GBM^c

Great Lakes Chemical Corporation Site Specific Water Quality Criterion Modification: Temperature

October 15, 2001

Revised March 4, 2002

GBM^c & Associates

Strategic Environmental Services

Site Specific Water Quality Criterion Modification: Temperature

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1.0 INTRODUCTION

1.1 Background

Great Lakes Chemical Corporation (GLCC) operates an industrial facility in the vicinity of El Dorado, AR (Figure 1.1). The GLCC facility (GLCC-Central), which first began operations in 1965, is located on Highway 15, approximately two miles south of El Dorado, and produces specialty chemicals including halogenated compounds, brominated organics, and inorganic chemicals. The GLCC-Central facility is located on approximately 1,400 acres. The facility center is located at Latitude 33°10'29", Longitude 92°42'40" in Sec. 1, T18S, R16W, Union County, AR. The standard industrial classification (SIC) code for the facility is 2819.

Although all wastewater associated with the bromine production process is re-injected into the source formation, water not directly associated with bromine production is discharged into Bayou de Loutre from Outfall 001. The discharge is authorized by the Arkansas Department of Environmental Quality (ADEQ), under National Discharge Elimination System (NPDES) Permit No. AR0001171. Water discharged through Outfall 001 consists mainly of non-contact cooling water and includes smaller volumes associated with roof drains, boiler blowdown, steam condensate, air conditioning drains, reactor jacket water and sanitary. The source of the non-contact cooling water is ground water from the Sparta Aquifer.

Currently, Bayou de Loutre is designated as a Seasonal Gulf Coastal Fishery, with an associated ecoregion water quality criterion for temperature of 86°F (30°C).

As noted previously the facility has been operating for over 30 years and the thermal discharge predates the ecoregion based temperature criterion by many years.

Historically, the Outfall 001 discharge was continuous; however, in an effort to be responsive to NPDES permit limit for temperature and conservation of the Sparta Aquifer, which has been designated as a critical ground water withdrawal area, GLCC-Central developed and implemented a project to transfer the Outfall 001 effluent to Lion Oil for their re-use. The initial transfer of the Outfall 001 effluent was completed during November 1999. The operational transfer of GLCC-Central Outfall 001 discharge was accomplished during January 2000.

This project has essentially eliminated the discharge from GLCC-Central Outfall 001 and provides Lion Oil water, which reduces the amount of water Lion Oil must pump from the Sparta Aquifer. This project is environmentally valuable as a conservation measure associated with the Sparta Aquifer. The joint project has received substantial recognition for water conservation efforts.

Despite the water re-use and conservation project, there have been occasions when the transfer to Lion Oil cannot be completed (e.g., electrical outages, pump malfunction, Lion Oil plant shutdown). Therefore, GLCC-Central must maintain its ability to discharge through Outfall 001 on an intermittent basis.

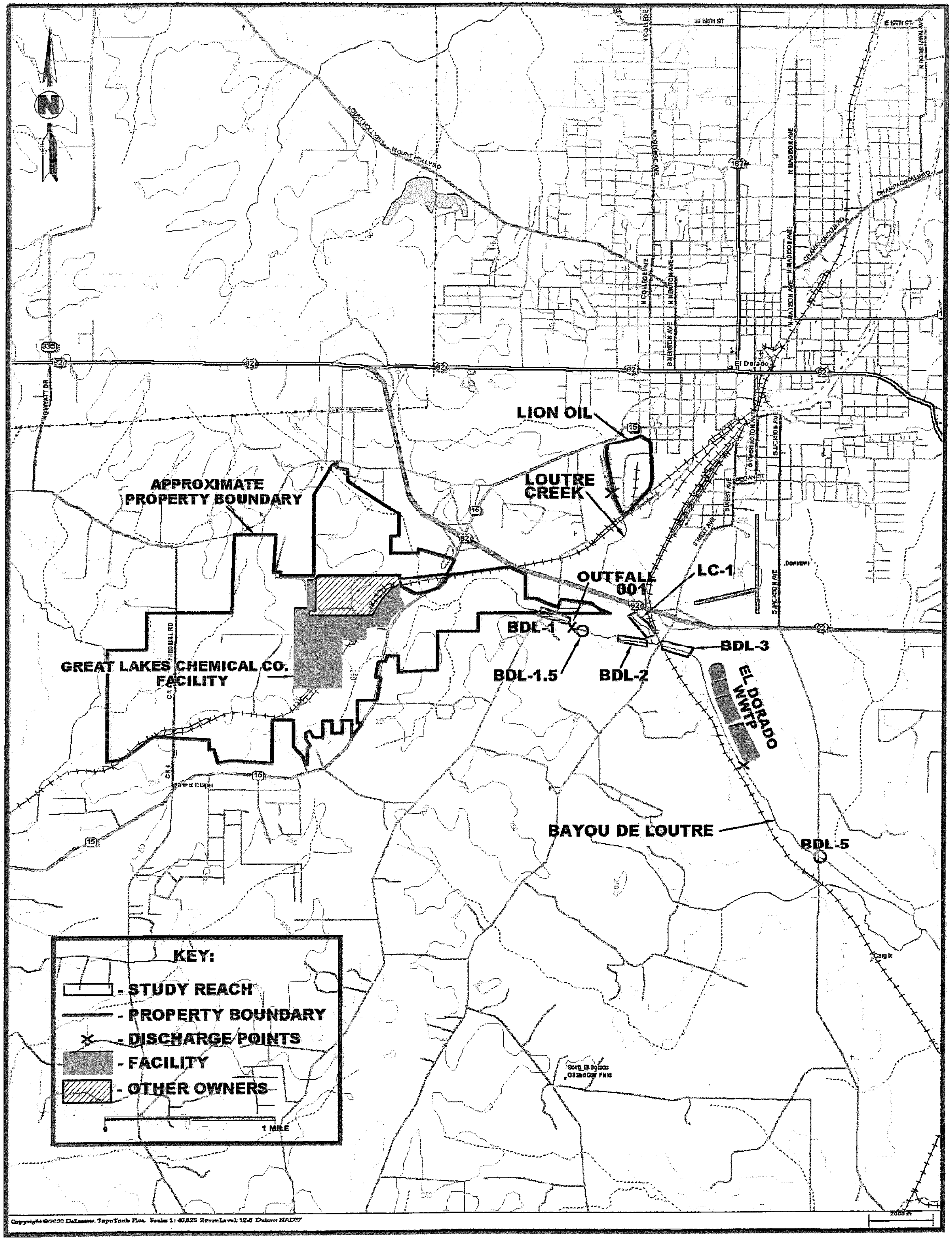


Figure 1.1. Location and vicinity map of GLCC-Central Facility.

The objective of this study was to determine if it is appropriate to modify the existing ecoregion based temperature criterion for Bayou de Loutre. The documentation developed during the study is presented in the following sections:

1) Conclusions and Recommendations (Section 2),
2) Background (Section 3),
3) Aquatic Life Field Study (Section 4),
4) Ambient water temperature monitoring and characterization (Section 5),
5) Alternative analyses, use summary, and criteria development (Section 6), and
6) References cited (Section 7).

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 Conclusions

Based on the information developed as part of this investigation, and as provided in subsequent sections, the following conclusions are provided.

1) Although the GLCC-Lion Oil water re-use project has eliminated the majority of the discharge from GLCC-Outfall 001, routine small volume discharges continue to occur into Bayou de Loutre. On occasion, the discharge from GLCC Outfall 001 reflects pre-project volumes of 1,500 gpm (2.2 mgd).

2) Due to the wide fluctuation of Outfall 001 flow volumes, there are no feasible cooling technologies available (see Section 6.4 for full discussion).

3) The transfer of effluent from GLCC to Lion Oil was shown to:
   a) reduce the frequency and magnitude of criterion exceedances in BDL,
   b) eliminate the temperature exceedances in near field reaches (BDL-3), and
   c) have little measurable effect on the water temperature of Loutre Creek and Bayou de Loutre in downstream far field monitoring location.

4) Although Bayou de Loutre does not reflect least disturbed ecoregion biotic communities, the aquatic life field survey demonstrates that a Seasonal Gulf Coastal Fishery is maintained.

5) The habitat conditions present as a result of small watershed size, historical land use, and long-term sustained instream velocities were found to limit the biotic community development.

6) The instream water temperatures were elevated above the ecoregion specific criterion and NPDES permit limit of 86°F sporadically for a short distance (less than 0.5 miles) as a result of the discharge from Outfall 001.

7) The water temperature of Bayou de Loutre was shown to exceed the criterion up-stream of the GLCC Outfall 001 during the critical low flow high temperature season.

8) The instream water temperatures are responsive to storm events and instream exceedances of the ecoregion specific criterion are generally of short duration and primarily restricted to the summer months.

9) Based on the documentation developed, the modification of the temperature criterion is supported.

2.2 Recommendations

As authorized in Section 2.308 (Site Specific Criteria) of the Arkansas Water Quality Standards (WQS) Regulation No. 2. (ADEQ, 1998), it is recommended that a site specific protective criterion for temperature be promulgated for Bayou de Loutre from the point where GLCC-Central's Outfall 001 discharges to the confluence with Loutre Creek. This reach represents a total stream reach of 0.5 mile.

This recommended criterion is 96°F. As documented within this report, the existing conditions support the designated Seasonal Gulf Coastal Fishery use. In addition, due to the unique nature of the re-use project intended to conserve Sparta Aquifer groundwater, no method of temperature treatment is feasible because of the variability of Outfall 001 discharge volume.

No change in designated uses is recommended, as the Seasonal Gulf Coastal Fishery is being maintained.

3.0 FACILITY BACKGROUND

3.1 Introduction

This section provides a historical perspective and background information for the GLCC-Central facility. This review includes a description of the facility, wastewater treatment system, watershed characteristics, regulatory requirements for wastewater discharges, discharge characteristics, and receiving stream characteristics.

GLCC was founded in Michigan in 1936 with the objective to extract bromine from subsurface saline deposits. Throughout the 1950's the company's operations were limited, but research activities led to the development of several new bromine based chemicals. GLCC formed joint venture with Arkansas Chemicals, Inc. in the 1960's and pioneered the development of Arkansas' brine fields. In 1965, the company built a facility in El Dorado and by 1975, the facility (GLCC-Central) was a major producer of bromine based flame-retardants. Since that time, facilities have been added and/or expanded to produce specialty chemicals, chemicals for the agriculture and oil industries, and new flame-retardants.

3.2 Facility Description

The GLCC-Central facility is located on approximately 1,200 acres southwest of El Dorado, AR (Figure 1.1). The facility is located on the west side of Highway 15, approximately 2 miles south of U.S. Hwy 82. The only vehicular access is from Arkansas Highway 15. GLCC employs approximately 800 workers with an annual payroll in excess of $41 million. GLCC pays approximately $4.4 million in local and state taxes annually. Additional details of facility operations are provided in the following sections.

3.2.1 Process Description

GLCC-Central manufactures elemental bromine and uses bromine in approximately 30 different manufacturing processes. Bromine is extracted from subsurface reserves and degassed (i.e., hydrogen sulfide separated) in the NAHS unit. The degassed brine, steam and chlorine are injected into the bromine extraction tower. Chlorine replaces the bromine from the sodium bromide in brine. Bromine vapor is condensed, distilled and sold as a product and/or used in the manufacture of other brominated compounds.

Various manufacturing processes at the central facility produce waste streams which, except where noted, are collected in sumps and transported by pipeline to the process wastewater treatment plant (PWTP). All waters treated at the PWTP are ultimately disposed via deep well injection. Process units are described below:

1) As discussed above, the NAHS process removes hydrogen sulfide from the brine.

2) The IOB unit primarily produces TBBPA. Methyl bromide is produced as a co-product.

3) The HBr/Calcium Bromide unit produces an aqueous solution of CaBr2.

4) The OCP unit produces numerous brominated organics.

5) The Fine Chemicals area produces a variety of alkyl bromides.

6) The TCO process produces a carbonated oligomer compound. Separation and purification steps follow the reaction.

7) The Brominated Organic Chemical (BOC) unit produces brominated organic compounds.

8) The Bromine recovery unit (BRU) recovers bromide ions to be used as raw material for other processes.

3.2.2 Process Water Source and Use

Water utilized in the plant is groundwater obtained from three wells completed in the Sparta Sand Aquifer. Groundwater from the Sparta Aquifer is used for non-contact cooling and boiler feed water. Brine produced from the Smackover Formation is the raw material from which bromine is extracted.

3.2.3 Current Process Waste Treatment Plant

GLCC-Central operates a PWTP to handle the facility's wastewater streams. These sources consist of process wastewater from the eight process units described in Section 3.2.1, and storm water collected in the West Side Sump. The PWTP is a RCRA regulated hazardous waste management facility, which was retrofitted in 1989 with secondary containment and leak detection in order to meet the new hazardous waste tank standards. The water treated in the PWTP is subsequently disposed by deep well injection in one of two permitted Class I wells. There is no surface discharge of this treated wastewater.

3.3 NPDES Requirements

The temperature restriction applicable to GLCC-Central's Outfall 001 discharge is based on provisions of the Arkansas WQS, as implemented through the NPDES permitting program and ADEQ regulations promulgated pursuant to the Arkansas Water and Air Pollution Control Act (Act 472, as amended).

3.3.1 NPDES Permit Requirements

The NPDES program issues effluent discharge permits under the authorities of Section 402 of the Clean Water Act (P.L. 92-500 as amended). The facility's current permit (Permit No. AR0001171) was effective on January 1998. GLCC-Central has four NPDES permitted surface water discharges. Only Outfall 001 is the subject of this report. Outfall 001 discharges primarily non-contact cooling water and other small volumes of non-process wastewater (e.g. boiler blowdown, etc.).

3.3.2 Discharge and Monitoring Requirements

Effluent limitations for Outfall 001 are based on a combination of water quality criteria in Regulation No. 2 application of best practicable control technology currently available (BPT) and best professional judgement of the ADEQ permit section.

Discharge from Outfall 001, largely non-contact cooling water, is transported via underground pipe approximately 1.3 miles from the plant site before it is discharged into Bayou de Loutre (Figure 1.1). Outfall 001 discharge limitations and monitoring frequency requirements are summarized in Tables 3.1 and 3.2, respectively.

Table 3.1. Discharge limitations for GLCC-Central Outfall 001.

Parameter	Monthly Average	Daily Maximum
Flow, gpm	n/a	1500
pH, su	n/a	6-9
Total Organic Carbon, mg/L	n/a	10
Total Residual Chlorine, mg/L	n/a	0.1
Oil and Grease, mg/L	10	15
Total Purgeable Halocarbons, mg/L	n/a	Report
Total Purgeable Aromatics, mg/L	n/a	Report
Temperature, °F	n/a	86
Turbidity, NTU	n/a	21
Sulfate, mg/L	n/a	90
Whole Effluent Toxicity (chronic)	Not< 100%	Not< 100%

Table 3.2. Current monitoring frequency requirements for GLCC-Central Outfall 001.

Parameter	Frequency of Monitoring
Flow, gpm	Continuously
pH, su	Daily when discharging
Total Organic Carbon, mg/L	1/week
Total Residual Chlorine, mg/L	1/week
Oil and Grease, mg/L	1/week
Total Purgeable Hydrocarbons, mg/L	Quarterly
Total Purgeable Aromatics, mg/L	Quarterly
Temperature, °F	Daily
Turbidity, NTU	1/week
Sulfate, mg/L	1/week
Whole Effluent Toxicity	Quarterly

3.3.3 Wastewater Discharge Characteristics

Under the provisions of its NPDES permit, GLCC-Central submits monthly discharge monitoring report (DMRs) on its effluent quality to the ADEQ. Current and historical data were compared to discharge limitations from the current NPDES permit. Discharge characteristics of flow and water temperature were substantially different between the pre and post transfer periods, reflecting the various non-contact cooling water sources and the variable discharge volume associated with the Sparta Conservation Project.

3.3.3.1 Permit Compliance

Outfall 001 effluent consists of once-through non-contact and re-circulating cooling water, boiler blowdown, steam condensate, air conditioning drains, reactor jacket water, roof drains, and sanitary wastewater.

With the exception of temperature, the DMR data for Outfall 001 demonstrates compliance with the current NPDES permit requirements. No violations of permit requirements for sulfate or turbidity have occurred under the conditions of the current permit. Minor exceedences for other parameters have been reported, but there has been no consistent problem with permit compliance except for discharge temperature when a discharge occurs.

3.3.3.2 Existing Discharge Conditions

Prior to December 1999, the discharge from GLCC-Central Outfall 001 continued, as allowed by the existing NPDES permit. During the period from April 1999 through December 1999 GLCC-Central initiated an instream temperature monitoring program. This resulted in an eight-month period of temperature monitoring that included spring seasonal and critical low flow periods while the daily discharge from Outfall 001 existed.

From December 1999 to February 2000, the outfall transfer project was implemented periodically to address operational procedures. During this three-month period, the transfer was implemented sporadically but was not "operational".

On or about February 22, 2000, the Outfall 001 transfer became operational. This resulted in the transfer of the majority of the GLCC-Central once-through cooling water to Lion Oil. The transfer process has been interrupted on occasion at which time the discharge was diverted back into Bayou de Loutre. Table 3.3 summarizes the discharge through GLCC-Central Outfall 001 since the transfer project became operational through May 2001. The daily record of discharges from Outfall 001 is provided in Appendix A. As indicated by Figure 3.1, the discharges from Outfall 001 since the transfer was initiated have been limited in both duration and volume.

Figure 3.1 illustrates the distribution of flow data from Outfall 001 after the transfer of water to Lion Oil was completed. Based on the daily flow record, 86% of the discharge events are equal to or less than 0.025 mgd. Figure 3.1 also demonstrates that 61% of the time there is no measurable flow through the GLCC-Central Outfall 001. Figure 3.1 demonstrates that the discharge from Outfall 001 has been reduced in both frequency and magnitude when compared to flows prior to the transfer project.

The transfer of the Outfall 001 discharge to Lion Oil was initiated in November 1999 and operational February 2000. During this period, the discharge from Outfall 001 in Bayou de Loutre was sporadic and when a discharge occurred it was reduced significantly from the permitted discharge of 2.2 mgd (1,500 gpm). These discharges were representative of typical water quality and quantity from GLCC-Central Outfall 001 into Bayou de Loutre after the transfer re-use project was completed. During the period from December 1999 to May 2001 a discharge from Outfall 001 occurred on 509 days. Although a discharge from Outfall 001 did occur on a majority of the days during this period of monitoring, the discharge volume was generally less than 0.1 mgd. This low volume discharge resulted from a variety of causes including, but not limited to:

1) fluxes in waste volume greater than the variable speed pumps installed in the sump transfer house can process,
2) variations in use at Lion Oil, and
3) variations in pumphead pressure.

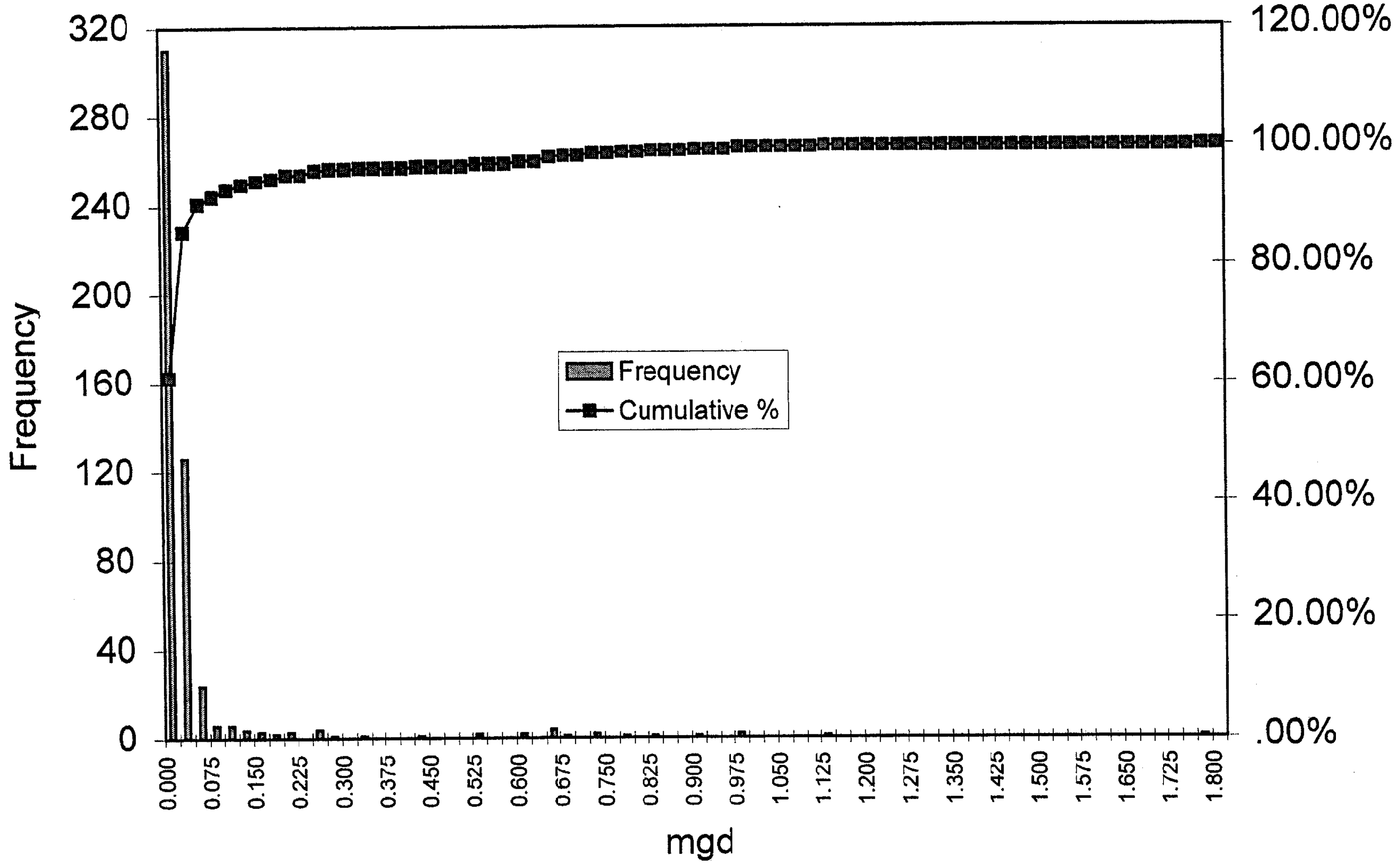


Figure 3.1. Volume, distribution, and frequency of discharges from GLCC-Central Outfall 001. December 1999-May 2001.

An additional 39 discharges occurred during this time period as a result of mechanical events (e.g., pump failure, electrical disruption, etc.) or other temporary interruption. These discharges reflect the historical discharge volumes as allowed by GLCC-Central's current NPDES permit. These 39 discharges are considered atypical of operations after the transfer project.

The maximum daily discharge (December 1999 to May 2001) was 1.8 mgd. Although the discharge events vary from minutes to hours, there were no periods when discharge occurred on a continuous basis over a 24-hour period. The mean discharge during this period was 0.04 mgd. As discussed in Section 3.3.2, the permitted discharge is 1500 gpm (2.2 mgd).

The water temperatures of discharge from GLCC-Central Outfall 001 following the transfer project are summarized in Table 3.3. The temperature ranged from 78°F to a maximum of 98°F. The average daily temperature of the 509 discharge events was 89°F. Figure 3.2 illustrates the frequency and distribution of daily maximum effluent temperatures of discharges following the transfer project (December 1999 through May 2001).

Table 3.3. Summary statistics of discharges from GLCC-Central Outfall 001 after transfer project.

