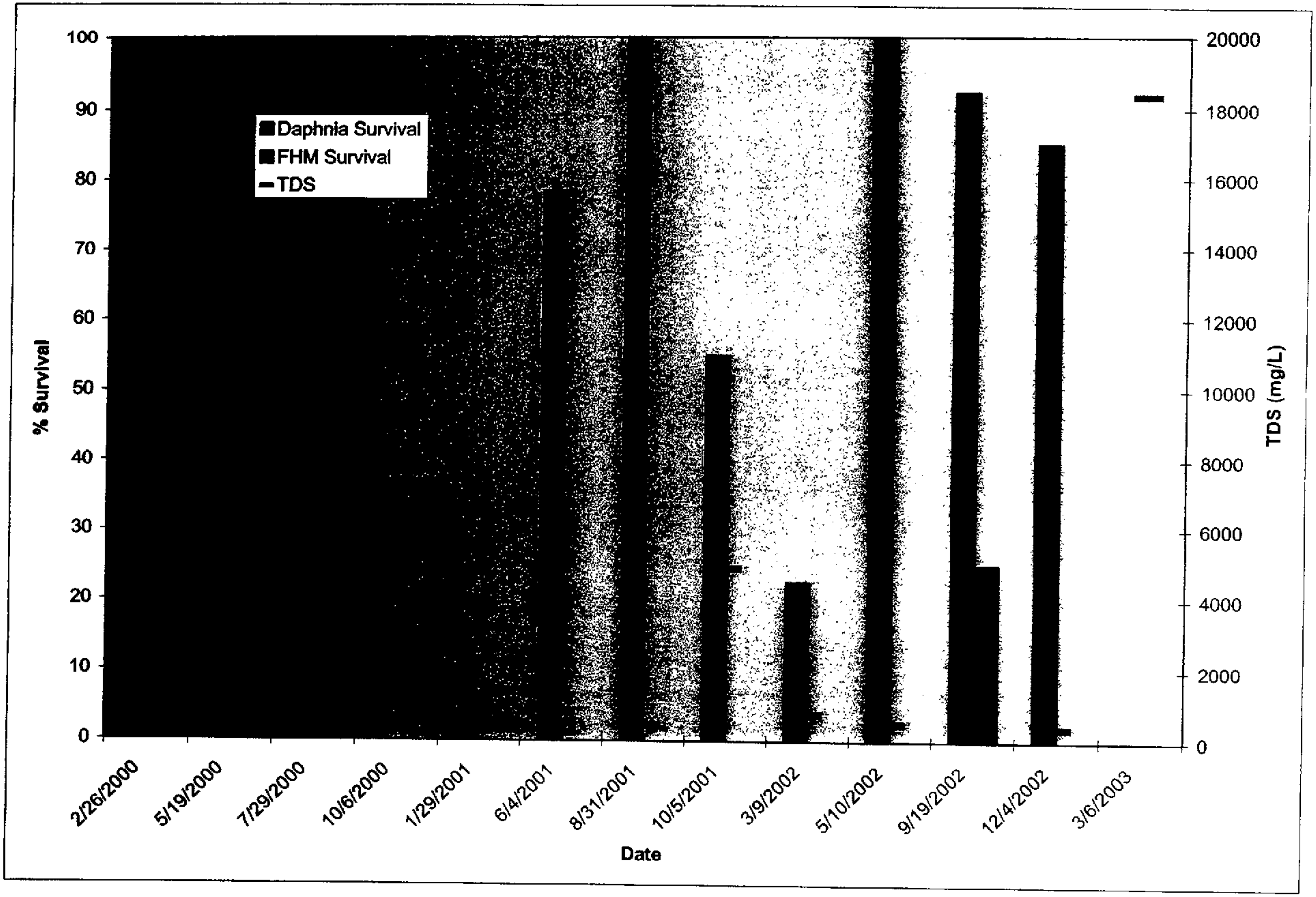
Schematic of TDS discharges considered for Great Lakes Chemical Company - Central Facility 3rd party rule making indicating the instream waste concentration resulting from the 95 percentile of historical discharges, the mean maximum monthly flow and background flow of 4 CFS for Bayou de Loutre and to the mouth of Loutre Creek.

Appendix D

Summary of Toxicity Testing Data

Summary of Toxicity testing Outfall 003. Period of Record October 1998 to October 2001.

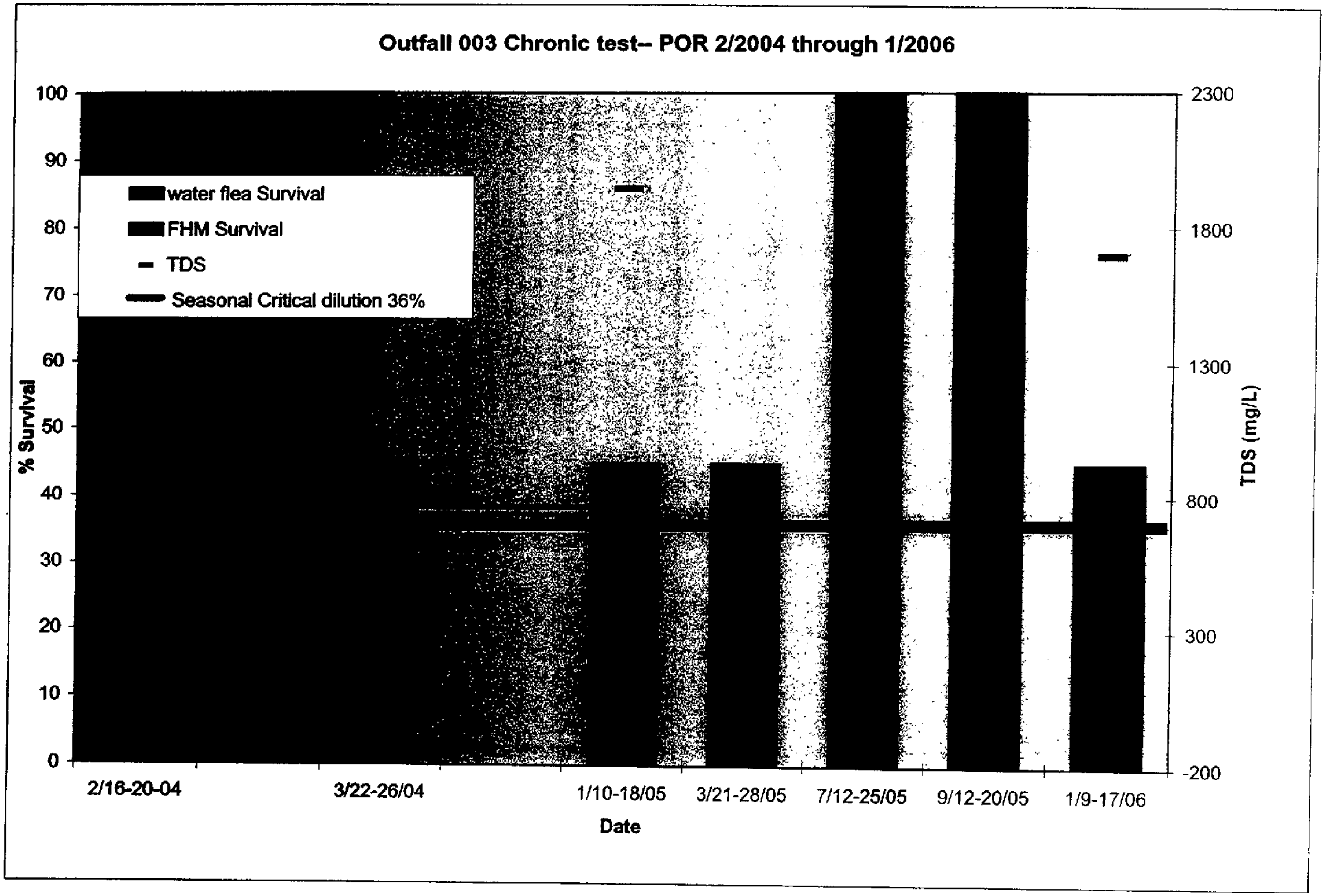
Measured endpoints	Waterflea				Fathead minnow				Water Chemistry		
Date of Test	24	48	LC50	Control	24	48	LC50	Control	Hardness	Alkalinity	Conductivity
Oct-98	NA	NA	NA	NA	97.5	95	>100%	100	40	8	228
Jun-98	100	100	>100%	100	100	100	>100%	100	121	10	723
Jul-98	90	65	>100%	100	0	0	5.25	100	63	<1	529
Jul-98	NA	NA	NA	NA	47.5	30	>100%	100	71	16	558
Aug-98	NA	NA	NA	NA	10	2.5	9.9	100	34	4	258
Dec-98	NA	NA	NA	NA	47.5 76	50 73	10.75	100	180 15	22 2.9	1077 52
Dec-98	NA	NA	NA	NA	7.5	0	9	100	63 4	11 7	320 16(57)
Jan-99	87.5	62.5	>100%	90	32.5 100	12.5 92.5	13.5	100	130 4	17 7	688 16
Jul-00	55	40	30		0	0	11	100	572	132	3900
Oct-00	0	0	9.9		0	0	9.9	100	164	26	990
Jan-01	70	2.5	15.5	97	22.5	0	9.9	100	56	24	412
Jun-01		79			0	0	9.8	100	44	16	343
Aug-01	100	100	>100%		0	0	9.8	100	120	28	715
Oct-01	100	55	>100%		0	0	9.5	100	224	112	7130


■ Daphnia Survival
■ FHM Survival
— TDS
% Survival
100
90
80
70
60
50
40
30
20
10
0
TDS (mg/L)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
2/26/2000
5/19/2000
7/29/2000
10/6/2000
1/29/2001
6/4/2001
8/31/2001
10/5/2001
3/9/2002
5/10/2002
9/19/2002
12/4/2002
3/6/2003
Date

GLCC-Central

Outfall 003 Toxicity Summary (48-h Acute Screening Test)

	Daphnia %Survival			Fathead Minnow %Survival			Maximum						Minimum	
Sample Date	CNTL	100% Eff	LC50	CNTL	100% Eff	LC50	TRC	Hardness	Alkalinity	Conductivity	TDS (est.)	pH	D.O.	NOTES
2/26/2000	100	95	na	100	20	18	0.01	120	6	728	473.2	7.5	7.2	MH dil. water / Increase in pH
5/19/2000	100	40	46	100	0	10	0.01	32	16	175.4	114.01	7	6	soft dil. Water / chemistry?
7/29/2000	100	40	30	100	0	11	0.01	572	132	3920	2548	7.8	6.5	soft dil. Water
10/6/2000	100	0	9.9	100	0	9.9	0.01	164	26	998	648.7	7.9	6.1	soft dil. Water
1/29/2001	97.5	2.5	15.5	100	0	9.9	0.01	56	24	415	269.75	8.7	7.5	soft dil. Water
6/4/2001	92.5	78.5	na	100	0	9.8	0.01	44	16	343	222.95	8.6	7.4	soft dil. Water
8/31/2001	100	100	na	100	0	9.6	na	120	28	698	453.7	8	7	soft dil. Water
10/5/2001	100	55	na	100	0	9.5	0.4	924	112	7540	4901	7.9	6.7	soft dil. Water
3/9/2002	100	22.5	20	100	0	8.9	0.1	231	8	1163	755.95	6.9	7	soft dil. Water
5/10/2002	100	100	na	100	0	9.6	0.1	96	32	750	487.5	7.9	7.4	soft dil. Water
9/19/2002	90	92.5	na	100	25	21	0.2	296	76	2300	1495	7.9	6.9	soft dil. Water
12/4/2002	90	85	na	100	0	9.5	0.2	112	16	596	387.4	7.2	5.5	soft dil. Water
3/6/2003	96	0	8.7	100	0	9.6	0.01	72	32	28300	18395	6.5	8.3	soft dil. Water


Outfall 003 Chronic test-- POR 2/2004 through 1/2006
% Survival
100
90
80
70
60
50
40
30
20
10
0
TDS (mg/L)
2300
1800
1300
800
300
-200
water flea Survival
FHM Survival
TDS
Seasonal Critical dilution 36%
2/16-20-04
3/22-26/04
1/10-18/05
3/21-28/05
7/12-25/05
9/12-20/05
1/9-17/06
Date

GLCC-Central

Outfall 003 Toxicity Summary (7-day chronic toxicity test) POR Fet

	Cerioaphnia					Min.	
Sample Date	Survival CNTL	Survival max diultuion	Survival NOEL	Repro. CNTL)	pH	D.O.	NOTES
2/16-20-04	90	0	15	18 3	6.6	5.1	Critical dilution 36%. Failed ALL ENDPOINTS AT CRITICAL DILUTION
3/22-26/04	100	90	45	24 1	6 4	4.2	1st retest of 003 failure CD repro effect at critical dilution, Pp noe effects even at 1 5X critical dilution . Not low DO 4.2ppm
1/10-18/05	100	90	45	23 6	7 4	7	Passed all endpoints except cd repo. Note last renewal very different from 1st two Incresaed hardness & conductivity and decrease in pH
3/21-28/05	90	100	45	24 8	7.7	7.4	PASSED ALL END POINTS Critical dilution based on seasonal flows
7/12-25/05	100	100	100	18	7.3	7.8	PASSED LETHALITY AT 100%, failed sub see contrl ???
9/12-20/05	97.5	97 5	100	18.9	7 2	6.9	PASSED ALL But sub Cd. Note cnt repo, barely passed minimum SEE DETAILS OF CONTROL & CULTURE
1/9-17/06	100	80	45	26.5	7 5	7.8	PASSED ALL But sub Cd. SEE DETAILS OF CONTROL & CULTURE

Bio-Analytical Laboratories' Executive Summary

Permittee:	Great Lakes Chemical Corporation P.O. Box 7020 El Dorado, AR 71731
Permit #:	AR0001171
Project #:	X2593
Outfall:	002 upstream and 004 upstream
Contact:	Mr. David Hill
Test Dates:	March 10 - 12, 2006
Test Type:	48-hour Acute Screening Toxicity Tests using *Pimephales promelas* and *Daphnia pulex* (EPA Methods 2000.0 and 2021.0)

Results:

Greater than 50 percent survival occurred in the 100 percent dilution after 48 hours of exposure in all tests.

Bio-Analytical Laboratories

3240 Spurgin Road
Post Office Box 527
Doyline, LA 71023

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1-800-259-1246
Fax: (318) 745-2773
bioanalytical@worldnet.att.net

THE RESULTS OF FOUR 48-HOUR ACUTE SCREENING TOXICITY TESTS ON 002 UPSTREAM AND 004 UPSTREAM WATER SAMPLES

FOR

GREAT LAKES CHEMICAL CORPORATION
El Dorado, Arkansas

NPDES #: AR0001171

EPA Methods 2000.0 and 2021.0

Project X2593

Test Dates: March 10 - 12, 2006
Report Date: March 23, 2006

Prepared for:
Mr. David Hill
Great Lakes Chemical Corporation
P.O. Box 7020
El Dorado, AR 71731

Prepared by:
Ginger Briggs
Bio-Analytical Laboratories
P.O. Box 527
Doyline, LA 71023
ADEQ 88-0630

TABLE OF CONTENTS

1.0 Introduction

Bio-Analytical Laboratories (BAL), Doyline, Louisiana conducted four 48-hour acute screening toxicity tests on water samples collected upstream from Outfalls 002 and 004 at Great Lakes Chemical Corporation's Central Plant, El Dorado, Arkansas. Such testing will determine compliance with Arkansas Department of Environmental Quality's Water Quality Standard of greater than 50 percent survival of the appropriate test organism in the defined low-flow effluent concentration (critical dilution) for a 48-hour period. The test organisms used were the fathead minnow, *Pimephales promelas* and the cladoceran, *Daphnia pulex*.

2.0 Methods and Materials

2.1 Test Methods

All methods followed were according to the latest edition of "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" (EPA-821-R-02-012).

2.2 Test Organisms

The fathead minnow test organisms were raised in-house and were approximately three days old at test initiation. The *Daphnia pulex* test organisms were also raised in-house and were less than 24 hours old at test initiation. The test organisms were acclimated to test temperature and dilution water hardness prior to test initiation.

2.3 Control Water

Soft reconstituted water made per EPA guidelines was used as the control for the acute screening tests.

2.4 Test Concentrations

The test concentrations used in the acute toxicity tests were 100.0 percent effluent and a reconstituted water control. The tests were conducted using five replicates of eight animals each for a total of 40 animals per concentration. Forty-eight hour reference toxicant tests, using sodium chloride (NaCl), was run with the acute screening tests in order to document organism sensitivity

2.5 Sample Collection

Grab samples of water, collected upstream of Outfalls 002 and 004 , were collected by Great Lakes Chemical personnel on March 9, 2006. Upon completion of collection, the samples were chilled to 4^0 Celsius and delivered to Bio-Analytical Laboratories by BAL personnel.

2.6 Sample Preparation

Upon arrival, the samples were logged in, given an identification number and refrigerated until needed. Prior to use, each sample was warmed to 25 ± 1^0 Celsius. Total residual chlorine levels were measured with a Capital Controls^R amperometric titrator and recorded if present. Dissolved oxygen, pH and conductivity measurements were taken at test initiation and at each renewal. Alkalinity and hardness levels were measured on the control and the highest effluent concentration.

2.7 Monitoring of the Tests

The tests were run in a Precision^R Model 818 dual programmable illuminated incubator at a temperature of 25 ± 1^0 Celsius. An AEMC^R data logger was used to monitor diurnal temperature throughout the testing period. Light cycle and intensity were recorded twice a month.

2.8 Data Analysis

The LC_{50} value from the reference toxicant tests were obtained by approved EPA methods of analysis, using a computer program developed by EMSL, Cincinnati, Ohio.

3.0 Results and Discussion

The results of the tests can be found in Table 1 on the following page. Greater than 50 percent survival occurred in the 100 percent dilution in all tests after 48 hours of exposure.

Table 1: Results of the 48-hour Acute Definitive Toxicity Tests

Percent Effluent	Percent Survival	
Test Organism	*D. pulex*	*P. promelas*
Control for 002 test	90.0	100.0
100%	100.0	100.0
Control for 004 test	90.0	100.0
100%	97.5	100.0

The 48-hour reference toxicant test results can be found in Table 2 below. The test results indicate that the test organisms were within the respective sensitivity range. The graphs of the acute reference toxicant tests can be found in Appendix D- Quality Assurance Charts.

Table 2: Results of the 48-hour Reference Toxicant Tests - g/L

Test Organisms	Date Started	LC_{50}	Upper and Lower CUSUM Chart Limits
Daphnia pulex	3/10/06	1.25	3.05 - 0.64
Pimephales promelas	3/9/06	8.99	9.14 - 7.17

4.0 Conclusions

The grab samples collected upstream from Outfalls 002 and 004 on March 9, 2006 at Great Lakes Chemical Corporation's Central Plant in El Dorado, Arkansas, were not found to be lethally toxic to the *Pimephales promelas* test organisms nor the *Daphnia pulex* test organisms in the 100 percent dilution after 48 hours of exposure.

5.0 References

EPA, 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition. EPA-821-R-02-012, Office of Water.

EPA, 2000. Method Guidance and Recommendations for Whole Effluent (WET) Testing. EPA/821-B-00-04, Office of Water

APPENDIX A
CHAIN-OF-CUSTODY DOCUMENTS

Bio-Analytical Laboratories
3240 Spurgin Road
Doyline, LA 71023
(318) 745-2772 Fax (318) 745-2773
bioanalytical@worldnet.att.net LELAP #01975, EPA Code LA00917, ADEQ 02-011-0

Laboratory Use Only:

Company: GLCC **Phone:**

Address: **Fax:**

Permit #: AR0001171 **Purchase Order:**

Sampler's Signature: David Hill **Printed Name:** DAVID HILL

Lab Control Number:

Project Number: X2593

Temp. upon arrival: 3°C

Date Start Date End	Time Start Time End	C	G	# containers	Sample Identification	Chronic Ceriodaphnia	Chronic minnow	Acute minnow	Acute Daphnia	Acute Ceriodaphnia	Acute Mysid	Fecal Coliform	Total Coliform	Lab Control Number	Preservative: (below)
3/9/06	1255		✓	2	Outfall 002 upstream			✓	✓					B9012	ICE
3/9/06	1245		✓	2	Outfall 004 upstream			✓	✓					B9013	

Relinquished by: David Hill **Date:** 3/10/06 **Time:** 0945 **Received by:** **Date:** 3/10/06 **Time:** 0945

Relinquished by: **Date:** **Time:** **Received by:** **Date:** **Time:**

Relinquished by: **Date:** 3/10/06 **Time:** 1220 **Received by laboratory:** Emma Deshotels **Date:** 3/10/06 **Time:** 1220

Method of Shipment: ✓ Lab ____ Bus ____ Fed Ex ____ Airborne ____ UPS ____ Client ____ Other Tracking # ____

Comments:

APPENDIX B
RAW DATA SHEETS

BIO-ANALYTICAL LABORATORIES
ACUTE TOXICITY TEST WATER QUALITY DATA

Project# X2593

Client Great Lakes Chemical Corp.

Address P.O. Box 7020, El Dorado, AR. 71731

NPDES# AR0001171 Outfall 002 upstream

Technicians Deshotels, Haughton

Test initiated: Date 3-10-06 Time 1415

Test terminated: Date 3/12/06 Time 1405

pH 7.1

Sample Information

Sample ID#	Initial D.O. (mg/L and %)	Aerate? Minutes/ Final D.O(mg/L & %)	Total Residual Chlorine (mg/L)	Dechlor inated?	Sodium thiosulfate (mg/l)	Salinity	Hardness	Alkalinity
B9012	7.7 / 93.12	No	<0.01	No	N/A	N/A	76.0	40.0
B9012	8.0 / 95.72	No	↓	↓			76.0	40.0

Dilution Water Information

~~Dilution~~ Water Control	ID#	Initial D.O (mg/L & %)	Aerate? Minutes/D.O (mg/L & %)	pH	Hardness	Alkalinity
SOFT reconstituted	2478	N/A	N/A	~~7.3~~ 7.8	48.0	~~48.0~~ 32.0
↓ ↓	2479			7.6	48.0	~~48.0~~ 28.0

FBB 3/22/06

Test Species Information

Test Species Info.	Species: P. promelas ID#: BAL/3706	Species: D. pulex ID#: BAL/DS-61	Species: ID#: N/A	Species: ID#: N/A
Age	~3 days	<24 hrs		
Test Container Size	250 ml	250 ml		
Test volume	200 ml	100 ml		
Feeding: Type	Artemia	YCT: Algae		
Amount	acclimated	acclimated		
Aeration? Amount	~~N/A~~	~~N/A~~		
Condition of survivors	good	good - active, large		

Comments: B9012 → yellow tint 3/10/06
No notable odor.

BIO-ANALYTICAL LABORATORIES
ACUTE TOXICITY TEST SURVIVAL AND WATER QUALITY DATA

Project# X2593
Client GLCC
Sample Description 002 - Upstream
Test started: Date 3/10/06 Time 1510
Test ended: Date 3/12/06 Time 1350
Test Species D. pulex ID# BAL/D5-G1

Technician: 0hour EL 24hour Q 48hour EL 72hour / 96hour /
Time: Inc#3 0hour 1510 24hour 1420 48hour 1350 72hour / 96hour /
Temperature: 0hour 24° 24hour 25°C 48hour 25.°C 72hour / 96hour /

Percent Effluent	Replicate	Test Salinity	# of Live Organisms					Dissolved Oxygen					pH					Conductivity				
			0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0	A	N/A	8	8	6			8.5	7.8/8.1	7.7			7.6	7.6/7.8	7.8			163.3	175.3/168.5	171.5		
	B		8	8	7																	
	C		8	8	8																	
	D		8	8	7																	
	E		8	8	8																	
100	A		8	8	8			7.7	7.6/7.8	7.6			7.2	7.5/7.3	7.7			657	648/655	653		
	B		8	8	8																	
	C		8	8	8																	
	D		8	8	8																	
	E		8	8	8																	

Key: prerenewal/postrenewal

BIO-ANALYTICAL LABORATORIES
ACUTE TOXICITY TEST SURVIVAL AND WATER QUALITY DATA

Project# X2593

Client GLCC

Sample Description 002 -Upstream

Test started: Date 3/10/06 Time 1415

Test ended: Date 3/12/06 Time 1405

Test Species P. promelas ID# BAL/3706

Technician: 0hour EL 24hour EL 48hour EL 72hour / 96hour /

Time: 0hour 1415 24hour 1400 48hour 1406 72hour / 96hour /

WB#2 Temperature: 0hour 25.5°C 24hour 24.5°C 48hour 24.5°C 72hour / 96hour /

Percent Effluent	Replicate	Test Salinity	# of Live Organisms					Dissolved Oxygen					pH					Conductivity				
			0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0	A	N/A	8	8	8			8.5	7.6/8.1	7.7			7.6	7.5/7.8	7.6			1633	1878/1685	1749		
	B		8	8	8																	
	C		8	8	8																	
	D		8	8	8																	
	E		8	8	8																	
100	A		8	8	8			7.7	7.3/7.8	7.4			7.2	7.5/7.3	7.6			657	676/655	668		
	B		8	8	8																	
	C		8	8	8																	
	D		8	8	8																	
	E		8	8	8																	

Key: prerenewal/postrenewal

File ACUTE2

BIO-ANALYTICAL LABORATORIES
ACUTE TOXICITY TEST WATER QUALITY DATA

Project# X2593

Client Great Lakes Chemical Corp

Address P.O. Box 7020, El Dorado, AR. 71731

NPDES# AR0001171 Outfall 004 upstream

Technicians Deshotels, Haughton

Test initiated: Date 3-10-06 Time 1415

Test terminated: Date 3-12-06 Time 1410

Sample Information

pH 7.1

Sample ID#	Initial D.O. (mg/L and %)	Aerate? Minutes/ Final D.O(mg/L & %)	Total Residual Chlorine (mg/L)	Dechlorinated?	Sodium thiosulfate (mg/l)	Salinity	Hardness	Alkalinity
B9013	9.2 / 111.0	yes/ 9min 8.1/97.72	<0.01	No	N/A	N/A	36.0	20.0
B9013	9.4 / 100.12	No	↓	↓			36.0	20.0

Dilution Water Information

~~Dilution~~ Water Control	ID#	Initial D.O (mg/L & %)	Aerate? Minutes/D.O (mg/L & %)	pH	Hardness	Alkalinity
SOFT reconstituted	2478	N/A	N/A	7.6	48.0	32.0
↓ ↓	2479			7.6	48.0	28.0

Test Species Information

Test Species Info.	Species: P. promelas ID#: BAL/3706	Species: D. pulex ID#: BAL/D5-G.	Species: N/A ID#:	Species: N/A ID#:
Age	<3 days	<24hrs		
Test Container Size	250ml	250ml		
Test volume	200ml	100ml		
Feeding: Type	Artemia	YCT: Algae		
Amount	acclimated	acclimated		
Aeration?	N/A	N/A		
Amount				
Condition of survivors	good	good → active little pale Smaller than 002 @ 3.12.06		

Comments: B9013 → turbid & golden tint @ 3/10/06
No notable odor.

BIO-ANALYTICAL LABORATORIES
ACUTE TOXICITY TEST SURVIVAL AND WATER QUALITY DATA

Project# X2593

Client GLCC

Sample Description 004 Upstream

Test started: Date 3/10/06 Time ~~1445~~ 1510 EL 3-10-06

Test ended: Date 3/12/06 Time 1400

Test Species D. pulex ID# BAL/D5-G,

Technician: 0hour EL 24hour EL 48hour EL 72hour / 96hour /

Time: 0hour 1510 24hour 1430 48hour 1400 72hour / 96hour /

Inc #3 Temperature: 0hour 24°C 24hour 25°C 48hour 25°C 72hour / 96hour /

Percent Effluent	Replicate	Test Salinity	# of Live Organisms					Dissolved Oxygen					pH					Conductivity				
			0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0	A	N/A	8	7	7			8.5	7.7/8.1	7.7			7.6	7.5/7.8	7.8			163.3	173.0/168.5	172.5		
	B		8	8	8																	
	C		8	8	6																	
	D		8	8	7																	
	E		8	8	8																	
100	A		8	8	8			8.0	7.4/8.1	7.5			7.4	7.6/~~7.5~~	7.5			125.2	130.6/124.4	125.8		
	B		8	8	7								EL 3-11-06	7.4								
	C		8	8	8																	
	D		8	8	8																	
	E		8	8	8																	

Key: prerenewal/postrenewal

File:ACUTE2

BIO-ANALYTICAL LABORATORIES
ACUTE TOXICITY TEST SURVIVAL AND WATER QUALITY DATA

Project# X2593

Client GLCC

Sample Description 004 Upstream

Test started: Date 3/10/06 Time 1415

Test ended: Date 3/12/06 Time 1410

Test Species P. promelas ID# BAL/3706

Technician: 0hour EU 24hour EU 48hour EU 72hour / 96hour /

Time: 0hour 1415 24hour 1400 48hour 1410 72hour / 96hour /

WB #2 Temperature: 0hour 25.5°C 24hour 24.5 48hour 24.5°C 72hour / 96hour /

Percent Effluent	Replicate	Test Salinity	# of Live Organisms					Dissolved Oxygen					pH					Conductivity				
			0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0	A	N/A	8	8	8			8.5	7.5 / ~~7.5~~ 8.1	*7.1			7.6	7.5 / ~~7.5~~ *7.8	7.7			163.3	~~184.6~~ 184.6 / *168.5	172.9		
	B		8	8	8																	
	C		8	8	8																	
	D		8	8	8																	
	E		8	8	8																	
	~~R~~ EU 3-10-06																					
100	A		8	8	8			8.0	7.3 / 8.1	7.4			7.4	7.4 / 7.4	7.5			125.0	142.0 / ~~141~~ 124.4 EU 3/11/06	128.3		
	B		8	8	8																	
	C		8	8	8																	
	D		8	8	8																	
	E		8	8	8																	

Key: prerenewal/postrenewal

* Day 1 of postrenewal corrections EU 3/11/06

File:ACUTED

BIO-ANALYTICAL LABORATORIES

REFERENCE TOXICANT TEST QUALITY DATA

Date start: 3-10-06 **Date end:** 3/12/06

Test organism: D. pulex

Age: <24hrs

Source and ID#: BAL / D5-G1

Dilution Water used: Type: MH * **Jug #:** 2476

Reference Toxicant: NaCl (BAL 3/2/06) + **Units:** 100 **g/L** ______ **ug/L**

Manufacturer: EMD **Lot:** #1375 B65

48-hour LC_{50}: 1.85 g/L **Statistical Method:** P ^

Upper and Lower CUSUM Chart Control Limits: 3.05-0.106

Test Number (for the year): 8

We verify that this data is true and correct:

Technician: Erin Kandle

Statistician: Erin M. Berger, BS

Quality Control Officer: Erin M. Berger, BS

***MH- Moderately hard**
S-Soft
H - Hard

+NaCl - Sodium Chloride
$CuSO_4$ - Copper Sulfate

^P - Probit
SK - Spearman Karber
TSK -Trimmed Spearman Karber
G - Graphical

File: Ref Tox Cover

BIO-ANALYTICAL LABORATORIES
ACUTE TOXICITY TEST SURVIVAL AND WATER QUALITY DATA

Project#

Client Ref Tox

Sample Description 100 g/L NaCl (B.R. 3 2-06)

Test started: Date 3/10/06 Time 1530

Test ended: Date 3/12/06 Time 1430

Test Species D. pulex ID# 32/D_5-G

Technician: 0hour [illegible] 24hour [illegible] 48hour (EL) 72hour 96hour

Time: 0hour 1340 24hour [illegible] 48hour 1430 72hour 96hour

Temperature: 0hour 23°C 24hour 24.5°C 48hour 21.5°C 72hour 96hour

~~Percent Effluent~~ g/L	Replicate	Test Salinity	# of Live Organisms					Dissolved Oxygen					pH					Conductivity				
			0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0	A	N/A	5	5	5			8.5	–	7.8			8.0	–	8.1			[illegible]	---	[illegible]		
	B		5	5	4																	
	C		5	5	4																	
	D		5	5	5																	
1	A		5	5	3			8.5	—	7.7			8.1	-	8.1			2050	–	2050		
	B		5	5	4																	
	C		5	5	3																	
	D		5	5	4																	
2	A		5	5	0			8.5	—	7.8			8.1	-	8.1			[illegible]	-	[illegible]		
	B		5	4	0																	
	C		5	4	0																	
	D		5	5	1																	

Key: prerenewal/postrenewal

File:ACUTE2

BIO-ANALYTICAL LABORATORIES
ACUTE TOXICITY TEST SURVIVAL AND WATER QUALITY DATA

Project#__________

Test started: Date 3-10-06 Time 1540

Client Ref Tox

Test ended: Date 3-12-06 Time 1430

Sample Description 100g/L NaCl (BAL 3-2-06)

Test Species D. pulex ID# BAL/D. [illegible]

Technician: 0hour (EU) 24hour [illegible] 48hour (EU) 72hour / 96hour /

Time: 0hour 1540 24hour [illegible] 48hour 1430 72hour / 96hour /

Temperature: 0hour 25°C 24hour [illegible] 48hour 25°C 72hour / 96hour /

~~Percent Effluent~~ g/L	Replicate	Test Salinity	# of Live Organisms					Dissolved Oxygen					pH					Conductivity				
			0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
3	A	N/A	5	2	0			8.5	—	7.8			8.1	. .	8.1			[illegible]	—	[illegible]		
	B		5	1	0																	
	C		5	2	0																	
	D		5	1																		
4	A		5	0				8.5	7.7				8.1	8.0				[illegible]	[illegible]			
	B		5	0																		
	C		5																			
	D		5	0																		
5	A		5	0	—			8.3	7.7				8.1	8.0				[illegible]	[illegible]			
	B		5	0																		
	C		5	0	—																	
	D		5	0	—																	

Key: prerenewal/postrenewal

File.ACUTE2

Stream Habitat Assessment (Semi-Quantitative)

Station #: UTA-4	Date/Time: 4/27/05	Initials: SK4 / BJP

9. Aquatic Macrophytes and Periphyton (Percent Coverage)

Habitat Type		Reach No. - Percent Coverage										
		1	2	3	4	5	6	7	8	9	10	Average
Riffle	Macrophytes	—	0	5	0	0	0	0	0	0	0	0
	Periphyton	—	0	0	0	0	0	0	0	0	0	0
Pool	Macrophytes	10	5	0	0	0	0	0	0	0	0	1.5
	Periphyton	0	0	0	0	0	0	0	0	0	0	0

10. Canopy Cover (Percent Stream Shading)

Section	Reach No. - Percent (%) Shaded Within Stream Channel									
	1	2	3	4	5	6	7	8	9	10	Average
Shading	40%	40%	60%	70%	80%	70%	30%	50	70	80	59

11. Bank Stability (Score) and Slope (Degrees)

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	9	9	8	8	6	5	6	7	6	5	6.9
Slope (°)	30°	45	45	35	45	80°	80	40	60°	60°	52
RB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	9	9	8	8	7	8	8	7	6	5	7.5
Slope (°)	50°	35°	45	45	45	45	60	70	80°	50	52.5

Score 9-10 = Stable, < 5% bank affected.
Score 6-8 = Moderately stable, 5-29% of bank eroding
Score 3-5 = Moderately unstable, 30-59% bank eroding.
Score 1-2 = Unstable, 60-100% bank eroding.

12. Vegetative Protection (Percent Banks Protected)

LB Section	1	2	3	4	5	6	7	8	9	10	Average
%	80	40	10	10	30	40	30	30	30	30	33
RB Section	1	2	3	4	5	6	7	8	9	10	Average
%	50	65	20	20	20	10	10	30	30	20	27.5

13. Riparian Vegetative Zone Width

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	10	9	10	10	10	10	10	10	10	10	9.9
[illegible]	1	2	3	4	5	6	7	8	9	10	[illegible]
Score	10	10	10	10	10	10	10	10	10	10	10

Score 9-10 = Riparian Zone Width > 18 meters
Score 6-8 = Riparian Zone Width 18 - 12 meters
Score 3-5 = Riparian Zone Width 11 - 6 meters
Score 1-2 = Riparian Zone Width < 6 meters

14. Land-Use Stream Impacts

[illegible]	1	2	3	4	5	6	7	8	9	10	[illegible]
Impact	I, 1 →										1.0

C = Cattle R = Row Crops U = Urban Encroachment I = Industrial Encroachment O = Other

Score 0 = none 1 = minor affect 2 = moderate affect 3 = major affect

U/S Industry

Page 2 of 2
V 2.1

Habitat Assessment Field Data Sheet (Low Gradient)

Station I.D: UTA-4	Client:
Stream name: Unnamed trib of BdL	Date/Time: 4/27/06
Location: Union County	Form Completed By: SKH

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate / Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble, or other stable habitat; and at a stage to allow full colonization.	30-50% mix of stable habitat suited for colonization; adequate habitat for maintenance of population; some newfall may be present.	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed.	Less than 10% stable habitat; lack of habitat obvious; substrate lacking..
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay to sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root or vegetation.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep small-shallow, small deep pools present.	Majority of pools large deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or absent.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
4. Channel Alteration	No channelization or dredging present. Stream channel normal.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging, (greater than past 20 yrs.) may be present, but recent channelization is not present.	Embankments present on both banks; channelization may be extensive, and 40%-80% of steam reach channelized and disrupted.	Extensive channelization; shored with Gabon cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
5. Sediment Deposition	Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars.	20-50% affected; some accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; moderate deposition; pools shallow, moderately silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Heavily silted; >80% affected; movement/shifting of bottom occurs frequently; pools nearly absent due to deposition.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1

Habitat Assessment Field Data Sheet (Low Gradient Cont.)

Station I.D: UTA-4	Date/Time: 4/27/06
Stream name: Unnamed trib of R d L	Form Completed By: SKY

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than it if was in a straight line.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
7. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or < 25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
8. Bank Stability	Banks stable; no evidence of erosion or bank failure. <5% affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5%-30% affected.	Moderately unstable; up to 30%-60% of banks in reach show areas of erosion. High erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; 60-100% of banks have erosion scars.
SCORE 7 LB	Left Bank 10 9	8 [✓ 7] 6	5 4 3	2 1
SCORE 6 RB	Right Bank 10 9	8 7 [✓ 6]	5 4 3	2 1
9. Vegetative Protection	More than 90% of the streambank surfaces and immediate riparian zone covered by vegetation. Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by vegetation. Disruption minimal or not evident; one group of plants likely not evident. Almost all plants allowed to grow naturally.	50-70% of the streambank surfaces covered by vegetation. Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of streambank surfaces covered by vegetation. Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 2 LB	Left Bank 10 9	8 7 6	5 4 3	[✓ 2] 1
SCORE 2 RB	Right Bank 10 9	8 7 6	5 4 3	[✓ 2] 1
10. Riparian Vegetative Zone Width	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clearcuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted a great deal.	Width of riparian zone <6 meters; little riparian vegetation to human activities.
SCORE 9 LB	Left Bank 10 [✓ 9]	8 7 6	5 4 3	2 1
SCORE 9 RB	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1

TOTAL SCORE: 104

AVERAGE SCORE: 10.4

Barbour, M.T. et.al., 1999. *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers.*

Discharge/Flow Measurement Form

Station: WTA-4

Waterbody: unnamed Trib at Bayou de Loutre

Date: 4/27/05

Crew: SKH/BJP	Start Time: 1255	Recorder: SKH
	End Time:	GH. Change: ________in ________hrs.
	Staff/Gage:	
Width: 3.8'	Area:	Velocity:
Disch/Flow:	Method:	No Secs:
Meter No:	Max Vel:	Min Vel:

ORIENTATION:

Wading, Boat, Upstream, Downstream, Side Bridge ______ ft/mi,

above, below gage, and ____________

Measurement rated: excellent good fair poor based on the following

conditions: Cross section ____________

Flow __________ Weather __________

Other __________ Air ______ °F @ ______

Gage __________ Water ______ °F @ ______

Observer ____________

Control ____________

Remarks ____________

(1) Distance from initial point	(2) Width (W)	(3) Depth (D)	Obstruction(s) (logs, rocks, other)	(4) Avg. Velocity At Point (V)	Method Depth (0.2, [✓ 0.6], or 0.8)	(5) Area (A)	(6) Discharge (Q)
0.5'	0.5'	0.4'		ND		0.2	0
1.0	0.5	0.5'		ND		0.25	0
1.5	0.5	0.6		ND		0.3	0
2.0	0.5	0.5		ND		0.25	0
2.5	0.5	0.5		ND		0.25	0
3.0	0.5	0.4		ND		0.2	6
3.8	0.8	0.0		ND		0	0
TOTALS						1.45	0.0

NOTE: Flow Not Detected. However, small visual flow observed d/s on small sandy riffle ~ 0.1' deep, flow = < 0.1 CFS

V1.0 1096

Completed By______ Checked by______ Reviewed by______

FIELD DATA SHEETS - FISH

Waterbody Name: UTA 004
Client: Great Lakes
Project no: 2072-05-070
Investigators: REM SKH
JBB BJP
Date Sample Collected: 4/27/05
Habitat Forms Completed: [✓ yes] / no

Location: Outfall 004
Ecoregion: Gulf Coastal
Weather: Sunny Clear
Mild
Form Completed By: JBB/REM
Form Checked By:
Fish Sampling Completed: yes / no

Collection Site Observations			
	UTA 004 ~~Above Station~~	Below Station	Additional Observations:
Total Time Sampled			
Relative Abundance of Aquatic Biota			
Periphyton:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Filamentous Algae:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Macrophytes:	0 1 2 3 [✓ 4]	0 1 2 3 4	
Slimes:	0 1 [✓ 2] 3 4	0 1 2 3 4	
Macroinvertebrates:	0 [✓ 1 2] 3 4	0 1 2 3 4	
Fish:	[✓ 0 1] 2 3 4	0 1 2 3 4	
Other______________:	0 1 2 3 4	0 1 2 3 4	
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant			
Major Habitat Sampled (%)			
Riffle/Run:	0/70		
Shallow Pool:	30		
Deep Pool:			
Backwaters:			
Chanelized:			
Microhabitats Sampled (%)			
Woody debris:			
Emergent Vegatation:	30		
Submerged Vegetation:			
Depositional Area:	30		
Overhanging Veg:			
Root Wads:	20		
Undercut Banks:			
Filamentous algae:			
Leafy debris:	20		
Substrate Type and Scoring			
Substrate	Score	Adj. Score	
Bedrock:	X 0.1		
Lg. Boulder:	X 1.0		
Boulders:	X 1.0		
Rubble:	X 1.0		
Gravel:	X 0.5		
Sand:	20 X 0.1		
Mud/Silt:	80 · lower silt X 0.1		
Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0			

upper 40 hard clay

Sampling Gear Type: [✓ Electrofishing] Seine Gill nets

Unit of Effort: Above: 487 PDT / 17 min Below:

Quantity of Available Fish Cover:

Above Station: Very Abundant, Abundant, Moderate, Sparse, Absent

Below Station: Very Abundant, Abundant, Moderate, Sparse, Absent

Site Description & Notes:

Above Station:

Below Station:

SP 5/8/05

Lab checked

Fish Species Observed

004 ~~Above Station #~~	Below Station #
(11) – Mosquito Fish 𝍸 𝍸 |	

FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: UTA 004
Client: Great Lakes
Project no: 2072-05-070
Investigators: REM, JBB
SKH, BJP
Date Sample Collected: 4/27/05
Habitat Forms Completed: [✓ yes] / no

Location: Outfall 004
Ecoregion: Gulf Coastal
Weather: Sunny Clear
Mild
Form Completed By: JBB/REM
Form Checked By:
Fish Sampling Completed: yes / no