Statistics	**Outfall 001**	
Number of Discharges	509	
Percentage of Days with Discharge	58%	
Summary Statistics	**Flow**	**Temperature**
Minimum	Trace (100 gallons)	78°F
Maximum	1.76 mgd	98°F
Average Daily	0.04 mgd	89°F
90th Percentile	0.04 mgd	94°F
99th Percentile	0.87 mgd	99°F

3.3.3.3 Routine Toxicity Testing

In addition to the temperature monitoring, GLCC-Central conducts quarterly chronic toxicity testing to fulfill its whole effluent toxicity testing (WET) permit limit of no significant lethality in 100% effluent. During the quarterly WET testing over the last two years, the effluent has passed all lethality endpoints monitored and sub-lethal effects to fathead minnows. On occasion sub-lethal reproduction effects to the water flea have been demonstrated. Despite the sporadic sub-lethal effects exhibited in 100% effluent from Outfall 001 discharge, the cause does not appear to be associated with temperature. The toxicity tests are conducted at a standard temperature and do not attempt to evaluate the effects of temperature.

The history of toxicity testing on Outfall 001 discharge has been well documented. Chronic toxicity tests have been conducted on effluent from GLCC-Central Outfall 001 at least quarterly as required by the NPDES permit. The testing methodology stipulated under previous permits was 24-hour acute screening test utilizing *Daphnia magna*. These tests indicated no acute toxicity as a result of exposure to the 001 effluent for 24 hours.

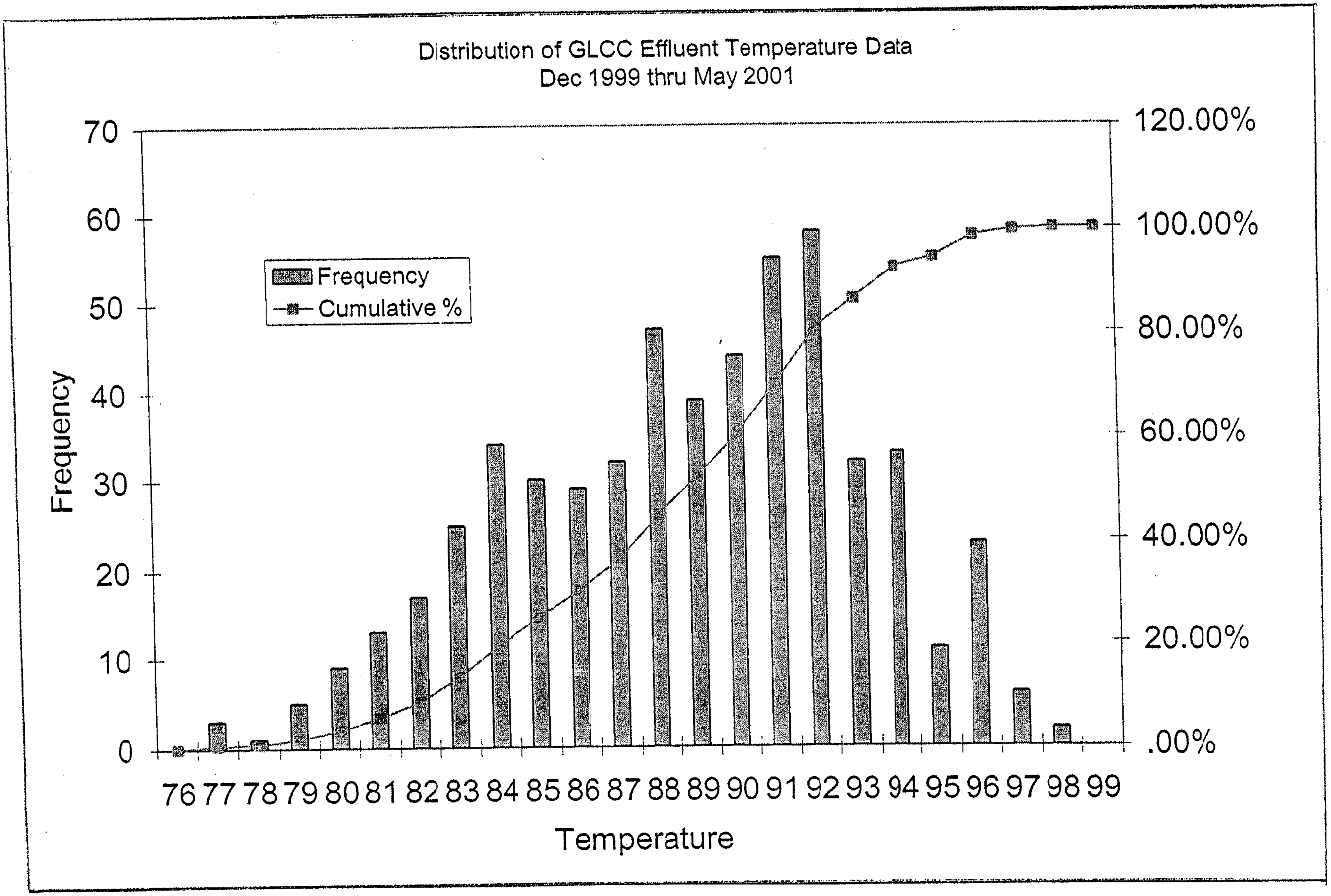


Figure 3.2. Frequency distribution and daily maximum temperatures of discharges from GLCC Outfall 001 after transfer to Lion Oil initiated.

Chronic toxicity testing has been required since 1990. The current permit has a WET limit and requires quarterly chronic toxicity testing on effluent from Outfall 001. This series of WET testing was initiated in 1996. Since that time, the quarterly frequency required on Outfall 001 effluent has been maintained.

Since March 1990, chronic toxicity tests, using both an invertebrate (*Ceriodaphnia dubia*) and a vertebrate (*Pimephales promelas*) as target organisms, have been completed. To date, the toxicity test results indicate the water flea is more sensitive to the effluent than the fathead minnow. Review of the toxicity data suggests that low hardness of the source water has been the cause of the sporadic sub-lethal effects demonstrated in chronic toxicity tests.

Often, the sub-lethal effect is exhibited as a mathematical difference to an artificial control and not an actual effect on the test organism. In other words, the reproduction and growth of organisms exposed to 100% effluent generally attain minimum levels of reproduction and growth for an acceptable test (i.e., 15 neonates produced and 0.25 mg/larval growth) but the reproduction and growth are less than those exposed to an artificial control.

Also, the role of the very low hardness and high iron content of the Sparta Aquifer source water has been documented to ADEQ on numerous occasions (Figures 3.3 and 3.4). Although the WET requirements have been routinely met, sporadic sub-lethal effects continue to be demonstrated.

3.4 Watershed and Waterways Description

GLCC-Central lies on the surface water divide between the Little Cornie Bayou and Bayou de Loutre watersheds. The lower most boundaries of these watersheds for the purpose of this study is on Bayou de Loutre at Southfield Road (Figure 3.1). The drainage area of Bayou de Loutre at this point is approximately 11.8 mi^2. The watershed of Bayou de Loutre at the point of discharge from Outfall 001 is approximately 3 mi^2.

3.4.1 Watershed Description

3.4.1.1 Physiography and Geology

GLCC-Central is located in the South Central Plains Ecoregion (Omernik and Gallant 1987). This area has also been characterized as the Gulf Coastal Plain Ecoregion (ADEQ, 1987). The Gulf Coastal Plain Ecoregion consists of rolling terrain broken by stream valleys (ANHC, 1974). Locally, elevations range from a maximum of about 270 ft mean sea level (fmsl) in the upland portions of the study area to a minimum of 200 fmsl along the lower reach of Bayou de Loutre. Streams meander and are of moderate to low gradient (all less than 10 ft/mi). Substrate types are dominated by hard pan clays, sand, mud, and silt. Small-sized gravel is present in some areas especially immediately downstream of secondary roads.

Soils in the watershed are broadly classified as ultisols (SCS 1982) which have moderate to high permeability, argillic horizons, low base saturations, and are usually

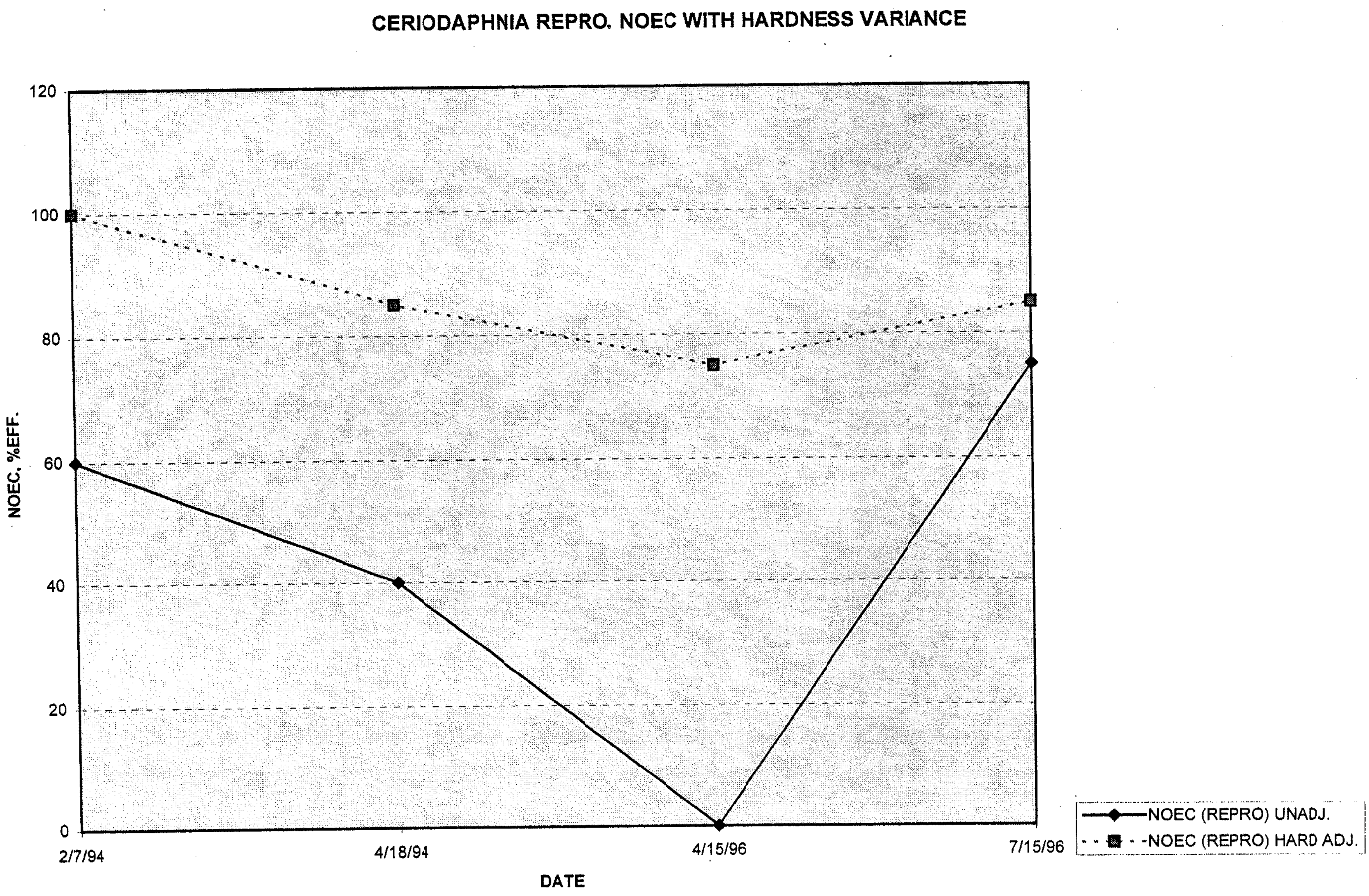


Figure 3.3. Results of *Ceriodaphnia dubia* chronic toxicity tests using 100% GLCC-Central effluent both adjusted and unadjusted for ultra-low hardness of Sparta Aquifer source water.

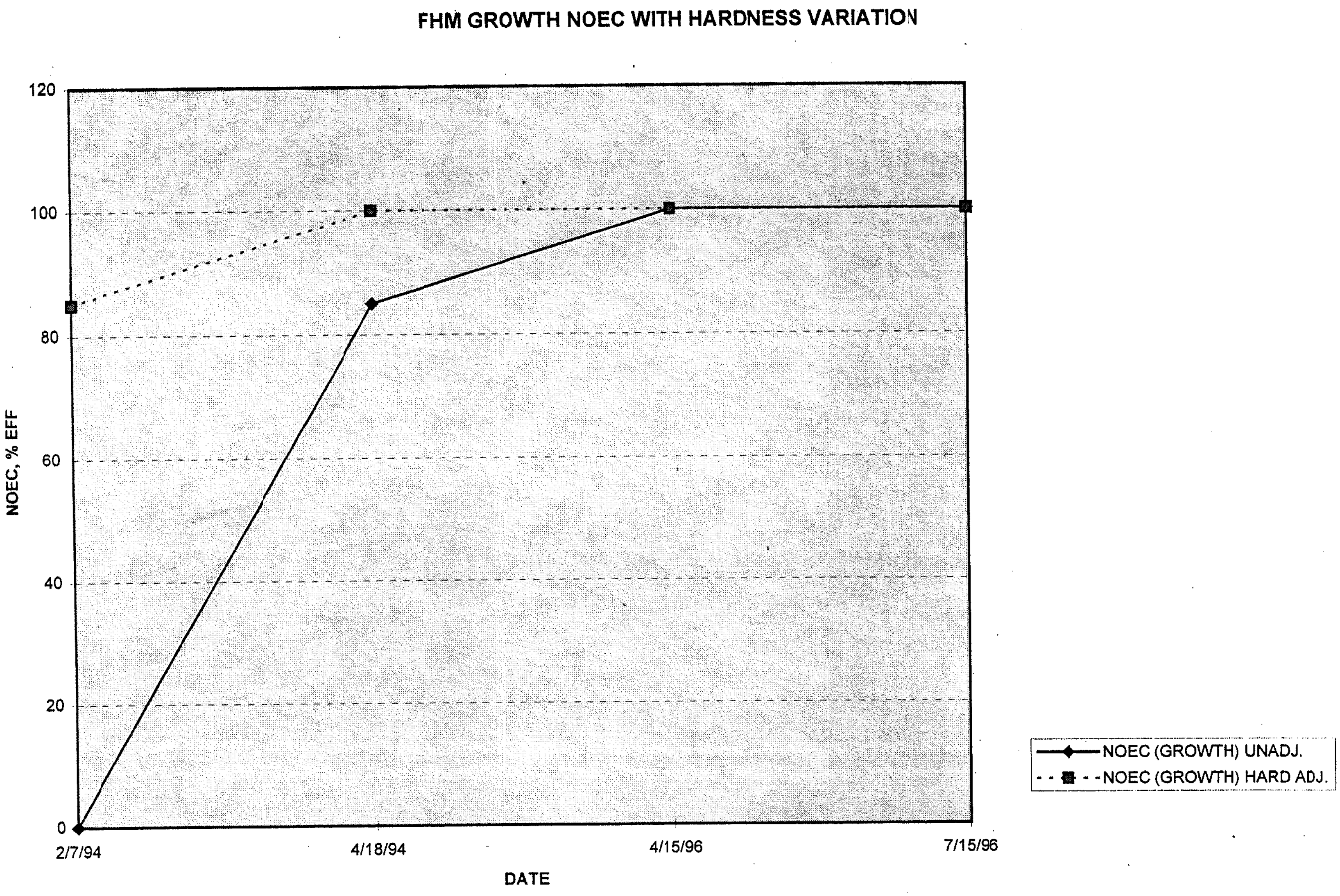


Figure 3.4. Results of *Pimephales promelas* chronic toxicity tests using 100% GLCC-Central effluent both adjusted and unadjusted for ultra-low hardness of Sparta Aquifer source water.

associated with forest vegetation. The upland areas of the watershed are represented by the Briley, Darden, Harleston, Rosalie, Warnock, and Smithdale map units. Bibb and Guyton loam soils are found predominantly in the flood plains.

Another group of soils common to this area is the Oil Wasteland-Fluvaquent complex, which are found on flood plains of local drainages and major streams. A large percent of the mapped areas in Union County consist of oil wasteland soils, which have been impacted by oil and salt water. These areas typically lack plant cover and are severely eroded. Fluvaquent soils comprise about 30% of mapped areas in Union County. These soils dominate the immediate stream channels and first order flood plains of Bayou de Loutre and its tributaries.

3.4.1.2 Demography and Land Use

The City of El Dorado, Arkansas with a population of approximately 25,000 is the largest population center in the watershed (Figure 3.1). A large portion of the watershed is a petroleum producing area. Approximately 10 to 15% of the lands occupied by forest and wetlands in the watershed have been directly impacted by oil waste and saltwater.

Land use in the Bayou de Loutre watershed is composed of forestland, which accounts for approximately 75% of the total acreage. This land is prime timberland for both pine and bottomland hardwoods. Wetlands cover approximately 17% of the watershed and agricultural land occupies approximately 6%. Of the remaining lands, urban and built-up areas account for about 6% of the Bayou de Loutre watershed, and pertinent water and other lands account for less than 1% of the watershed (USGS 1976).

3.4.1.3 Climate

The climate within the watershed is classified as Subtropical Humid. This climate is characterized by long, hot summers. Winters in the region are cool and fairly short with only a rare cold wave that moderates in a few days. Average and maximum monthly temperatures for each month of 1999 and 2000 are presented on Figures 3.5 and 3.6. (NOAA, 2001)

The average annual precipitation measured at the El Dorado airport, 6 miles northwest of GLCC-Central, is 49.23 inches per year (NOAA, 2001). Precipitation is generally well distributed throughout the year. Monthly variations of precipitation are typical for Arkansas. The months of March, April, and May were the wettest three consecutive months of 1999 and 2000. The driest three consecutive months are generally August, September, and October.

3.4.2 Hydrology

3.4.2.1 Surface Water

The GLCC-Central facility lies within the Lower Ouachita River Basin. The headwaters of the Ouachita River originate in west central Arkansas in the higher elevations of the Ouachita Mountains. The Ouachita River flows southeasterly through Arkansas and Louisiana until it converges with the Red River in east central Louisiana.

The receiving stream for GLCC-Central Outfall 001 is Bayou de Loutre. The headwaters of this stream originate on the west and southwest side of the City of El Dorado. Bayou de Loutre flows approximately 25 miles southeast into Louisiana and empties into the Ouachita River.

3.4.2.2 Groundwater

The Bayou de Loutre watershed is located in the outcrop area of the Cockfield Formation. The Cockfield Formation sands can yield as much as 400 gpm to municipal and industrial wells. However, groundwater contamination from historical and current oil and gas production has limited the use of this groundwater formation. The deeper Sparta Sand Aquifer is an important source of groundwater used for public supply (e.g., El Dorado and other water associations) and self-supplied industry within the watersheds (ASWCC 1987).

3.5 Designated Uses and Water Quality Standards

The Arkansas Water Quality Standards (WQS) Regulation No. 2 (ADEQ 1998) provide the general and numerical criteria which constitute the stream standards. Designated uses and specific standards for the Bayou de Loutre, and any tributaries not specifically listed in Regulation No. 2 are described below.

The receiving stream for Outfall 001 is Bayou de Loutre, which is in Segment 2D of the Ouachita River Basin. Designated beneficial uses have been established for Bayou de Loutre and associated unnamed tributaries with watershed areas of less than 10 mi^2. These uses are:

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

Designated beneficial uses for Bayou de Loutre where the watershed size exceeds 10 mi^2 are:

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

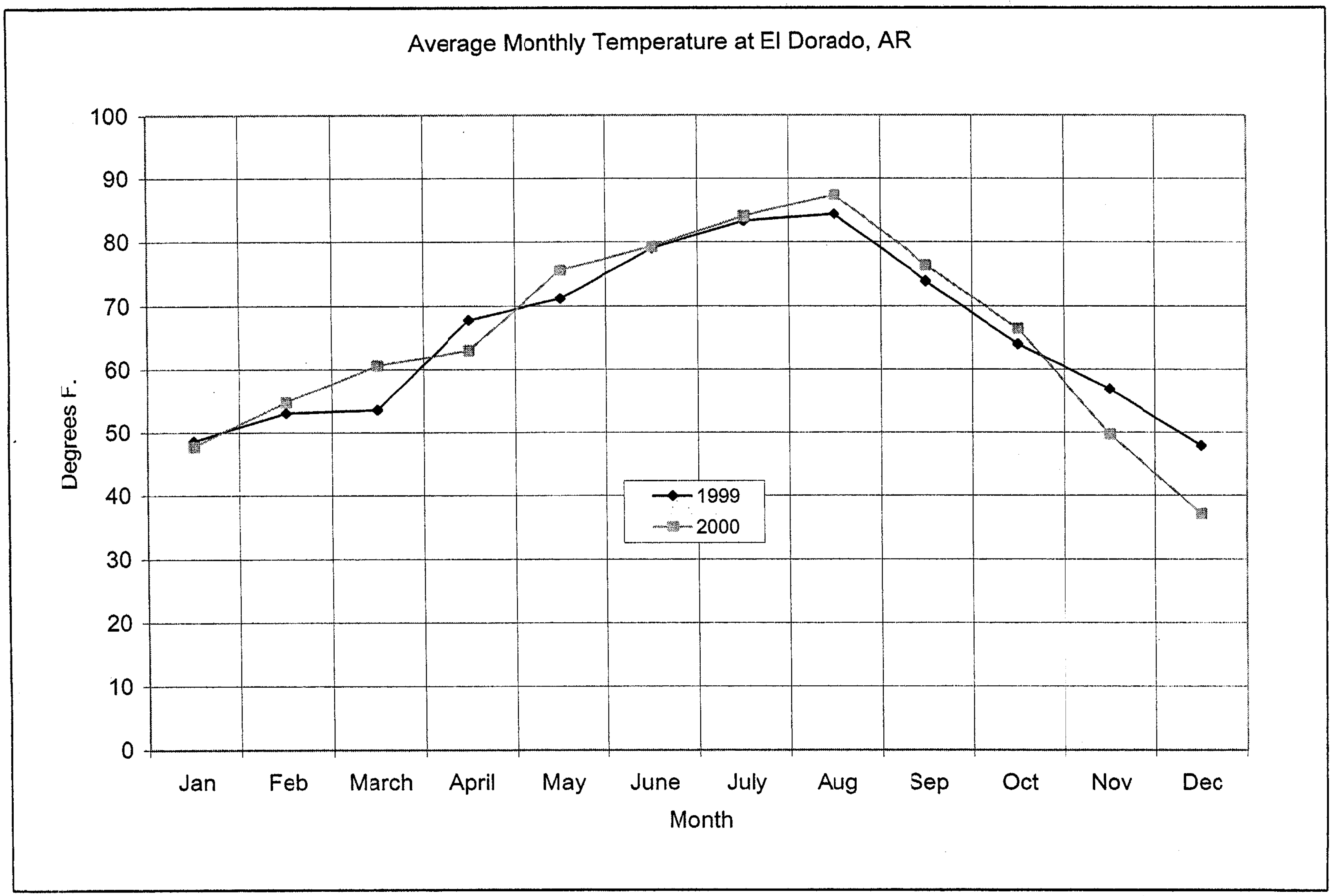


Figure 3.5. Average monthly temperatures as recorded for 1999 and 2000 at El Dorado Airport, Union County, AR.

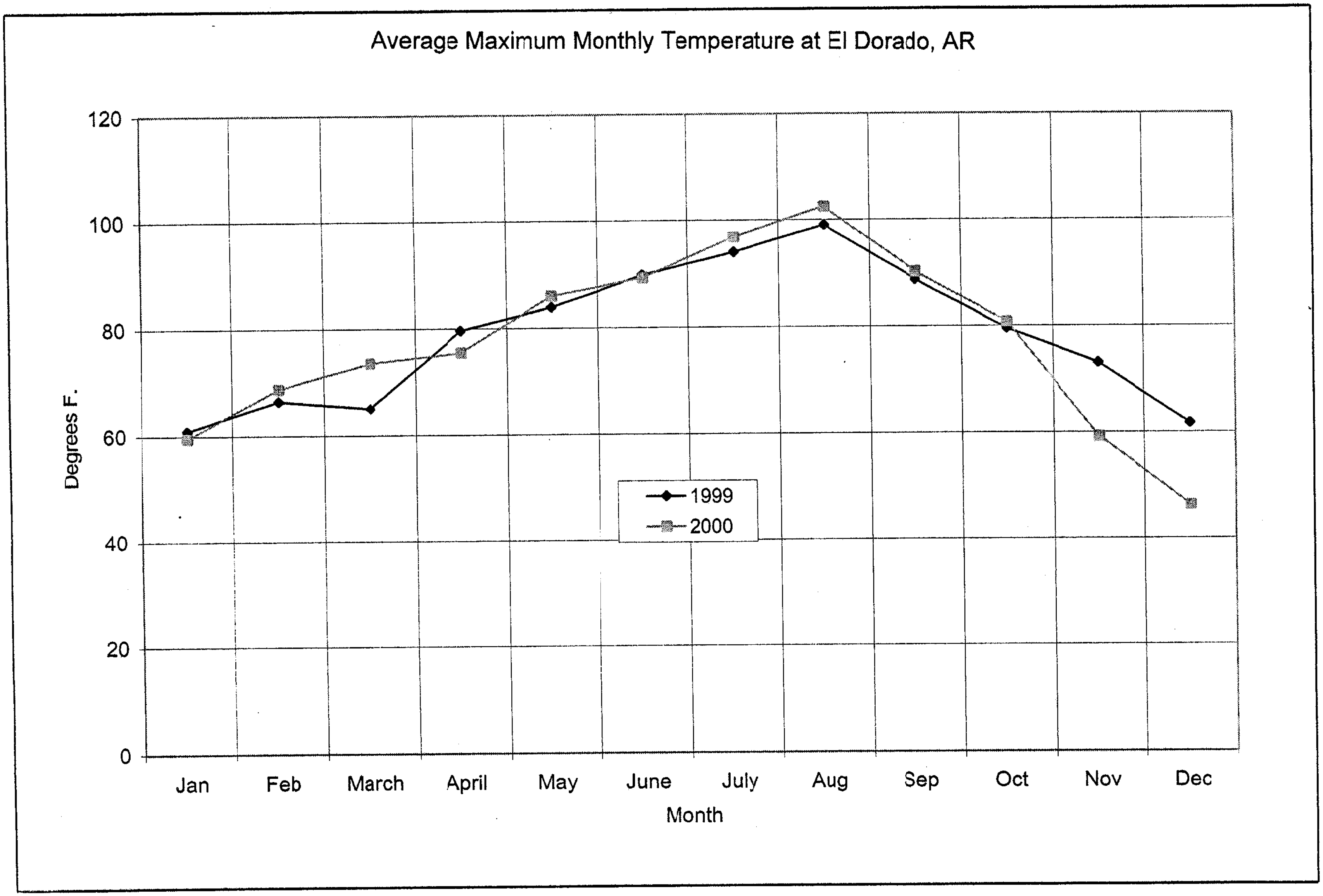


Figure 3.6. Average maximum monthly temperatures as recorded at El Dorado Airport, Union County, AR.

As indicated by GLCC-Central's NPDES permit, specific water quality standards of concern applicable to Bayou de Loutre at the point of discharge of Outfall 001 included but are not limited to:

a) Temperature shall not exceed 30°C (86°F) or be increased by more than 5°F above natural background by man induced conditions.

b) pH values must remain within the range of 6.0 to 9.0.

c) Dissolved oxygen must be maintained at 2 mg/L during the critical season (June-October) to prevent nuisance conditions; a level of 5 mg/L must be maintained during the primary season (November-May) to support a warm water fishery (except as noted below for discharges of 1 cfs or more).

d) Fecal coliform count shall not exceed a geometric mean of 1,000 per 100 ml.

e) Turbidity (instream) shall not exceed 21 turbidity units due to factors other than natural conditions.

f) Oil and grease shall not exceed 10 mg/L average or 15 mg/L maximum when discharging to surface waters.

g) Toxic substances shall not be present in receiving waters after mixing, in such quantities to be toxic to human, animal, plant, or aquatic life or to interfere with the normal propagation, growth, and survival of indigenous aquatic biota.

In addition, all streams with watersheds of less than 10 mi^2, where wastewater discharges are 1 cfs or more, are expected to support a perennial fishery and, therefore, must meet the dissolved oxygen standards of the next size category of streams (i.e., watershed size of 10 mi^2 to 500 mi^2). As indicated by Table 3.3, wastewater discharges at Outfall 001 could and do exceed 1.0 cfs on a sporadic basis. However, the average discharge is well below the 1 cfs threshold and should not be expected to maintain the Perennial Gulf Coast Fishery.

3.6 Other Point and Nonpoint Sources

Several point source discharges from industries and municipalities occur within the watershed. The most significant, in addition to GLCC-Central, include discharges from permitted facilities at Coleman Cement Co., Cooper Industries, ENSCO, Georgia Pacific, Great Lakes Chemical Corporation-South, Lion Oil Company and the City of El Dorado's south sewage treatment facility.

The Bayou de Loutre watershed has also been effected by nonpoint source pollution. Runoff from oil and gas field operations have resulted in elevated chloride concentrations and reduced pH values in Bayou de Loutre. According to ADEQ "the largest source of degradation within this segment stems from oil field runoff which has resulted in extremely elevated chloride concentrations" (ADEQ 1986). Elevated fecal coliform counts may be caused by nonpoint agricultural activities within the watersheds.

4.0 AQUATIC LIFE FIELD STUDY

4.1 Introduction

The objectives of the aquatic life field study were to:

- document whether the designated aquatic life use for Bayou de Loutre was being maintained by the existing discharge from Outfall 001;
- establish a baseline stream condition prior to the transfer of the discharge to Lion Oil; and
- demonstrate the effect of the transfer (limited continued discharge) on the aquatic life of Bayou de Loutre.

To accomplish these objectives, the aquatic life field study included evaluations of the habitat conditions, water quality, the aquatic macroinvertebrate community, and fish community assemblages. The results of this evaluation are provided in this section.

The results of the aquatic life field studies completed during 1999 and 2000 were compared to similar activities completed at some of the same reaches during a study completed during 1990-1991. Although there were some variations in methods, broad comparisons can provide indications of water quality improvements in the watershed. A comparison of historical vs. current conditions is provided where appropriate.

4.2 Specific Study Reaches

The Bayou de Loutre watershed originates in Union County, just to the north of the GLCC-Central facility (Figure 4.1). The Bayou de Loutre watershed doubles in size with the addition of Loutre Creek, which joins Bayou de Loutre just downstream of the Outfall 001 discharge from GLCC-Central. As part of the aquatic life characterization portion of the site specific water quality analyses, stations on both Bayou de Loutre and Loutre Creek were evaluated. As indicated by Figure 4.1, the individual study reaches included:

1) BDL-1 Bayou de Loutre upstream of the discharge from Outfall 001,
2) BDL-2 Bayou de Loutre just upstream of the confluence with Loutre Creek,
3) BDL-3 Bayou de Loutre downstream of mouth of Loutre Creek, and
4) LC-1 Loutre Creek upstream of the confluence with Bayou de Loutre.

4.3 Period of Study

The watershed of Bayou de Loutre at the point of discharge from GLCC-Central Outfall 001 is less than 10 mi^2. As a result of the small watershed size and the limited discharge after the transfer to Lion Oil was completed, the evaluation of aquatic life focused on the spring seasonal conditions and the maintenance of the designated seasonal fishery use. Therefore, data collection for the aquatic life characterization portion of the site specific water quality study occurred during different periods of the year including:

1) during spring seasonal conditions (Spring 1999) at base flow conditions (while Outfall 001 was discharging),
2) during spring seasonal conditions (Spring 2000) at base flow after the discharge from Outfall 001 had been routed to Lion Oil and removed from Bayou de Loutre, and
3) *In-situ* temperature monitoring stations were established and data collection was initiated in April of 1999 and continued through October 2000, encompassing both periods indicated in 1 and 2 above.

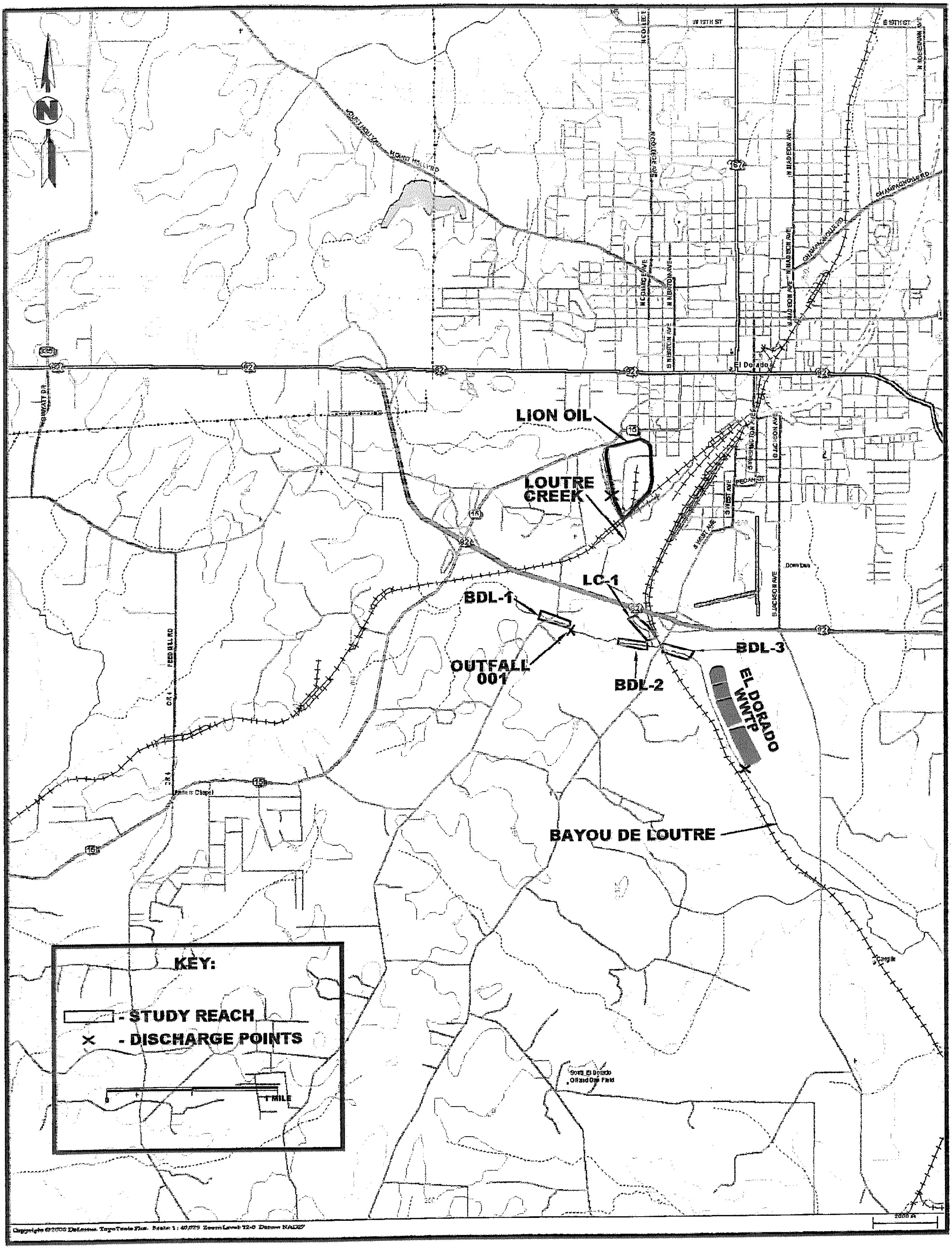


Figure 4.1. Site map of individual study reaches.

4.4 Habitat Characterization

4.4.1 Introduction

4.4.1.1 Overview

Physical habitat in streams includes all those features that influence or provide sustenance to the biota within the stream. Stream physical habitat varies naturally, as do biological characteristics; thus, habitat conditions differ even in the absence of point and nonpoint disturbances. Physical habitat characterization plays a strong role in determining the aquatic life uses that are attainable for a given stream. Therefore this study used two separate techniques to assess physical characteristics and habitat; quantitative analyses of selected attributes and a qualitative assessment of habitat potential.

The seven general physical habitat attributes identified by Kaufmann (1993) as important in influencing stream ecology and maintenance of biological integrity were measured or estimated multiple times during the course of the aquatic life characterization portion of the site specific water quality study. These factors are:

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.

In addition, habitat potential was qualitatively evaluated using procedures adapted from EPA's rapid bioassessment protocols (Plafkin et al, 1989). This procedure numerically scores each of 12 habitat features which can then be translated as "optimal", "suboptimal", "marginal" or "poor". Land use activities can directly or indirectly alter any and/or all of these attributes.

4.4.1.2 Objective

The objectives of the habitat characterization were 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 aquatic uses and biological integrity.

4.4.1.3 Approach

The field physical habitat measurements are used in conjunction with water chemistry, temperature, invertebrate and vertebrate 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.

The procedures described in the following sections are intended for evaluating physical habitat in wadeable streams. The field procedures applied to this project are most efficiently applied during low flow conditions and during times when terrestrial vegetation is active, but will also be applied during spring seasonal conditions with higher base flows. This collection of procedures is designed for monitoring applications where robust, quantitative descriptions of habitat are desired.

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 or points are placed systematically at spacing that is proportional to baseflow channel width. This systematic sampling design scales the sampling reach length and resolution in proportion to stream size.

The protocol is made objective and repeatable by using previously developed methods to produce repeatable measures of physical habitat in place of estimation techniques wherever possible.

The procedures are employed on a sampling reach length three times the top of bank channel width. Measurement points are systematically placed to represent the entire reach. Stream depth and wetted width are measured at evenly spaced intervals, whereas channel cross-section profiles, substrate, bank characteristics and riparian vegetation structure was measured at larger spacing. Woody debris is evaluated both along the full length of the sampling reach, and at the specific transect cross sections. Discharge is measured at one location in each reach. The depth and width measures allow calculation of indices of channel structural complexity, objective classification of channel units such as pools, and quantification of residual pool depth, pool volume, and total stream volume.

4.4.2 Habitat Study Reaches

The physical habitat was characterized from measurements and observations of stream attributes made along three transects in each of the study reaches. The physical habitat was characterized during the spring, once prior to and once after the transfer of the discharge to Lion Oil. Three habitat evaluation reaches were established in Bayou de Loutre, and one in Loutre Creek:

1) BDL-1 (Bayou de Loutre upstream of the GLCC effluent discharge),
2) BDL-2 (Bayou de Loutre downstream of the GLCC effluent discharge and immediately upstream of the confluence of Loutre Creek),

3) BDL-3 (Bayou de Loutre downstream of the confluence with Loutre Creek), and
4) LC-1 (Loutre Creek upstream of the confluence with Bayou de Loutre, Figure 4.1).

4.4.3 Physical Habitat Methods

The habitat evaluation following Kaufmann was conducted within the same stream reach where fish and benthics were collected. The physical habitat was characterized from measurements and observations of stream attributes made along three transects within each of the study reaches.

The habitat characterization was evaluated at three levels of resolution. The measured attributes (primary scale) were used to reflect short-term characteristics that often change from sample event to sample event (e.g., flow, water depth, etc.). The secondary scale includes both measured and estimated characteristics that describe current conditions but that reflect historical activities within the reach. The secondary scale attributes (e.g., substrate type, channel morphology) are generally not subject to change from sample event to sample event but are developed as a result of modifications within the watershed over a long period of time or result from specific anthroprogenic activities. The third level of resolution will evaluate habitat potential on a per reach basis.

4.4.3.1 Measured Attributes

The following physical characteristics were measured at three transects within each reach.

1) stream flow,
2) channel width,
3) stream width,
4) velocity,
5) depth, and
6) substrate.

Stream Flow

Stream flow was measured using a Marsh-McBirney Model 201 Portable Water Current Meter following the "velocity-area procedure" outlined in Field Operations and Methods for Measuring the Ecological Condition of Wadeable Streams (EPA, 1998). The specific location selected for flow measurements was 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.

The velocity and depth measurements used to calculate total stream discharge were made at only one carefully chosen channel cross section within the sampling reach. The measurements were made at equally spaced intervals (e.g., at each 1-ft mark) along the cross section. The velocity measurements were made at 60% of the total depth. Rocks and other obstructions were removed to improve the cross section before any flow/velocity measurements were made. All measurements were recorded on specially designed Field Measurement Forms (Appendix B).

Where stream flow was extremely low (e.g., station BDL-1 in 2000) the discharge was measured by determining the time it takes to fill a container of known volume. The procedure is repeated five times and the stream flow calculation consists of averaging the five values.

Channel Width

At each of the three transects within each study reach, the channel width was measured by stringing a cloth non-stretch tape measure from the top of one stream bank directly across the steam to the top of the opposite stream bank. The three values were averaged to produce a mean channel width for each reach. All values were recorded on the Physical Characterization Field Forms (Appendix B).

Stream Width

At each of three transects within each study reach, the stream width was measured by stringing a cloth non-stretch tape measure from the water's edge directly across the steam to the water's edge adjacent to the opposite stream bank. The three values were averaged to produce a mean stream width for each reach. All values were recorded on Physical Characterization Field Forms (Appendix B).

Stream Velocity

Stream velocity was determined by averaging the readings obtained during flow measurements as recorded on the Stream Flow Measurement Forms (Appendix B).

Stream Depth

Stream depth was determined by measuring the depth at regular intervals, at each of the three transects within each study reach. An average depth was calculated for each transect, and an overall stream depth average was obtained by averaging the three transect averages. All values were recorded on the Habitat Characterization Field Forms (Appendix B).

Stream Substrate

Substrate size is one of the most important determinants of habitat character for fish and macroinvertebrates in streams. Along with bedform (e.g., riffle and pools configuration), substrate influences the hydraulic roughness and consequently of the range of water velocities in the channel. It also influences the size range of interstices that provide living space and cover for macroinvertebrates, and other benthic dwelling vertebrates (e.g., darters). Substrate characteristics are often sensitive indicators of the effects of human activities on streams. For example, decreases in the mean substrate size and increases in the percentage of fine sediments, may destabilize channels and indicate changes in the rates of upland erosion and sediment supply (Dietrich et al, 1989; Wilcock, 1988).

The composition of the stream substrate was determined along each of the three transects within each reach. A cloth tape was stretched across the stream channel and substrate compositions were noted at 1-ft increments. The predominant type of substrate found at each 1-ft increment was recorded on the Habitat Characterization Field Forms (Appendix B). The categories of substrate types to be recorded follow EPA, 1982 and include:

Bedrock	
Large Boulders	> 45cm
Boulders	25cm – 45cm
Rubble	6cm – 25cm
Rock	20mm – 6cm
Gravel	6mm – 60mm
Sand	0.06mm – 6mm
Mud/Silt	
Hardpan-Clay	

The percent composition was then determined on both a per transect and per reach basis. This information was used to characterize the similarities and or differences in substrate structure and complexity as it relates to the development and maintenance of the systems biological integrity.

In the process of measuring substrate particle sizes at each channel cross section, the wetted width of the channel and the water depth at each substrate sample point was also measured. If the wetted channel was split by a mid-channel bar, the substrate points are centered between the wetted width boundaries regardless of the mid-channel bar in between. Consequently, substrate particles selected in some cross-sections may be "high and dry".

The substrate particles were classified into one of the size classes listed above based on the middle dimension of its length, width, and depth. This "median" dimension represents a sieve size through which the particle can pass. Hardpan was always distinguished from fines. Similarly, concrete or asphalt was always distinguished from bedrock. Artificial substrates were noted as "other" and described in the comments section of the field data form.

4.4.3.2 Estimated Habitat Attributes

The following seven attributes were qualitatively estimated for each transect and averaged for the entire reach:

1) percent pool and/or riffle/run,
2) instream habitat,
3) bank slope,
4) bank stability,
5) riparian cover
6) percent canopy cover, and
7) percent embeddedness.

The above parameters were either measured and or estimated on a per-transect basis (representing a secondary scale of resolution). The results of both the primary and secondary scale were aggregated and expressed for the entire reach. This multi-level characterization allows the assessment of habitat over stream reach lengths that are approximately 10 times their average wetted width at base flow. Many of the channel and riparian features are characterized on cross-sections and in pairs of riparian plots spaced at 3 channel-width intervals.

Drainage areas and stream gradients were estimated from USGS 7.5 minute topographic maps and field verified as possible. This information was recorded on the Habitat Characterization Field Forms (Appendix B).

Percentage Pools and Riffles

For each stream reach, measurements were made regarding the percentage of the reach consisting of pools or riffles. Pooled areas were further characterized as deep (pools too deep to wade at low flow conditions, e.g., in excess of 5 feet deep), moderate (pools typically at or deeper than 3 feet deep) or shallow (pools uniformly more shallow than 3 feet). Riffles are typically characterized by depth, substrate and water velocity.

Instream Habitat

Instream habitat was evaluated primarily based on fishery needs. While measuring individual transect stream widths and substrate, the observer noted the dominant cover types at each 1-ft interval. Categories of habitat features recorded included; undercut stream banks, brush, logs, debris, overhanging vegetation and inundated vegetation. Instream habitat was recorded both on a transect and an overall reach basis. This information was used to characterize the similarities and or differences in substrate structure and complexity as it relates to the development and maintenance of the systems biological integrity.

Large woody debris and other instream structure was noted between each transect within a given reach.

Bank Slope

The stream bank slope at each transect point was recorded as flat (<8%), moderate (9-30%), or steep (>30%) slope for both the left and right stream banks. Other related bank features, including bank full channel height and incision height were also noted.

Estimation of the level of bank full flow during base flow conditions is somewhat subjective. In many cases there is an obvious slope break that differentiates the channel from a relatively flat floodplain terrace located higher than the channel. Because scouring and inundation from bank full flows are often frequent enough to inhibit the growth of terrestrial vegetation, the bank full channel may be evident by a transition from exposed stream sediments to terrestrial vegetation.

Bank Stability

The "bank full" 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 flows do not generally overtop the channel banks to inundate the valley floodplain, and are believed to control channel dimensions in most streams. Both banks at each of the three transects were classed as follows:

1) Stable	little evidence of new bank sloughing scars
2) Moderately stable	new bank sloughing scars
3) Unstable	extensive new bank sloughing conditions apparent

Riparian Cover

Riparian vegetation and human disturbances were observed approximately 5 meters upstream and 5 meters downstream from each cross-section transect. Additional boundaries extend into the riparian area 10 meters on both the left and right banks. These boundaries were estimated. Observations made regarding riparian cover included vegetation types and percent coverage and/or lack of vegetation.

Percent Canopy Cover

Canopy cover over the stream was determined at each of the three transects. Observations were noted at mid-channel and at each stream banks. Observations were recorded as percent canopy coverage or percent of stream shading.

Embeddedness

Embeddedness is the percentage of a substrate surface feature that is surrounded by (embedded in) sand or finer sediments on the stream bottom. Following that definition, the embeddedness of sand, silt, clay, and muck was considered 100% embedded, and the embeddedness of hardpan and bedrock was 0% embedded. In addition to the substrate type, an estimation of the "percent embeddedness" was recorded for each transect.

4.4.3.3 Habitat Potential

To further evaluate habitat, a habitat assessment protocol that has been adapted from EPA's "rapid" bioassessment protocols (Barbour, M.T. et al., 1999) was employed. The habitat assessment approach focused on integrating information gained from completing all measurements and collections from each reach and synthesizing that information on the Habitat Assessment Field Data Sheets shown in Appendix B.