Collection Site Observations		
	UTA 4 ~~Above Station~~	Below Station
Date/Time Sampled:		
Relative Abundance of Aquatic Biota		
Periphyton:	[✓ 0] 1 2 3 4	0 1 2 3 4
Filamentous Algae:	[✓ 0] 1 2 3 4	0 1 2 3 4
Macrophytes:	0 1 2 3 [✓ 4]	0 1 2 3 4
Slimes:	0 [✓ 1 2] 3 4	0 1 2 3 4
Macroinvertebrates:	0 [✓ 1 2] 3 4	0 1 2 3 4
Fish:	[✓ 0 1] 2 3 4	0 1 2 3 4
Other__________:	0 1 2 3 4	0 1 2 3 4
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant		
Major Habitat Sampled (%)		
Riffle/Run:	40	
Shallow Pool:	20	
Deep Pool:		
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:	30	
Emergent Vegatation:		
Submerged Vegetation:		
Depositional Area:	30	
Overhanging Veg:		
Root Wads:	15	
Undercut Banks:	15	
Filamentous algae:		
Leafy Debris:	10	
Other__________:		

Macroinvertebrate Qualitative Sample List		
Taxa	Above Station	Below Station
Annelida		
Decapoda		
Gastropoda		
Pelecypoda		
Hemiptera		
Coleoptera		
Lepidoptera		
Odonata		
Megaloptera		
Diptera		
Chironomidae		
Plecoptera		
Ephemeroptera		
Trichoptera		
Amphipoda		

R=Rare, C=Common, A=Abundant, D=Dominant
Rare<3, Common 3-9, Abundant>10, Dominant>50

Site Description and Observations:

Frog/Tadpoles
Abundant
Cray Fish - Dominant
"No Fish"

GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

STATION I.D: UTA-3
LOCATION: West of GLCC outfall 003
STREAM NAME: Unnamed Trib of Little Cornie Bayou
RIVER BASIN: Ouachita River
LAT: **LONG:**
PROJECT:
INVESTIGATORS: SKH/BJP
DATE/TIME: 4/27/05 (1710)
FORM CHECKED BY:

WEATHER CONDITIONS

Now		Past 24-hr
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☑
☐	showers (intermittent)	☒
__% ☐	% cloud cover	☐ ____%
☒	clear/sunny	☐

Heavy rain in the last 7 days? ☒ Yes ☐ No
Air Temperature 75 °C/[✓ F]
Other ______

STREAM ATTRIBUTES

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Montane, non-glacial ☒ Mixture of origins
☐ Swamp and bog ☐ Other ______

Catchment Area: ______ mi^2
Stream Order: ______

Stream Gradient: ☐ High (≥25ft/mi) ☐ Moderate (10-24 ft/mi) ☒ Low (<10 ft/mi)

HYDROLOGY

Flows
☐ High ☐ Moderate ☒ Low ☐ None

Flows Measured? ☒ Yes ☐ No

Reach: **Slope** ______ ft/mi **&** **Sinuosity** ______

WATERSHED FEATURES

Predominant Surrounding Landuse
☒ Forest 100 % ☐ Sub-Urban
☐ Pasture ____% ☐ Commercial ____%
☐ Row Crops ____% ☐ Industrial ____%
☐ Urban ____% ☐ Other ______ %

Local Watershed NPS Pollution
☐ No evidence ☐ Agricultural
☐ Industrial Storm Water
☐ Urban/Sub-Urban Storm Water

RIPARIAN VEGETATION

☒ Mature Forest 70 % ☒ Shrub/Sapling 20 % ☒ Herbs/Grasses 10 % ☐ Turf ____%

STREAM MORPHOLOGY

☐ Riffle ____% ☒ Run 55.8 % ☒ Pool 44.2 %

STREAM DISTURBANCES

☐ Roads ☒ Bridges ☐ Pipelines ☐ Beaver Dams ☐ Point Source
☐ Dams ☐ Trash ☐ Cattle Access ☐ Mining ☐ ATV Crossing ☐ Other ______
u/s

Channelized: ☐ Yes ☐ Some ☒ No
Local Watershed Erosion: ☐ None ☒ Minimal ☐ Moderate ☐ Heavy
Channel Dynamics: ☐ Aggrading ☒ Degrading ☐ Widening ☐ Headcutting

Water Odors
☒ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other ______

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs
☐ Flecks ☒ None ☐ Other ______

Turbidity/Water Clarity (if not measured)
☐ Clear ☒ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other 17.0 NTU

Sediment Odor
☒ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other ______

Sediment Deposits
☐ Sludge ☐ Sawdust ☐ Oils
☒ Sand ☐ Relict shells
☒ Other Silt

Stream Habitat Assessment (Semi-Quantitative)

Station #: UTA-3	Stream: unnamed trib of Little Cypress Bayou	Date/Time: 4/27/05	Analyst: [illegible]
	Location: [illegible]	1525 – 1710	

[illegible] GPS U/S 33°10'52.2' 92°43'21.8 (240) D/S 33 10 51.9 92 43 22.9 (347)

1. Reach Length Determination

Parameter	Measurement Number 1	2	3	4	5	Average	Total Reach Length¹ (ft)	Sub-Reach Length² (ft)
Bankfull Width	10'	9.2'	8.1	10.2	7.5'	9.0	180	18.0'
Bankfull Depth	1.6'	1.3	1.4'	1.3	1.8'	1.4	na	na
	H₂O 0.7'	0.7	0.8'	0.5	1.0'			

¹Average width times 20 ²Total Length divided by 10

2. Riffle-Pool Sequence

Morph Type	Reach Number - Length in Feet 1	2	3	4	5	6	7	8	9	10	Total
Riffle											
Run	5.5	18.0	18.0	18.0	12	11	18				100.5
Pool	12.5				6	7		18	18	18	79.5 44:
Total											
Sequence¹	~~~~---	-----	-----	-----	~-----	~~~----	-----	~~~~~	~~~~~	~~~~~	

¹Riffle="xxx", Run="-----", Pool="~~~"

3. Depth and Width Regime

Morph Type	Reach No. - Average Depth (ft)/Width (ft) 1	2	3	4	5	6	7	8	9	10	Average
Riffle Depth	0.7	0.4	0.7	0.9	0.5	0.6	0.7	–	–	–	.64
Riffle Width	4.0	4.8	4.5	4.5	6.5	5.5	6.0	–	–	–	4.97
Pool Depth	1.7'	–	–	–	0.8	0.9	–	1.8	1.0	0.7	1.15
Pool Width	9.0'	–	–	–	5.0	5.5	–	7.5	8.5	8	~~43.5~~ 7.25

Heavy with Run Creek channel is new.

4. Epifaunal Substrate, Percent Stable Habitat (for Macroinvertebrates)

Section	1	2	3	4	5	6	7	8	9	10	Average
% Area	45%	30%	50	30%	50%	60	50	45	60	40	46

Most Habitat is Leaf & small woody debris packs

5. In-Stream Habitat, Percent Stable Habitat (Available Fish Cover in Wetted Perimeter)

Section	Reach No. - Availability and Quality of Fish Habitat 1	2	3	4	5	6	7	8	9	10	Average
% Area	50%	25	40	30	50%	60	40	50	60	40	44.5

6. Substrate Characterization (Dominant Substrate)

Morph Type	Reach No. - Dominant Substrate 1	2	3	4	5	6	7	8	9	10	Average
Riffle	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	–	–	S(2)
Pool	S(2)	–	–	–	S(2)	S(2)	–	S(2)	S(2)	S(2)	S(2)

BR=Bedrock(7), BLD=Boulder(6), COB=Cobble(5), GC=Gravel Coarse(4), GF=Gravel Fine(3), S=Sand(2), SC=Silt/Clay(1)

7. Embeddedness (Gravel, Cobble, Boulders Percent Embedded)

Low

Section	1	2	3	4	5	6	7	8	9	10	11	12	Average
% Embedded													

8. Sediment Deposition (Percent of Bottom Affected)

Section	1	2	3	4	5	6	7	8	9	10	Average
%	80	30	45	75	75	70%	60	80	80	60	65.5

Stream Habitat Assessment (Semi-Quantitative)

Station #: UTA-9	Date/Time: 4/27/05	Initials: SKH/BJP

9. Aquatic Macrophytes and Periphyton (Percent Coverage)

[illegible]	[illegible]	Reach No. - Percent Coverage										
		1	2	3	4	5	6	7	8	9	10	Average
Riffle	Macrophytes	0	0	0	0	0	0	0	0	0	0	0
	Periphyton	0	0	0	0	0	0	0	0	0	0	0
Pool	Macrophytes	0	0	0	0	0	0	0	0	0	0	0
	Periphyton	0	0	0	0	0	0	0	0	0	0	0

10. Canopy Cover (Percent Stream Shading)

	Reach No. - Percent (%) Shaded Within Stream Channel									
Section	1	2	3	4	5	6	7	8	9	10	Average
Shading	95	80	95	85	90	90	90	90	90	90	89.5

11. Bank Stability (Score) and Slope (Degrees)

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	7	8	6	8	8	8	8	~~6~~ 7	8	6	7.4
Slope (°)	60°	45°	50°	40°	30°	50	50	60	40	45	4.7
RB Section	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average Score**
Score	7	7	6	7	7	8	7	6	6	6	6.7
Slope (°)	60°	50°	65	60	40	40	55	70	65	40	53.5

Score 9-10 = Stable, < 5% bank affected.

Score 6-8 = Moderately stable, 5-29% of bank eroding

Score 3-5 = Moderately unstable, 30-59% bank eroding.

Score 1-2 = Unstable, 60-100% bank eroding.

12. Vegetative Protection (Percent Banks Protected)

LB Section	1	2	3	4	5	6	7	8	9	10	Average
%	30	20	30	10	20	20	20	20	15	15	20
RB Section	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
%	40	20	40	20	15	20	10	10	20	10	20.5

13. Riparian Vegetative Zone Width

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	10	10	10	10	10	10	10	10	10	10	10
RB Section	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average Score**
Score	10	10	10	10	10	10	10	10	10	10	10

Score 9-10 = Riparian Zone Width > 18 meters

Score 6-8 = Riparian Zone Width 18 - 12 meters

Score 3-5 = Riparian Zone Width 11 - 6 meters

Score 1-2 = Riparian Zone Width < 6 meters

14. Land-Use Stream Impacts

	Reach No. - Impact Type									
Section	1	2	3	4	5	6	7	8	9	10	Average
Impact	0	0	0	0	0	0	0	0	0	0	0

C = Cattle R = Row Crops U = Urban Encroachment I = Industrial Encroachment O = Other ____________

Score 0 = none 1 = minor affect 2 = moderate affect 3 = major affect

Habitat Assessment Field Data Sheet (Low Gradient)

Station I.D: UTA - 003	Client:
Stream name: Unnamed Trib of Little Corney Bayou	Date/Time: 4/27/06
Location: Union County	Form Completed By: SKH

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate / Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble, or other stable habitat; and at a stage to allow full colonization.	30-50% mix of stable habitat suited for colonization; adequate habitat for maintenance of population; some newfall may be present.	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed.	Less than 10% stable habitat; lack of habitat obvious; substrate lacking..
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay to sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root or vegetation.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep small-shallow, small deep pools present.	Majority of pools large deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or absent.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
4. Channel Alteration	No channelization or dredging present. Stream channel normal.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging, (greater than past 20 yrs.) may be present, but recent channelization is not present.	Embankments present on both banks; channelization may be extensive, and 40%-80% of steam reach channelized and disrupted.	Extensive channelization; shored with Gabon cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
5. Sediment Deposition	Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars.	20-50% affected; some accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; moderate deposition; pools shallow, moderately silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Heavily silted; >80% affected; movement/shifting of bottom occurs frequently; pools nearly absent due to deposition.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1

Habitat Assessment Field Data Sheet (Low Gradient Cont.)

Station I.D: UTA-3	Date/Time: 4/27/04
Stream name: Unnamed Trib of LCB	Form Completed By: SKH

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than it if was in a straight line.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
7. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or < 25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability	**Banks stable; no evidence of erosion or bank failure. <5% affected.**	**Moderately stable; infrequent, small areas of erosion mostly healed over. 5%-30% affected.**	**Moderately unstable; up to 30%-60% of banks in reach show areas of erosion. High erosion potential during floods.**	**Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; 60-100% of banks have erosion scars.**
SCORE 7 LB	Left Bank 10 9	8 [✓ 7] 6	5 4 3	2 1
SCORE 7 RB	Right Bank 10 9	8 [✓ 7] 6	5 4 3	2 1
9. Vegetative Protection	**More than 90% of the streambank surfaces and immediate riparian zone covered by vegetation. Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.**	**70-90% of the streambank surfaces covered by vegetation. Disruption minimal or not evident; one group of plants likely not evident. Almost all plants allowed to grow naturally.**	**50-70% of the streambank surfaces covered by vegetation. Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.**	**Less than 50% of streambank surfaces covered by vegetation. Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.**
SCORE 2 LB	Left Bank 10 9	8 7 6	5 4 3	[✓ 2] 1
SCORE 2 RB	Right Bank 10 9	8 7 6	5 4 3	[✓ 2] 1
10. Riparian Vegetative Zone Width	**Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clearcuts, lawns or crops) have not impacted zone.**	**Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.**	**Width of riparian zone 6-12 meters; human activities have impacted a great deal.**	**Width of riparian zone <6 meters; little riparian vegetation to human activities.**
SCORE 9 LB	Left Bank 10 [✓ 9]	8 7 6	5 4 3	2 1
SCORE 9 RB	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1

TOTAL SCORE: 115
AVERAGE SCORE: 11.5

Barbour, M.T. et.al., 1999. *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers.*

Discharge/Flow Measurement Form

Station: UTA-3

Waterbody:

Date: 4/27/05

Crew: SKH/BJP

Start Time: 1715

Recorder: SKH

End Time: 1725

GH. Change: ____ in ____ hrs.

Staff/Gage:

Width: 7.0

Area:

Velocity:

Disch/Flow:

Method:

No Secs:

Meter No:

Max Vel:

Min Vel:

ORIENTATION:

Wading, Boat, Upstream, Downstream, Side Bridge ____ ft/mi,

above, below gage, and ____

Measurement rated: excellent good fair poor based on the following

conditions: Cross section ____

Flow ____ Weather ____

Other ____ Air ____ °F @ ____

Gage ____ Water ____ °F @ ____

Observer ____

Control ____

Remarks ____

(1) Distance from Initial point	(2) Width (W)	(3) Depth (D)	Obstruction(s) (logs, rocks, other)	(4) Avg. Velocity At Point (V)	Method Depth (0.2, 0.6, or 0.8)	(5) Area (A)	(6) Discharge (Q)
0.5	0.5	0.3		0.03		0.15	0.005
1.5	1.0	0.5		0.10		0.5	0.05
2.5	1.0	0.7		0.13		0.7	0.091
3.5	1.0	0.7		0.14		0.7	0.098
4.5	1.0	0.8		0.13		0.8	0.104
5.5	1.0	0.7		0.13		0.7	0.09[illegible] [illegible]
6.5	1.0	0.5		0.07		0.5	0.035
7.0	0.5	0.1		ND			
TOTALS				0.09		4.10	0.474

Avg

V1.0 1096

Completed By SKH Checked by ____ Reviewed by ____

FIELD DATA SHEETS - FISH

Waterbody Name: UTA3
Client: Great Lakes
Project no: 2072-05-070
Investigators: REM, SKH, JBB, BJD
Date Sample Collected: 4/27/05
Habitat Forms Completed: [✓ yes] / no

Location: Outfall 003
Ecoregion: Gulf Coastal
Weather: Sunny Clear
Mild
Form Completed By: JBB/REM
Form Checked By:
Fish Sampling Completed: yes / no

Collection Site Observations

	# 003 ~~Above Station~~	Below Station	Additional Observations:
Total Time Sampled			
Relative Abundance of Aquatic Biota			
Periphyton:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Filamentous Algae:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Macrophytes:	0 1 [✓ 2] 3 4	0 1 2 3 4	
Slimes:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Macroinvertebrates:	0 1 2 [✓ 3 4]	0 1 2 3 4	
Fish:	0 [✓ 1 2] 3 4	0 1 2 3 4	
Other ______:	0 1 2 3 4	0 1 2 3 4	
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant			
Major Habitat Sampled (%)			
Riffle/Run:	5/25		
Shallow Pool:	65		
Deep Pool:			
Backwaters:			
Chanelized:			
Microhabitats Sampled (%)			
Woody debris:	70		
Emergent Vegatation:			
Submerged Vegetation:			
Depositional Area:	25		
Overhanging Veg:			
Root Wads:	5		
Undercut Banks:			
Filamentous algae:			
Leafy debris:			

Substrate Type and Scoring

Substrate	Score		Adj. Score
Bedrock:		X 0.1	
Lg. Boulder:		X 1.0	
Boulders:		X 1.0	
Rubble:		X 1.0	
Gravel:		X 0.5	
Sand:	20	X 0.1	
Mud/Silt:	80	X 0.1	

Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0

Sampling Gear Type: [✓ Electrofishing] Seine Gill nets

Unit of Effort: Above: 1726 s 57min Below:

Quantity of Available Fish Cover:

Above Station: Very Abundant, Abundant, Moderate, Sparse, Absent

Below Station: Very Abundant, Abundant, Moderate, Sparse, Absent

Site Description & Notes:

Above Station:

Below Station:

[illegible] SKL

RB Checked

Fish Species Observed

~~Above Station #~~ #003	Below Station #
⑤ — Grass Pickerel 𝍸 |	
① — Black bullhead catfish |	
① — Lepomis X |	— HAS ALL Longear Characteristics
② — Green Sunfish ||	
① — Warmouth |	
④ — Pirate Perch ||||	
① — Black spotted Topminnow |	
② — Gambusia ||	

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FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: UTA3

Client: Great Lakes

Project no: 2072-05-070

Investigators: REM, SKH, JBB, BJP

Date Sample Collected: 4/24/05

Habitat Forms Completed: [✓ yes] / no

Location: Outfall 003

Ecoregion: Gulf Coastal

Weather: Sunny Clear Mild

Form Completed By: REM/JBB

Form Checked By: REM

Fish Sampling Completed: [✓ yes] / no

Collection Site Observations	003 ~~Above Station~~	Below Station
Total Time Sampled		
Relative Abundance of Aquatic Biota		
Periphyton:	[✓ 0 1] 2 3 4	0 1 2 3 4
Filamentous Algae:	[✓ 0] 1 2 3 4	0 1 2 3 4
Macrophytes:	0 [✓ 1 2] 3 4	0 1 2 3 4
Slimes:	[✓ 0] 1 2 3 4	0 1 2 3 4
Macroinvertebrates:	0 1 [✓ 2 3] 4	0 1 2 3 4
Fish:	0 [✓ 1] 2 3 4	0 1 2 3 4
Other__________:	0 1 2 3 4	0 1 2 3 4
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant		
Major Habitat Sampled (%)		
Riffle/Run:	5/35	
Shallow Pool:	60	
Deep Pool:		
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:	50	
Emergent Vegatation:	X see notes.	
Submerged Vegetation:		
Depositional Area:	10	
Overhanging Veg:		
Root Wads:	20	
Undercut Banks:	15	
Filamentous algae:		
Leafy Debris:	5	
Other__________:		

Macroinvertebrate Qualitative Sample List		
Taxa	Above Station	Below Station
Annelida		
Decapoda		
Gastropoda		
Pelecypoda		
Hemiptera		
Coleoptera		
Lepidoptera		
Odonata		
Megaloptera		
Diptera		
Chironomidae		
Plecoptera		
Ephemeroptera		
Trichoptera		
Amphipoda		

R=Rare, C=Common, A=Abundant, D=Dominant

Rare<3, Common 3-9, Abundant>10, Dominant>50

Site Description and Observations:

YWDF - TNTC

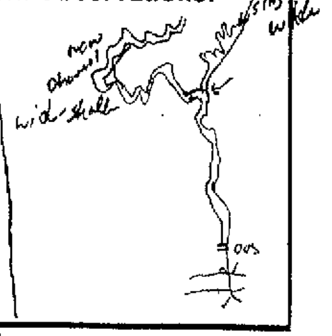
new channel being cut to South → impacts communities of fish - very shallow flow over/through lowlands

large pop. of Beetles whirligigs/ beetles etc.

*Instream woody debris very abundant.

= Stream channel very silted &

= emergent veg. at water edge



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Rapid Bioassessment Field Sheet

Point Source GLCC Outfall 003

Collector REM Sample Technique 3m pool Date

Sediment ?