For each prevalent habitat type, twelve characteristics (termed "parameters") of habitat were considered and evaluated as part of the rapid habitat assessment. These parameters are listed below. Most of the parameters were evaluated similarly for both types of prevalent habitats. In four cases, the same parameter is evaluated differently, or a different (but ecologically equivalent) parameter is evaluated in riffle/run prevalent versus pool/glide prevalent streams. The detailed rational for each of the parameters and the scoring forms (as provided by Barbour, M.T. et al, 1999) are provided in Appendix B.

The objective of the visual stream assessment was to record field crew observations of catchment/stream characteristics useful for future data interpretation, ecological value assessment, development of associations, and verification of stressor data. Observations and impressions of field crews are extremely valuable.

Habitat Potential Assessment Methods

For each of the twelve parameters, the overall quality of the sampling reach is rated on a scale of 0 to 20. Scores for each parameter are recorded on the pool/glide or riffle/run version of the Habitat Assessment Field Data Sheets (Appendix B).

The following parameters was used to assess habitat potential:

1) instream cover,
2) epifaunal substrate,
3) pool substrate characterization,
4) pool variability,
5) channel alteration,
6) sediment deposition,
7) channel sinuosity,
8) channel flow status,
9) condition of banks,
10) bank vegetative protection,
11) disruptive pressure, and
12) riparian vegetative zone width.

Each reach was evaluated by at least three experienced field biologists who ranked each attribute independently. The individual attributes were summed to produce a total reach score. The three total reach scores (one each from the three field biologists) was then averaged to produce the overall reach score. Calculated scores placed the reach into a habitat category of optimal (181-240), suboptimal (121-180), marginal (61-120), or poor (0-60). The habitat potential assessment was initiated after all other sampling and measurement activities were completed. This allows all observations of the sampling team to be taken into account.

4.4.4 Results and Discussion

A summary of the physical attributes of all reaches where physical data was collected is presented in Table 4.1 (1999 evaluation) and Table 4.2 (2000 evaluation). The initial habitat characterization was completed during the Spring 1999 field activities. Subsequently, the habitat was also evaluated in Spring 2000, after the discharge from Outfall 001 had been removed from Bayou de Loutre and routed to Lion Oil Company. Pictures which depict the study reaches during both surveys, are provided in Appendix C. The Field Data Forms and raw habitat data are provided in Appendix D.

4.4.4.1 Habitat Characterization Prior to Outfall 001 Transfer (April 1999)

Reach BDL-1

As summarized in Table 4.1, the upstream reach, BDL-1, was composed mostly of shallow pools (Figure C-1) with riffle/run areas accounting for only 25% of the reach (Figure C-2). The average stream width was 8.0 ft and the average stream depth was

0.9 ft. The average velocity and flow recorded at this reach were 0.16 fps and 0.34 cfs, respectively. The average channel width as measured bank to bank was 14.2 ft (Figure C-3). The stream segments above this reach are braided into a wetland complex with channels that are ephemeral in nature and serve as the headwaters of Bayou de Loutre (Figure C-4).

Instream habitat was composed mostly of logs and debris (75%) with 25% of the area devoid of habitat. The stream substrate was composed of mud and clay with an equal scattering of gravel which was concentrated primarily in the riffle/run areas. The existing bank habitat was composed of roots, however, the majority of the banks were nearly devoid of habitat (77%) (Figure C-3). The bank slope was steep (>30°) to moderately steep (9°-30°) with the soils being stable to moderately stable from an erosion perspective (Figure C-5). This reach had a noticeably small riparian zone due to incursions from development within the City of El Dorado and highway right-of-ways (Figure C-2).

Reach BDL-2

Reach BDL-2, was composed mostly of run areas with pooled areas comprising approximately 33% of the reach. The pools were actually deepened areas created by the flow cascading over debris dams and/or fallen trees eroded as a result of constant flow. Even in the deeper "pools" the velocity was not reduced substantially. The average stream width was 8.7 ft; the average depth was 1.0 ft (Figure C-6). An average flow of 4.41 cfs was measured with an average velocity of 0.59 fps. The average channel width as measured bank to bank was 13.8 ft. The flow was created by the discharge from the GLCC-Central Outfall 001.

Table 4.1. Summary of Physical Habitat Data for Bayou de Loutre and Loutre Creek in April 1999.

Parameter/Reach	BDL-1	BDL-2	BDL-3	LC-1
Date	4/22/99	4/22/99	4/21/99	4/22/99
Time	1035-1155	1600-1725	1425-1550	0750-0900
Stream Characteristics:				
% Pool	75	33	30	40
% Riffle	5	17	20	5
% Run	20	40	50	55
Velocity (fps)	0.16	1.75	0.69	0.89
Flow (cfs)	0.34	4.41	8.49	3.14
Average Depth, ft	0.93	0.98	1.07	1.18
Stream Wetted Width, ft	8.0	8.7	18	13
Channel Width, ft	14.2	13.8	28.7	20.7
Average Bank Depth, ft	3.2	4.1	6.7	8.9
Periphyton Coverage/Abundance: *				
On Substrate (0 1 2 3 4)	0	0	2	2
On Habitat (0 1 2 3 4)	0	0	2	2
Habitat				
Roots (0 1 2 3 4)	2	1	0	2
Brush (0 1 2 3 4)	1	1	0	1
Undercut Bank (0 1 2 3 4)	1	1	1	2
Vegetation (0 1 2 3 4)	0	0	0	1
Devoid (0 1 2 3 4)	4	2	4	4
Periphyton & Cover Scores: 1=Sparse(1-10%) 2=Moderate(10-40%) 3=Heavy(40-75%) 4=Very Heavy(>75%)				
Bank Slope:				
Flat (<8°)	0	0	0	0
Moderate (9-30°)	45	19	18	35
Steep (>30°)	55	81	72	65
Bank Stability:				
Stable	72	49	64	56
Moderately Stable	23	47	123	40
Unstable	5	4	13	4
Riparian Ground Cover (Total = 100%):				
% Vegetated, Herbs/Grasses	75	45	5	45
% Vegetated, Shrubs/Trees	20	45	35	55
% Sand/Soils	5	10	40	0
Riparian Canopy Cover:				
% Canopy Cover, Trees	45	48	40	10
Stream Habitat (Fish Cover)				
Depressions	0	1	1	2
Large Woody Debris	1	1	1	2
Small Woody Debris	2	2	1	1
Aquatic Vegetation	0	0	0	0
Leafy Debris	2	1	0	1
Overhanging Vegetation	0	0	0	1
Devoid	2	3	4	3
Habitat Abundance: 1=Sparse(1-10%) 2=Moderate(10-40%) 3=Heavy(40-75%) 4=Very Heavy(>75%)				
% Stream Substrate:				
Cobble	0	0	0	0
Coarse Gravel	20	0	10	0
Fine Gravel	30	0	5	0
Sand	0	0	5	0
Silt/Mud/Clay	50	45	55	45
Hardpan	0	55	25	55
% Stream Canopy Cover:				
Stream Canopy Cover	84	52	60	27

*Numbers in categorical sections are rounded up.

Table 4.2. Summary of Physical Habitat Data for Bayou de Loutre post transfer of Outfall 001 to Lion Oil in May 2000. GLCC-Central

Parameter/Reach	BDL-1	BDL-2	BDL-3	LC-1
Date	5/2/00	5/1/00	5/1/00	5/2/00
Time	1255 - 1345	1530 - 1645	1415 - 1450	0955 - 1020
Stream Characteristics:				
% Pool	40	65	65	60
% Riffle	10	5	10	5
% Run	50	30	25	35
Velocity (fps)	0.83	0.05	0.69	0.62
Flow (cfs)	0.58	0.24	4.37	4.31
Average Depth, ft	1.4	0.8	0.7	1.0
Stream Wetted Width, ft	9.4	7.1	17.2	10.2
Channel Width, ft	16.3	14.8	37.7	17.0
Average Bank Depth, ft	2.9	3.7	7.1	9.2
Periphyton Coverage/Abundance: *				
On Substrate (0 1 2 3 4)	0	0	1	3
On Habitat (0 1 2 3 4)	0	0	2	2
Habitat				
Roots (0 1 2 3 4)	2	2	1	2
Brush (0 1 2 3 4)	1	1	1	1
Undercut Bank (0 1 2 3 4)	1	1	1	2
Vegetation (0 1 2 3 4)	1	1	1	2
Devoid (0 1 2 3 4)	2	4	4	2
Periphyton & Cover Scores: 1=Sparse(1-10%) 2=Moderate(10-40%) 3=Heavy(40-75%) 4=Very Heavy(>75%)				
Bank Slope:				
Flat (<8°)	12.5	0	0	0
Moderate (9-30°)	25	10	16.7	16.7
Steep (>30°)	62.5	90	83.3	83.3
Bank Stability:				
Stable	62.5	0	0	0
Moderately Stable	37.5	50	50	50
Unstable	0	50	50	50
Riparian Ground Cover (Total = 100%):				
% Vegetated, Herbs/Grasses	50	23	22.5	40.8
% Vegetated, Shrubs/Trees	25	39	35	51.7
% Sand/Soils	25	38	42.5	7.5
Riparian Canopy Cover:				
% Canopy Cover, Trees	33	46	49	2
Stream Habitat (Fish Cover):				
Depressions	0	0	1	2
Large Woody Debris	0	1	1	0
Small Woody Debris	2	2	1	1
Aquatic Vegetation	1	0	0	0
Leafy Debris	2	1	0	1
Overhanging Vegetation	1	0	0	0
Devoid	1	3	3	3
Habitat Abundance: 1=Sparse(1-10%) 2=Moderate(10-40%) 3=Heavy(40-75%) 4=Very Heavy(>75%)				
% Stream Substrate:				
Cobble	0	0	0	0
Coarse Gravel	21	0	9	0
Fine Gravel	34	0	3	0
Sand	0	0	2.4	0
Silt/Mud/Clay	45	43.4	58.3	20
Hardpan	0	56.6	27.3	80
% Stream Canopy Cover:				
Stream Canopy Cover	95	89.4	55	24

*Numbers in categorical sections are rounded up.

The existing instream habitat was composed mostly of logs and debris with much of the reach (39%) being devoid (Figure C-7). A substrate of mud and clay dominated the streambed in this reach. The bank habitat was composed of undercut banks and roots with approximately 79% of the area being devoid of habitat (Figure C-8). The bank slope was generally steep with moderately stable to stable soils.

In comparison with the upstream reach (BDL-1), BDL-2 differed primarily in flow and instream velocities, which were almost four times the velocity and 13 times the flow.

Despite the increased flows, the stream channel width and depths were not increased proportionally.

Reach BDL-3

Reach BDL-3, located below the confluence of Bayou de Loutre and Loutre Creek, was composed mostly of riffle/run areas with pools comprising approximately 30% of the reach. The average stream width was 18.0 ft, approximately twice the size of the stream at BDL-2 or LC-1; the average depth was 1.1 ft. An average flow of 8.49 cfs was measured with an average velocity of 1.39 fps. The average channel width, as measured bank to bank, was 28.7 ft, again almost twice that measured at BDL-2 and LC-1 (Figure C-9 and C-10).

The instream habitat was mostly absent (86% devoid) from this reach with a few intermittent areas containing vegetation or logs and debris (Figure C-9 and C-10). The substrate varied between mud, clay, and gravel with some smaller areas containing a mixture of gravel. Although not included in the habitat reach evaluated, cobble/rock was present just downstream of the road and railroad crossing. This habitat was not found in any other study reaches in Bayou de Loutre except in the immediate vicinity of the railroad crossing. The bank habitat was lacking, being 97% devoid (Figure C-9). The bank slope was generally steep with mostly stable soils (Figure C-11 and C-12). The stream in this reach reflected the increased watershed size downstream of the confluence of Bayou de Loutre and Loutre Creek. Also, this reach reflects the old channeled stream section that paralleled the railroad right of way.

In comparison to upstream reaches (BDL-1 and BDL-2), the habitat has been modified by both natural and anthropogenic forces. The changes reflect the doubling of watershed size and the resulting increased flows. Although not measured at the time of sampling, the differences in habitat characteristics reflect the potential storm runoff via Loutre Creek, which drains a largely developed area of southwest El Dorado. Anthropogenic forces are reflected in the channelization resulting from the construction of the railroad right-of-way and remediation activities of a closed superfund site to the south of Bayou de Loutre adjacent to Reach BDL-3.

The variability of substrate reflects contribution from efforts to stabilize bridge and railroad crossings within the reach (Figure C-13). Compared to upstream reaches, both bank and instream habitats were reduced at Reach BDL-3.

Reach LC-1

Reach LC-1 of Loutre Creek was composed mostly of pooled areas with riffle/run areas comprising only about 30% of the reach (Figure C-14). This is a contrast to Bayou de Loutre where riffle/run areas dominated. The average stream width was 12.7 ft. The average depth was 1.18 ft. An average flow of 3.14 cfs was measured with an average velocity of 0.53 fps. The average channel width, as measured bank to bank, was 20.7 ft. The pooled areas appeared large enough to maintain perennial fish community.

The existing instream habitat was composed mostly of logs and debris with some scattered vegetated areas (Figure C-15). However, approximately 37% of the stream was devoid of significant habitat. A substrate of mud and clay and or sand dominated the streambed in this reach. The bank habitat was mostly lacking, with a few areas (approximately 21%) composed of undercut banks and roots (Figure C-16). The bank slope was generally steep with stable to moderately stable soils (Figure C-17).

4.4.4.2 Habitat Characterization After Outfall 001 Transfer (May 2000)

The same reaches evaluated prior to the transfer of the Outfall 001 discharge to Lion Oil were also evaluated after the project was accomplished and operational. This section provides a summary of the habitat characterization in Table 4.2 and highlights those parameters that were found to be significantly different from the pre-transfer condition as described in Section 4.3.1. The Field Data Forms are provided in Appendix B.

Reach BDL-1

Due to recent rains the average depth, percent riffle runs, and stream width were all increased when compared to 1999 characterization. The flow was approximately twice that measured during 1999 (Figure C-18). The increased wetted area increased the percent of instream habitat but did not result in significant changes to the substrate composition.

Reach BDL-2

The flow at BDL-2 was reduced from 4.41 cfs to 0.24 cfs and the average velocity was reduced from 0.49 to 0.05 fps. In addition, water levels were reduced as indicated in Figure C-19, where normal water levels are depicted by the stained roots along banks and at tree root ball in center background. These reductions reflect the removal of the GLCC-Central Outfall 001 discharge from Bayou de Loutre. There were no other significant changes between the 1999 and 2000 habitat assessments within this reach.

Reach BDL-3

The flow was reduced almost 50% from 1999 levels as were average velocities. Despite the reduced flows, the stream width and average depths were not significantly modified from the 1999 characterization (Figure C-20). This reflects the channelized configuration of BDL-3. As a result of the reduction in velocity a greater percentage of the reach was characterized by pools rather than runs (Figure C-21). The substrates and instream habitats were not significantly modified from the 1999 characterization.

Reach LC-1

The stream flow increased approximately 25% from that measured in 1999 and the average velocity also increased slightly. These changes reflect the natural variability and not a result of increased discharge from Lion Oil. Slight increases were also demonstrated at BDL-1 (the upstream condition). Other habitat characteristics were not modified significantly between 1999 and 2000.

4.4.5 Habitat Potential

The results of the qualitative assessment of habitat potential indicates little difference between the study reaches. These results reflect the general close proximity of the study reaches, all with small watersheds and with generally same watershed development.

1999 Assessment

The results of the qualitative habitat assessment indicates the presence of more available habitat for fish and macroinvertebrates at BDL-2 than at the other three sites but probably not significantly so. The upstream reach, BDL-1 was lacking most in habitat for potential fish and macroinvertebrate colonization and is reflective of the watershed size upstream of the reach.

The qualitative assessment of the habitat placed BDL-1 in the marginal category and BDL-2, BDL-3, and LC-1 in the sub-optimal category with mean scores of 9.9, 13.2, 12.1, and 12.2, respectively (Table 4.3). The minimum (9.9) and maximum (13.2) scores represent a habitat similarity of 75% between the two reaches. The differences in the scores between BDL-1 and BDL-2 were demonstrated most significantly by differences in instream cover (4.4 points), sediment composition (5.3 points), and riparian vegetative zone width (9.0 points). The only other sites whose comparisons exhibited significant differences in habitat were BDL-2 and BDL-3 where pool substrate and channel sinuosity varied by 4.3 and 4.6 points, respectively.

Table 4.3. Summary of Qualitative Habitat Assessment of Bayou de Loutre watershed prior to Outfall 001 transfer in April 1999. GLCC-Central

Parameter	BDL-1	BDL-2	LC-1	BDL-3
Instream Cover	10	15	14	12
Epifaunal Substrate	11	14	12	12
Pool Substrate Characteristics	11	13	11	9
Pool Variability	7	10	13	12
Channel Alteration	13	16	13	13
Sediment Composition	9	14	11	13
Channel Sinuosity	11	13	11	9
Channel Flow Status	9	11	12	12
Bank Condition	12	12	11	13
Bank Vegetative Protection	8	10	10	10
Disruptive Pressure	11	14	13	15
Riparian Vegetative Zone Width	7	16	14	16
Score (Total)	119	158	145	146
Score Average	10	13	12	12
Ranking	M	S	S	S

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

2000 Assessment

The qualitative assessment completed after the transfer of the GLCC-Central Outfall 001 discharge to Lion Oil revealed no appreciable differences in habitat compared with the assessment completed prior to the transfer. Three of the four reaches scored in the mid-range of sub-optional condition and the upstream reach (BDL-1) was indicated to provide only marginal habitat potential (Table 4.4). Although changes in flow and velocity should result in habitat changes over time, the habitat potential will not respond to primary level modifications over a single annual cycle.

Table 4.4. Summary of Qualitative Habitat Assessment Bayou de Loutre watershed after Outfall 001 transfer in May 2000. GLCC-Central

Parameters	BDL-1	BDL-2	LC-1	BDL-3
Instream Cover	12	15	15	12
Epifaunal substrate	11	13	14	12
Pool substrate characteristics	10	11	12	10
Pool variability	8	7	13	13
Channel alteration	11	15	15	13
Sediment composition	10	13	13	12
Channel sinuosity	10	14	12	10
Channel flow status	10	12	13	12
Bank condition	10	14	12	12
Bank vegetative protection	11	12	13	10
Disruptive pressure	12	16	13	15
Riparian vegetative zone width	9	17	11	14
Score (Total)	124	157	156	145
Score Average	10	13	13	12
Ranking	M	S	S	S

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

4.4.6 Comparisons with Historical Habitat Conditions

In 1990, a habitat characterization of Bayou de Loutre was completed and reported in FTN (1991). In the FTN report GLM 001C was the same reach as BDL-1, and GLM 001A was the same reach as BDL-2, and BDL-3 was the same area in both studies. The primary differences relate to the period of characterization, in 1991 the stream was evaluated during summer low flow conditions rather than seasonal spring flow conditions. Despite the seasonal differences, the stream habitat had not changed substantially between 1991 and 1999. The dominant substrate was mud and the instream and near bank habitat was predominately devoid with logs/debris secondary at all three stations. Despite low flow conditions during the 1991 study, BDL-2 and BDL-3 reflected the discharge from GLCC-Central Outfall 001 and had significant flow, 4.09 and 5.46 cfs. The flow at BDL-1 was undetectable but downstream at BDL-2 and BDL-3 it was 0.26 and 0.39 cfs, respectively.

4.4.7 Habitat Conclusions

4.4.7.1 Summary of Habitat Characterizations

The following observations are provided based on the habitat characterization:

1) The stream morphology of Bayou de Loutre in the study area has been developed as a result of many years of high volume discharge from the

GLCC-Central Outfall 001. This discharge has resulted in a narrow incised stream channel dominated by a clay/hard-pan substrate.

2) The consistent elevated velocities in the study reaches downstream of the GLCC Outfall 001 discharge have limited instream habitat for the development of benthic communities and fish assemblages to eroded root systems and depression in the lithified clay substrate.

3) The majority of the stream reaches are shallow runs with little or no vegetation. The limited deeper pools provide restricted areas of sanctuary during summer low flow periods.

4) The majority of habitat diversity is restricted to just downstream of road and railroad crossings where gravel or rock has been deposited for channel stabilization.

5) Although sufficient for community maintenance, the habitat of Bayou de Loutre and Loutre Creek is limited and therefore inhibits biotic community development.

6) The reductions in flow and velocity resulting from the transfer will allow development of habitat diversity over time, thereby allowing for improved biotic community development.

7) The watershed size limits the ultimate use attainment as recognized by Arkansas' WQS.

8) Although greatly reduced, discharges from Outfall 001 will provide water during low flow conditions, thereby providing a continuous wetted habitat by providing water during intermittent stream conditions.

9) The habitat at BDL-2, BDL-3, and LC-1 is sufficient for the maintenance and development of a benthic macroinvertebrate and a fish community representative of a Gulf Coastal stream but poor substrate characteristics and reduced instream habitat diversity limits the diversity and development of biological communities.

10) The habitat at BDL-1 is only marginally capable of maintaining a macroinvertebrate and fish community typical for the ecoregion and reflects the small watershed upstream of BDL-1.

11) With the exception of the upstream reach (BDL-1), which is limited by watershed size and losses to the riparian zone, all of the stream reaches sampled have very similar habitat with adequate potential for aquatic life establishment and maintenance of biological integrity characteristic of small watersheds of the region.

4.5 Water Quality *In-situ* Measurements

4.5.1 Overview

This section presents the methods used to characterize basic water quality parameters of Bayou de Loutre and Loutre Creek. The following parameters were routinely monitored at the study reaches:

1) temperature, °C
2) dissolved oxygen, mg/L
3) specific conductance, µS
4) pH, su

The *in-situ* measurements are recorded on the Field Data Form (Appendix B). Other information recorded on the Field Data Forms includes:

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.

4.5.2 Methods for *In-situ* Measurements

The aquatic life field survey was conducted during the spring of 1999 and 2000 to reflect conditions prior to and after the removal of the GLCC-Central Outfall 001 discharge from Bayou de Loutre. Water quality parameters were measured at sites BDL-1, BDL-1.5 (immediately below the GLCC-Central discharge), BDL-2, BDL-3, and LC-1. Water quality analysis consisted of *in-situ* measurements that included water temperature (°C), dissolved oxygen (DO mg/L), pH (su), and specific conductance (µS). Meters were calibrated daily according to the individual manufacturer's specifications. Calibrations were recorded on daily field data sheets and are provided in Appendix D-2.

The following section provides the details of the methods used to collect the *in-situ* data.

4.5.2.1 Dissolved Oxygen Meter

The dissolved oxygen meter is configured to record both dissolved oxygen and water temperature. As an initial performance test before use each day, the dissolved oxygen (DO) meter was tested for accuracy against the Winkler titration method. In addition, the dissolved oxygen meter was tested at the station location before each site visit.

The probe was submerged in a grab sample of stream water collected from midstream at the same location where the water chemistry sample was collected. The probe was allowed to equilibrate. The measured DO and stream temperature were recorded on the Field Data Form. If the DO meter malfunctioned, the stream temperature was measured with a field thermometer and the reading recorded on the Discharge/Flow Measurement Form along with data flags and comments. The temperature probe on the conductivity meter was used as a QA/QC check.

After recording the *in-situ* DO, the probe was rinsed with distilled water, the meter and probe inspected, and air calibrated a second time, following the instructions on the back panel of the meter. After the second air calibration, the meter was redlined and stored with the probe in the wet chamber to maintain the membrane integrity. The meter was checked for calibration again at each stream site. At the end of the daily operations the meter was again air calibrated. Any apparent drift was recorded in the Field Data Form.

4.5.2.2 Temperature

At the study reach the following steps were completed to obtain a measure of the ambient water temperature. After recording the DO, the meter selection indicator was switched to zero, then back to temperature. After allowing the reading to stabilize, the temperature indicated was recorded on page two of the Field Data Form in the same column as the other *in-situ* measurements are recorded.

4.5.2.3 Specific Conductance

At each of the study reaches, the following steps were completed to obtain a measure of the ambient water conductivity.

1) The probe was submerged in the water or a sample of the water collected from the study reach.
2) The measured conductivity was recorded on the Field Data Form.
3) The probe was rinsed with distilled water and the probe secured for transit to the next measurement location.

4.5.2.4 pH

At each of the study reaches, the following steps were completed to obtain a measure of the ambient water pH:

1) The probe was submerged in a grab sample collected from mid-stream water and stirred using a gentle swirling motion to ensure good ion contact.
2) The measured pH was recorded on the Field Data Form.
3) The probe was rinsed with distilled water and secured for transit to the next measurement location.

4.5.3 Results

The following sections provide a summary of the *in-situ* water chemistry as measured during the aquatic life field surveys. The following sections provide significant findings for both periods. Appendix D-2 provides the details of data collected during the aquatic life field survey of the site specific water quality study.

4.5.3.1 *In-situ* Water Quality During 1999 Field Survey

All *in-situ* water quality data is presented in Table 4.5 and the field forms are presented in Appendix D. The *in-situ* data described in the following paragraphs was collected in April and May 1999. The temperature was lowest at the BDL-1, averaging 19.2°C in April. The temperature was highest at BDL-1.5 immediately below the effluent discharge, averaging 32.2°C in April. The DO ranged from an average of 3.5 at BDL-1 to 7.8 at BDL-3. Specific conductance varied greatly with a range averaging 651 µS to 3105 µS. Figure 4.2 illustrates the relationship of specific conductance with water temperatures at each of the reaches evaluated during the aquatic life field study on Bayou de Loutre. As indicated, the specific conductance increased sharply downstream of the confluence with Loutre Creek.

The pH at BDL-1 was the lowest at 4.5 su then remained fairly consistent in the other reaches with a range of 7.4 to 7.6. The pH was less than the WQS of 6.0 su at the upstream most location, upstream of the discharge from GLCC-Central. However, the pH below wetland systems often exhibited pH below the WQS of 6.0 su. This reflects the natural decomposition process whereby tannic and lignin acids are released from decomposition of organic matter.

Table 4.5. *In-situ* water quality of Bayou de Loutre and Loutre Creek during Spring 1999. GLCC-Central

Observation	BDL-1			BDL-1.5		BDL-2		BDL-3		LC-1	
Date	4/21	4/22	5/13	4/21	4/22	4/22	5/13	4/21	5/13	4/22	5/13
Temperature, °C (°F)	18 (65)	20 (68)	29 (84)	31 (90)	33 (91)	30 (86)	26 (79)	27 (81)	25 (77)	23 (73)	24 (75)
Dissolved Oxygen, mg/L	4.3	3.5	7.2	6.6	6.5	6.2	6.3	7.8	5.8	5.8	7.0
Specific Conductance, µS	899	1302	720	644	657	638	624	1724	1046	3105	2126
pH, su	5.6	4.5	7.6	7.3	7.9	7.8	7.4	7.4	7.4	7.4	7.3

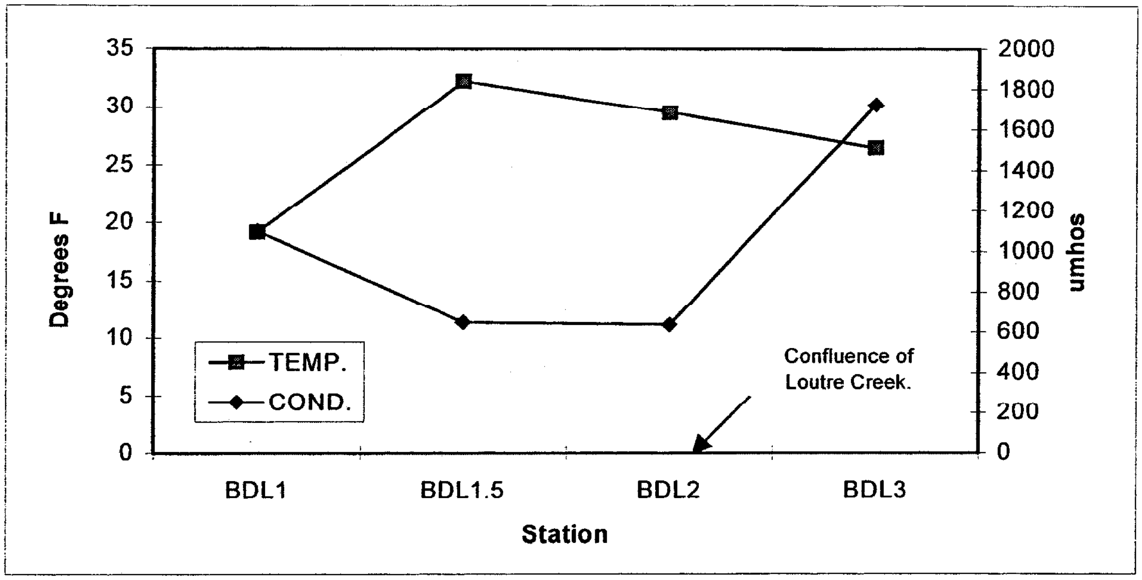


Figure 4.2. Schematic relationship of *in-situ* temperatures and specific conductance in Bayou de Loutre during Spring 1999.

4.5.3.2 *In-situ* Water Quality During 2000 Field Survey

The *in-situ* water quality of the study reaches are summarized in Table 4.6 and the actual Field Data Forms are provided in Appendix D-2. As demonstrated during the 1999 *in-situ* monitoring, the DO was maintained above the WQS. The water temperature was maintained within a more narrow range and also within WQS. When compared to 1999, the instream conductivity was increased at BDL-1 and BDL-2, approximately the same at BDL-3, but decreased substantially in Loutre Creek. Also like 1999, the pH of the upstream reach (BDL-1) did not maintain the WQS of 6-9 su. The measured pH was 3.7 su. This value was verified by calibration of the pH meter between measurements.

Table 4.6. *In-situ* water quality of Bayou de Loutre and Loutre Creek during Spring 2000. GLCC-Central

Parameter/Reach	BDL-1	BDL-2	BDL-3	LC-1
Date	5/2/00	5/2/00	5/1/00	5/2/00
Time	1125	0725	1100	0725
Temperature, °C (°F)	19 (66)	20 (67)	22 (72)	22 (71)
Dissolved Oxygen, mg/L	3.5	3.5	4.4	3.7
Conductivity, µS	1146	1008	1719	1576
pH, su	3.7	6.1	7.4	7.3

4.5.4 Comparison with Historical Data

The 1991 field study indicated that the WQS were maintained in Bayou de Loutre. The low pH values at BDL-1 measured during the current survey were not demonstrated during the 1991 *in-situ* monitoring. Other parameters were similar in value between sample periods.

4.5.5 Conclusions of *In-situ* Water Quality

The *in-situ* parameters measured indicate that each stream reach is capable of maintaining biological integrity despite some WQS violations. The study site is located in an area of historical oil production and refinery operations.

1) The instream temperatures, though elevated downstream of the discharge, were meeting the prescribed WQS of less than 30°C (86°F) at all reaches sampled for macroinvertebrates and fish. Although a naturally occurring condition, the upstream most reach was found to exhibit pH values less than the water quality criteria of 6 su.

2) The *in-situ* water quality parameters reflected the historical land use of the watershed and the point source discharges. In Bayou de Loutre, the water temperature was controlled by the discharge in 1999 and reflects background conditions in 2000, except in the reach immediately downstream of the discharge.

3) The *in-situ* dissolved oxygen concentrations measured met the WQS.

4) The specific conductance reflected historical land use, inputs and point source contributions in 1999. The 2000 results reflected the transfer of the once-through cooling water from Bayou de Loutre to Loutre Creek with increases in Bayou de Loutre and decreases in Loutre Creek.

5) The pH was consistently below the WQS at the upstream reach (BDL-1). This reflects the impact of the wetland complex just upstream of the study reach. The pH in other study reaches was within the WQS.

4.6 Benthic Macroinvertebrate Community

4.6.1 Introduction

The benthic invertebrate community reflects the habitat availability and the long-term exposure to physical and chemical properties of the water in which they develop and live. 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 development reflect the maintenance of a systems biological integrity.

Monitoring these assemblages is useful in assessing the status of the water body and detecting trend 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 (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 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" (RBA) 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 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 site specific water quality study, the benthic community of the following reaches was evaluated:

1) BDL-1 Bayou de Loutre upstream of the discharge from Outfall 001,
2) BDL-2 Bayou de Loutre just upstream of the confluence with Loutre Creek,
3) BDL-3 Bayou de Loutre downstream of mouth of Loutre Creek, and
4) LC-1 Loutre Creek upstream of the confluence with Bayou de Loutre.

4.6.2 Methods

Qualitative samples of the benthic macroinvertebrate assemblage were collected over a pre-determined period of time using an aquatic dip net and sampling all available microhabitats present within the stream reach.

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

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

The 100-organism sub-samples were 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 was 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 keys developed specifically for Arkansas may be utilized for the laboratory verification of the field identifications.

After the 100-organism random sample was collected, labeled and preserved, the larger debris items (e.g., leaves, sticks, rocks, etc.) in the collected sample were examined for clinging benthic macroinvertebrates. Any organisms were removed prior to the debris being discarded. The remainder of the original sample not utilized in the selection of the 100-organism sub-sample was concentrated and retained as a voucher for the sample picking techniques used. The voucher samples were preserved with 70% ethanol or Kayles solution. These voucher samples are to 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 assemblage from each station was 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 also included the seven biometrics used by the State of Arkansas (ADEQ, 1988) in their RBA scoring system (Appendix D). 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 indicates the impacts to a benthic community when compared to the benthic community of different reaches, to demonstrate effects of point and or nonpoint source contributions between reaches.

For each study site, a complete tabulation of taxa, numbers of individuals and their percent composition was included on the Field Data Sheet – Benthic Macroinvertebrates (Appendix D-3). The first page of the two page data sheet 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 two are the general reach identifiers and preliminary summary sections to be used in the application of selected biometric scoring criteria (Appendix D-3).

4.6.3 Results and Discussion

A summary of the benthic macroinvertebrates collected at the sample reaches on Bayou de Loutre and Loutre Creek before (1999) and after (2000) the transfer of the GLCC-Central discharge to Lion Oil are provided in this section. Appendix D-3 provides the details of data collected as part of the aquatic life field survey.

4.6.3.1 Benthic Community with Discharge (Spring 1999)

The number of taxa (taxa richness) of the communities at BDL-1, BDL-2, BDL-3, and LC-1, were 10, 12, 8, and 9, and the species diversity was 1.70, 2.28, 1.56, and 1.44, respectively (Table 4.7). Each of the four assemblages was dominated by Dipterans and Odonates, which together comprised at least 71% of the total community (Table 4.8). The trophic structure of each community was composed mostly of collectors (67%-80%) and predators (16%-25%). The community assemblages are limited when compared to other Gulf Coastal Ecoregion streams. However, the communities are more diverse than those present during the field studies completed during the summer of 1990 (FTN, 1991).

The biometric scores calculated for the sample comparisons ranged from 2.9 to 3.1, each indicating only minimal differences between the sampled communities (Table 4.8). All four of the samples demonstrated very similar community structure with insignificant variability. The sample whose community was the most different to the others was that of BDL-2 which demonstrated the highest richness, the highest diversity, and the smallest number of Dipterans. This location was downstream of the GLCC-Central Outfall 001 but upstream of the confluence with Loutre Creek. However, these differences are likely to be statistically insignificant.

Table 4.7. Macroinvertebrates collected from Bayou de Loutre and Loutre Creek, at El Dorado, AR in April 1999 prior to the transfer of Outfall 001 to Lion Oil. GLCC-Central

Taxa	Reach			
	BDL-1	BDL-2	BDL-3	LC-1
ANNELIDA				
Oligocheata	8	5	3	4
GASTROPODA				
Physa	--	7	1	--
Limpet	--	--	--	1
CRUSTACEA				
Cambarinae	3	5	8	--
Isopoda	--	--	2	--
EPHEMEROPTERA				
Caenis	--	3	--	--
ODONATA				
Argia	--	9	16	22
Boyeria verosa	--	1	--	--
Erythemis	--	--	--	1
Ischnura	4	2	--	1
Pachydiplax	4	--	--	--
Sympetrum	1	--	--	--
HEMIPTERA				
Belostoma	--	2	1	1
Corixidae	--	--	1	--
COLEOPTERA				
Hydrocanthus	--	3	--	--
Peltodytes	1	--	--	--
Laccobius	1	--	--	--
Notomicrus	--	1	--	--
Uvarus	4	3	--	--
DIPTERA				
Bezzia	--	--	--	1
Chaoborus	3	--	--	--
Chironomidae	71	59	68	68
Tipulidae	--	--	--	1
Sum of Percentages	100	100	100	100
Total Abundance:	100	100	100	100
Species Richness:	10	12	8	9
Shannon-Wiener Diversity Index	1.70	2.28	1.56	1.44

Table 4.8. Macroinvertebrate community metric analysis for Bayou de Loutre and Loutre Creek prior to the transfer of Outfall 001 discharge in April 1999. GLCC-Central

Parameter	BDL-1	BDL-2	BDL-3	LC-1
COMMUNITY MEASURES				
Total number of Taxa (Richness)	10	12	8	9
EPT Richness	--	1	--	--
Diversity Indices (Shannon-Wiener)	1.70	2.28	1.56	1.44
Total % of 5 Dominant Taxa	91	85	97	94
RANK OF ORDINAL GROUPS*				
Ephemeroptera	--	--	--	--
Trichoptera	--	--	--	--
Odonata	2	2	2	2
Coleoptera	4	3	--	--
Diptera	1	1	1	1
Crustacea	--	4	3	--
Gastropoda	--	3	--	--
Oligocheata	3	--	4	3
FUNCTIONAL FEEDING ASSEMBLAGES %				
Shredders	4	5	8	1
Scrapers	--	7	1	1
Collectors	80	67	73	73
Predators	16	21	18	25
Reach Comparison:	2 to 1	2 to 3	LC to 3	2 to LC
Biometric Scores:	2.9	3.1	3.1	3.0

4.6.3.2 Benthic Community without Discharge (Spring 2000)

Tables 4.9 and 4.10 summarize the benthic community assemblages as sampled during May 2000. The benthic community at the study reaches reflected only minor changes between the 1999 and 2000 evaluations. All reaches reflected slight increases in diversity indices and in total species. At Reach BDL-1, the benthic community demonstrated the greatest increase in species diversity. The diversity occurred as the result of eight taxa of dragonflies compared to only 3 in 1999. Despite this change in diversity, Chironomidae (bloodworms) still dominated the community.

At BDL-2, the major difference was a reduction in the dominance of the assemblage by bloodworms. Also, unlike other reaches, a mayfly taxa was found to be a significant part of the assemblage. These modifications in the benthic assemblages resulted in a slight increase of the diversity index.

Reach BDL-3 demonstrated the greatest improvements in benthic diversity within seven taxa found in 2000 that were not collected in 1999. Also, like Reach BDL-2, the dominance of the bloodworm component was reduced 50% from 1999 to 2001. This may be an indication of improved water quality but may also simply reflect annual variability.

Reach LC-1, demonstrated the fewest differences from 1999 to 2000. The bloodworm component of the benthic assemblage was only slightly reduced from 1999 to 2000. This reach also reflected the smallest overall diversity with only eight taxa.

4.6.3.3 Community Analyses

As discussed in the reach summaries, the community diversity measure generally increased when compared to 1999 samples. As with 1999, the benthic assemblages were dominated by diptera and the sub-dominant ordinal group was Odonata.

The benthic assemblage failed to demonstrate significant modifications between 1999 and 2000. This reflects the lack of impact the water quality has on the benthic assemblages when compared to the substrate, which has not been modified.

Despite the modifications in stream flow and velocity that resulted from the transfer of GLCC-Central's discharge to Lion Oil, the benthic communities demonstrated only minor modifications. This suggests that the primary scale habitat/physical properties (flow, velocity, and water temperatures) do not dictate the benthic community development.

The benthic community is more strongly associated with substrate types, variability of food source, and instream habitat. These habitat parameters can be modified as a result of modification to water temperature, flow and velocity however such a response generally requires a longer time scale.

4.6.4 Comparisons with Historical Benthic Assemblages

The benthic community characterized in 1991 was similar to that found in 1999 and 2000, except at BDL-2. Also, the diversity indices were increased at all reaches but not significantly. Likewise, all reaches were dominated by bloodworms. The changes at BDL-2 reflects the differences in sampling period, spring seasonal versus the summer low flow, high temperature. During the spring seasonal periods, the instream water temperatures at BDL-2 had not reached maximum summer temperatures. In 1991, only five taxa were found at BDL-2 (i.e., GLM001a), compared to 12 taxa during 1999 and 11 taxa in 2000.

Despite the differences, the benthic communities remain restricted when compared to other gulf coastal streams.

Table 4.9. Macroinvertebrates collected in Bayou de Loutre and Loutre Creek after the transfer of Outfall 001 to Lion Oil in May 2000. GLCC-Central

Taxa/Station Data	BDL-1	BDL-2	BDL-3	LC-1
ANNELIDA				
Hirundea	--	1	--	--
Oligocheata	4	5	3	11
CRUSTACEA				
Amphipoda		1		--
Cambarinae	4	2	5	3
Paleomonetes	--	--	4	--
COLLEMBOLA				
Colembola Sp. 1	1	--	--	--
EPHEMEROPTERA				
Caenis	--	16	2	--
ODONATA				
Argia	2	35	36	18
Boyeria verosa	--	--	1	--
Enallagma	6	--	2	2
Erythemis	1	--	--	--
Lestes	1	--	--	--
Libellula	1	--	--	--
Pachydiplax	6	1	--	--
Sympetrum	1	--	--	--
Tramea	12	--	--	--
HEMIPTERA				
Belostoma	1	--	--	--
Corixidae	--	--	--	1
MEGALOPTERA				
Corydalus	--	--	1	--
Chauloides	1	2	--	--
COLEOPTERA				
Berosus	--	--	--	1
Coleoptera Sp. 1	--	--	--	1
Curculinoidae	--	1	--	--
Uvarus	3	--	--	--
DIPTERA				
Chironomidae	56	33	39	63
Hemerodromia	--	--	4	--
Probezzia	--	3	3	--
Sum of Percentages	100	100	100	100
Total Abundance	100	100	100	100
Species Richness	15	11	11	8
Shannon-Wiener Diversity Index	2.42	2.34	2.31	1.68

Table 4.10. Macroinvertebrate community metric analysis for Bayou de Loutre and Loutre Creek after the transfer of Outfall 001 discharge in May 2000. GLCC-Central

Parameter	BDL-1	BDL-2	BDL-3	LC-1
COMMUNITY MEASURES				
Total number of Taxa (Richness)	15	11	11	8
EPT Richness	0	1	1	0
Diversity Indices (Shannon-Wiener)	2.42	2.34	2.31	1.68
Total % of 5 Dominant Taxa	84	92	91	97
PERCENT OF FIVE DOMINANT ORDINAL GROUPS				
Ephemeroptera	--	3	5	--
Odonata	2	1	2	2
Coleoptera	5	--	--	5
Diptera	1	1	1	1
Crustacea	3	5	3	4
Oligocheata	3	4	4	3
FUNCTIONAL FEEDING ASSEMBLAGES %				
Shredders	4	3	5	3
Scrapers	0	0	0	0
Collectors	61	55	48	75
Predators	35	42	47	22
Station Comparison:	2 to 1	2 to 3	LC to 3	2 to LC
Biometric Scores:	2.4	3.5	2.7	3.5

4.6.5 Conclusions

Based on the results of the macroinvertebrate collections, the following conclusions are provided:

1) The historical and current discharge from GLCC-Central does not preclude the maintenance of aquatic life.

2) The macroinvertebrate communities observed in each reach are similar in structure and composition, though BDL-2 does appear to be somewhat enhanced compared to the other reaches.

3) Although the characterization demonstrates the maintenance of a benthic community at each reach, the existing communities are less diverse than those expected in typical Gulf Coastal Plain streams of similar size.

4) The dominance of bloodworms and the lack of taxonomic diversity demonstrates a response to sediment quality as affected by historical watershed land uses and the resulting sediment conditions.

5) The lack of changes resulting from the transfer from Bayou de Loutre indicates the benthic communities were not being limited by the water

temperature of Bayou de Loutre, but that other factors (e.g., substrate) may limit benthic community development.

6) The benthic community structure demonstrates an overall improvement in community diversity when compared to those assemblages characterized at the same reaches during the period from 1992-1993.

4.7 Fish Community

4.7.1 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 was 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 was used as the principal sampling gear supplemented by block netting and seining in habitats where flow, substrate and structure affect capture of benthic species. The fish community of the following reaches was evaluated during this site specific water quality study.

1) BDL-1 Bayou de Loutre upstream of the discharge from Outfall 001,
2) BDL-2 Bayou de Loutre just upstream of the confluence with Loutre Creek,
3) BDL-3 Bayou de Loutre downstream of mouth of Loutre Creek, and
4) LC-1 Loutre Creek upstream of the confluence with Bayou de Loutre.

Two collections, one during Spring 1999 and one during Spring 2000, were made during the study. The collections were made when flow conditions were not controlled by large runoff events.

The fish collections from the reaches listed were evaluated to assist in determining the status of the designated aquatic life use, the effect of the existing point source discharges on the stream and the potential effect of any proposed modification of the water quality criteria for temperature.

4.7.2 Methods

Major factors that influence the collecting of fish include flows, water depth, instream obstructions, water turbidity, temperature and conductivity. The primary tool utilized in the fish collections was a Smith-Root backpack electroshocker. However, seines and block nets were utilized as necessary to adequately characterize the fish community of the study reaches. The shocker is equipped with an automated timing mechanism, which records the amount of time that electricity is actually being applied. This period is also referred to as pedal down time (PDT).

Sampling fish species to determine their proportionate abundance was conducted after all water quality parameters and/or samples were collected but prior to the collection of the benthic and habitat data as described in previous sections.

Shocked fish were captured with hand held dip nets and held in buckets while the sampling continued. The entire channel within the sampling reach is sampled. Actual shocking time continued for not less than 30 minutes unless the wetted habitat of any reach was too small for 30 minutes of shocking time. In addition to PDT, the total collection time was recorded. There was no maximum time limit for the collection period. However, the collections were terminated when the principal investigator determined that additional collection time would not likely result in additional fish species. Sampling information was recorded on the Field Data Sheet - Fish (Appendix D-4). General comments (perceived fishing efficiency, missed fish, and gear operational settings) were recorded on the first page of the Field Data Sheet - Fish.

An effort to collect fish was completed at all reaches, even if the stream was extremely small and appeared that sampling would not yield specimens.

4.7.2.1 Electroshocking Procedures

The procedure to be used in sampling with the backpack electroshocking unit is presented below:

1) The initial voltage was selected based on the measured conductivity of the stream.

2) The initial frequency was selected based on the expected size of fish to be sampled. If fishing success was poor, the pulse width was increased first and then the frequency.

3) The electroshocking was started and the timer set to zero after initial settings were finalized. Starting at the downstream terminus of each reach, the collection was made in an upstream direction. Voltage and waveform output was adjusted 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. The audio alarm begins as a strong continuous tone and begins to beep slowly at currents of approximately 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. When the unit overloaded, the anode switch was released and the voltage and waveform were adjusted and fishing resumed.