Habitat Description: ABOVE UTA003: unnamed tributary to unnamed tributary of Little Cornie Bayou

BELOW UTLCB-1 - unnamed trib. to Little Cornie Bayou - above UT003

MACROINVERTEBRATE COMMUNITY

ABOVE Station # UTA 003

Cnt.	Taxa	Tally
10	Cambarinae	𝍸 𝍸
26	Isopoda	𝍸𝍸𝍸𝍸𝍸|
1	Mooreobdella	|
1	Cordulegaster	|
2	Calopteryx	||
4	Hyphilidae (L)	||||
2	Dineutus (L)	||
16	Corixidae	𝍸 𝍸 𝍸 |
11	Uvarus	𝍸 𝍸 |
1	Thermonectus	|
2	Stenelmis	1 (adult) 1 (larva)
1	Tipula	|
1	Simulium	|
8	Hexatoma	𝍸 |||
5	Corbicula	𝍸
9	Chironomidae	
100	:TOTAL:	

BELOW Station # UTLCB-1

Cnt.	Taxa	Tally
13	Cambarinae	𝍸 𝍸 |||
4	Isopoda	||||
3	Oligochaeta	|||
4	Palaemonetes	||||
19	Hyalella azteca	𝍸 𝍸 𝍸 ||||
23	Cheumatopsyche	𝍸 𝍸 𝍸 𝍸 |||
5	Caenis	𝍸
1	Tropisternus	|
3	Dineutus (L)	|||
12	Corixidae	𝍸 𝍸 ||
6	Uvarus	𝍸 |
1	Thermonectus	|
1	Notonecta	|
5	Chironomidae	𝍸
100	:TOTAL:	

Community Structure

	ABOVE	BELOW
% Ephem.	0	5
% Plecop.	0	—
% Trichop.	0	23
% EPT	0	28
% Chir.	9	5
Diptera	19	5

	ABOVE	BELOW
% Odon.	3	0
% Cole.	20	11
% Crustacea	34	40
# of Taxa:	16	14
Biotic Score:		

mments:

GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

STATION I.D: UTLCB-1
LOCATION: Union County
STREAM NAME: Little Corney Bayou
RIVER BASIN: Ouachita River
LAT:
LONG:
PROJECT: ULCC-46
INVESTIGATORS: SK4/BBB/KKM/BJB
DATE/TIME: 5/23/05 (1544)
FORM CHECKED BY:

WEATHER CONDITIONS

Now		Past 24-hr
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
__%☐	% cloud cover	☐____%
☒	clear/sunny	☒

Heavy rain in the last 7 days? ☐ Yes ☒ No
Air Temperature 90 °C/°F
Other

STREAM ATTRIBUTES

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Montane, non-glacial ☒ Mixture of origins
☐ Swamp and bog ☐ Other

Catchment Area: ________ mi^2
Stream Order:

Stream Gradient: ☐ High (≥25ft/mi) ☐ Moderate (10-24 ft/mi) ☒ Low (<10 ft/mi)

HYDROLOGY

Flows
☐ High ☐ Moderate ☒ Low ☐ None

Flows Measured?
☒ Yes ☐ No

Reach: **Slope** ____ft/mi **&** **Sinuosity** ____

WATERSHED FEATURES

Predominant Surrounding Landuse
☒ Forest 75% ☐ Sub-Urban
☐ Pasture ___% ☐ Commercial ___%
☐ Row Crops ___% ☐ Industrial ___%
☐ Urban ___% ☒ Other Powerline/Pipeline

Local Watershed NPS Pollution
☒ No evidence ☐ Agricultural
☐ Industrial Storm Water
☐ Urban/Sub-Urban Storm Water

RIPARIAN VEGETATION

☒ Mature Forest 70 % ☒ Shrub/Sapling 20 % ☒ Herbs/Grasses 10 % ☐ Turf ___%

STREAM MORPHOLOGY

☐ Riffle ___% ☒ Run 19 % ☒ Pool 81 %

STREAM DISTURBANCES

☐ Roads ☐ Bridges ☒ Pipelines ☐ Beaver Dams ☐ Point Source
☐ Dams ☐ Trash ☐ Cattle Access ☐ Mining ☐ ATV Crossing ☐ Other

Channelized: ☐ Yes ☐ Some ☒ No
Local Watershed Erosion: ☐ None ☒ Minimal ☐ Moderate ☐ Heavy
Channel Dynamics: ☒ Aggrading ☐ Degrading ☐ Widening ☐ Headcutting

Water Odors
☒ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs
☐ Flecks ☒ None ☐ Other

Turbidity/Water Clarity (if not measured)
☐ Clear ☐ Slightly turbid ☒ Turbid
☐ Opaque ☒ Stained ☐ Other

Sediment Odor
☒ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other

Sediment Deposits
☐ Sludge ☐ Sawdust ☐ Oils
☒ Sand ☐ Relict shells
☒ Other Soils/Clay/Silt

Stream Habitat Assessment (Semi-Quantitative)

Station #: LCB-1	Stream: Little Chronic Bayou	Date/Time: 5/23/05	Analyst: SZ4/JBB
	Location:	1430 –	

wpt 115 d/s 33 10 53.1 92 44 04.2 wpt 116 u/s lat: long:

1. Reach Length Determination

Rw 12' 1.1

Parameter	Measurement Number Pool 1	Run 2	Pool 3	Run 4	Pool 5	Average	Total Reach Length¹ (ft)	Sub Reach Length² (ft)
Bankfull Width	13'	11'	12	12'	15	12.5	250'	25'
Bankfull Depth	2.4'	1.7'	2.3'	1.4'	2.0'	1.4	na	na

¹Average width times 20 ²Total Length divided by 10

2. Riffle-Pool Sequence

Morph Type	Reach Number / Length in Feet 1	2	3	4	5	6	7	8	9	10	Total	
Riffle												
Run		13		9			25				47	19%
Pool	25'	12	25	16	25	25		25	25	25	203	81%
Total												
Sequence¹	∼∼∼∼	∼∼---	∼∼∼∼	∼∼--∼∼	∼∼∼∼	∼∼∼∼	---	∼∼∼∼	∼∼∼∼	∼∼∼∼		

¹Riffle="xxx", Run="-----", Pool="~~~"

3. Depth and Width Regime

Rw Rw Rw

Morph Type	Reach No. / Average Depth (ft) / Width (ft) 1	2	3	4	5	6	7	8	9	10	Average
Riffle Depth		0.4/0.3		0.2/0.1			0.5/0.3				
Riffle Width		4'		5'			7.0				
Pool Depth	1.1/0.8	1.0/0.7	0.7/0.4	0.8/0.5	1.2/0.7	0.6/0.4	–	1.9/1.0	2.9/2.4	0.7/0.6	0.8
Pool Width	11'	13	8.0	7.0'	9.0'	7'	–	13	14	10	10.2

Thalweg/Avg

4. Epifaunal Substrate, Percent Stable Habitat (for Macroinvertebrates)

Section	1	2	3	4	5	6	7	8	9	10	Average
% Area	20	30	35	35	15	20	20	35	50	60	32.0

5. In-Stream Habitat, Percent Stable Habitat (Available Fish Cover in Wetted Perimeter)

Section	Reach No. / Availability and Quality of Fish Habitat 1	2	3	4	5	6	7	8	9	10	Average
% Area	10	20	35	25	10	25	25	55	60	100	30.5

6. Substrate Characterization (Dominant Substrate)

Run Rw Run

Morph Type	Reach No. / Dominant Substrate 1	2	3	4	5	6	7	8	9	10	Average
Riffle	–	2		1			1				
Pool	1	1	1	1	1	1		1	1	1	Silt/Clay

BR=Bedrock(7), BLD=Boulder(6), COB=Cobble(5), GC=Gravel Coarse(4), GF=Gravel Fine(3), S=Sand(2), SC=Silt/Clay(1)

7. Embeddedness (Gravel, Cobble, Boulders Percent Embedded)

OW

Section	1	2	3	4	5	6	7	8	9	10	11	12	Average
~~% Embedded~~													

8. Sediment Deposition (Percent of Bottom Affected)

Section	1	2	3	4	5	6	7	8	9	10	Average
%	50	40	40	50	35	65	45	60	40	40	46.5

Stream Habitat Assessment (Semi-Quantitative)

Station #: LCB-1	Date/Time: 5/23/05	Initials: SKY/JRR

9. Aquatic Macrophytes and Periphyton (Percent Coverage)

Flow

Run

Habitat Type		Reach No. – Percent Coverage										
		1	2	3	4	5	6	7	8	9	10	Average
Riffle	Macrophytes		5		0			5				
	Periphyton		0		0			0				
Pool	Macrophytes	0	0	0	0	0	5		0	0	5	
	Periphyton	0	0	0	0	0	0		0	0	0	

10. Canopy Cover (Percent Stream Shading)

	Reach No. – Percent (%) Shaded Within Stream Channel										
Section	1	2	3	4	5	6	7	8	9	10	Average
Shading	95	90	95	80	90	70	70	80	95	95	86.0

11. Bank Stability (Score) and Slope (Degrees)

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	5	6	6	7	6	5	6	6	8	8	Mod 5
Slope (°)	85	70	70	60	65	85	85	85	65	70	74
RB Section	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average Score**
Score	2	2	6	5	7	7	8	7	6	6	Mod 5.
Slope (°)	95	95	75	80	80	60	75	90	90	95	83.5

Score 9-10 = Stable, < 5% bank affected.
Score 6-8 = Moderately stable, 5-29% of bank eroding
Score 3-5 = Moderately unstable, 30-59% bank eroding.
Score 1-2 = Unstable, 60-100% bank eroding.

12. Vegetative Protection (Percent Banks Protected)

LB Section	1	2	3	4	5	6	7	8	9	10	Average
%	40	60	40	30	30	30	20	40	25	30	35.5
RB Section	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
%	20	20	50	45	50	40	50	30	55	45	40.5

13. Riparian Vegetative Zone Width

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	9	9	9	9	9	9	9	9	9	9	>18
RB Section	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average Score**
Score	9	9	9	9	9	9	9	9	9	9	>18

Score 9-10 = Riparian Zone Width > 18 meters
Score 6-8 = Riparian Zone Width 18 - 12 meters
Score 3-5 = Riparian Zone Width 11 - 6 meters
Score 1-2 = Riparian Zone Width < 6 meters

14. Land-Use Stream Impacts

	Reach No. – Impact Score										
Section	1	2	3	4	5	6	7	8	9	10	Average
Impact	0	0	0	0	0	0	0	0	0	0	—

C = Cattle R = Row Crops U = Urban Encroachment I = Industrial Encroachment O = Other ____________

Score 0 = none 1 = minor affect 2 = moderate affect 3 = major affect

Habitat Assessment Field Data Sheet (Low Gradient)

Station I.D: LCB-1	Client:
Stream name: Little Cane Bayou	Date/Time: 5/23/04
Location: Union County	Form Completed By: SKM

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate / Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble, or other stable habitat; and at a stage to allow full colonization.	30-50% mix of stable habitat suited for colonization; adequate habitat for maintenance of population; some newfall may be present.	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed.	Less than 10% stable habitat; lack of habitat obvious; substrate lacking..
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay to sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root or vegetation.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep small-shallow, small deep pools present.	Majority of pools large deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or absent.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
4. Channel Alteration	No channelization or dredging present. Stream channel normal.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging, (greater than past 20 yrs.) may be present, but recent channelization is not present.	Embankments present on both banks; channelization may be extensive, and 40%-80% of steam reach channelized and disrupted.	Extensive channelization; shored with Gabon cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 18	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Sediment Deposition	Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars.	20-50% affected; some accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; moderate deposition; pools shallow, moderately silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Heavily silted; >80% affected; movement/shifting of bottom occurs frequently; pools nearly absent due to deposition.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1

Habitat Assessment Field Data Sheet (Low Gradient Cont.)

Station I.D: LCB-1	Date/Time: 5/23/06
Stream name: Little [illegible] Basin	Form Completed By: SKH

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than it if was in a straight line.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or < 25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 17	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability	Banks stable; no evidence of erosion or bank failure. <5% affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5%-30% affected.	Moderately unstable; up to 30%-60% of banks in reach show areas of erosion. High erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; 60-100% of banks have erosion scars.
SCORE 8 LB	Left Bank 10 9	[✓ 8] 7 6	5 4 3	2 1
SCORE 8 RB	Right Bank 10 9	[✓ 8] 7 6	5 4 3	2 1
9. Vegetative Protection	More than 90% of the streambank surfaces and immediate riparian zone covered by vegetation. Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by vegetation. Disruption minimal or not evident; one group of plants likely not evident. Almost all plants allowed to grow naturally.	50-70% of the streambank surfaces covered by vegetation. Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of streambank surfaces covered by vegetation. Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 3 LB	Left Bank 10 9	8 7 6	5 4 [✓ 3]	2 1
SCORE 3 RB	Right Bank 10 9	8 7 6	5 4 [✓ 3]	2 1
10. Riparian Vegetative Zone Width	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clearcuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted a great deal.	Width of riparian zone <6 meters; little riparian vegetation to human activities.
SCORE 9 LB	Left Bank 10 [✓ 9]	8 7 6	5 4 3	2 1
SCORE 9 RB	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1

TOTAL SCORE: 132

AVERAGE SCORE: 13.2

Barbour, M.T. et.al., 1999. *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers.*

Discharge/Flow Measurement Form

Station: LCB-1

Waterbody: Little Chenier Bayou

Date: 5/23/05

Crew: SM/DBM	Start Time: 1650	Recorder: SM
	End Time: 1720	GH. Change: ________ in ________ hrs.
	Staff/Gage:	
Width: 5.5	Area:	Velocity:
Disch/Flow:	Method:	No Secs:
Meter No:	Max Vel:	Min Vel:

ORIENTATION:

[✓ Wading,] Boat, Upstream, [✓ Downstream,] Side Bridge ______ ft/mi, above, below gage, and __________

Measurement rated: excellent good fair poor based on the following conditions: Cross section __________

Flow __________ Weather __________

Other __________ Air ______ °F @ ______

Gage __________ Water ______ °F @ ______

Observer __________

Control __________

Remarks __________

(1) Distance from initial point	(2) Width (W)	(3) Depth (D)	Obstruction(s) (logs, rocks, other)	(4) Avg. Velocity At Point (V)	Method Depth (0.2, [✓ 0.6,] or 0.8)	(5) Area (A)	(6) Discharge (Q)
0.5	0.5	0.2		ND		0.1	0
1.0		0.2		ND		0.1	0
1.5		0.3		0.01		0.15	0.0015
2.0		0.4		0.01		0.2	0.002
2.5		0.4		0.01		0.2	0.002
3.0		0.4		0.03		0.2	0.006
3.5		0.4		0.01		0.2	0.002
4.0		0.4		0.01		0.2	0.002
4.5		0.3		ND		0.15	0
5.0		0.2		ND		0.1	0
5.5		0.0		ND		0	0
TOTALS						1.60	002

Avg - 0.01

V1.0 1096

Completed By SM ____ Checked by ________ Reviewed by ________

FIELD DATA SHEETS - FISH

Waterbody Name: Little Caillou Bayou
Client: GLCC
Project no:
Investigators: RDM
RLM
Date Sample Collected: 5/23/05
Habitat Forms Completed: [✓ yes] / no

Location: LCB-1
Ecoregion: Coastal Plain
Weather:
Form Completed By:
Form Checked By:
Fish Sampling Completed: [✓ yes] / no

Collection Site Observations

	Above Station	Below Station	Additional Observations:
Total Time Sampled:	LCB-1		
Relative Abundance of Aquatic Biota			
Periphyton:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Filamentous Algae:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Macrophytes:	0 [✓ 1] 2 3 4	0 1 2 3 4	
Slimes:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Macroinvertebrates:	0 1 2 [✓ 3] 4	0 1 2 3 4	
Fish:	0 1 2 [✓ 3] 4	0 1 2 3 4	
Other ______:	0 1 2 3 4	0 1 2 3 4	
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant			
Major Habitat Sampled (%)			
Riffle/[✓ Run]:	5/20		
Shallow Pool:	60		
Deep Pool:	15		
Backwaters:			
Chanelized:			
Microhabitats Sampled (%)			
Woody debris:	30		
Emergent Vegatation:	–		
Submerged Vegetation:	5		
Depositional Area:	~~8~~20		
Overhanging Veg:	–		
Root Wads:	15		
Undercut Banks:	~~5~~ –		
Filamentous algae:	–		
Leafy debris:	25		
Substrate Type and Scoring			
Substrate	Score	Adj. Score	
Bedrock:	– X 0.1		
Lg. Boulder:	– X 1.0		
Boulders:	– X 1.0		
Rubble:	– X 1.0		
Gravel:	– X 0.5		
Sand:	20 X 0.1		
Mud/Silt:	80 X 0.1		
Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0			

Sampling Gear Type: [✓ Electrofishing] Seine Gill nets start 1425

Unit of Effort: Above: PDT 29/3 Below: stop 1545

Quantity of Available Fish Cover:

Above Station: Very Abundant, [✓ Abundant,] Moderate, Sparse, Absent

Below Station: Very Abundant, Abundant, Moderate, Sparse, Absent

Site Description & Notes:

Above Station: LCB-1

Below Station:

ck SKH 7/7/05

LCB-1

Fish Species Observed

		Above Station #		Below Station #	Rel----
	8	Green Sunfish	𝍸 |||		
	9	Banded Pygmy	𝍸 𝍸		
+	9	Warmouth	𝍸 ||||		4
	41	Bluegill	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||		
D+	19	grass pickerel	𝍸 𝍸 𝍸 ||||		19
	29	pyrate perch	𝍸 𝍸 𝍸 𝍸 𝍸 ||||		5
	5	red fin shiner	𝍸		
	3	golden shiner	|||		
	9	long ear	𝍸 ||		
	6	spotted sun	||||		
	37	black spotted top	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||	1 w/ Growth	
		~~golden top~~	~~||~~		
	1	creek chub	|		
	37	gambusia	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 |||		
	10	slough darter	𝍸 𝍸		
D+	6	yellow bullhead	𝍸 |	1 w/ External parasites	1
	1	creek chubsucker	|		
	6	sun YOY	𝍸 𝍸 𝍸 |||		
		~~orange spot~~	~~|~~		
	1	flier	|		
	1	Bluntnose darter	|		

Fish collected ~~up~~

bug sample!

Banded Pigmy: 10

Slough darter: 14

Gambusia: 1

Revision 1.2 05/28/02
GBM^c & Assoc. Doc. 1
Page 2 of 2

FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: Little Cornie Bayou
Location: UTLCB-1
Client: GLCC 4(g)
Ecoregion: Gulf Coastal
Project no: 2072-05-070
Weather: Clear - Sunny - Hot
Investigators: REM JKH BSP JBB
Date Sample Collected: 5/23/05
Form Completed By: REM
Habitat Forms Completed: [✓ yes] / no
Fish Sampling Completed: [✓ yes] / no

Collection Site Observations		
	Above Station	Below Station
Total Time Sampled	LCA-1	
Relative Abundance of Aquatic Biota		
Periphyton:	0 1 2 3 4	0 1 2 3 4
Filamentous Algae:	0 1 2 3 4	0 1 2 3 4
Macrophytes:	0 1 2 3 4	0 1 2 3 4
Slimes:	0 1 2 3 4	0 1 2 3 4
Macroinvertebrates:	0 1 [✓ 2] [✓ 3] 4	0 1 2 3 4
Fish:	0 1 2 [✓ 3] [✓ 4]	0 1 2 3 4
Other________:	0 1 2 3 4	0 1 2 3 4
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant		
Major Habitat Sampled (%)		
Riffle/Run:	5/20	
Shallow Pool:	65	
Deep Pool:	10	
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:	20	
Emergent Vegatation:		
Submerged Vegetation:		
Depositional Area:	30	
Overhanging Veg:		
Root Wads:		
Undercut Banks:		
Filamentous algae:		
Leafy Debris:	50	
Other________:		

Macroinvertebrate Qualitative Sample List		
Taxa	Above Station	Below Station
Annelida		
Decapoda		
Gastropoda		
Pelecypoda		
Hemiptera		
Coleoptera		
Lepidoptera		
Odonata		
Megaloptera		
Diptera		
Chironomidae		
Plecoptera		
Ephemeroptera		
Trichoptera		
Amphipoda		

R=Rare, C=Common, A=Abundant, D=Dominant
Rare<3, Common 3-9, Abundant>10, Dominant>50

Site Description and Observations:

Low flow conditions
- undercut banks exposed
- root wads out of water

Rapid Bioassessment Field Sheet

Point Source GLCC- OUTFALL 003

Date

Collector REM

Sample Technique 3 m pool

Sediment ?