4) When fishing, the anode wand was moved from side to side in the water in riffles and pools. All available habitats, as well as riffles and pools, were sampled. In fast, shallow water a seine was used as a block net into which fish were allowed to drift after shocking.

5) In streams wider than were effectively sampled during a single pass (generally 5 ft or more as in BDL-3), shocking was completed from the midline of the stream channel to the banks on each side. All habitats were sampled. In stretches with deep pools, the margins of the pool were fished to the extent possible and to the maximum depth possible.

6) Netters followed along beside or slightly behind the person operating the electrofisher (on the anode side). Each netter used a dip net to retrieve stunned individuals, which were then deposited into a bucket carried by one of the netters for later processing.

7) At the completion of electrofishing, the total operating time (shock time) shown on the electrofisher timer and the distance sampled by electrofishing were recorded on the Field Data Sheet - Fish. If other sampling activities (electrofishing and seining) were completed for the sample reach, the total fishing time was recorded on the Field Data Sheet - Fish.

4.7.2.2 Seining

Seining was 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 was also used in sites where it was more effective (low conductivity reaches of BDL-1).

Depending on the particular use (block netting vs. active seining) and the habitat, different sizes of seines were used. In riffle habitats, the seine was held stationary while the substrate immediately upstream of the net was shocked and disturbed. In pools, the seine was 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.

Fish collections proceeded upstream through the reach, allocating the seining effort among habitat areas (riffles and pools) so that the entire reach was sampled. All fish collected were deposited into a bucket for later processing. The fish were not segregated by collected via electroshocking or seining. The number of seine hauls and the time expanded in seining were recorded on the Field Data Sheet - Fish. At the completion of sampling activities (electrofishing and/or seining), the total fishing time was recorded on the Field Data Sheet - Fish (Appendix D-4).

4.7.2.3 Sample Processing

Following collection, fish from the entire reach were preserved in formalin for later processing. Sample processing involved tallying and identifying fish, examining individual specimens for external anomalies, preparing voucher specimens for taxonomic confirmation and archival at a museum, as necessary.

For each study site, a complete tabulation of taxa, numbers of individuals and their percent composition was included on the second page Field Data Sheet - Fish as provided in Appendix D-4. The first page of the two page data form includes 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.

The second page provides for the listing of the taxa (field identifications) and the numbers individuals of each. Also included on page two are the general reach identifiers.

Ultimately, the fish identification was 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 was 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 Reg. No. 2.

In addition, the fish assemblage was evaluated utilizing the fish community biocriteria and compared 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.

4.7.3 Results and Discussion

The following sections provide a summary of the fish community as measured during the aquatic life field surveys and significant findings for both periods. Appendix D-4 provides the details of data collected as part of the aquatic life field survey.

4.7.3.1 Spring 1999 with GLCC-Central Outfall 001 Discharge

Reach Assemblage

The fish assemblage at each reach is summarized in the following sections.

Reach BDL-1

The fish collected in BDL-1 reflect the limitations to community development presented by the watershed size (less than 2 mi^2) above the study reach. As typical of Gulf Coastal Streams, sunfish dominated the sample. The available habitat limited actual PDT; however, the catch per unit effort approximated that of Loutre Creek. The Shannon-Wiener diversity at BDL-1 was higher than any other reach evaluated in 1999.

Reach BDL-2

The fish assemblage of BDL-2 reflected a more typical gulf coastal fish community. The reach community was dominated by sunfish and other fish families were represented. The catch per unit effort was three times that of BDL-1. Although not as numerically abundant as typically associated with other larger gulf coastal ecoregion streams, the fish assemblage demonstrates that a Seasonal Gulf Coastal Fishery is maintained downstream of the discharge from Outfall 001.

Reach BDL-3

This fish assemblage of BDL-3 was characteristic of small gulf coastal ecoregion streams. The catch per unit effort and total number of fish collected was the most of any reach sampled. Although not present in expected numbers, other family groups were present in the assemblage. As at BDL-2, the presence of the fish assemblage demonstrates that a seasonal fishery is maintained despite the GLCC Outfall 001.

Reach LC-1

Loutre Creek fish community also reflected limitations of small habitat size and the effect of historical land use activities. The fish community of Loutre Creek was dominated by sunfish and the catch per unit effort was similar to BDL-1 (the upstream condition).

Community Analysis

The fish community of Bayou de Loutre was improved downstream of the GLCC-Central Outfall 001 discharge when compared to the upstream condition. The fish communities represented from each of the four sampling reaches (BDL-1, BDL-2, BDL-3, and LC-1) were similar in structure (Table 4.11 and Table 4.12). The PDT at BDL-1, BDL-2, BDL-3, and LC-1 was 19.4, 30.6, 61.0, and 37.1 minutes, respectively. The fish collection from each reach was dominated by sunfish, which comprised at least 43% of the communities. The next most dominant group was the mosquito fish, which comprised at least 13% of each community.

Trophically, the communities were dominated by insectivores, which accounted for greater than 75% of each community. Only BDL-1 had a significant portion of carnivores, comprising 24% of the community. Fish assemblage from the community at reach LC-1 differed from the other reaches communities in that it was composed of more pollution tolerant species (24% of the sampled community) than at the other reaches where the proportion of tolerant species ranged from only 5% to 13%.

Of note was the number of diseased fish present in the sample from LC-1, where 13% of the assemblage (all 6 of the yellow bullheads) exhibited fin and tail rot, usually caused by a bacterial infection. The same species, yellow bullheads, at BDL-2 exhibited no signs of disease.

The fish assemblages in reaches BDL-2 and BDL-3 were similar to those expected in a typical Gulf Coastal Plain Fishery. The fish assemblage at BDL-2 contained 50% of the key species and 33% of the indicator species that generally characterize a Gulf Coastal Plain stream as listed in Arkansas Regulation No. 2. The fish assemblage at BDL-3 contained 33% of the key species and 50% of the indicator species that generally characterize a Gulf Coastal Plain stream. The fish collected in reaches BDL-1 and LC-1 were less similar to those typically found in Gulf Coastal Plain streams compared with the assemblages from reaches BDL-2 and BDL-3. Both assemblages (BDL-1 and LC-1) contained only 17% of key species and 33% of indicator species of Gulf Coastal Plain Fisheries.

Species richness exhibited some variation between the reaches with BDL-1 and LC-1 being the lowest at 7 and 8, and BDL-2 and BDL-3 being the highest at 11 and 12, respectively. There appears to be trend that groups the assemblages from reaches BDL-2 and BDL-3 as similar to one another but different from the assemblages in reaches BDL-1 and LC-1. This apparent trend was also exhibited in the key and indicator species metric where BDL-2 and BDL-3 were similar to one another but different from the other two reaches. Fewer fish were found at reaches BDL-1 and LC-1 than at the other reaches. The numbers of fish caught per minute of PDT were 1.1, 1.2, 3.2, and 3.3 at reaches BDL-1, LC-1, BDL-2, and BDL-3, respectively.

Table 4.11. Summary of fish collected from Bayou de Loutre and Loutre Creek (LC-1) prior to the transfer to Lion Oil in May 1999. GLCC-Central

Scientific Name	Common Name	Reach			
		BDL-1	BDL-2	LC-1	BDL-3
ESOCIDAE					
*Esox americanus**	Grass Pickerel	1	--	--	--
CYPRINIDAE					
Pimephales notatus	Bluntnose Minnow	--	3	--	1
Notropis umbratilis*	Redfin Shiner	--	2	--	2
ICTALURIDAE					
*Ictalurus natalis**	Yellow Bullhead Catfish	--	6	6	8
Ictalurus melas	Black Bullhead Catfish	--	--	--	1
APHREDODERIDAE					
*Aphredoderus sayanus***	Pirate Perch	--	3	--	2
FUNDULIDAE					
Fundulus chrysotus	Golden Topminnow	--	2	2	1
POECILIDAE					
Gambusia affinis	Mosquito Fish	7	39	6	39
CENTRARCHIDAE					
Lepomis cyanellus	Green Sunfish	1	4	5	9
*Lepomis gulosus***	Warmouth	4	--	2	4
Lepomis macrochirus	Bluegill	2	2	--	--
Lepomis megalotis	Longear Sunfish	--	32	21	111
Lepomis microlophus	Redear Sunfish	3	--	1	--
*Lepomis punctatus***	Spotted Sunfish	3	4	3	20
Lepomis x Lepomis	Hybrid Sunfish	--	--	--	1
PERCIDAE					
*Etheostoma gracile**	Slough Darter	--	1	--	--
Total No. Taxa Collected		7	11	8	12
Total Fish Collected		21	98	46	199
Level of Effort (Minutes) PDT***		19.4	30.6	37.1	61.0
Catch per Minute, PDT		1.08	3.20	1.24	3.26

* Key species as listed by Arkansas' Regulation No. 2 - 1998

** Indicator Species as listed by Arkansas' Regulation No. 2 - 1998

*** Pedal Down Time - actual time of current generation

Table 4.12. Fish community structural and metric analysis for Bayou de Loutre and Loutre Creek prior to the transfer of Outfall 001 Discharge (1999). GLCC-Central

Parameter	Reach			
	BDL-1	BDL-2	LC-1	BDL-3
COMMUNITY MEASURES				
Richness (Total number of Taxa)	7	11	8	12
Darter Richness	0	1	0	0
Sunfish Richness	5	4	5	4
% Pollution Tolerant Species	5	13	24	9
Key and Indicator Species	3	5	3	5
% Diseased	--	--	13	2
Diversity Indices (Shannon-Wiener)	2.53	2.40	2.40	2.05
Abundance, fish collected/minute	1.1	3.2	1.2	3.3
TROPHIC STRUCTURE				
% Omnivores	0	3	--	0.5
% Insectivores	76	97	96	97.5
% Carnivores	24	--	4	2
PERCENT OF 5 DOMINANT ORDINAL GROUPS				
Centrarchidae	62	43	70	73
Cyprinidae	--	5	--	--
Esocidae	5	--	--	--
Fundulidae	--	--	4	--
Ictaluridae	--	6	13	5
Poeciliidae	33	40	13	20
Total % of 5 Dominant Taxa	100	94	100	98

4.7.3.2 Spring 2000 Without Discharge

The fish community of the four reaches characterized during the spring of 1999 was also characterized in 2000 after the discharge from GLCC-Central Outfall 001 was transferred to Lion Oil. The fish community, during the Spring of 2000, was maintained even without the continuous discharge from Outfall 001 and likely benefits from the sporadic discharge.

As indicated by Table 4.13, the fish assemblages of 2000 demonstrated limited improvements in the Bayou de Loutre reaches downstream of the GLCC-Central 001 discharge location. The following sections summarize differences between the collection completed prior to and after the transfer project.

Table 4.13. Summary of fish collected from Bayou de Loutre and Loutre Creek after the transfer of Outfall 001 to Lion Oil in May 2000. GLCC-Central

Scientific Name	Common Name	Reach			
		BDL-1	BDL-2	LC-1	BDL-3
ESOCIDAE					
*Esox americanus***	Grass Pickerel	1	2	--	2
CYPRINIDAE					
Notemigonus crysoleucas	Golden Shiner	--	4	--	--
*Lythrurus umbratilis***	Redfin Shiner	--	--	--	3
Pimephales tenellus	Slim Minnow	--	--	--	1
CATOSTOMIDAE					
*Erimyzon oblongus****	Creek Chubsucker	--	1	--	--
ICTALURIDAE					
*Ameiurus natalis***	Yellow Bullhead Catfish	--	4	5	6
POECILIIDAE					
Gambusia affinis	Mosquitofish	--	12	15	68
APHREDODERIDAE					
*Aphredoderus sayanus****	Pirate Perch	--	3	--	1
FUNDULIDAE					
Fundulus chrysotus	Golden Topminnow	--	8	--	9
CENTRARCHIDAE					
*Centrarchus macropterus***	Flier	--	3	--	2
Lepomis cyanellus	Green Sunfish	3	6	7	6
*Lepomis gulosus****	Warmouth	1	--	1	1
Lepomis megalotis	Longear Sunfish	--	41	27	116
*Lepomis punctatus****	spotted sunfish	--	15	22	30
Lepomis humilis	Orangespotted Sunfish	--	1	--	--
Lepomis symmetricus	Bantam Sunfish	--	--	--	1
Lepomis X Lepomis	Hybrid Sunfish	--	1	--	--
Lepomis YOY	Juvenile Sunfish	--	1	--	2
Micropterus punctulatus	Spotted Bass	--	1	--	--
ELASSOMATIDAE					
*Elassoma zonatum****	Banded Pygmy Sunfish	--	--	--	1
Total No. Taxa Collected		3	13****	6	14****
Total Fish Collected		5	103	77	249
Level of Effort (Minutes) PDT*		17.3	34.2	46.1	52.2
Catch per Minute, PDT		0.29	3.01	1.67	4.77
Shannon-Wiener Diversity Index		1.37	2.92	2.16	2.23

* Pedal Down Time

** Key Ecoregion species

*** Indicator Ecoregion species

****Hybrid sunfish and juvenile sunfish not included in number of taxa.

5 yellow bullhead catfish from LC-1 and 6 yellow bullhead catfish from BDL-3 with finrot.

Reach BDL-1

Reach BDL-1, demonstrated reductions in species richness numerical abundance, diversity and catch per unit effort. The reason for the reductions was not clearly evident. This may be a natural annual variability, response to the drier than average conditions during 1999, or a slight reduction in sample collection efforts (19.4 vs. 17.3 PDT). Regardless, this reach represented the most restricted fish community during both collection periods and reflected the limitations of the small watershed size. The fish community characterized at BDL-1 reflects the designated use of a "seasonal" fishing due to a watershed less than 10 mi^2.

Reach BDL-2

The fish community of BDL-2 in 2000 exhibited slight increases in taxonomic diversity, numerical abundance, and variability of trophic structure. The primary difference was reflected in the reduction of the dominant taxa (mosquito fish) which was reduced by 70% from 1999 to 2000 (40% to 12% of the assemblage). The results indicate that the designated fishery use is being maintained while the discharge from GLCC-Central was managed as described in Section 3.5.

Reach BDL-3

As with BDL-2, the 2000 fish community demonstrated improvements in diversity, and numerical abundance, when compared to 1999 assemblages. These increases were not statistically significant and could represent natural variability. The collections demonstrate that the designated fisheries use is being maintained in Bayou de Loutre under the existing operational conditions with existing discharges.

Reach LC-1

The fish community of 2000 was not substantially different from that characterized by the 1999 collection. As in 1999, the black bullhead catfish demonstrated the fin rot but no other signs of stress were apparent. It should be noted that differences in the fish assemblages of Loutre Creek were of reduced quality compared with those of Bayou de Loutre. As with the other study reaches, any differences observed could represent natural variability.

4.7.4 Comparison With Historical Fish Data

The fish community of Bayou de Loutre was found to be significantly different in 1991 compared with 1999/2000. All stations demonstrated increased taxonomic diversity and numerical abundance in 1999/2000 when compared to 1991, except for the upstream most reach (above Outfall 001). The fish communities of BDL-2, BDL-3, and LC-1 were more diverse than in 1991. The increase in taxonomic diversity and numerical abundance reflects improved water quality within the watershed. At BDL-2, only six taxa were collected in 1991 compared to 13 in 1999. At BDL-3, only three species were collected in 1991 compared to 14 in 1999. Also, only one key species and two indicator species were collected in 1991 compared to six and eight collected in 1999/2000.

Table 4.14. Fish community structural analysis for Bayou de Loutre and Loutre Creek, Union County, AR. Post transfer of Outfall 001 discharge in May 2000. GLCC-Central

Parameter	Reach			
	BDL-1	BDL-2	LC-1	BDL-3
COMMUNITY MEASURES				
Richness (Total Number of Taxa)	3	13**	6	15**
Darter Richness	0	0	0	0
Sunfish Richness	2	5**	4	7
% Pollution Tolerant Species	33.3	23.1	33.3	14.3
Key and Indicator Species*	2	6	3	8
% Diseased	0	0	6.5	2.4
Diversity Indices (Shannon-Wiener)	1.37	2.92	2.16	2.23
Abundance, fish collected/minute	0.29	3.01	1.67	4.77
TROPHIC STRUCTURE				
% Omnivores	0	3.9	0	0.4
% Insectivores	80	93.2	100	98.8
% Piscivores	20	2.9	0	0.8
PERCENT OF 5 DOMINANT FAMILY GROUPS				
Centrarchidae	80.0	67.0	74.0	63.5
Cyprinidae	--	3.9	--	1.6
Esocidae	20.0	--	--	--
Fundulidae	--	7.8	--	3.6
Ictaluridae	--	3.9	6.5	2.4
Poeciliidae	--	11.7	19.5	27.3
Total % of 5 Dominant Groups	100	94.3	100	98.4

* Possible total of 12 Key and Indicator Species

** Hybrid sunfish and juvenile sunfish not included in number of taxa.

4.7.5 Conclusions

Based on the results of the fish collections, the following conclusions are provided:

1) The designated fishery use was being maintained in Bayou de Loutre during the period of elevated temperature from the GLCC-Central discharge from Outfall 001 during 1999.

2) The fish community of Bayou de Loutre did not demonstrate significant changes resulting from the transfer of the Outfall 001 discharge from GLCC-Central to Lion Oil, or the periodic discharges, which still occur to Bayou de Loutre.

3) The fish community assemblages do not appear to be limited by the temperatures that result from the reduced intermittent discharges from GLCC-Central's Outfall 001.

4) The fish community development in the BDL-1 reach, upstream of the GLCC discharge, is limited by habitat availability and reduced flows. These characteristics are typical of the small watershed size at this location.

5) The fish community of LC-1 reach is limited, though not obviously hindered by habitat availability or flow. It is likely that the differences found in the fish assemblages of this reach are due to lingering habitat (e.g., sediment) quality problems resulting from historical land use activities.

5.0 TEMPERATURE CRITERIA DEVELOPMENT

5.1 Introduction

As discussed in Section 3.3.3, the existing GLCC-Central discharge from Outfall 001 results in an instream exceedance in the Gulf Coastal Ecoregion criterion for temperature when it occurs. GLCC-Central has developed and implemented a forward thinking water conservation project that all but eliminates the need to discharge heated water though Outfall 001. The vast majority of the time, a low volume discharge continues on a routine basis. The discharge through Outfall 001 may be increased to pre-project volumes should the non-contact cooling water transfer to Lion Oil be interrupted. In order to develop documentation to determine the feasibility of modifying the temperature criteria, GLCC-Central has completed a comprehensive temperature monitoring program.

5.2 Approach

Instream Stowaway® temperature data loggers were deployed at six locations in Bayou de Loutre during the spring of 1999 (Figure 5.1). The data loggers collected temperature data during the spring and critical low flow period while the discharge from Outfall 001 occurred (February 1999 through December 1999) and during the spring and critical low flow period after the discharge from Outfall 001 had been transferred to Lion Oil.

5.3 Methods

The temperature monitoring data loggers were deployed in April 1999 in anticipation of the pending diversion of Outfall 001. The data loggers were designed for *in-situ* exposures for extended periods of time. The accuracy of the data loggers is +/- 0.1°C (1.0°F). The loggers were downloaded in the field approximately every 30 days, and reset and re-deployed immediately for continuous recording. Prior to the initial deployment, the data loggers were normalized according to the procedures recommended by the manufacturer. Each of the individual data loggers were calibrated

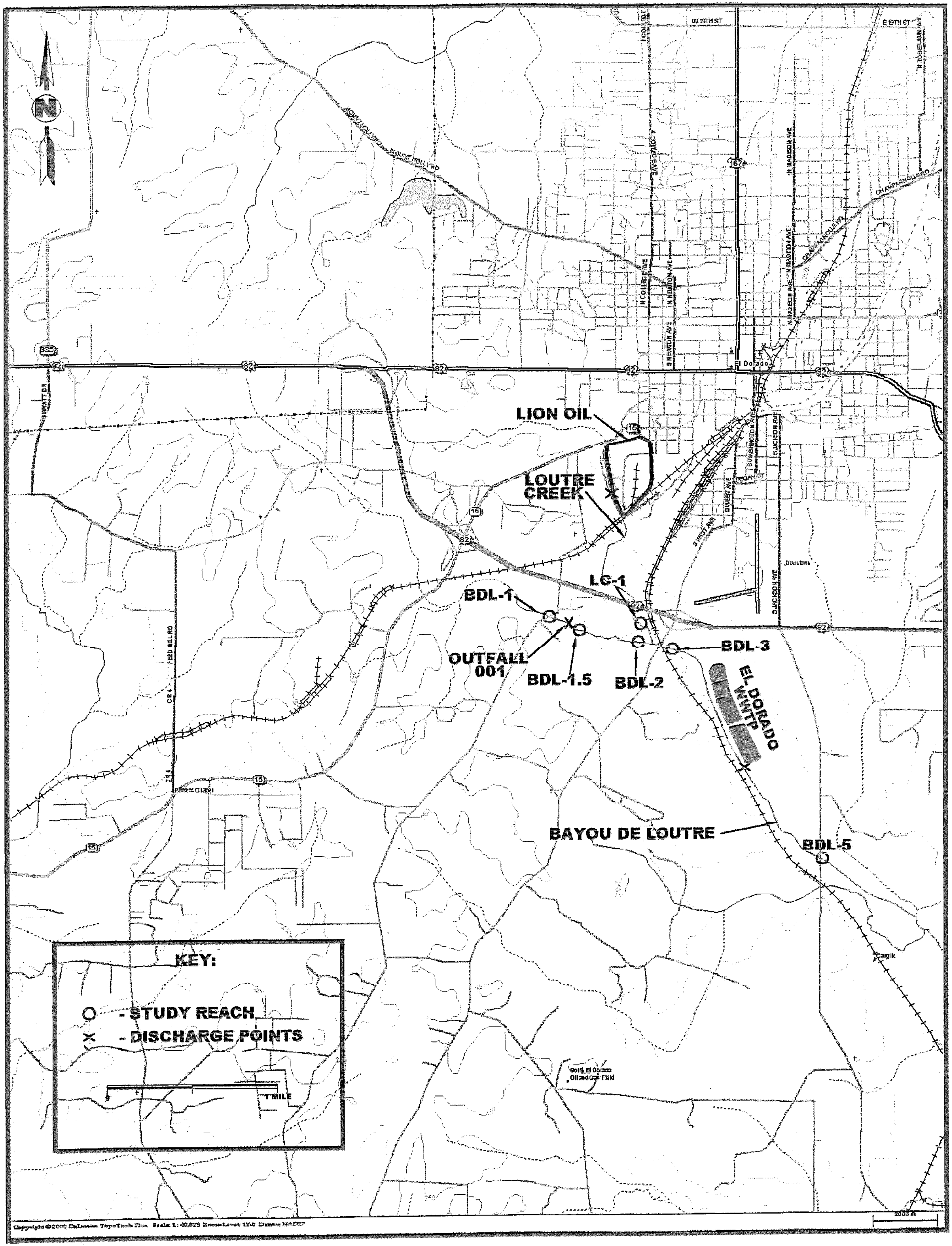


Figure 5.1. Temperature monitoring stations on Bayou de Loutre and Loutre Creek, Union County, AR.

(normalized) using a certified thermometer. Results of this normalization are provided in Appendix E-1. This procedure is designed to establish a baseline for individual loggers as compared to a certified thermometer, allowing all probes to be normalized to a baseline condition.

The temperature data loggers were deployed at the following locations:

1) BDL-1 Bayou de Loutre upstream of the discharge from Outfall 001,
2) BDL-1.5 Bayou de Loutre approximately 100 meters downstream of the Outfall 001 discharge,
3) BDL-2 Bayou de Loutre just upstream of the confluence with Loutre Creek,
4) BDL-3 Bayou de Loutre downstream of the confluence with Loutre Creek,
5) BDL-5 Bayou de Loutre at Southfield Road, and
6) LC-1 Loutre Creek upstream of the confluence with Bayou de Loutre (Figure 5.1).