Habitat Description ABOVE UTLCA-1 , upstream of GLCC OUTFALL 003 mouth (DUPE)

BELOW LCB-2 , downstream of GLCC 003 and watershed ~ 4x as large

MACROINVERTEBRATE COMMUNITY

ABOVE Station # UTLCB-1 (DUPE)

Cnt.	Taxa	Tally
13	Cambarinae	卌 卌 |||
4	Palamonetes	||||
26	Isopoda	卌 卌 卌 卌 卌	
19	Hyallea azteca	卌 卌 卌 [illegible] |||| Rem
3	Oligochetae	|||
23	Cheumatopsyche	卌 卌 卌 卌 |||
5	Caenis	卌
12	Corixidae	卌 卌 ||
6	Uvarus	卌	
1	Tropisternus		
3	Dineutis (L)	|||
5	Chironomidae	卌
1	Thermonectus		
1	Neoneuta		
	:TOTAL:	

BELOW Station # LCB-2

Cnt.	Taxa	Tally
7	Cambarinae	卌 ||
9	Palaemonetes	卌 ||||
3	Isopoda	|||
16	Amphipoda	卌 卌 卌	
2	Cheumatopsyche	||
17	Caenis	卌 卌 卌 ||
9	Baetis	卌 ||||
1	Corduliidae		
8	Corixidae	卌 |||
7	Uvarus	卌 ||
2	Ranatra	||
1	Argia		
1	Caborhaus		
5	Enallagma	卌
6	Hexatoma	卌	
1	Pelastoma		
1	Chauliodes		
2	Sialis	||
1	Probezzia		
6	Chironomidae	卌	
	:TOTAL:	

Community Structure

	ABOVE	BELOW		ABOVE	BELOW
% Ephem.	5	24	% Odon.	0	7
% Plecop.	—	—	% Cole.	14	7
% Trichop.	23	2	% Crustacea	17	16
% EPT	28	28			
% Chir.	5	6	# of Taxa:	14	20
Diptera	0	14	Biotic Score:		

[illegible]nments: CA/8 CA/6

GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

STATION I.D: ut LCB-2	LOCATION: d/s of Hwy 15 Bridge, Union Co
STREAM NAME: Little Cornie Bayou	RIVER BASIN: Ouachita River
LAT: LONG:	PROJECT:

INVESTIGATORS: Ren/BKH/BJP/DBD
DATE/TIME: 5/24/05 (1035)
FORM CHECKED BY:

WEATHER CONDITIONS

Now		Past 24-hr
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
__% ☐	% cloud cover	☐ ____%
☒	clear/sunny	☒

Heavy rain in the last 7 days? ☐ Yes ☒ No
Air Temperature 80 °C/°F
Other ____

STREAM ATTRIBUTES

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Montane, non-glacial ☒ Mixture of origins
☐ Swamp and bog ☒ Other outfall 003

Catchment Area: ____ mi^2
Stream Order: ____

Stream Gradient: ☐ High (≥25ft/mi) ☐ Moderate (10-24 ft/mi) ☒ Low (<10 ft/mi)

HYDROLOGY

Flows
☐ High ☐ Moderate ☐ Low ☒ None

Flows Measured? ☐ Yes ☒ No

Reach: Slope ____ ft/mi & Sinuosity ____

WATERSHED FEATURES

Predominant Surrounding Landuse
☒ Forest 90 % ☐ Sub-Urban
☐ Pasture ___% ☐ Commercial ___%
☐ Row Crops ___% ☐ Industrial ___%
☐ Urban ___% ☒ Other Pipeline/Road %

Local Watershed NPS Pollution
☐ No evidence ☐ Agricultural
☐ Industrial Storm Water
☐ Urban/Sub-Urban Storm Water

RIPARIAN VEGETATION

☒ Mature Forest 70% ☒ Shrub/Sapling 20% ☒ Herbs/Grasses 10 % ☐ Turf ___%

STREAM MORPHOLOGY

☐ Riffle ___% ☐ Run ___% ☒ Pool 100 %

STREAM DISTURBANCES

☒ Roads ☒ Bridges ☐ Pipelines ☐ Beaver Dams ☒ Point Source u/s
☐ Dams ☐ Trash ☐ Cattle Access ☐ Mining ☐ ATV Crossing ☐ Other ____

around bridge

Channelized: ☐ Yes ☒ Some ☐ No
Local Watershed Erosion: ☐ None ☒ Minimal ☐ Moderate ☐ Heavy
Channel Dynamics: ☐ Aggrading ☒ Degrading ☐ Widening ☐ Headcutting

Water Odors
☒ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other ____

Water Surface Oils
☐ Slick ☒ Sheen ☐ Globs
☐ Flecks ☐ None ☐ Other ____

organic

Turbidity/Water Clarity (If not measured)
☐ Clear ☒ Slightly turbid ☐ Turbid
☐ Opaque ☒ Stained ☐ Other ____

Sediment Odor
☒ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other ____

Sediment Deposits
☐ Sludge ☐ Sawdust ☐ Oils
☒ Sand ☐ Relict shells
☐ Other Silt/Soils

Stream Habitat Assessment (Semi-Quantitative)

Station #: LCB-2	Stream: Little Cane Bayou	Date/Time: 5/24/05	Analyst: SEH/BJP
	Location: d/s of Hwy 15 Bridge	0925 - 1035	

1. Reach Length Determination

d/s upt over (no GPS Signal)

Parameter	Measurement Number					Average	Total Reach Length (ft)	Sub-Reach Length (ft)
	1	2	3	4	5			
Bankfull Width	20'	21'	22	20'	20'	20.4	412	41.2
Bankfull Depth	2.5'	4.5'	4.1	5.1'	2.9	—	na	na

[1]Average width times 20 [2]Total Length divided by 10

2. Riffle-Pool Sequence

Habitat Type	Reach Number - Length in Feet										Total
	1	2	3	4	5	6	7	8	9	10	
Riffle											
Run											
Pool	41.2										
Total											
Sequence[1]	~~~	~~~	~~~	~~~	~~~	~~~	~~~	~~~	~~~	~~~	

[1]Riffle="xxx", Run="-----"; Pool="~~~"

3. Depth and Width Regime

Habitat Type	Reach No. - Average Depth (ft) / Width (ft)										Average
	1	2	3	4	5	6	7	8	9	10	
Riffle Depth											
Riffle Width											
Pool Depth	3.8/2.5	3.5/2.0	29/1.5	2.6/1.8	3.0/1.5	28/1.5	3.5/2.0	3.7/2.2	3.8/2.0	2.7/2.0	1.9
Pool Width	20'	24'	18	18	21'	20	17	18	19	18	19.3

Thalweg / Avg

4. Epifaunal Substrate, Percent Stable Habitat (for Macroinvertebrates)

Section	1	2	3	4	5	6	7	8	9	10	Average
% Area	30	30	30	50	30	40	30	45	30	30	32.5

5. In-Stream Habitat, Percent Stable Habitat (Available Fish Cover in Wetted Perimeter)

Section	Reach No. - Availability and Quality of Fish Habitat										Average
	1	2	3	4	5	6	7	8	9	10	
% Area	45	50	60	40	45	50	60	65	40	50	50.5

6. Substrate Characterization (Dominant Substrate)

Habitat Type	Reach No. - Dominant substrate										Average
	1	2	3	4	5	6	7	8	9	10	
Riffle											
Pool	1	1	1	1	1	1	1	1	1	1	silt/clay

BR=Bedrock(7), BLD=Boulder(6), COB=Cobble(5), GC=Gravel Coarse(4), GF=Gravel Fine(3), S=Sand(2), SC=Silt/Clay(1)

7. Embeddedness (Gravel, Cobble, Boulders Percent Embedded)

Section	1	2	3	4	5	6	7	8	9	10	11	12	Average
% Embedded													

8. Sediment Deposition (Percent of Bottom Affected)

Section	1	2	3	4	5	6	7	8	9	10	Average
%	75	85	85	75	70	80	60	60	60	70	72.0

Stream Habitat Assessment (Semi-Quantitative)

Station #: LCB-2	Date/Time: 4/24/05	Initials: SKY/BJP

9. Aquatic Macrophytes and Periphyton (Percent Coverage)

Morph. Type	Macrophytes / Periphyton	Reach No. - Percent Coverage 1	2	3	4	5	6	7	8	9	10	Average
Riffle	Macrophytes											
	Periphyton											
Pool	Macrophytes	0	5	0	0	0	0	0	0	0	0	
	Periphyton	0	0	0	0	0	0	0	0	0	0	

10. Canopy Cover (Percent Stream Shading)

Section	Reach No. - Percent (%) Shaded Within Reach Channel 1	2	3	4	5	6	7	8	9	10	Average
Shading	95	70	50	70	90	85	70	90	40	40	70

11. Bank Stability (Score) and Slope (Degrees)

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	9	9	7	9	8	9	7	8	9	9	8.4
Slope (°)	60	60	80	45	50	45	70	50	45	45	55
RB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	9	9	9	8	8	9	9	9	8	8	8.6
Slope (°)	60	60	60	75	50	45	70	45	60	60	59.5

Score 9-10 = Stable, < 5% bank affected.
Score 6-8 = Moderately stable, 5-29% of bank eroding
Score 3-5 = Moderately unstable, 30-59% bank eroding.
Score 1-2 = Unstable, 60-100% bank eroding.

12. Vegetative Protection (Percent Banks Protected)

LB Section	1	2	3	4	5	6	7	8	9	10	Average
%	60	70	60	40	40	40	40	50	65	80	54.5
RB Section	1	2	3	4	5	6	7	8	9	10	Average
%	70	70	80	70	50	60	70	80	75	70	69.5

13. Riparian Vegetative Zone Width

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	9	9	9	9	9	9	9	9	9	9	7 18
RB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	9	9	9	9	9	9	9	9	9	9	718

Score 9-10 = Riparian Zone Width > 18 meters
Score 6-8 = Riparian Zone Width 18 - 12 meters
Score 3-5 = Riparian Zone Width 11 - 6 meters
Score 1-2 = Riparian Zone Width < 6 meters

14. Land-Use Stream Impacts

Section	Reach No. - Impact Score 1	2	3	4	5	6	7	8	9	10	Average
Impact	0										

C = Cattle R = Row Crops U = Urban Encroachment I = Industrial Encroachment O = Other ______
Score 0 = none 1 = minor affect 2 = moderate affect 3 = major affect

Bridge at u/s Terminus of Reach
Hwy 15

Habitat Assessment Field Data Sheet (Low Gradient)

Station I.D.: LCB-2	Client:
Stream name: Little Cornie Bayou	Date/Time: 5/24/06
Location: Union County	Form Completed By: SKH

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate / Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble, or other stable habitat; and at a stage to allow full colonization.	30-50% mix of stable habitat suited for colonization; adequate habitat for maintenance of population; some newfall may be present.	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed.	Less than 10% stable habitat; lack of habitat obvious; substrate lacking..
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay to sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root or vegetation.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep small-shallow, small deep pools present.	Majority of pools large deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or absent.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Channel Alteration	No channelization or dredging present. Stream channel normal.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging, (greater than past 20 yrs.) may be present, but recent channelization is not present.	Embankments present on both banks; channelization may be extensive, and 40%-80% of steam reach channelized and disrupted.	Extensive channelization; shored with Gabon cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 17	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Sediment Deposition	Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars.	20-50% affected; some accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; moderate deposition; pools shallow, moderately silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Heavily silted; >80% affected; movement/shifting of bottom occurs frequently; pools nearly absent due to deposition.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1

Habitat Assessment Field Data Sheet (Low Gradient Cont.)

Station I.D: LCB-2	Date/Time: 5/24/06
Stream name: Little Conner Bayou	Form Completed By: SKA

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than it if was in a straight line.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
7. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or < 25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 18	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability	Banks stable; no evidence of erosion or bank failure. <5% affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5%-30% affected.	Moderately unstable; up to 30%-60% of banks in reach show areas of erosion. High erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; 60-100% of banks have erosion scars.
SCORE 8 LB	Left Bank 10 9	[✓ 8] 7 6	5 4 3	2 1
SCORE 9 RB	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1
9. Vegetative Protection	More than 90% of the streambank surfaces and immediate riparian zone covered by vegetation. Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by vegetation. Disruption minimal or not evident; one group of plants likely not evident. Almost all plants allowed to grow naturally.	50-70% of the streambank surfaces covered by vegetation. Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of streambank surfaces covered by vegetation. Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 4 LB	Left Bank 10 9	8 7 6	5 [✓ 4] 3	2 1
SCORE 7 RB	Right Bank 10 9	8 [✓ 7] 6	5 4 3	2 1
10. Riparian Vegetative Zone Width	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clearcuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted a great deal.	Width of riparian zone <6 meters; little riparian vegetation to human activities.
SCORE 9 LB	Left Bank 10 [✓ 9]	8 7 6	5 4 3	2 1
SCORE 9 RB	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1

TOTAL SCORE: 133

AVERAGE SCORE: 13.3

Barbour, M.T. et.al., 1999. *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers.*

FIELD DATA SHEETS - FISH

Waterbody Name: Little Cocrny Bayou
Client: GLCC
Project no: 2072-05-070
Investigators: SKH, BJP, JBB, REM
Date Sample Collected: 5/25/05
Habitat Forms Completed: [✓ yes] / no

Location: LCB-2
Ecoregion: Gulf Coastal
Weather: Sunny Clear Hot
Form Completed By: REM/JBB
Form Checked By:
Fish Sampling Completed: [✓ yes] / no

Collection Site Observations

	Above Station	LCB-2 ~~Below Station~~
Total Time Sampled:		
Relative Abundance of Aquatic Biota		
Periphyton:	0 1 2 3 4	[✓ 0 1] 2 3 4
Filamentous Algae:	0 1 2 3 4	0 1 2 3 4
Macrophytes:	0 1 2 3 4	0 1 [✓ 2 3] 4
Slimes:	0 1 2 3 4	[✓ 0] 1 2 3 4
Macroinvertebrates:	0 1 2 3 4	0 1 2 [✓ 3 4]
Fish:	0 1 2 3 4	0 1 [✓ 2 3] 4
Other_____________:	0 1 2 3 4	0 1 2 3 4
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant		
Major Habitat Sampled (%)		
Riffle/Run:		
Shallow Pool:		25
Deep Pool:		75
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody debris:		50
Emergent Vegatation:		10
Submerged Vegetation:		
Depositional Area:		
Overhanging Veg:		
Root Wads:		20
Undercut Banks:		20
Filamentous algae:		
Leafy debris:		

Substrate Type and Scoring

Substrate	Score	Adj. Score
Bedrock:	X 0.1	
Lg. Boulder:	X 1.0	
Boulders:	X 1.0	
Rubble:	X 1.0	
Gravel:	10 X 0.5	
Sand:	10 X 0.1	
Mud/Silt:	80 X 0.1	

Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0

Additional Observations:

Many small Fish collected in Insect collection

Fish collection effort limited by
- surface scum
- water depth
- abundance of habitat.

good representation of Key & indicator species

- abundant CPOM = many areas up to knee accumulation

- Darter in sample very small.

Sampling Gear Type: [✓ Electrofishing] Seine Gill nets

Unit of Effort: Above: Below: 3160 pdt

Quantity of Available Fish Cover:

Above Station: Very Abundant, Abundant, Moderate, Sparse, Absent

Below Station: [✓ Very Abundant], Abundant, Moderate, Sparse, Absent

Site Description & Notes:

Above Station:

Below Station: UCB-2

Fish Species Observed

~~Above~~ Station # UCB-2	~~Below Station #~~
Gambusia 𝍸 𝍸 1	
Grass Pickerel 𝍸 1	
Yellow Bullhead Catfish 1	
Warmouth 𝍸 11	
Bluegill 11	
Large Mouth Bass 1	
Banded Pygmie Sunfish	1111
Long ear 𝍸 111	
black spotted 11	
Pirate Perch 𝍸	
Green Sunfish 111	
YOY Lepomis 1	

Sampling Gear Type: [✓ Electrofishing] Seine Gill nets

Unit of Effort: Above: Below: LCB-2 PDT-3160

Quantity of Available Fish Cover:

Above Station: Very Abundant, Abundant, Moderate, Sparse, Absent

Below Station: Very Abundant, [✓ Abundant], Moderate, Sparse, Absent

Site Description & Notes:

Above Station:

Below Station: LCB-2

Fish Species Observed

lab ck GM 7/7/05

Above Station #	Below Station # LCB-2	
	Yellow Bullhead	①
	Largemouth Bass	①
	Longear	⑥
	Green	⑤
	Grass pickeral	⑦
	Blackspotted Topminnow	②
	Banded pygmy	⑨
	Gambusia	⑪
	Pirate perch	④
	Bluegill	②
	Warmouth	⑦
	Slough darter	①

Fish Collected in bug sample

Banded Pigmy : ㉗

Pirate perch : ⑧

slough Darter : ⑲

Gambusia : ㉕

FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: LCB-2
Location: LCB-2
Client: GLC -
Ecoregion: Gulf Coastal
Project no: 2072.05.070
Weather: Sunny Clear Hot
Investigators: SKH BJP JBB REM
Date Sample Collected: 5/25/05
Form Completed By: REM/JBB
Habitat Forms Completed: [✓ yes] / no
Fish Sampling Completed: [✓ yes] / no

Collection Site Observations		
	Above Station	LCB-2 Below Station
Time Sampled:		
Relative Abundance of Aquatic Biota		
Periphyton: on wood	0 1 2 3 4	0 [✓ 1 2] 3 4
Filamentous Algae:	0 1 2 3 4	0 1 2 3 4
Macrophytes: Back H2O area	0 1 2 3 4	0 1 [✓ 2 3] 4
Slimes:	0 1 2 3 4	0 1 2 3 4
Macroinvertebrates:	0 1 2 3 4	0 1 2 [✓ 3 4]
Fish:	0 1 2 3 4	0 1 [✓ 2 3] 4
Other________:	0 1 2 3 4	0 1 2 3 4
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant		
Major Habitat Sampled (%)		
Riffle/Run:		
Shallow Pool:		10
Deep Pool:		90
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:		10
Emergent Vegatation:		
Submerged Vegetation:		
Depositional Area:		10
Overhanging Veg:		
Root Wads:		25
Undercut Banks:		
Filamentous algae:		
Leafy Debris:		5
Other________:		

Macroinvertebrate Qualitative Sample List		
Taxa	Above Station	Below Station
Annelida		
Decapoda		
Gastropoda		
Pelecypoda		
Hemiptera		
Coleoptera		
Lepidoptera		
Odonata		
Megaloptera		
Diptera		
Chironomidae		
Plecoptera		
Ephemeroptera		
Trichoptera		
Amphipoda		

R=Rare, C=Common, A=Abundant, D=Dominant

Rare<3, Common 3-9, Abundant>10, Dominant>50

Site Description and Observations:

- most of collection at wood water interface some leafy debris
- many small fish collected in invert sample.
- Pool d/s of Hwy Bridge

BIO-ANALYTICAL LABORATORIES

REFERENCE TOXICANT TEST QUALITY DATA

Date start: 3/9/06 **Date end:** 3/11/06

Test organism: P. promelas

Age: ~2 days

Source and ID#: BAL/ 3/7/06

Dilution Water used: Type: MH * **Jug #:** 3474

Reference Toxicant: NaCl (BAL 3/2/06) + **Units:** 100 g/L ______ ug/L

Manufacturer: EMD **Lot:** 4 1375 B6S

48-hour LC$_{50}$: 8.99 g/L **Statistical Method:** SK ^

Upper and Lower CUSUM Chart Control Limits: 9.14-7.17

Test Number (for the year): 9

We verify that this data is true and correct:

Technician:

Statistician:

Quality Control Officer:

***MH- Moderately hard**
S-Soft
H - Hard

+NaCl - Sodium Chloride
$CuSO_4$ - Copper Sulfate

^P - Probit
SK - Spearman Karber
TSK -Trimmed Spearman Karber
G - Graphical

File: Ref Tox Cover

BIO-ANALYTICAL LABORATORIES
ACUTE TOXICITY TEST SURVIVAL AND WATER QUALITY DATA

Project#

Client Ref Tox

Sample Description 10 g/L NaCl (BAL 3 [illegible])

Test started: Date 3/9/06 Time 1430

Test ended: Date [illegible] Time [illegible]

Test Species P. promelas ID# [illegible]

Technician: Ohour EK 24hour [illegible] 48hour [illegible] 72hour / 96hour /
Time: Ohour 1430 24hour 1240 48hour [illegible] 72hour / 96hour /
Temperature: Ohour 24.3° 24hour 24.5° 48hour 24.5° 72hour / 96hour /

Percent Effluent g/L	Replicate	Test Salinity	# of Live Organisms					Dissolved Oxygen					pH					Conductivity				
			0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0	A	N/A	10	10	10			8.3		7.6			7.9		8.0			[illegible]		[illegible]		
	B	/	10	10	10																	
5	A		10	[illegible]	[illegible]			8.3		[illegible]			8.0		[illegible]			8330		[illegible]		
	B		10	10	10																	
7	A		10	10	10			8.3		7.6			8.0		[illegible]			[illegible]		[illegible]		
	B		10	10	10																	
9	A		10	[illegible]	[illegible]			8.3		[illegible]			8.0		[illegible]			[illegible]		[illegible]		
	B		10	[illegible]	[illegible]																	
11	A		10	[illegible]	0			8.2		7.5			8.0		[illegible]			[illegible]		[illegible]		
	B		10	6	0																	
13	A		10	0	---			8.3	7.4				8.0	7.6				[illegible]				
	B		10	0	-																	