As an additional QA/QC check, triplicate data loggers were deployed at two critical locations, BDL-2 and BDL-3. These triplicate probes provided an additional QA/QC measure by providing multiple temperature profiles at these locations.

The data loggers were downloaded approximately every 30 days. At the time of the downloading, *in-situ* temperatures are recorded with a hand held thermometer for comparison checks with the data logger. Table 5.1 provides a summary of the data logger temperatures and measured *in-situ* temperatures.

5.4 Results and Discussion

This section provides the results of the instream temperature monitoring program. The results are presented in three primary sections. The first section (5.4.1) presents a characterization of each study reach over the period of record and summarizes the conditions at each station prior to the transfer of discharge to Lion Oil.

Section 5.4.2 provides a summary of conditions at each reach for the period from April through September 1999 and 2000. This comparison provides a representation of the effects on water temperature prior to and after the transfer to Lion Oil.

Lastly, Section 5.4.3 provides a summary of effects on the water temperatures resulting from seasonal temperature cycle, daily variability, storm induced effects, and the periodic discharges from GLCC Outfall 001 after the project was operational.

5.4.1 Bayou de Loutre Temperature Profile with Discharge

The temperature monitoring program was initiated on April 22, 1999. The following sections provide a summary of conditions at individual reaches from April 22, 1999 to October 10, 1999. This time frame encompassed the critical season (low flow and maximum temperature) prior to the transfer of once-through cooling water from GLCC to Lion Oil Company. The following sections provide critical observations from each reach beginning with the upstream reach and proceeding downstream to the last monitoring point (BDL-1 to BDL-5; Figure 5.1).

5.4.1.1 Reach BDL-1

The temperature data collected at this reach (upstream of the Outfall 001 location) demonstrated that the Gulf Coastal Ecoregion WQS criterion for temperature (86°F) is not maintained during the critical season of the year. This indicates that for some streams, the ecoregion standard has been applied without consideration of natural conditions.

The BDL-1 data, summarized in Table 5.1, demonstrates that the WQS criterion of 86°F is exceeded during the low flow critical period without contributions from point source discharges. As indicated by Figure 5.1, this location is upstream of the discharge and served as a background condition in this study. As indicated by Table 5.1 and Figure 5.2, the temperature monitoring demonstrates that water temperatures exceeded the WQS criterion of 86°F approximately 4.3% of the time during the study period. These exceedances occurred during the critical low flow period from July through September. Figure 5.3 represents the frequency and distribution of hourly temperature measurements from BDL-1 upstream of the GLCC-Central discharge from Outfall 001. The maximum temperature recorded was 97°F and the 86°F standard was exceeded approximately 23% of the time during August 1999 and 50% during August 2000.

Figure 5.2 represents the record of temperatures over the study period. On three occasions, the data logger was exposed to air temperatures due to low flow conditions. These periods were eliminated from the analyses of water temperature data from BDL-1, and are not included in the data summary (Table 5.1) and the frequency distribution (Figure 5.3).

Table 5.1. Summary of water temperatures at BDL-1 as recorded by instream data loggers and adjusted to certified thermometer. POR April 1999 – October 2000. GLCC-Central

Total Data Set		Hourly Data													
Average Temp °F	69.0	Parameter	Year	Month											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Max. Temp °F	97.0	No. of hourly data points >86.0°F	1999	--	--	--	0	0	0	0	173	2	10	0	0
			2000	0	0	0	0	0	0	129	180	0	0	--	--
Min. Temp °F	36.8	% of hourly data points >86.0°F	1999	--	--	--	0	0	0	0	23.2	0.3	1.3	0	0
Number	11554		2000	0	0	0	0	0	0	17.4	50	0	0	--	--
No. >86.0°F	494														
% >86.0°F	4.3														

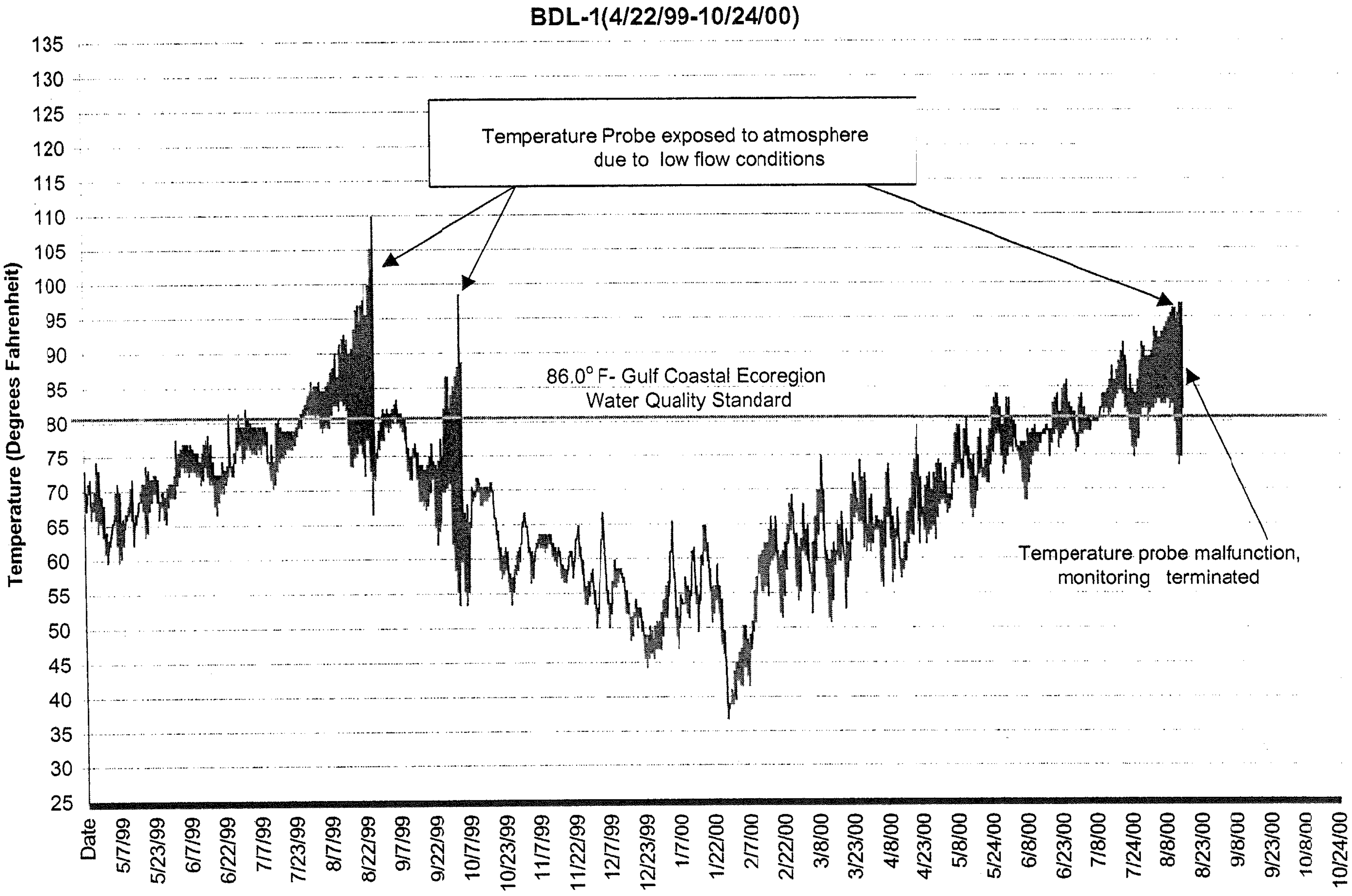


Figure 5.2. Water temperature of Bayou de Loutre upstream of GLCC-Central Outfall 001 pre and post transfer project. POR April 1999 through October 24, 2000.

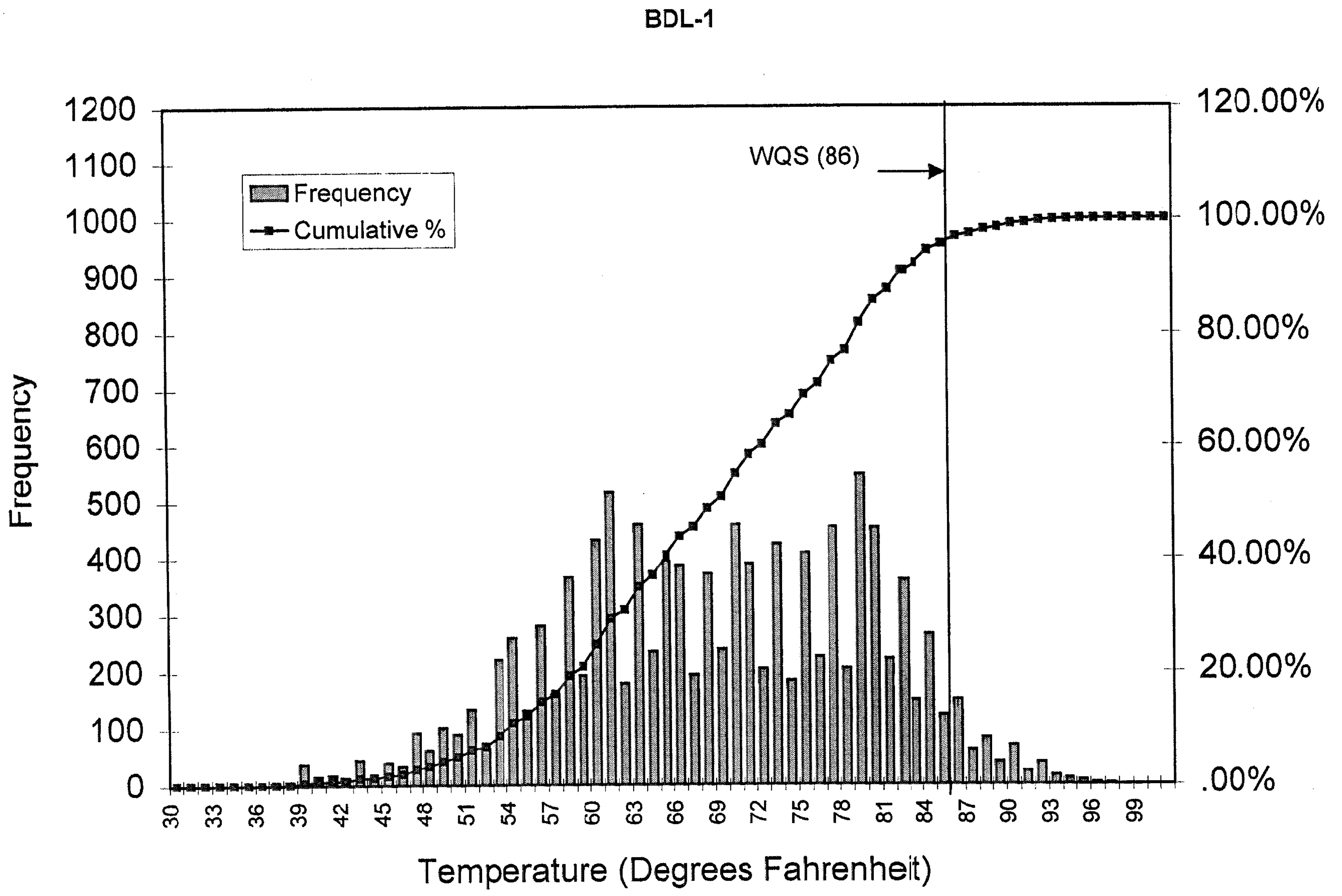


Figure 5.3. Frequency and distribution of hourly water temperatures at BDL-1. POR April 1999-October 2000.

5.4.1.2 Reach BDL-1.5

This study reach is just downstream (approximately 100 yards) of the discharge from GLCC-Central's Outfall 001. This monitoring location reflected contributions from the Outfall 001 effluent. In addition, as depicted in Figures C-22 through C-25, two brine transmission lines cross Bayou de Loutre just upstream and just downstream of the discharge (Figures C-21 through C-23). These lines transmit unprocessed brine with temperatures that often exceed 150°F. The outside surfaces of the transmission lines are hotter than the water temperature and contribute radiant heat to the water of Bayou de Loutre. As indicated by Figures C-22 and C-23, during an Outfall 001 discharge these transmission lines are at or below the water surface. When not discharging the brine line surface contact with the water is reduced.

Table 5.2 indicates that the water temperature exceeded the 86°F WQS approximately 46% of the time during the study period. The water temperature at this location was greater than 86°F the majority of the time from April 10, 1999 through November 1999 (78 to 100% of data points on a monthly basis).

Figure 5.4 demonstrates that while the water temperatures were generally greater than 86°F during 1999, storm events reduced instream temperatures providing periodic relief from elevated temperatures created by the Outfall 001 discharge. Daily fluctuations in water temperature were reduced when compared to daily variability from other reaches.

Figure 5.5 represents the distribution and frequency of water temperatures through the study period. The 86°F WQS criterion was maintained by approximately 55% of the data points. Also, due to the effect of the discharge, the range of temperatures was greatest at this reach, a range of 68°F.

During May 2000, the probe at BDL-1.5 recorded a short term spike to approximately 117°F, the cause of this spike is not clearly evident. The spike was not demonstrated at the next downstream reach (BDL-2). Since the spike was a short term event, and not reflected at the next downstream reach, this event was assumed to be an equipment malfunction and not utilized in the criteria analysis.

Table 5.2. Summary of water temperature at BDL-1.5 as recorded by instream data loggers and adjusted to certified thermometer. POR April 1999 – October 2000. GLCC-Central

Total Data Set		Hourly Data													
Average Temp °F	81	Parameter	Year	Month											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Max. Temp °F	116.8	No. of hourly data points >86.0°F	1999	--	--	--	197	577	578	642	740	719	742	687	359
			2000	387	133	0	10	50	4	68	116	102	11	--	--
Min. Temp °F	48.1	% of hourly data points >86.0°F	1999	--	--	--	97.0	77.6	80.3	86.3	99.5	100	99.7	95.4	48.3
Number	13220		2000	52.0	19.1	0.0	1.4	6.9	0.5	9.2	15.6	14.2	2.0	--	--
No. >86.0°F	6123														
% >86.0°F	46.3														

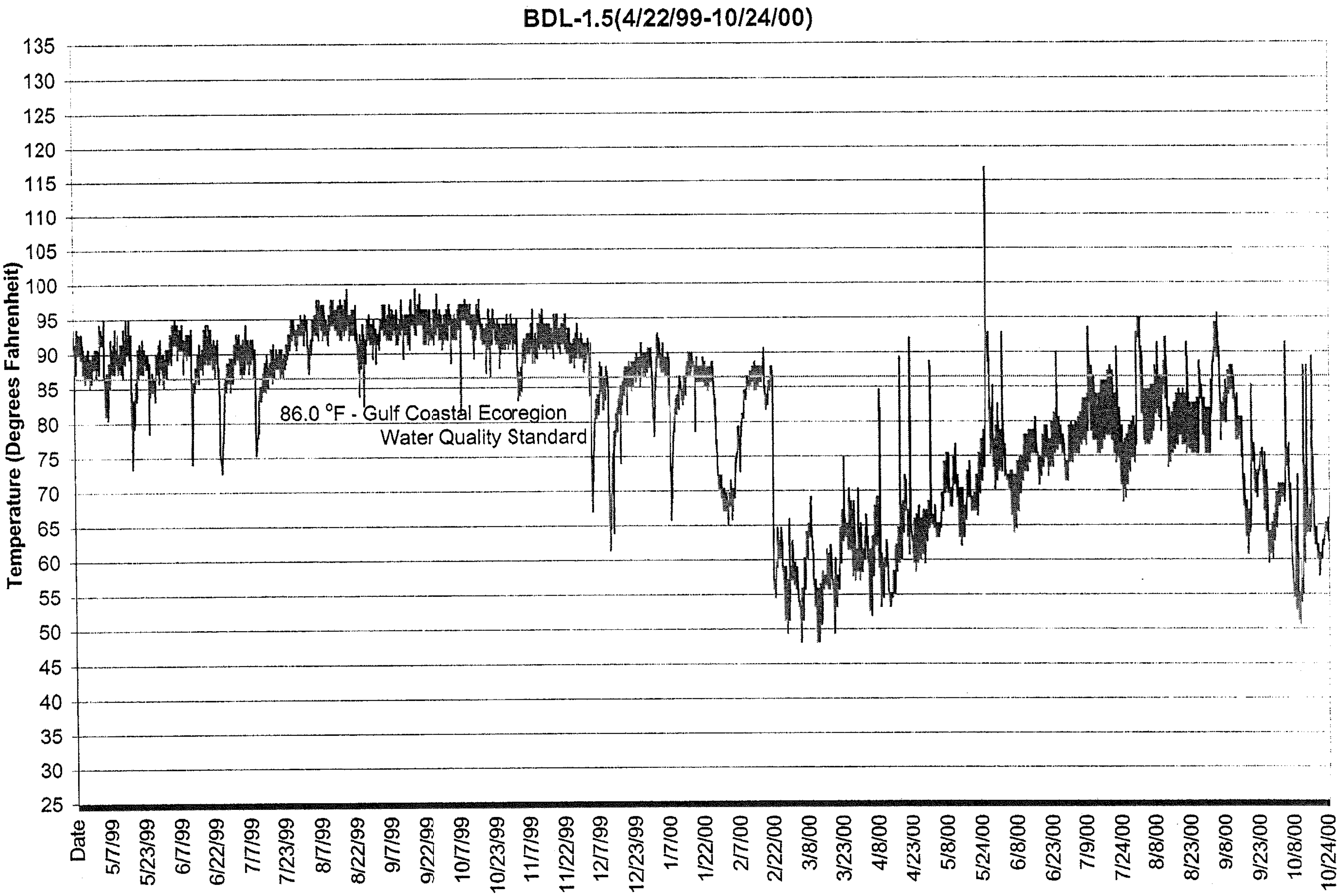


Figure 5.4. Water temperature of BDL-1.5 pre and post transfer project. POR April 1999-October 2000.

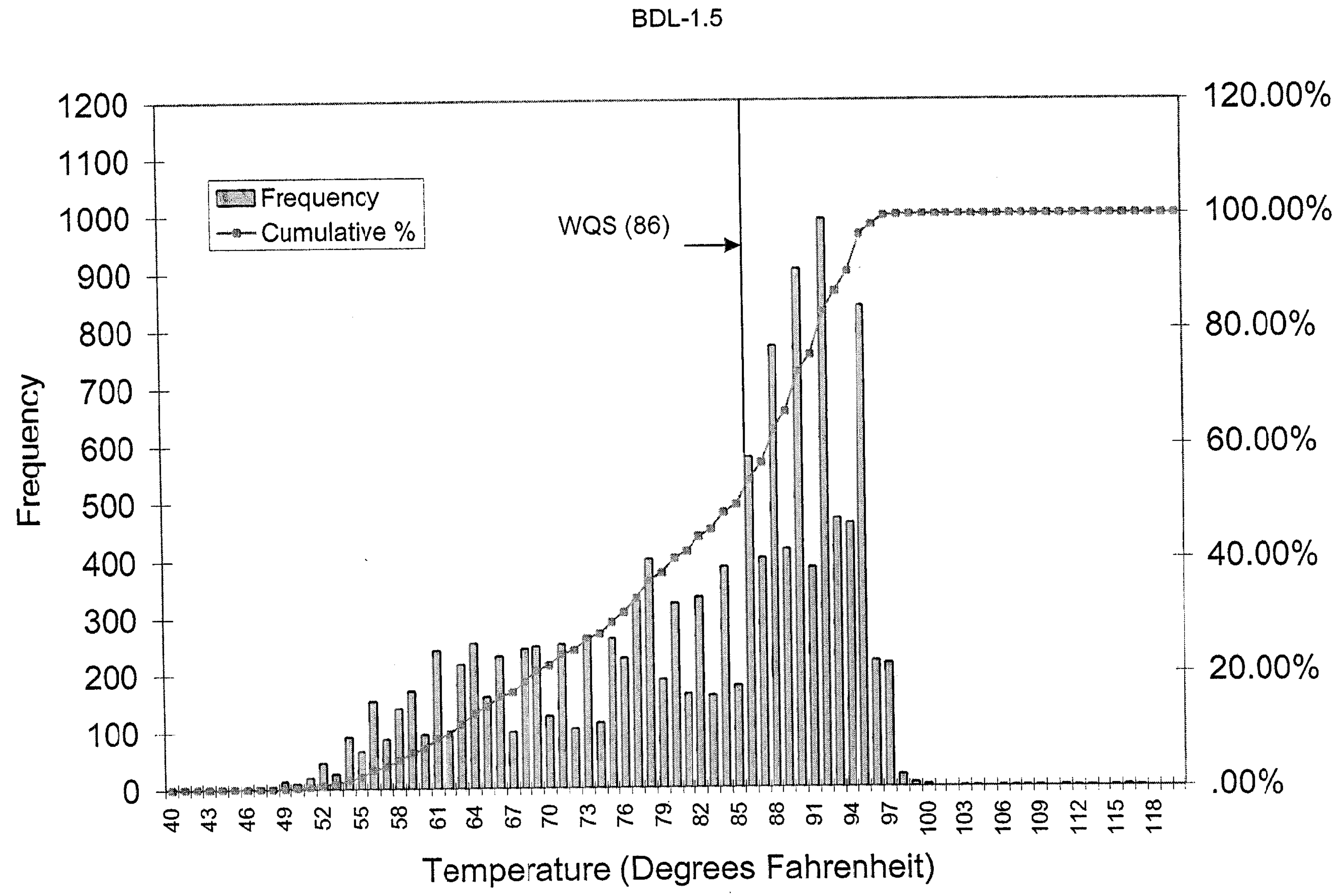


Figure 5.5. Frequency and distribution of hourly water temperatures at BDL-1.5. POR April 1999-October 2000.

5.4.1.3 Reach BDL-2

BDL-2 is located approximately 500 yards (1/4 mile) downstream of Outfall 001 discharge. As noted in Section 5.3, BDL-2 served as a QA/QC location where triplicate data loggers were deployed. During the study, one of the data loggers drifted from original calibration. Due to this drift, the results presented for BDL-2 represent an average of all readings for the remaining two data loggers.

The temperature monitoring indicated that the water temperature was greater than the WQS approximately 9% of the time during the study period, slightly greater than the upstream BDL-1 site (Table 5.3). Eighty percent of the measurements exceeding 86°F occurred during the critical season of 1999 (July-September). The 86°F WQS was also exceeded during this period at Reach BDL-1, upstream of the Outfall 001 discharge.

Figure 5.6 depicts the annual cycle from spring period through summer low flow critical condition during the discharge period. The maximum temperature recorded at BDL-2 was approximately 95°F. The instream monitoring reflects the seasonal variability, with elevated temperatures restricted to the low flow high temperature summer period. The effect of storm water inflows is also reflected by the short-term decreases as reflected on Figure 5.6.

Seasonal differences in water temperature were more clearly defined at BDL-2 than at BDL-1.5. The minimum temperatures recorded were approximately 45°F, which occurred during a period around a storm event (ice) in January 2000 (Figure 5.6).

During the study period, the range of temperature demonstrated the standard seasonal curve, like Reach BDL-1, skewed slightly upward due to an elevated temperature. The range of temperatures was 51°F compared to 68°F at BDL-1.5. Figure 5.7 demonstrates a normal distribution of temperature data points with a bell shape. The WQS temperature criterion was met by 90% of the data points.