Key: prerenewal/postrenewal

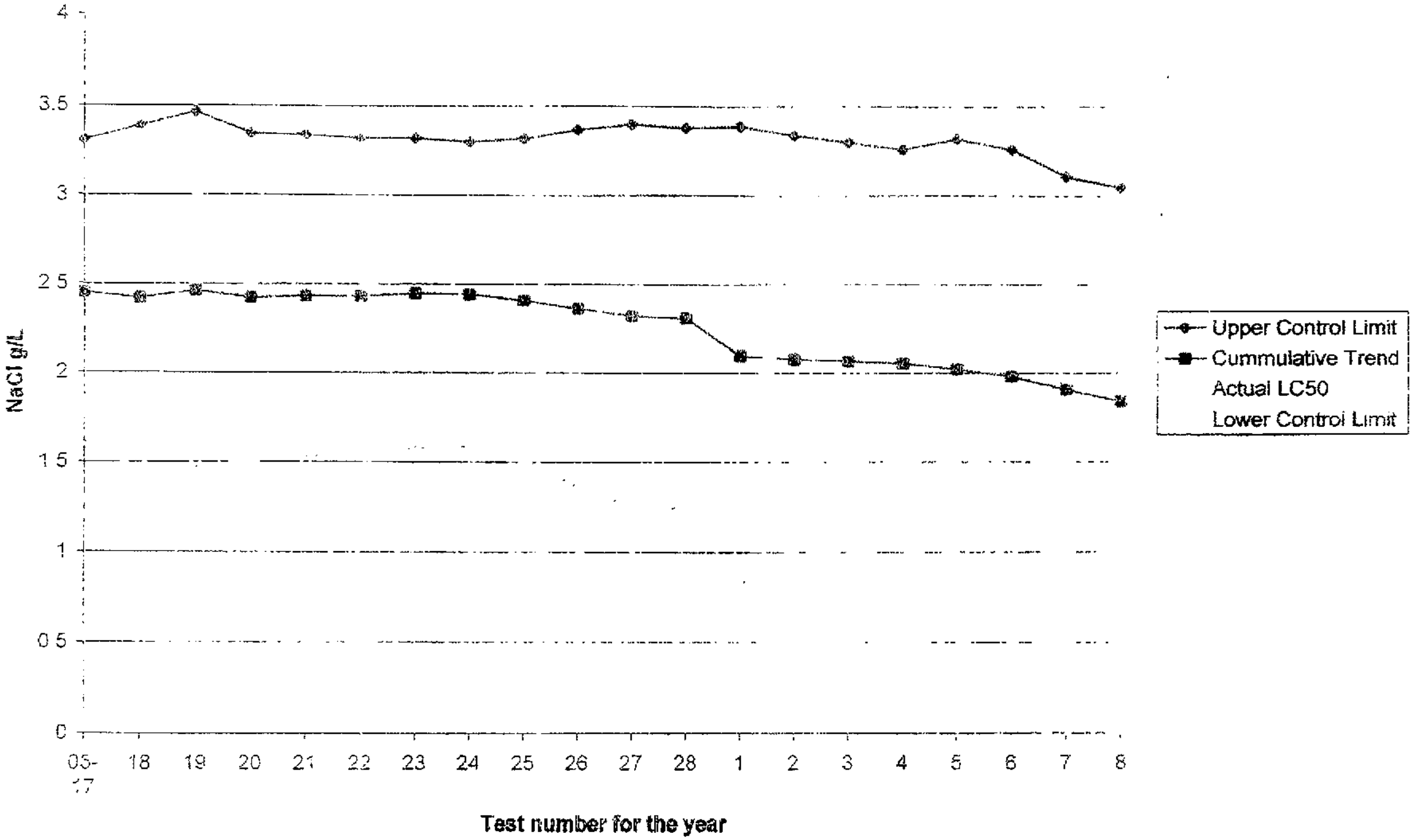
File:ACUTE2

APPENDIX C
STATISTICAL ANALYSIS

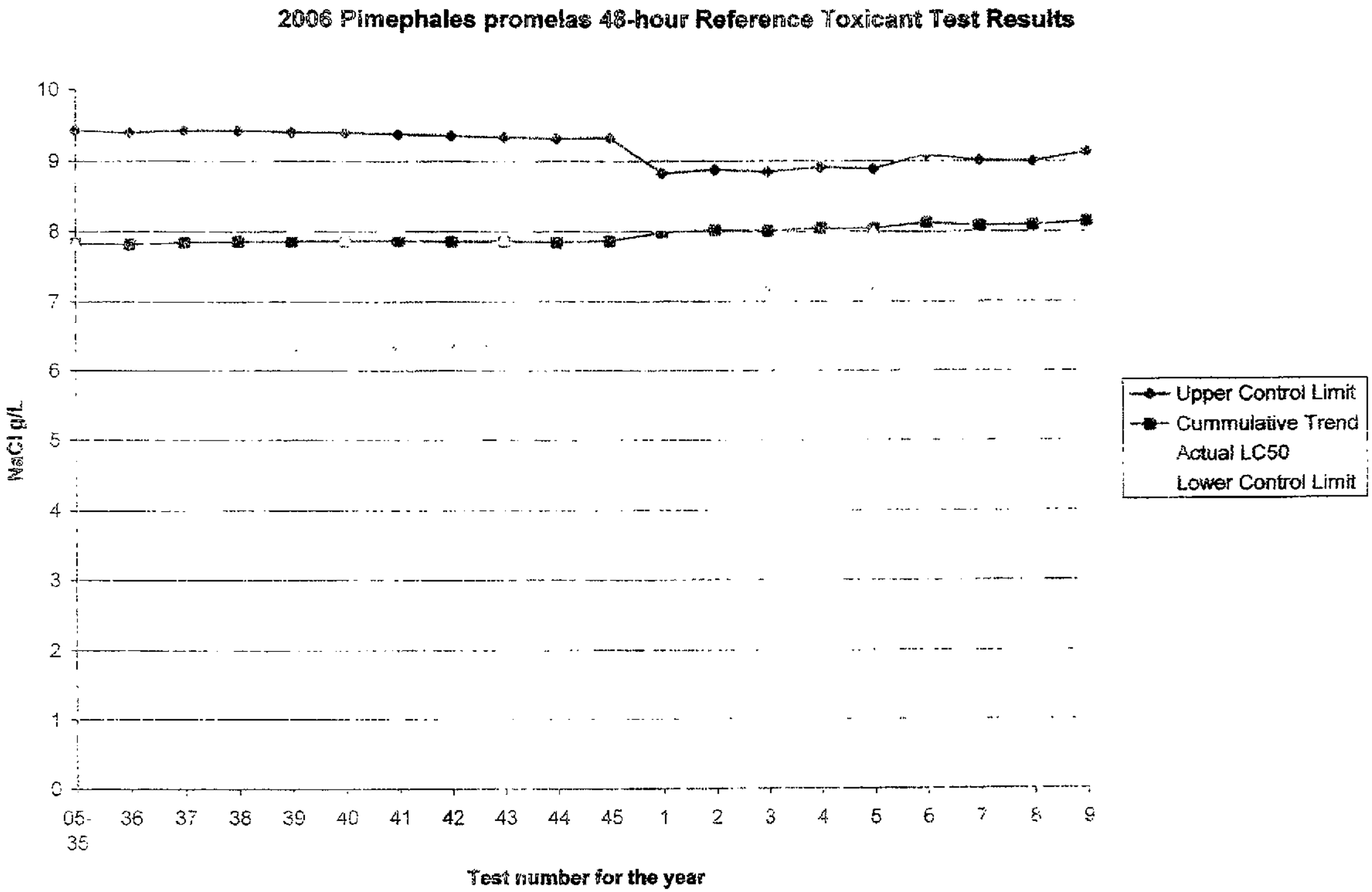
```
PROBIT DAPHNIA 3/10/06

                                                      Proportion
                                           Observed   Responding
            Number       Number          Proportion  Adjusted for
   Conc.   Exposed        Resp.          Responding    Controls

  Control     20             2             0.1000       0.0000
   1.0000     20             6             0.3000       0.2219
   2.0000     20            19             0.9500       0.9444
   3.0000     20            20             1.0000       1.0000
   4.0000     20            20             1.0000       1.0000
   5.0000     20            20             1.0000       1.0000


Chi - Square for Heterogeneity (calculated)         =     0.027
Chi - Square for Heterogeneity
        (tabular value at 0.05 level)               =     7.815


PROBIT DAPHNIA 3/10/06

      Estimated LC/EC Values and Confidence Limits

                      Exposure            95% Confidence Limits
Point                   Conc.               Lower        Upper

LC/EC  1.00             0.638               0.289          0.859
LC/EC 50.00             1.251               0.971          1.513
```

```
TRIMMED SPEARMAN-KARBER METHOD.  VERSION 1.5


 DATE:   3/9/06              TEST NUMBER: 3706          DURATION:   48 H
 TOXICANT :  NACL
 SPECIES:  P.PROMELAS

 RAW DATA:  Concentration         Number      Mortalities
 --- ----    (G/L)                Exposed
                   .00               20           0
                  5.00               20           0
                  7.00               20           0
                  9.00               20           9
                 11.00               20          20
                 13.00               20          20

  SPEARMAN-KARBER TRIM:                  .00%

  SPEARMAN-KARBER ESTIMATES:      LC50:              8.99
                     95% LOWER CONFIDENCE:           8.55
                     95% UPPER CONFIDENCE:           9.45
----------------------------------------------------------------------
```

APPENDIX D
QUALITY ASSURANCE CHARTS



2006 Daphnia pulex 48-hour Reference Toxicant Test Results



2006 Pimephales promelas 48-hour Reference Toxicant Test Results

APPENDIX E
AGENCY FORMS

Acute Forms
Daphnia pulex Survival

Permittee: Great Lakes Chemical Corporation- Outfall 002 upstream
NPDES Permit Number: AR0001171
Composite Collected **From: 3/9/06** **To: 3/9/06**
From: **To:**
Test Initiated: 3/10/06
Dilution Water Used: Receiving Water X Reconstituted Water

Dilution Series Results - Percent Survival

TIME OF READING	REP	0	100				
24-hour	A	100	100				
	B	100	100				
	C	100	100				
	D	100	100				
	E	100	100				
48-hour	A	75.0	100				
	B	87.5	100				
	C	100	100				
	D	87.5	100				
	E	100	100				
	Mean	90.0	100				

1. Dunnett's Procedure or Steel's Many-One Rank Test as appropriate: Is the mean survival at 48 hours significantly different (p=.05) than the control survival for the % effluent corresponding to:

a.) LOW FLOW OR CRITICAL DILUTION (100%) YES X NO

b.)½ LOW FLOW OR 2X CRITICAL DILUTION (N/A%) YES NO

2. Enter percent effluent corresponding to the LC_{50} below:

LC_{50} = N/A% effluent
95 % confidence limits: N/A
Method of LC_{50} calculation: N/A

3. If you answered NO to 1.a) enter (P) otherwise enter (F): P

4. Enter response to item 3 on DMR Form, parameter TEM3D

5. If you answered NO to 1.b) enter (P) otherwise enter (F): N/A

6. Enter response to item 5 on DMR Form, parameter TFM3D

Biomonitoring

Daphnia 48 hour Acute Static Renewal
Chemical Parameters Chart*

Permittee: Great Lakes Chemical Corporation
NPDES Number: AR0001171- 002 Upstream
Contact: David Hill
Analyst: Deshotels

Sample Collected	**From:**	**Date**	**Time**
	To:	**Date 3/9/06**	**Time 1255**
Test Begin		**Date 3/10/06**	**Time 1510**
Test End		**Date 3/12/06**	**Time 1350**

Parameter	D.O.			Temperature			Alkalinity			Hardness			pH		
Dilut./Time	0hrs.	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs
0	8.5	8.1	7.8	24	25	25	32.0	28.0		48.0	48.0		7.6	7.8	7.6
100	7.7	7.8	7.6	24	25	25	40.0			76.0			7.2	7.3	7.7

*This Form is to be submitted with each DMR.
Alkalinity and hardness to be reported as mg/l $CaCO_3$

Acute Forms
Pimephales promelas (Fathead Minnow) Survival

Permittee: Great Lakes Chemical Corporation- Outfall 002 upstream
NPDES Permit Number: AR0001171
Composite Collected **From: 3/9/06** **To: 3/9/06**
From: **To:**
Test Initiated: 3/10/06
Dilution Water Used: Receiving Water X **Reconstituted Water**

Dilution Series Results - Percent Survival

TIME OF READING	REP	0	100				
24-hour	A	100	100				
	B	100	100				
	C	100	100				
	D	100	100				
	E	100	100				
48-hour	A	100	100				
	B	100	100				
	C	100	100				
	D	100	100				
	E	100	100				
	Mean	100	100				

1. Dunnett's Procedure or Steel's Many-One Rank Test as appropriate: Is the mean survival at 48 hours significantly different (p=.05) than the control survival for the % effluent corresponding to:
a.) LOW FLOW OR CRITICAL DILUTION (100%) YES X NO
b.)½ LOW FLOW OR 2X CRITICAL DILUTION (N/A%) YES NO
2. Enter percent effluent corresponding to the LC_{50} below:
LC_{50} = N/A% effluent
95 % confidence limits: N/A
Method of LC_{50} calculation: N/A
3. If you answered NO to 1.a) enter (P) otherwise enter (F): P
4. Enter response to item 3 on DMR Form, parameter TEM3D
5. If you answered NO to 1.b) enter (P) otherwise enter (F): N/A
6. Enter response to item 5 on DMR Form, parameter TFM3D

Biomonitoring
Fathead Minnow 48 hour Acute Static Renewal
Chemical Parameters Chart*

Permittee: Great Lakes Chemical Corporation
NPDES Number: AR0001171- 002 Upstream
Contact: David Hill
Analyst: Deshotels
Sample Collected **From:** **Date** **Time**
To: **Date 3/9/06** **Time 1255**
Test Begin **Date 3/10/06** **Time 1415**
Test End **Date 3/12/06** **Time 1405**

Parameter	D.O.			Temperature			Alkalinity			Hardness			pH		
Dilut./Time	0hrs.	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs
0	8.5	8.1	7.7	24	25	25	32.0	28.0		48.0	48.0		7.6	7.8	7.6
100	7.7	7.8	7.4	24	25	25	40.0			76.0			7.2	7.3	7.6

*This Form is to be submitted with each DMR.
Alkalinity and hardness to be reported as mg/l CaCO$_3$

Acute Forms
Daphnia pulex Survival

Permittee: Great Lakes Chemical Corporation - Outfall 004 upstream
NPDES Permit Number: AR0001171
Composite Collected From: To:
From: 3/9/06 To: 1245
Test Initiated: 3/10/06
Dilution Water Used: Receiving Water X Reconstituted Water

Dilution Series Results - Percent Survival

TIME OF READING	REP	0	100				
24-hour	A	87.5	100				
	B	100	100				
	C	100	100				
	D	100	100				
	E	100	100				
48-hour	A	87.5	100				
	B	100	87.5				
	C	75.0	100				
	D	87.5	100				
	E	100	100				
	Mean	90 0	97.5				

1. Dunnett's Procedure or Steel's Many-One Rank Test as appropriate: Is the mean survival at 48 hours significantly different (p=.05) than the control survival for the % effluent corresponding to:
a.) LOW FLOW OR CRITICAL DILUTION (100%) YES X NO
b.)½ LOW FLOW OR 2X CRITICAL DILUTION (N/A%) YES NO
2. Enter percent effluent corresponding to the LC_{50} below:
LC_{50} = N/A% effluent
95 % confidence limits: N/A
Method of LC_{50} calculation: N/A
3. If you answered NO to 1.a) enter (P) otherwise enter (F): P
4. Enter response to item 3 on DMR Form, parameter TEM3D
5. If you answered NO to 1.b) enter (P) otherwise enter (F): P
6. Enter response to item 5 on DMR Form, parameter TFM3D

Biomonitoring

Daphnia 48 hour Acute Static Renewal

Chemical Parameters Chart*

Permittee: Great Lakes Chemical Corporation - Outfall 004 upstream

NPDES Number: AR0001171

Contact: David Hill

Analyst: Deshotels

Sample Collected	**From:**	**Date**	**Time**
	To:	**Date 3/9/06**	**Time 1245**
Test Begin		**Date 3/10/06**	**Time 1510**
Test End		**Date 3/12/06**	**Time 1400**

Parameter	D.O.			Temperature			Alkalinity			Hardness			pH		
Dilut./Time	0hrs.	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs
0	8.5	8.1	7.7	24	25	25	32.0	28.0		48.0	48.0		7.6	7.8	7 8
100	8.0	8.1	7.5	24	25	25	20.0			36 0			7.4	7.4	7.5

*This Form is to be submitted with each DMR.

Alkalinity and hardness to be reported as mg/l $CaCO_3$

Acute Forms
Pimephales promelas (Fathead Minnow) Survival

Permittee: Great Lakes Chemical Corporation - Outfall 004 upstream
NPDES Permit Number: AR0001171

Composite Collected	**From:**	**To:**
	From: 3/9/06	**To: 1245**

Test Initiated: 3/10/06
Dilution Water Used: **Receiving Water** **X** **Reconstituted Water**

Dilution Series Results - Percent Survival

TIME OF READING	REP	0	100				
24-hour	A	100	100				
	B	100	100				
	C	100	100				
	D	100	100				
	E	100	100				
48-hour	A	100	100				
	B	100	100				
	C	100	100				
	D	100	100				
	E	100	100				
	Mean	100	100				

1. Dunnett's Procedure or Steel's Many-One Rank Test as appropriate: Is the mean survival at 48 hours significantly different (p=.05) than the control survival for the % effluent corresponding to:

a.) LOW FLOW OR CRITICAL DILUTION (100%) **YES** **X** **NO**
b.)½ LOW FLOW OR 2X CRITICAL DILUTION (N/A%) **YES** **NO**

2. Enter percent effluent corresponding to the LC_{50} below:

LC_{50} = N/A% effluent
95 % confidence limits: N/A
Method of LC_{50} calculation: N/A

3. If you answered NO to 1.a) enter (P) otherwise enter (F): P
4. Enter response to item 3 on DMR Form, parameter TEM3D
5. If you answered NO to 1.b) enter (P) otherwise enter (F): P
6. Enter response to item 5 on DMR Form, parameter TFM3D

Biomonitoring
Fathead Minnow 48 hour Acute Static Renewal
Chemical Parameters Chart*

Permittee: Great Lakes Chemical Corporation - Outfall 004 upstream
NPDES Number: AR0001171
Contact: David Hill
Analyst: Deshotels

Sample Collected	**From:**	**Date**	**Time**
	To:	**Date 3/9/06**	**Time 1245**
Test Begin		**Date 3/10/06**	**Time 1415**
Test End		**Date 3/12/06**	**Time 1410**

Parameter	D.O.			Temperature			Alkalinity			Hardness			pH		
Dilut./Time	0hrs.	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs
0	8.5	8.1	7.7	24	25	25	32.0	28.0		48.0	48.0		7.6	7.8	7 7
100	8.0	8.1	7.4	24	25	25	20.0			36.0			7.4	7.4	7.5

*This Form is to be submitted with each DMR.
Alkalinity and hardness to be reported as mg/l $CaCO_3$

APPENDIX F
REPORT QUALITY ASSURANCE FORM

Bio-Analytical Laboratories

3240 Spurgin Road
Post Office Box 527
Doyline, LA 71023
bioanalytical@worldnet.att.net

(318) 745-2772
1-800-259-1246
Fax: (318) 745-2773

REPORT QUALITY ASSURANCE FORM

Client: Great Lakes Chemical Corporation

Project#: X2593

Proofed First Draft: [illegible] **Date:** 3-24-06

Proofed Final Draft: Erin H. Bragg **Date:** 3-24-06

I certify that this document was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. The information contained in this document, to the best of my knowledge, is true, accurate and complete.

Erin H. Bragg, BS
Quality Assurance Officer

Date: 3-24-06

No part of this work may be altered in any form or by any means without written permission from Bio-Analytical Laboratories.

Appendix E

Field Data Sheets

Page 1 of 1

Field Data Form

FIELD MEASUREMENT RECORD (Date 4/27- /05 **)** **REVIEWED BY:**

Station/Depth	Date	Time	Field Crew	Temp C°	DO mg/l	Sp. Cond. uS	pH su	Turb. (ntu)	Sample # of Containers		Notes
									S=Sed.	W=Wat.	
UTA-2	4/27/05	0755- ~~0745~~	ns RM BJP/SKH	14.9°C	75.2% 7.5	475	6.5	12.7	—	1	sample collected @0740 Cl, Sulfate, TDS
UTA-4	4/27/05	1140	BJP/SKH	16.5°C	34% 3.5 mg/L	4299	5.6	21.2	—	1	WQ samples collected Cl, SO4, TDS
UTA-3	4/27/05	1505	SKH/BJP	17.4°C	70.5% 7.5 mg/L	495	6.4	17.0	—	1	"
LC-3	4/28/05	0800	SKH/BJP	23.6°C	53.0% 4.4 mg/L	2788	7.5	22.0	—	1	"
LC-2	4/28/05	1045	SKH/SB	26.8°C	66.6% 5.2 mg/L	2874	7.9	24.0	—	1	"
LC-1	4/28/05	1410	SKH/DB	21.1°C	41.0% 3.7 mg/L	295	6.7	133	—	1	"

* Indicates calibration check was made

V1.2 04/18/2004

Page ____ of ______

GLCC

Field Data Form

FIELD MEASUREMENT RECORD (Date 5/25/05) **REVIEWED BY:**____________

Station/Depth	Date	Time	Field Crew	Temp C°	DO mg/l /%	Sp. Cond. uS	pH su	Turb. (ntu)	Sample # of Containers		Notes
									S=Sed.	W=Wat.	
LCB-1	5/25/05	1640	BTP/SKH KEM/JD	21.8	3.5 mg/l / 35.3%	126.9 uS	6.9	42.1			

* Indicates calibration check was made

V1.2 04/18/2004

Page ____ of ______

Field Data Form

FIELD MEASUREMENT RECORD (Date 5/24/05) **REVIEWED BY:________________**

Station/Depth	Date	Time	Field Crew	Temp C°	DO mg/l	Sp. Cond. uS	pH su	Turb. (ntu)	Sample # of Containers		Notes
									S=Sed.	W=Wat.	
LCB-2	5/24/05	1009	REM/DB	25.3	2.75	53.0 ~~15.9~~	6.64	29.2		1	

*** Indicates calibration check was made**

V1.2 04/18/2004

Calibration Field Form

Dissolved Oxygen Meter Air Calibration Record

Date/Time:	Calibrators Initials:	Meter:	100 % Air Saturation (mg/l)	Altitude (ft)	Barometric Pressure (mm Hg)	Comments:
4/27/05 (0740)	BJP	YSI 85	100%	0	↑29.92"	

pH Meter Calibration Record

Date/Time:	Calibrators Initials:	Meter:	Standard (4, 7, 10):	Slope:	7.00 Buffer Check	Comments:
4/27/05 (0727)	BJP	Orion 1	(4,7)	92.5%	7.0	

Conductivity Meter Calibration Record

Date/Time:	Calibrators Initials :	Meter:	Standard:	Meter Cond:	Comments:
4/27/05 (0730)	BJP	YSI 85	1000	905	(adjusted to 1000)

Turbidity Meter Calibration Record

Date/Time:	Calibrators Initials :	Meter:	Gel Standard:			Meter Reading			Comments:
			0-10	0-100	0-1000	0-10	0-100	0-1000	
4/27/05 (734)	BJP	HACH 2100P	5.17	51.1	435	5.18	51.1	437	

Temperature Meter Calibration Record

Date/Time:	Calibrators Initials:	Meter:	Thermometer Temperature °C:	Meter Temperature °C:	Comments:

V1.0 04/00

Calibration Field Form

Dissolved Oxygen Meter Air Calibration Record

Date/Time:	Calibrators Initials:	Meter:	100 % Air Saturation (mg/l)	Altitude (ft)	Barometric Pressure (mm Hg)	Comments:
4/28/05 (0800)	BOP	YSI 85				

pH Meter Calibration Record

Date/Time:	Calibrators Initials:	Meter:	Standard (4, 7, 10):	Slope:	7.00 Buffer Check	Comments:
4/28/05 (0750)	BOP	Orion 1	(4,7)		7.09	meter slow to calibrate
						@ 7.0

Conductivity Meter Calibration Record

Date/Time:	Calibrators Initials :	Meter:	Standard:	Meter Cond:	Comments:
4/28/05 (0745)	BOP	YSI 85	1000	1014	

Turbidity Meter Calibration Record

Date/Time:	Calibrators Initials :	Meter:	Gel Standard:			Meter Reading			Comments:
			0-10	0-100	0-1000	0-10	0-100	0-1000	
4/28/05 (0747)	BOP	HACH 2100	5.17	51.1	431	5.21	50.4	435	

Temperature Meter Calibration Record

Date/Time:	Calibrators Initials:	Meter:	Thermometer Temperature °C:	Meter Temperature °C:	Comments:

V1.0 04/00

Winkler Calibration Field Form

Dissolved Oxygen Meter Winkler Calibration Record

Date/ Time:	Calibrators Initials:	Meter:	100 % Air Saturation (mg/l):	Altitude (ft):	Barometric Pressure (mm Hg):	Titration #1: 200mL	Titration #2: 195mL	Winkler/Air RPD:
5/11/05 0640	BJP/JB	YSI85 6.2mg/L Inst reading	100%	0	29.98	Final: 26.3 Initial: 20.0 Difference: 6.3	Final: 36.0 Initial: 30.0 Difference: 6.0	
						Final DO: 6.3		
						Final: Initial: Difference:	Final: Initial: Difference.	
						Final DO:		

Comments:

Mc & Associates, Inc.
[illegible] Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 89880-1
Sample Identification: UTA-2 4-27-05 (0740)

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	280	10	mg/l	W13814	
Chloride	EPA 300.0	79	0.2	mg/l	S15746	
Sulfate	EPA 300.0	12	0.2	mg/l	S15746	

AIC No. 89880-2
Sample Identification: UTA-3 4-27-05 (1505)

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	300	10	mg/l	W13814	
Chloride	EPA 300.0	100	2	mg/l	S15746	D
Sulfate	EPA 300.0	15	0.2	mg/l	S15746	

AIC No. 89880-3
Sample Identification: UTA-4 4-27-05 (1140)

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	2000	10	mg/l	W13814	
Chloride	EPA 300.0	1200	20	mg/l	S15746	D
Sulfate	EPA 300.0	11	0.2	mg/l	S15746	

AIC No. 89880-4
Sample Identification: LC-1 4-28-05 (1410)

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	190	10	mg/l	W13817	
Chloride	EPA 300.0	70	0.2	mg/l	S15746	
Sulfate	EPA 300.0	4.4	0.2	mg/l	S15746	

AIC No. 89880-5
Sample Identification: LC-2 4-28-05 1045

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	1800	10	mg/l	W13817	
Chloride	EPA 300.0	220	2	mg/l	S15746	D
Sulfate	EPA 300.0	960	2	mg/l	S15746	D

AIC No. 89880-6
Sample Identification: LC-3 4-28-05 (0800)

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	1800	10	mg/l	W13817	
Chloride	EPA 300.0	220	2	mg/l	S15746	D
Sulfate	EPA 300.0	950	2	mg/l	S15746	D

Mc & Associates, Inc
9 Brown Lane
Bryant, AR 72022

SAMPLE PREPARATION REPORT

AIC No. 89880-1

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	Batch	Qualifier
Total Dissolved Solids	-	03MAY05 0926 223		W13814	
Chloride	29APR05 1557 252	29APR05 2116 252		S15746	
Sulfate	29APR05 1557 252	29APR05 2116 252		S15746	

AIC No. 89880-2

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	Batch	Qualifier
Total Dissolved Solids	-	03MAY05 0926 223		W13814	
Chloride	29APR05 1557 252	29APR05 2132 252	10	S15746	D
Sulfate	29APR05 1557 252	29APR05 2148 252		S15746	

AIC No. 89880-3

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	Batch	Qualifier
Total Dissolved Solids	-	03MAY05 0926 223		W13814	
Chloride	29APR05 1557 252	02MAY05 0956 252	100	S15746	D
Sulfate	29APR05 1557 252	29APR05 2219 252		S15746	

AIC No. 89880-4

lyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	Batch	Qualifier
al Dissolved Solids	-	03MAY05 1246 223		W13817	
Chloride	29APR05 1557 252	29APR05 2345 252		S15746	
Sulfate	29APR05 1557 252	29APR05 2345 252		S15746	

AIC No. 89880-5

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	Batch	Qualifier
Total Dissolved Solids	-	03MAY05 1246 223		W13817	
Chloride	29APR05 1557 252	30APR05 0001 252	10	S15746	D
Sulfate	29APR05 1557 252	30APR05 0001 252	10	S15746	D

AIC No. 89880-6

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	Batch	Qualifier
Total Dissolved Solids	-	03MAY05 1246 223		W13817	
Chloride	29APR05 1557 252	30APR05 0032 252	10	S15746	D
Sulfate	29APR05 1557 252	30APR05 0032 252	10	S15746	D

[illegible]Mc & Associates, Inc.
[illegible] Brown Lane
Bryant, AR 72022

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	% Recovery	% Recovery Limits	RPD	RPD Limit	Batch	Qualifier
Total Dissolved Solids	250 mg/l	101/102	85-115	0.791	10	W13814	
Total Dissolved Solids	250 mg/l	104/103	85-115	0.193	10	W13817	
Chloride	10 mg/l	97 1/95.2	90-110	2.01	10	S15746	
Sulfate	30 mg/l	99.8/100	90-110	0.180	10	S15746	

MATRIX SPIKE SAMPLE RESULTS

Analyte	Spike Amount	% Recovery	% Recovery Limits	RPD	RPD Limit	Batch	Qualifier
Chloride	10 mg/l	94 5/97.5	80-120	2.64	10	S15746	
Sulfate	30 mg/l	97.9/98.2	80-120	0.322	10	S15746	

LABORATORY BLANK RESULTS

Analyte	Method	Result	Units	RL	QC Sample	Qualifier
[illegible]al Dissolved Solids	EPA 160.1	< 10	mg/l	10	W13814-1	
[illegible]al Dissolved Solids	EPA 160.1	< 10	mg/l	10	W13817-1	
Chloride	EPA 300.0	< 0.2	mg/l	0.2	S15746-1	
Sulfate	EPA 300.0	< 0.2	mg/l	0.2	S15746-1	

Mc & Associates, Inc.
Brown Lane
Bryant, AR 72022

QUALITY CONTROL PREPARATION REPORT

LABORATORY CONTROL SAMPLES

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	QC Sample	Qualifier
Total Dissolved Solids	-	03MAY05 0926 223		W13814-2	
Total Dissolved Solids	-	03MAY05 0926 223		W13814-3	
Total Dissolved Solids	-	03MAY05 1246 223		W13817-2	
Total Dissolved Solids	-	03MAY05 1246 223		W13817-3	
Chloride	29APR05 1132 252	29APR05 1333 252		S15746-2	
Chloride	29APR05 1132 252	29APR05 1400 252		S15746-3	
Sulfate	29APR05 1132 252	29APR05 1333 252		S15746-2	
Sulfate	29APR05 1132 252	29APR05 1400 252		S15746-3	

MATRIX SPIKE SAMPLES

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	QC Sample	Qualifier
Chloride	29APR05 1132 252	29APR05 1427 252		S15746-4	
Chloride	29APR05 1132 252	29APR05 1459 252		S15746-5	
Sulfate	29APR05 1132 252	29APR05 1427 252		S15746-4	
Sulfate	29APR05 1132 252	29APR05 1459 252		S15746-5	

LABORATORY BLANKS

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	QC Sample	Qualifier
Total Dissolved Solids	-	03MAY05 0926 223		W13814-1	
Total Dissolved Solids	-	03MAY05 1246 223		W13817-1	
Chloride	29APR05 1132 252	29APR05 1319 252		S15746-1	
Sulfate	29APR05 1132 252	29APR05 1319 252		S15746-1	

GBM^c & Associates
Strategic Environmental Services
219 Brown Ln.
Bryant, AR 72022 X
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

89880

CLIENT INFORMATION		BILLING INFORMATION		SPECIAL INSTRUCTIONS/PRECAUTIONS:
Company:	GBM^c & Associates	Bill To:		Contact Brad Phillips or Kyle
Project Name/No.:	2160-05-070 / 2072-05-070	Company:	See	Hathcoat with any questions @
Send Report To:	McDaniel	Address:	Client	501-847-7077
Address:	219 Brown Lane		Information	Parameters for Analysis/Methods
	Bryant AR 72022	Phone No.:		
Phone/Fax No.:		Fax No.:		

Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Cl, SO4, TDS									
① UTA-2		4/27/05	0740	W	1	G	X									
② UTA-3		4/27/05	1505	W	1	G	X									
③ UTA-4		4/27/05	1140	W	1	G	X									
④ LC-1		4/28/05	1410	W	1	G	X									
⑤ LC-2		4/28/05	1045	W	1	G	X									
⑥ LC-3		4/28/05	0800	W	1	G	X									
Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)						I									

Sampler(s): BJP/SKH/JB
Shipment Method: GBM^c Delivery
Turnaround Time Required: Normal

COC Completed by: Date: 4/29/05 Time: 1230
COC Checked by: Date: 4/29/05 Time: 1235

Relinquished by: Bradley J Phillips Date: 4/29/05 Time: 1315
Received by: ____________ Date: ________ Time: ________

Relinquished by: ____________ Date: ________ Time: ________
Received in lab by: Date: 4-29-05 Time: 1315

LABORATORY USE ONLY: Samples Received On Ice? YES or NO
Sample Temperature: ____________

V1.3 04/14/04

Mc & Associates, Inc.
19 Brown Lane
Bryant, AR 72022

ANALYTICAL RESULTS

AIC No. 90507-1
Sample Identification: LCB-1 5/23/05 (1640)

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	140	10	mg/l	W13959	
Chloride	EPA 300.0	12	0.2	mg/l	S15910	
Sulfate	EPA 300.0	4.4	0.2	mg/l	S15910	

AIC No. 90507-2
Sample Identification: LCB-2 5/24/05 1000

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	220	10	mg/l	W13959	
Chloride	EPA 300.0	62	0.2	mg/l	S15910	
Sulfate	EPA 300.0	21	0.2	mg/l	S15910	

Mc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

SAMPLE PREPARATION REPORT

AIC No 90507-1

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	Batch	Qualifier
Total Dissolved Solids	-	26MAY05 1400 223		W13959	
Chloride	25MAY05 1331 252	25MAY05 1741 252		S15910	
Sulfate	25MAY05 1331 252	25MAY05 1741 252		S15910	

AIC No. 90507-2

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	Batch	Qualifier
Total Dissolved Solids	-	26MAY05 1400 223		W13959	
Chloride	25MAY05 1331 252	25MAY05 1757 252		S15910	
Sulfate	25MAY05 1331 252	25MAY05 1757 252		S15910	

AMERICAN INTERPLEX
CORPORATION
LABORATORIES

[illegible]Mc & Associates, Inc.
[illegible]9 Brown Lane
Bryant, AR 72022

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	% Recovery	% Recovery Limits	RPD	RPD Limit	Batch	Qualifier
Chloride	10 mg/l	97.0/96 5	90-110	0.507	10	S15910	
Sulfate	30 mg/l	101/101	90-110	0.0132	10	S15910	

MATRIX SPIKE SAMPLE RESULTS

Analyte	Spike Amount	% Recovery	% Recovery Limits	RPD	RPD Limit	Batch	Qualifier
Chloride	10 mg/l	98.6/104	80-120	1.75	10	S15910	
Sulfate	30 mg/l	99.2/98.7	80-120	0.237	10	S15910	

LABORATORY BLANK RESULTS

Analyte	Method	Result	Units	RL	QC Sample	Qualifier
Chloride	EPA 300.0	< 0.2	mg/l	0.2	S15910-1	
[illegible]lfate	EPA 300.0	< 0.2	mg/l	0.2	S15910-1	

[illegible]Mc & Associates, Inc.
219 Brown Lane
Bryant, AR 72022

QUALITY CONTROL PREPARATION REPORT

LABORATORY CONTROL SAMPLES

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	QC Sample	Qualifier
Chloride	25MAY05 1331 252	25MAY05 1425 252		S15910-2	
Chloride	25MAY05 1331 252	25MAY05 1439 252		S15910-3	
Sulfate	25MAY05 1331 252	25MAY05 1425 252		S15910-2	
Sulfate	25MAY05 1331 252	25MAY05 1439 252		S15910-3	

MATRIX SPIKE SAMPLES

Analyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	QC Sample	Qualifier
Chloride	25MAY05 1331 252	25MAY05 1453 252		S15910-4	
Chloride	25MAY05 1331 252	25MAY05 1508 252		S15910-5	
Sulfate	25MAY05 1331 252	25MAY05 1453 252		S15910-4	
Sulfate	25MAY05 1331 252	25MAY05 1508 252		S15910-5	

LABORATORY BLANKS

[illegible]alyte	Date/Time Prepared By	Date/Time Analyzed By	Dilution	QC Sample	Qualifier
[illegible]oride	25MAY05 1331 252	25MAY05 1412 252		S15910-1	
Sulfate	25MAY05 1331 252	25MAY05 1412 252		S15910-1	

GBM^c & Associates
219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

90507

Client/Billing Information:	
Client:	GBM^c & Associates
Company:	2072-05-070
Address:	219 Brown Lane
	Bryant, AR 72022
Phone No.:	501-847-7077
Fax No.:	501-847-7943

SPECIAL INSTRUCTIONS/PRECAUTIONS:

Project Name / Number: 2072-05-070

Parameters for Analysis/Methods

Sample ID	Sample Description	Date	Time	Matrix S=Sed/Soil W=Water	Number of Containers	Composite or Grab	Cl^{-}, SO_4^{2-}, TDS									
LCB-1		5/23/05	1640	W	1	G	X									
LCB-2		5/24/05	1000	W	1	G	X									
Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)															

Sampler(s): REM/JBB/SKH/BJP
Shipment Method: GBM^c Delivery
Turnaround Time Required: Normal

COC Completed by: JBB Date: 5/24/05 Time: 15:20
COC Checked by: Date: 5/24/05 Time: 1540

Relinquished by: Date: 5/24/05 Time: 16:33
Received by: ______ Date: ______ Time: ______

Relinquished by: Date: ______ Time: ______
Received in lab by: Robert Leddy Date: 5-24-05 Time: 1633

LABORATORY USE ONLY: Samples Received On Ice? [✓ YES] or NO
Sample Temperature: 1°C

V1.2 03/11/05

GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

...N I.D: UTA-2		LOCATION: East of Hwy 15 & UCC outfall pn
...REAM NAME: Unnamed Trib of Bayou de Loutre		RIVER BASIN: Ouachita River
LAT: 33 11 2.1	LONG: 92 41 56.7	PROJECT: UCC UAA
INVESTIGATORS: SKH/BJD	DATE/TIME: 4/27/05	FORM CHECKED BY:

WEATHER CONDITIONS

Now		Past 24-hr
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☒
☐	showers (intermittent)	☐
__% ☐	% cloud cover	☐ ____%
☒	clear/sunny	☐

Heavy rain in the last 7 days? ☒ Yes ☐ No 1.0" event

Air Temperature 60° C °C/°F

Other ____________

STREAM ATTRIBUTES

Stream Subsystem
☐ Perennial ☒ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Montane, non-glacial ☒ Mixture of origins
☐ Swamp and bog ☒ Other Point Discharge (storm water)

Catchment Area: ________ mi²

Stream Order: 1

Stream Gradient: ☐ High (≥25ft/mi) ☐ Moderate (10-24 ft/mi) ☒ Low (<10 ft/mi)

HYDROLOGY

Flows
☐ High ☐ Moderate ☒ Low ☐ None

Flows Measured? ☒ Yes ☐ No

Reach: Slope ________ ft/mi & Sinuosity ________

WATERSHED FEATURES

Predominant Surrounding Landuse
☒ Forest 100 % ☐ Sub-Urban
☐ Pasture ____% ☐ Commercial ____%
☐ Row Crops ____% ☐ Industrial ____%
☐ Urban ____% ☒ Other Logging 25 %

Local Watershed NPS Pollution
☐ No evidence ☐ Agricultural
☐ Industrial Storm Water
☐ Urban/Sub-Urban Storm Water

RIPARIAN VEGETATION

☒ Mature Forest 70 % ☒ Shrub/Sapling 20 % ☒ Herbs/Grasses 10 % ☐ Turf ____%

STREAM MORPHOLOGY

☒ Riffle 20 % ☒ Run 10 % ☒ Pool 70 % over Entire Fin Reach

STREAM DISTURBANCES

☐ Roads ☐ Bridges ☐ Pipelines ☐ Beaver Dams ☒ Point Source (storm water)
☐ Dams ☐ Trash ☐ Cattle Access ☐ Mining ☐ ATV Crossing ☒ Other Logging

Channelized: ☐ Yes ☐ Some ☒ No
Local Watershed Erosion: ☐ None ☒ Minimal ☐ Moderate ☐ Heavy
Channel Dynamics: ☐ Aggrading ☒ Degrading ☐ Widening ☐ Headcutting

Water Odors
☒ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other ____________

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs
☐ Flecks ☒ None ☐ Other ____________

Turbidity/Water Clarity (If not measured) 12.2 NTU
☐ Clear ☒ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other ____________

Sediment Odor
☒ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other ____________

Sediment Deposits
☐ Sludge ☐ Sawdust ☐ Oils
☒ Sand ☐ Relict shells
☒ Other Silts

Stream Habitat Assessment (Semi-Quantitative)

Station #: UTA-2	Stream: UT of Bayou de Loutre	Date/Time: 4/27/05	Analyst: SKH/BJD
	Location: Union County	(0830 – 1030)	

1. Reach Length Determination

Caro 6 PS d/s Lat: 33° 11' 4" wpt [redacted] Long: 92° 41 56" 342 u/s Lat: 33 11 2.1 Long: 92 41 56.7 341

Parameter	Measurement Number 1	2	3	4	5	Average	Total Reach Length¹ (ft)	Sub-Reach Length² (ft)
Bankfull Width	7.2'	7.8	8.1'	8.3'	6.9'	7.7'	154'	15.4'
Bankfull Depth	1.0'	2.0	1.4'	2.5'	1.4'	1.7	na	na

¹Average width times 20 ²Total Length divided by 10

Depth H₂O = 0.3'	1.0'	0.3	1.3'	0.7

2. Riffle-Pool Sequence

Morph Type	Reach Number – Length in Feet 1	2	3	4	5	6	7	8	9	10	Total	
Riffle	~~xxx~~ 6.0'		13'	9.4'						5.0'	33.4'	22%
Run	~~2.4~~											
Pool	9.4	15.4'	2.4'	6.0'	15.4'	15.4'	15.4'	15.4'	13.4'	10.4'	120.6	78%
Total												
Sequence¹	xxx—∼∼	∼∼∼	xxxxx	xxxx∼∼	∼∼∼	∼∼∼	∼∼∼	∼∼∼	∼∼∼	xxx∼∼		

¹Riffle="xxx", Run="----", Pool="~~~"

3. Depth and Width Regime

Morph Type	Reach No. – Average Depth (ft)/Width (ft) 1	2	3	4	5	6	7	8	9	10	Average
Riffle Depth	0.1'	—	0.2	0.1	—	—	—	—	—	0.2	0.15
Riffle Width	3.5'	—	2.5	2.0'	—	—	—	—	—	1.5'	2.4'
Pool Depth	0.7'	1.0'	0.6	0.4'	0.4'	0.4'	0.6'	0.6'	0.5	0.5	0.57
Pool Width	5.5'	5.0'	4.0'	4.0'	5.0'	5.5'	5.5'	8.0'	5.0'	4.5'	5.2'

4. Epifaunal Substrate, Percent Stable Habitat (for Macroinvertebrates)

Section	1	2	3	4	5	6	7	8	9	10	Average
% Area	15%	30%	50%	40%	30%	10%	10%	20%	30%	20%	25.5%

5. In-Stream Habitat, Percent Stable Habitat (Available Fish Cover in Wetted Perimeter)

Section	Reach No. – Availability and Quality of Fish Habitat 1	2	3	4	5	6	7	8	9	10	Average
% Area	10%	35%	20%	15%	30%	5%	10%	20%	30%	15%	19%

6. Substrate Characterization (Dominant Substrate)

Morph Type	Reach No. – Dominant Substrate 1	2	3	4	5	6	7	8	9	10	Average
Riffle	GF(3)	—	GF(3)	GF(3)	—	—	—	—	—	S(2)	2.8
Pool	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	SC(1)	1.9

BR=Bedrock(7), BLD=Boulder(6), COB=Cobble(5), GC=Gravel Coarse(4), GF=Gravel Fine(3), S=Sand(2), SC=Silt/Clay(1)

7. Embeddedness (Gravel, Cobble, Boulders Percent Embedded)

NA Low

Section	1	2	3	4	5	6	7	8	9	10	11	12	Average
% Embedded													

8. Sediment Deposition (Percent of Bottom Affected)

Section	1	2	3	4	5	6	7	8	9	10	Average
%	5%	5%	5%	5%	10%	5%	5%	10%	10%	5%	6.5%

Stream Habitat Assessment (Semi-Quantitative)

Station #: UTA-2	Date/Time: 4/27/05	Initials: SKH/BD

9. Aquatic Macrophytes and Periphyton (Percent Coverage)

Morph Type		Reach No. - Percent Coverage 1	2	3	4	5	6	7	8	9	10	Average
Riffle	Macrophytes	0%	0%	—	—	—	—	—	—	—	—	0%
	Periphyton	0%	0%	—	—	—	—	—	—	—	—	0%
Pool	Macrophytes	0%	0%	—	—	—	—	—	—	—	—	0%
	Periphyton	0%	0%	—	—	—	—	—	—	—	—	0%

10. Canopy Cover (Percent Stream Shading)

Section	Reach No. Percent (%) Shaded Within Stream Channel 1	2	3	4	5	6	7	8	9	10	Average
Shading	95%	95%	95%	50%	60%	90%	80%	80%	90%	90%	82.5%

11. Bank Stability (Score) and Slope (Degrees)

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	7	6	5	6	6	7	7	5	2	5	5.6
Slope (°)	80°	80°	80°	80°	70°	80°	70°	60°	80°	75°	75.5°
RB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	3	5	5	7	7	7	2	1	7	5	4.9
Slope (°)	80°	80°	60°	70°	70°	80°	90°	90°	60°	60°	74.0°

Score 9-10 = Stable, < 5% bank ~~affected~~ eroding. Score 6-8 = Moderately stable, 5-29% of bank eroding

Score 3-5 = Moderately unstable, 30-59% bank eroding. Score 1-2 = Unstable, 60-100% bank eroding.

12. Vegetative Protection (Percent Banks Protected)

LB Section	1	2	3	4	5	6	7	8	9	10	Average
%	60%	60%	50%	60%	50%	60%	60%	30%	20%	50%	50.0%
RB Section	1	2	3	4	5	6	7	8	9	10	Average
%	80%	50%	30%	70%	70%	60%	30%	10%	60%	25%	43.5%

13. Riparian Vegetative Zone Width

LB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	10	9	10	9	8	8	9	8	5	5	7.2
RB Section	1	2	3	4	5	6	7	8	9	10	Average Score
Score	10	9	10	10	10	10	10	10	10	10	9.9

Score 9-10 = Riparian Zone Width > 18 meters Score 6-8 = Riparian Zone Width 18 - 12 meters

Score 3-5 = Riparian Zone Width 11 - 6 meters Score 1-2 = Riparian Zone Width < 6 meters

14. Land-Use Stream Impacts

Section	Reach No. - Impact(s) 1	2	3	4	5	6	7	8	9	10	Average
Impact	0, 0.0	0, 0.0	0, 0.0	0, 0.0	0, 1	0, 1	0, 1	0, 1	0, 1	0, 1	0.6

C = Cattle R = Row Crops U = Urban Encroachment I = Industrial Encroachment O = Other ________

Score 0 = none 1 = minor affect 2 = moderate affect 3 = major affect

Logging u/s

NOTES: STREAM very small w/ deep cut banks Historical Flood Plain ~5'
Flashy, watershed small

Habitat Assessment Field Data Sheet (Low Gradient)

Station I.D: UTA-002	Client:
Stream name: Unnamed trib of Bayou de Loutre	Date/Time: 4/27/05
Location: Union County	Form Completed By: SKH

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate / Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble, or other stable habitat; and at a stage to allow full colonization.	30-50% mix of stable habitat suited for colonization; adequate habitat for maintenance of population; some newfall may be present.	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed.	Less than 10% stable habitat; lack of habitat obvious; substrate lacking..
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay to sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root or vegetation.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep small-shallow, small deep pools present.	Majority of pools large deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or absent.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
4. Channel Alteration	No channelization or dredging present. Stream channel normal.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging, (greater than past 20 yrs.) may be present, but recent channelization is not present.	Embankments present on both banks; channelization may be extensive, and 40%-80% of steam reach channelized and disrupted.	Extensive channelization; shored with Gabon cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Sediment Deposition	Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars.	20-50% affected; some accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; moderate deposition; pools shallow, moderately silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Heavily silted; >80% affected; movement/shifting of bottom occurs frequently; pools nearly absent due to deposition.
SCORE 19	20 [✓ 19] 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Assessment Field Data Sheet (Low Gradient Cont.)

Station I.D: UTR-2	Date/Time: 4/27/06
Stream name: Unnamed trib of Rd L	Form Completed By: SKM

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than it if was in a straight line.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
7. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or < 25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability	Banks stable; no evidence of erosion or bank failure. <5% affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5%-30% affected.	Moderately unstable; up to 30%-60% of banks in reach show areas of erosion. High erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; 60-100% of banks have erosion scars.
SCORE 8 LB	Left Bank 10 9	[✓ 8] 7 6	5 4 3	2 1
SCORE 5 RB	Right Bank 10 9	8 7 6	[✓ 5] 4 3	2 1
9. Vegetative Protection	More than 90% of the streambank surfaces and immediate riparian zone covered by vegetation. Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by vegetation. Disruption minimal or not evident; one group of plants likely not evident. Almost all plants allowed to grow naturally.	50-70% of the streambank surfaces covered by vegetation. Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of streambank surfaces covered by vegetation. Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 4 LB	Left Bank 10 9	8 7 6	5 [✓ 4] 3	2 1
SCORE 3 RB	Right Bank 10 9	8 7 6	5 4 [✓ 3]	2 1
10. Riparian Vegetative Zone Width	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clearcuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted a great deal.	Width of riparian zone <6 meters; little riparian vegetation to human activities.
SCORE 7 LB	Left Bank 10 9	8 [✓ 7] 6	5 4 3	2 1
SCORE 9 RB	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1

TOTAL SCORE: 132

AVERAGE SCORE: 13.2

Barbour, M.T. et.al., 1999. *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers.*

Discharge/Flow Measurement Form

Station: UTA-2

Waterbody: Unnamed Trib of Bayou De Loutre

Date: 4/27/05

Crew: SKY/BTP

Start Time: 1110

Recorder: SKY

End Time: 1115

GH. Change: ______ in ______ hrs.

Staff/Gage:

Width: 2.7'

Area:

Velocity:

Disch/Flow:

Method:

No Secs:

Meter No:

Max Vel:

Min Vel:

ORIENTATION:

[✓ Wading], Boat, [✓ Upstream], Downstream, Side Bridge ______ ft/mi,
above, below gage, and ______

Measurement rated: excellent good [✓ fair] poor based on the following conditions: Cross section ______

Flow ______ Weather ______

Other ______ Air ______ °F @ ______

Gage ______ Water ______ °F @ ______

Observer ______

Control ______

Remarks ______

(1) Distance from initial point	(2) Width (W)	(3) Depth (D)	Obstruction(s) (logs, rocks, other)	(4) Avg. Velocity At Point (V)	Method Depth (0.2, ~~0.6,~~ or 0.8)	(5) Area (A)	(6) Discharge (Q)
0.5	0.3'	0.2		0.04		0.1	0.004
1.0	0.5	0.2		0.09		0.1	0.009
1.5	0.5	0.2		0.15		0.1	0.015
2.0	0.5	0.1		0.12		0.05	0.006
2.7	0.7	0.0		ND		0	0
TOTALS					0.08	0.35	0.03

Avg

V1.0 1096

Completed By SKY

Checked by ______

Reviewed by ______

FIELD DATA SHEETS - FISH

Waterbody Name: UTA 2
Client: Great Lakes
Project no: 2072-05-070
Investigators: REM, JBB, SCH, BPP
Date Sample Collected: 4/27/05
Habitat Forms Completed: [✓ yes] / no

Location: d/s outfall 002
Ecoregion: Gulf Coastal Ecoregion
Weather: Sunny - clear mild
Form Completed By: REM/JBB
Form Checked By:
Fish Sampling Completed: yes / no

Collection Site Observations			
	UTA 2 ~~Above Station~~	UTA 4 Below Station	Additional Observations:
Total Time Sampled:	PDT 1868 / 62 min		
Relative Abundance of Aquatic Biota			
Periphyton:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Filamentous Algae:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Macrophytes:	0 [✓ 1] 2 3 4	0 1 2 3 4	
Slimes:	[✓ 0] 1 2 3 4	0 1 2 3 4	
Macroinvertebrates:	0 1 2 3 [✓ 4]	0 1 2 3 4	
Fish:	0 1 2 [✓ 3] 4	0 1 2 3 4	
Other______:	0 1 2 3 4	0 1 2 3 4	
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant			
Major Habitat Sampled (%)			
Riffle/Run:	10 / 40		
Shallow Pool:	50		
Deep Pool:			
Backwaters:			
Chanelized:			
Microhabitats Sampled (%)			
Woody debris:	35		
Emergent Vegetation:			
Submerged Vegetation:			
Depositional Area:	10		
Overhanging Veg:			
Root Wads:	20		
Undercut Banks:	20		
Filamentous algae:			
Leafy debris:	5		
Substrate Type and Scoring			
Substrate	Score	Adj. Score	
Bedrock:	X 0.1		
Lg. Boulder:	X 1.0		
Boulders:	X 1.0		
Rubble:	X 1.0		
Gravel:	30 X 0.5		
Sand:	60 X 0.1		
Mud/Silt:	10 X 0.1		
Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0			

Sampling Gear Type: [✓ Electrofishing] Seine Gill nets

Unit of Effort: Above: 1868 PDT / 63m. total Below:

Quantity of Available Fish Cover:

UTA 2 ~~Above Station~~: Very Abundant, Abundant, [✓ Moderate,] Sparse, Absent

Below Station: Very Abundant, Abundant, Moderate, Sparse, Absent

Site Description & Notes:

UTA2 ~~Above Station~~: UTA d/s of HWY 15. Began ~ 0.2 miles d/s ó shaked w/c trap.

Below Station:

(8/04)

ab Checked 6/19/05

Fish Species Observed

~~Above Station #~~ UTA 2	Below Station #
(9) — Banded Pygmie Sunfish 𝍸	
(5) - Slough Darter |||	1 w/ internal parasite
(30) - Mosquito Fish 𝍸 𝍸𝍸 𝍸 ||||	
-Grass Pickerel 𝍸 𝍸 |	
~~Dollar Sunfish |~~ NOT Found	
(23) - Creek Chubsucker 𝍸 𝍸 𝍸 𝍸 |||	
(2) - Warmouth |||	
(2) - Longear Sunfish 𝍸 𝍸 ||| -	Number Running
(1) - Yellow Bullhead Catfish |	
(2) - Pirate Perch ||	
(1) - Golden Shiner |	
(19) - Green Sunfish 𝍸 |	
(1) - Black Bullhead ~~Sunfish~~ Catfish	
~~Creole Darter 𝍸~~	
~~Darter ? ||~~	
(7) - Gold Stripe Darter	

FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: UTA 2
Client: Great Lakes
Project no: 2072-05-070
Investigators: REM, BJP, SKH, JBB
Date Sample Collected: 4/27/05
Habitat Forms Completed: [✓ yes] / no

Location: Outfall 002
Ecoregion: Gulf Coastal
Weather: Sunny Clear Mild
Form Completed By: JBB/REM
Form Checked By:
Fish Sampling Completed: [✓ yes] / no

Collection Site Observations		
	UTA 2 Ab~~ove Station~~	Below Station
Total Time Sampled?		
Relative Abundance of Aquatic Biota		
Periphyton:	[✓ 0] 1 2 3 4	0 1 2 3 4
Filamentous Algae:	[✓ 0] 1 2 3 4	0 1 2 3 4
Macrophytes:	0 [✓ 1] 2 3 4	0 1 2 3 4
Slimes:	[✓ 0] 1 2 3 4	0 1 2 3 4
Macroinvertebrates:	0 1 2 3 [✓ 4]	0 1 2 3 4
Fish:	0 1 2 [✓ 3] 4	0 1 2 3 4
Other__________:	0 1 2 3 4	0 1 2 3 4
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant		
Major Habitat Sampled (%)		
Riffle/Run:	10/40	
Shallow Pool:	50	
Deep Pool:		
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:	10	
Emergent Vegatation:		
Submerged Vegetation:		
Depositional Area:	10	
Overhanging Veg:		
Root Wads:	20	
Undercut Banks:	60	
Filamentous algae:		
Leafy Debris:		
Other__________:		

Macroinvertebrate Qualitative Sample List		
Taxa	UTA 2 A~~bove Station~~	Below Station
Annelida		
Decapoda	C	
Gastropoda		
Pelecypoda		
Hemiptera		
Coleoptera	R	
Lepidoptera		
Odonata	D	
Megaloptera	Present	
Diptera	Present	
Chironomidae		
Plecoptera		
Ephemeroptera		
Trichoptera		
Amphipoda	D	
R=Rare, C=Common, A=Abundant, D=Dominant Rare<3, Common 3-9, Abundant>10, Dominant>50		

Site Description and Observations:

UTA 2
Cordalegaster (lots)
Ophigomphus (lots)
see FISH
clean white sand/gravel

Rapid Bioassessment Field Sheet

Point Source: Storm water discharge from Outfall 002 and 004

Collector: REM

Date:

Sample Technique: 3m Pool

Sediment ?: None collected

Habitat Description: ABOVE: Outfall 002 ditch - d/s of 002

BELOW: Outfall 004 ditch · d/s of 004

MACROINVERTEBRATE COMMUNITY

ABOVE Station #: Outfall 002 ditch

Cnt.	Taxa	Tally
7	Cambarinae	卌||
5	Hyalella azteca	卌|
31	Isopoda	卌卌卌卌卌卌|
6	Oligochaeta	卌|
14	Cordulegaster	卌卌||||
2	Gomphus	||
13	Cheumatopsyche	卌卌|||
12	Chironomidae	卌卌||
4	Hexatoma	||||
1	Tipula	|
7	Bittacomorpha	卌||
	Stenelmis (larva)	||||
1	Hemerodromia	|
1	Collem	| (spring Tail)
2	Simulium	||
	:TOTAL:	

BELOW Station #: Outfall 004 ditch

Cnt.	Taxa	Tally
5	Cambarinae	卌
13	Hyalella azteca	卌卌|||
10	Isopoda	卌卌
14	Oligochaeta	卌卌卌卌
5	Cordulia	卌
1	Cheumatopsyche	|
1	Tropisternus	|
8	Hexatoma	卌|||
1	Tipula	|
3	Bittacomorpha	卌
7	Tipulidae	卌||
1	Terr Bug |	
8	Diptera ?? 卌|	
28	Chironomidae	
	Ablabesmyia 卌卌||||	
	Chiron 卌||	
	Tanypodinae 卌|	
	:TOTAL:	

Community Structure

	ABOVE	BELOW
% Ephem.	0	
% Plecop.	0	
% Trichop.	0	
% EPT	0	
% Chir.	12	28
Diptera		

	ABOVE	BELOW
% Odon.		
% Cole.		
% Crustacea		
# of Taxa:	15	17
Biotic Score:		

Comments:

GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

STATION I.D: UTA 4

STREAM NAME: UNNAMED Tributary

LAT:

LONG:

INVESTIGATORS: REM/SKH/BPP/JOB

LOCATION:

RIVER BASIN:

PROJECT:

DATE/TIME: 4/27/05 12:39

FORM CHECKED BY:

WEATHER CONDITIONS

Now		Past 24-hr
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☑ 0.1 inch
☐	showers (intermittent)	☐
__% ☐	% cloud cover	☑ 100 %
☑	clear/sunny	☐

Heavy rain in the last 7 days? ☑ Yes ☐ No

Air Temperature 70° °C/[✓ °F]

Other

STREAM ATTRIBUTES

Stream Subsystem

☐ Perennial ☑ Intermittent ☐ Tidal

Stream Type

☐ Coldwater ☑ Warmwater

Stream Origin

☐ Glacial

☐ Montane, non-glacial

☐ Swamp and bog

☐ Spring-fed

☐ Mixture of origins

☐ Other Storm Flows From GLCC

Catchment Area: ~0.4 mi²

Stream Order: 1st

Stream Gradient: ☐ High (≥25ft/mi) ☐ Moderate (10-24 ft/mi) ☑ Low (<10 ft/mi)

HYDROLOGY

Flows

☐ High ☐ Moderate ☑ Low ☐ None

wider stream flow

Flows Measured? ☑ Yes ☐ No

Reach: Slope & Sinuosity

_______ ft/mi _______

WATERSHED FEATURES

Predominant Surrounding Landuse

☑ Forest 20 %

☐ Pasture ___%

☐ Row Crops ___%

☐ Urban ___%

☐ Sub-Urban

☐ Commercial ___%

☐ Industrial 80 %

☐ Other __________%

Local Watershed NPS Pollution

☐ No evidence ☐ Agricultural

☑ Industrial Storm Water

☐ Urban/Sub-Urban Storm Water

RIPARIAN VEGETATION

☑ Mature Forest 90 % ☐ Shrub/Sapling ___% ☐ WETLAND Herbs/Grasses 10 % ☐ Turf ___%

STREAM MORPHOLOGY

☐ Riffle ___% ☑ Run 15 % ☑ Pool 25 %

STREAM DISTURBANCES

☐ Roads ☐ Bridges ☐ Pipelines ☐ Beaver Dams ☐ Point Source

☐ Dams ☐ Trash ☐ Cattle Access ☐ Mining ☐ ATV Crossing ☐ Other ________

Channelized: ☐ Yes ☐ Some ☑ No

Local Watershed Erosion: ☐ None ☐ Minimal ☑ Moderate ☐ Heavy

Channel Dynamics: ☐ Aggrading ☐ Degrading ☐ Widening ☐ Headcutting

Water Odors

☐ Normal/None

☑ Petroleum

☐ Fishy

☐ Sewage

☑ Chemical

☐ Other________

Water Surface Oils

☐ Slick ☐ Sheen ☐ Globs

☑ Flecks ☐ None ☐ Other________

on disturbance of sediments

Turbidity/Water Clarity (If not measured)

☐ Clear ☐ Slightly turbid ☐ Turbid

☐ Opaque ☐ Stained ☐ Other________

Sediment Odor

☐ Normal ☐ Sewage ☐ Petroleum

☐ Chemical ☐ Anaerobic ☐ None

☐ Other________

Sediment Deposits

☐ Sludge ☐ Sawdust ☐ Oils

☑ Sand ☐ Relict shells

☐ Other________

Stream Habitat Assessment (Semi-Quantitative)

Station #: UTA-4	Stream: Unnamed trib to Bayou L	Date/Time: 4/27/05	Analyst: SK-4 BJP
	Location: Union County	1150 - 1255	

Amo GPS d/s Lat: 33°11'19.1" Long: 92°41'55.6"

u/s Lat: 33°11'19.0 Long: 92°41'56.2

1. Reach Length Determination

Parameters (ft)	Measurement Number 1	2	3	4	5	Average	¹Total Reach Length (ft)	²Sub-Reach Length (ft)
Bankfull Width	5.5	4.5	4.0'	7.7'	6.5	5.6'	112'	11.2'
Bankfull Depth	0.9	1.0'	1.1'	1.2'	1.1	1.06'	na	na

¹Average width times 20 ²Total Length divided by 10

0.4 (0.1 Hu) board Riffle

2. Riffle-Pool Sequence

Morph Type	Reach Number - Length in Feet 1	2	3	4	5	6	7	8	9	10	Total
Riffle	~~8~~	3.0'	1.0'					6.0	—		[illegible] 10
Run	3.2							5.2'	9.2	4.0	[illegible] 21.6
Pool	8.0	8.2	10.2	11.2	11.2	11.2	11.2	[illegible]	2.0	7.2	[illegible] 80.4
Total											
Sequence¹	∼∼∼---	∼xxx∼∼	xx∼∼∼∼	∼∼∼∼	∼∼∼∼	∼∼∼∼	∼∼∼∼	xxxx[illegible]	----∼∼	∼∼∼-	

¹Riffle="xxx", Run="——", Pool="∼∼∼"

Runs

Pool

Post Bne

3. Depth and Width Regime

Morph Type	Reach No. - Average Depth (ft) / Width (ft) 1	2	3	4	5	6	7	8	9	10	Average
Riffle Depth	—	0.1'	0.2	—	—	—	—	0.1	—	—	.13
Riffle Width	—	1.5'	1.5'	—	—	—	—	20'	—	—	1.7
Pool Depth	0.4'	0.4'	0.4'	0.7	0.8	0.8	1.2'	0.2	0.8	0.5	.62
Pool Width	5.5'	2.8'	50'	5.5'	6.75	4.5	6.0'	3.2'	4.0	4.2	47

4. Epifaunal Substrate, Percent Stable Habitat (for Macroinvertebrates)

Section	1	2	3	4	5	6	7	8	9	10	Average
% Area	40	50	30	20	30	40	40	10	30	40	33

Most HABITAT is Leaf packs & Small woody debris

5. In-Stream Habitat, Percent Stable Habitat (Available Fish Cover in Wetted Perimeter)

Section	Reach No. - Availability and Quality of Fish Habitat 1	2	3	4	5	6	7	8	9	10	Average
% Area	30	30	25	20	30	30	40	10	30	40	28.5

Most HABITAT is small woody debris

6. Substrate Characterization (Dominant Substrate)

Morph Type	Reach No. - Dominant Substrate 1	2	3	4	5	6	7	8	9	10	Average
Riffle	-	S(2)	S(2)	—	—	—	—	S(2)	—	—	S(2)
Pool	SC(1)	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	S(2)	(1.8)

BR=Bedrock(7), BLD=Boulder(6), COB=Cobble(5), GC=Gravel Coarse(4), GF=Gravel Fine(3), S=Sand(2), SC=Silt/Clay(1)

7. Embeddedness (Gravel, Cobble, Boulders Percent Embedded)

only

Section	1	2	3	4	5	6	7	8	9	10	11	12	Average
% Embedded													

8. Sediment Deposition (Percent of Bottom Affected)

Section	1	2	3	4	5	6	7	8	9	10	Average
%	60	50	70	60	60%	70%	70%	50	20	30	54

Appendix F

Photos of Study Reaches

Appendix F
Photo Log

F-1 UT002: UT002 view upstream through study reach. Note: depth of cut channel, 3-4 ft into flood plains

F-2 UT002: UT002 view downstream through study reach. Note: channel width approximately 3 ft., depth less than 3 inches.

F-3 UT004: UT004 study reach substrate clay. Channel depth 1 ft or less. Note: isolated pools only during seasonal period.

F-4 UT004: UT004 study reach. Note: very shallow pool with trickle flow through isolated pools.

F-5 UT004: Downstream terminus of UT004. Large wetland complex.

F-6 UT004: Upstream of UT004 mouth into large wetland complex.

F-7 UT003: Mid-reach of UT003. Shallow channel with no flow.

F-8 UT003: Mid-reach of UT003. Collecting stream habitat data.

F-9 UT003: Downstream end of UT003 reach.

F-10 UTLCB-1: Mid-reach view upstream. Note pooled area and depths of channel development. No flow. Exposed streambed sand and gravel.

F-11 UTLCB-1: Mid-reach view downstream. Continued pool with exposed stream bed silt and sand.

F-12 UTLCB-1: Downstream end of reach. Wider stream channel. Edges of stream bed exposed.

F-13 UTLCB-2: View mid-reach upstream to Hwy 15 Bridge, Note pooled condition with developed organic surface film.

F-14 UTLCB-2: Study reach view upstream. Wide stagnant deep pool. Note: development of organic surface film.

F-15 UTLCB-2: Stream bank interface. Note: pool level reduced after recent rains. Pool remains Bank full.

F-1

F-2

F-4

F-5

F-6


F-7


F-10


F-8


F-11


F-9


F-12


F-13


F-14


F-15