Table 5.3. Summary of water temperature at BDL-2 as recorded by instream data loggers and adjusted to certified thermometer. POR April 1999-October 2000. GLCC-Central

Total Data Set	
Average Temp °F	74.7
Max. Temp °F	95.4
Min. Temp °F	43.5
Number	13220
No. >86.0°F	1255
% >86.0°F	9.5

Hourly Data													
		Month											
Parameter	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
No. of hourly data points >86.0°F	1999	--	--	--	3	23	72	318	539	137	0	0	0
	2000	0	0	0	0	47	45	21	18	2	0	--	--
% of hourly data points >86.0°F	1999	--	--	--	1.5	3.1	10.0	42.7	72.4	19.1	0	0	0
	2000	0	0	0	0	6.3	6.3	2.8	2.4	0.3	0	--	--

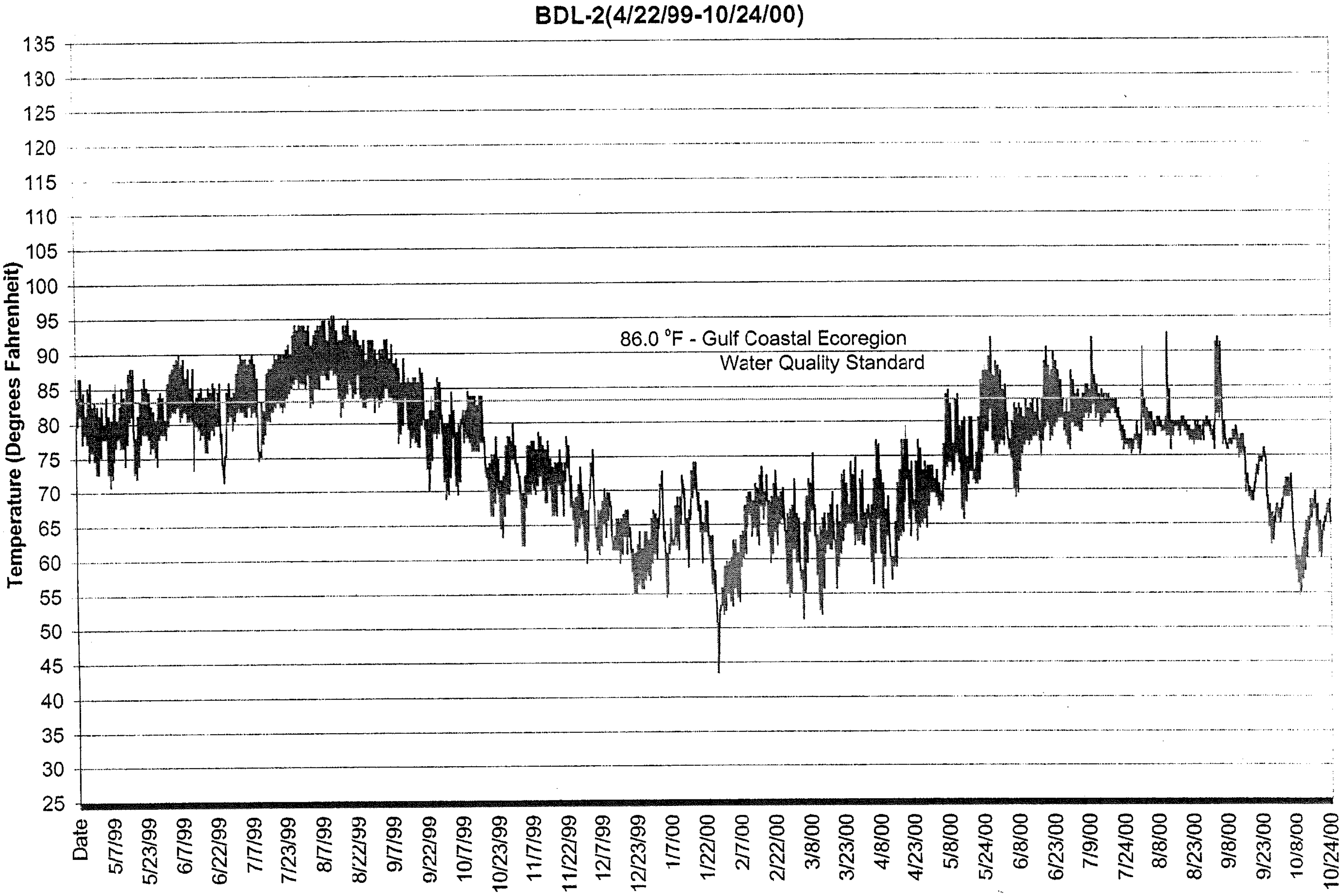


Figure 5.6. Water temperature of BDL-2 pre and post transfer project. POR April 1999-October 2000.

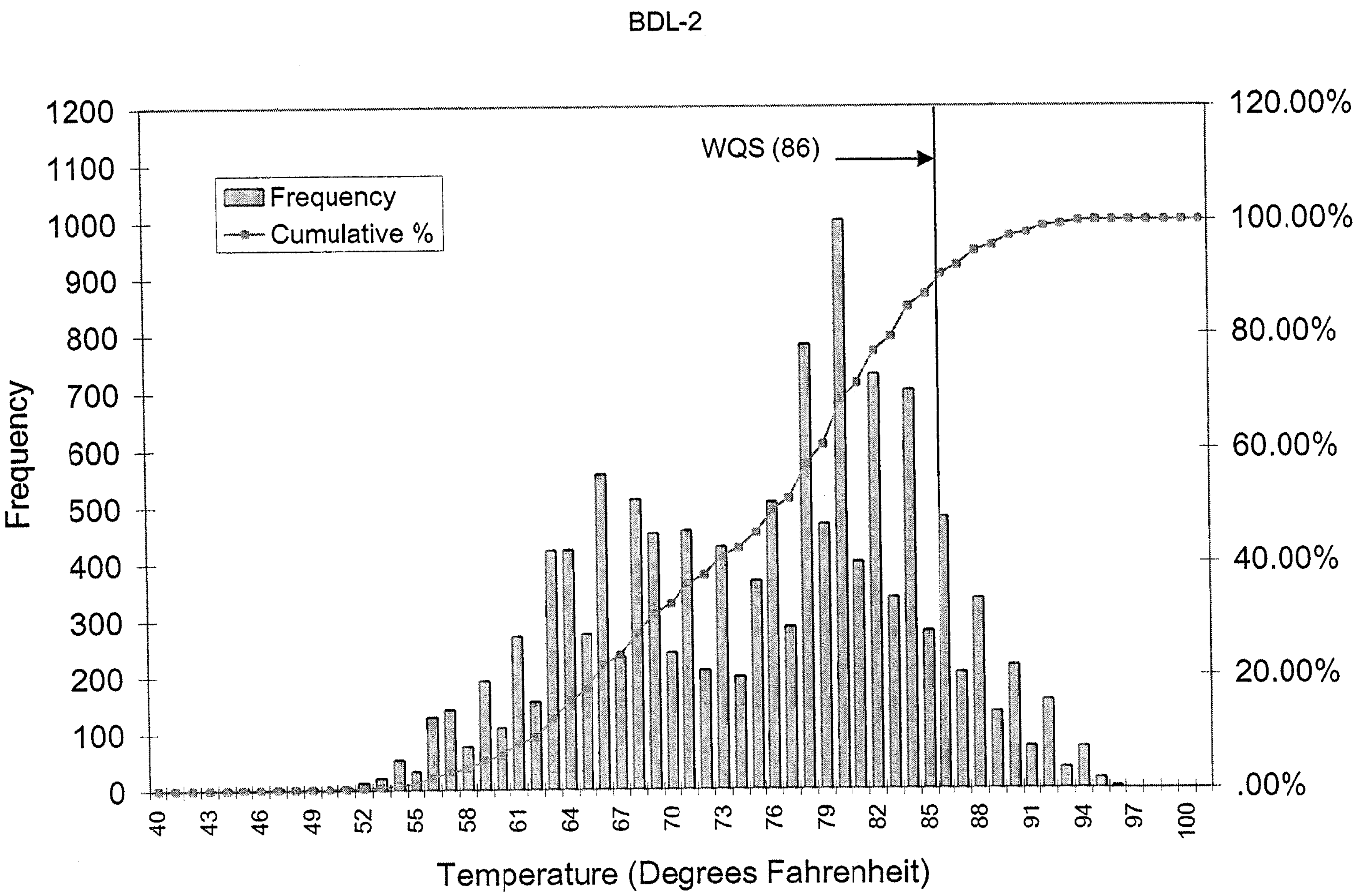


Figure 5.7. Frequency and distribution of hourly water temperatures at BDL-2. POR April 1999-October 2000.

5.4.1.4 Reach BDL-3

As indicated in Figure 5.1 BDL-3 is located downstream of the confluence with Loutre Creek. As a result of this addition, the combined watershed of Bayou de Loutre and Loutre Creek at Reach BDL-3 is approximately 8.1 mi^2.

During the study period with discharge from GLCC-Central Outfall 001 the WQS temperature criterion was met 94% of the time (Table 5.4). The maximum temperature was 94°F while the winter minimum was 46°F. The majority of the recorded temperatures above 86°F occurred in July 1999 when the water temperature was above the criterion approximately 63% of the time. The July 1999 data represented approximately 60% of all temperatures above the WQS temperature criterion. In August 1999, the water temperature exceeded 86°F only 30% of the time. This represents a switch from BDL-2 when maximum temperatures were recorded in August 1999. These changes reflect the contribution from Loutre Creek and demonstrate that the inflow from Loutre Creek influences the water temperature of this reach more than does the water temperature in Bayou de Loutre upstream.

Figures 5.8 and 5.9 depict the water temperature during the study period. The water temperature at BDL-3 demonstrated variability over the annual cycle than at any other reach on Bayou de Loutre. Also apparent in Figure 5.8 is the effect of storm water inflows, which create sudden reductions in water temperature. This further demonstrates the effect of Loutre Creek in controlling the physical properties of the water in Bayou de Loutre in this reach.

The frequency distribution of water temperature data demonstrates the reduced water temperatures when compared to other Bayou de Loutre locations, both upstream and downstream.

Table 5.4. Summary of water temperatures at BDL-3 as recorded by instream data loggers and adjusted to certified thermometer. POR April 1999 to October 2000. GLCC-Central

Total Data Set		Hourly Data													
				Month											
Average Temp °F	64.4	Parameter	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Max. Temp °F	94.1	No. of hourly data points >86.0°F	1999	--	--	--	0	17	83	470	221	2	0	0	0
			2000	0	0	0	0	0	0	0	0	0	0	--	--
Min. Temp °F	25.0	% of hourly data points >86.0°F	1999	--	--	--	0	2.3	11.5	63.2	29.7	0.3	0	0	0
Number	13196		2000	0	0	0	0	0	0	0	0	0	0	--	--
No. >86.0°F	793														
% >86.0°F	6.0														

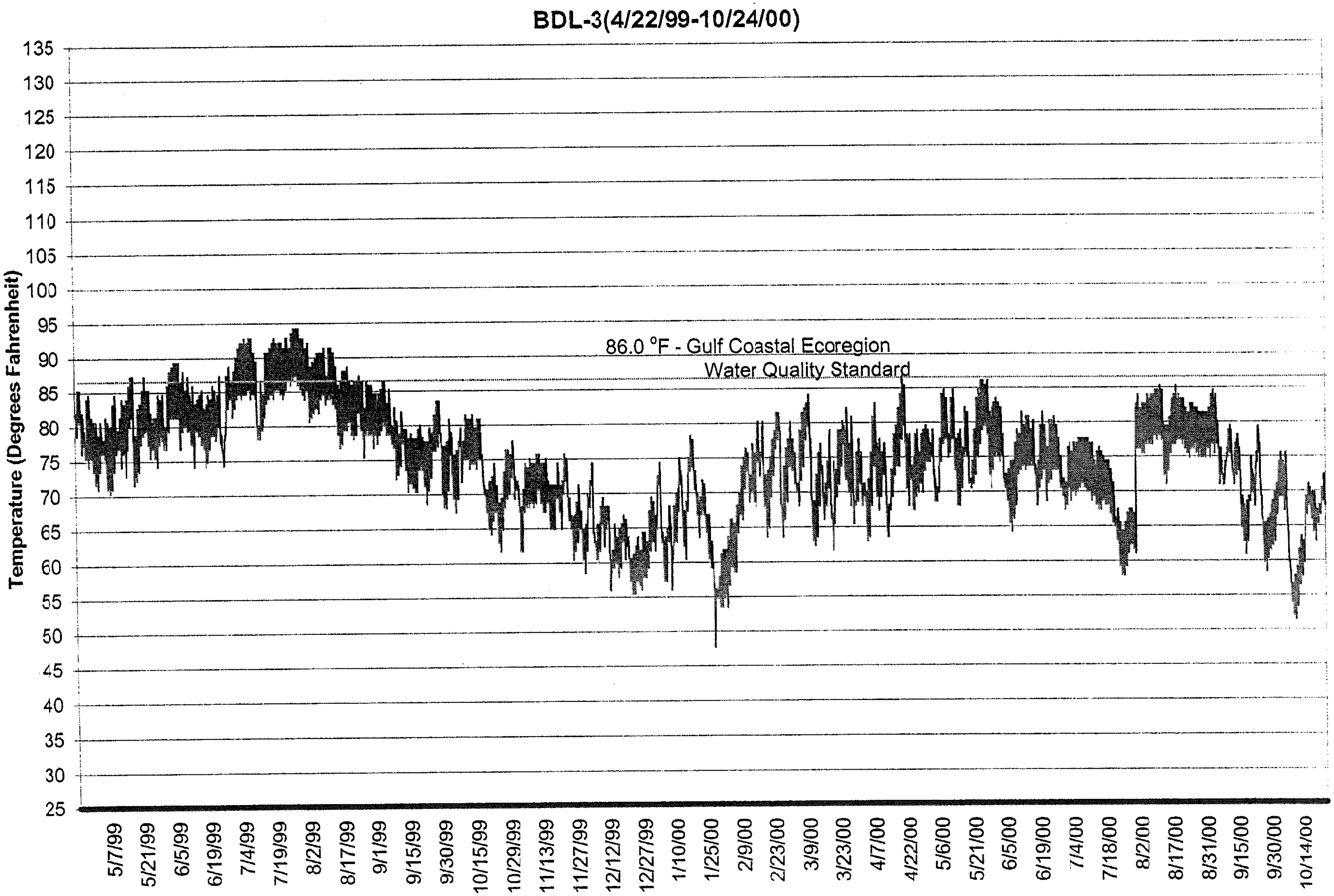


Figure 5.8. Water temperature of BDL-3 pre and post transfer project. POR April 1999-October 2000.

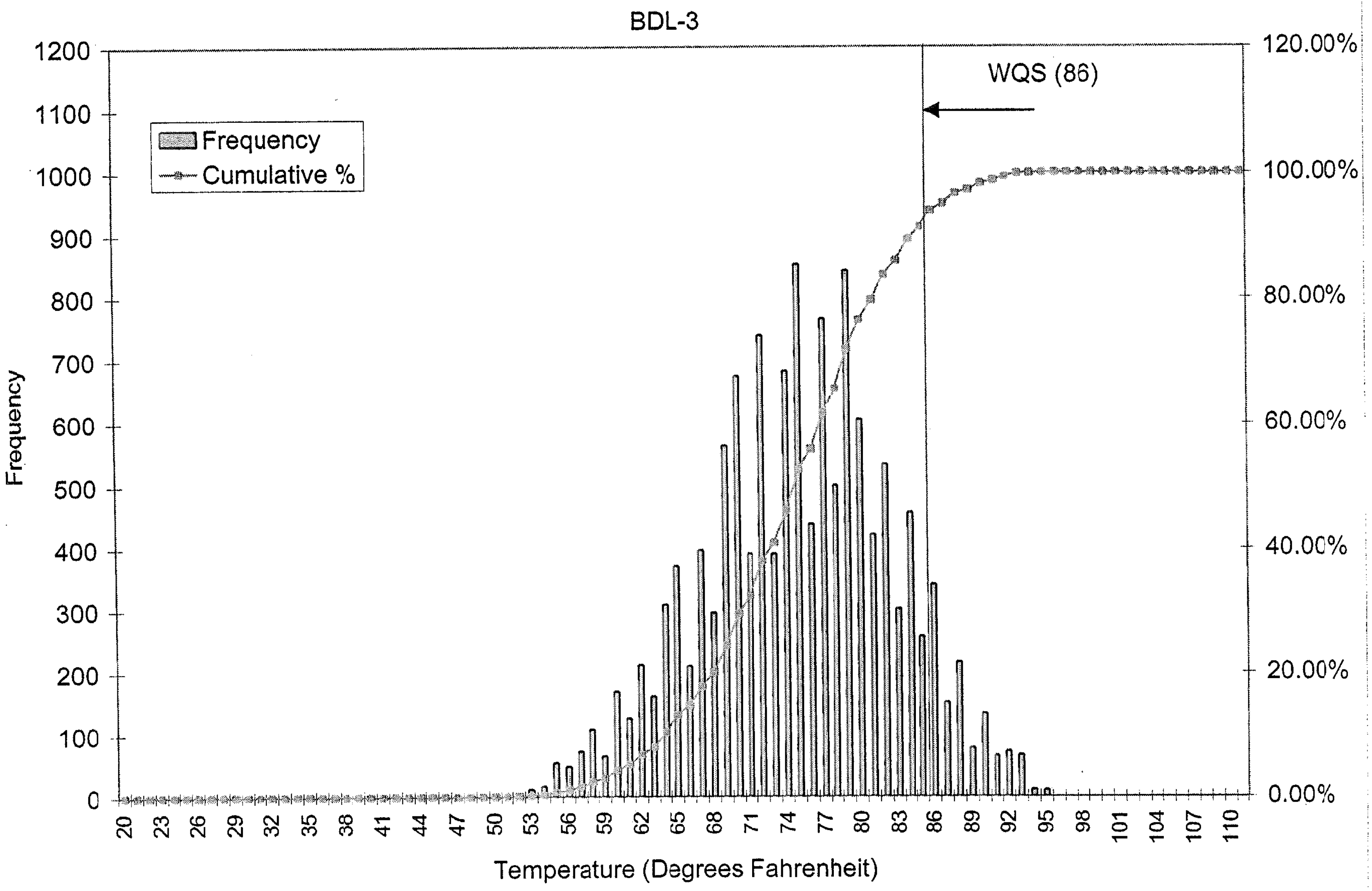


Figure 5.9. Frequency and distribution of hourly water temperatures at BDL-3. POR April 1999-October 2000.

5.4.1.5 Reach BDL-5

The monitoring of BDL-5 demonstrated increased water temperatures during the June-September 1999 period. In July, the water temperature exceeded the WQS approximately 84% of the time. This is second only to the BDL-1.5 reach, inside the mixing zone of Outfall 001. These temperatures reflect an increase from BDL-3 and are likely increased as a result of solar influx and discharge from the City of El Dorado wastewater treatment system into Bayou de Loutre (Table 5.5).

During the field study, the water temperature exceeded the ecoregion standard approximately 25% of the time. The maximum temperature recorded was 98.3°F. In 1999, the standard was exceeded 12.5% of the time. Figures 5.10 and 5.11 represent the distribution of water temperatures across the study period. The WQS temperature criterion was met by approximately 55% of the data points.

Table 5.5. Summary of water temperatures at BDL-5 as recorded by instream data loggers and adjusted to certified thermometer. POR April 1999-October 2000. GLCC-Central

Total Data Set		Hourly Data													
Average Temp °F	76.3	Parameter	Year	Month											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Max. Temp °F	98.3	No. of hourly data points >86.0°F	1999	--	--	--	0	32	234	625	618	145	0	0	0
			2000	0	0	0	0	94	272	569	652	103	0	--	--
Min. Temp °F	41.7	% of hourly data points >86.0°F	1999	--	--	--	0	4.20	32.5	84.0	83.1	20.1	0	0	0
Number	13220		2000	0	0	0	0	12.6	37.8	76.6	87.6	14.3	0	--	--
No. >86.0°F	3344														
% >86.0°F	15.3														

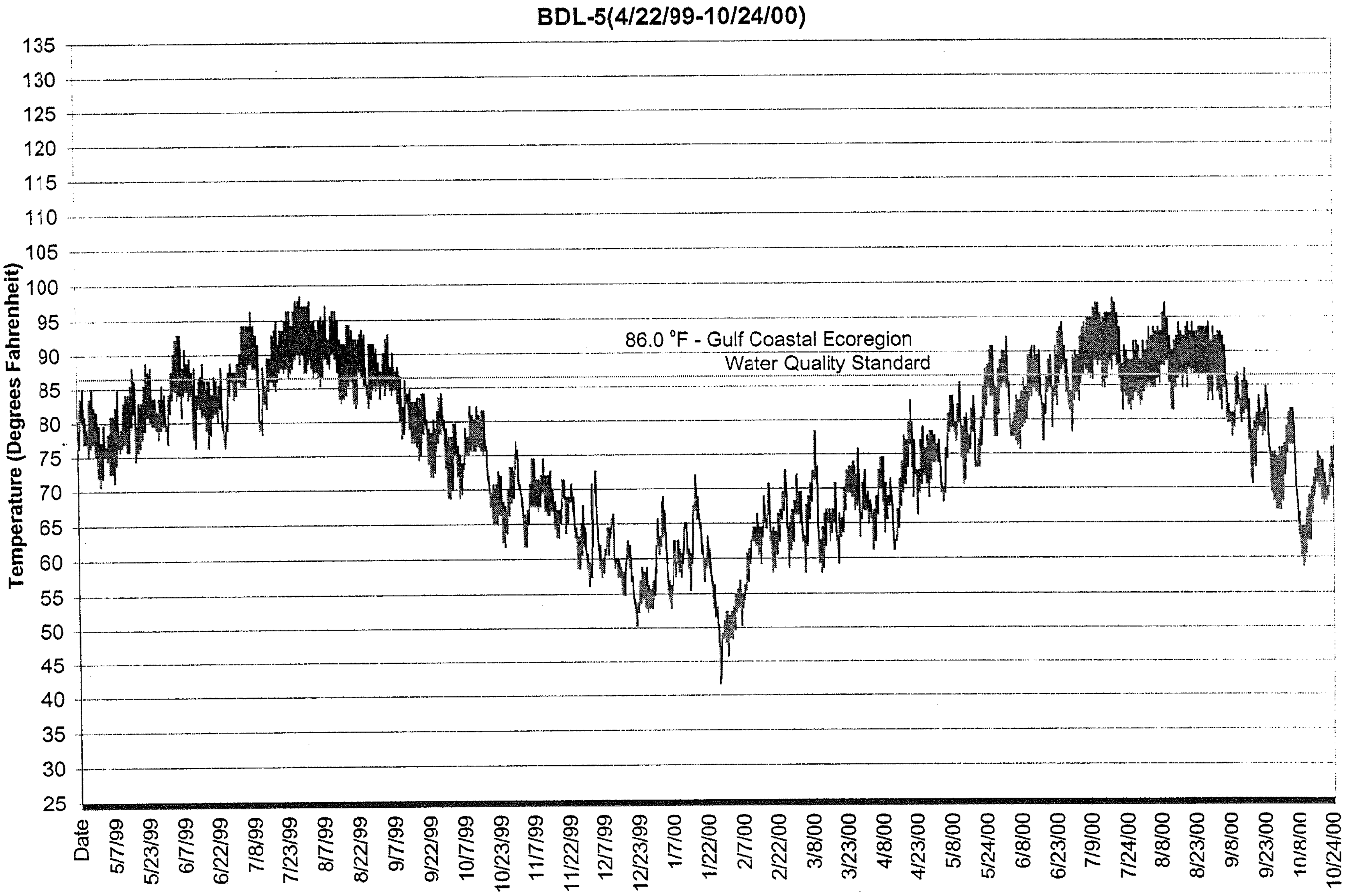


Figure 5.10. Water temperature of BDL-5 pre and post transfer project. POR April 1999-October 2000.

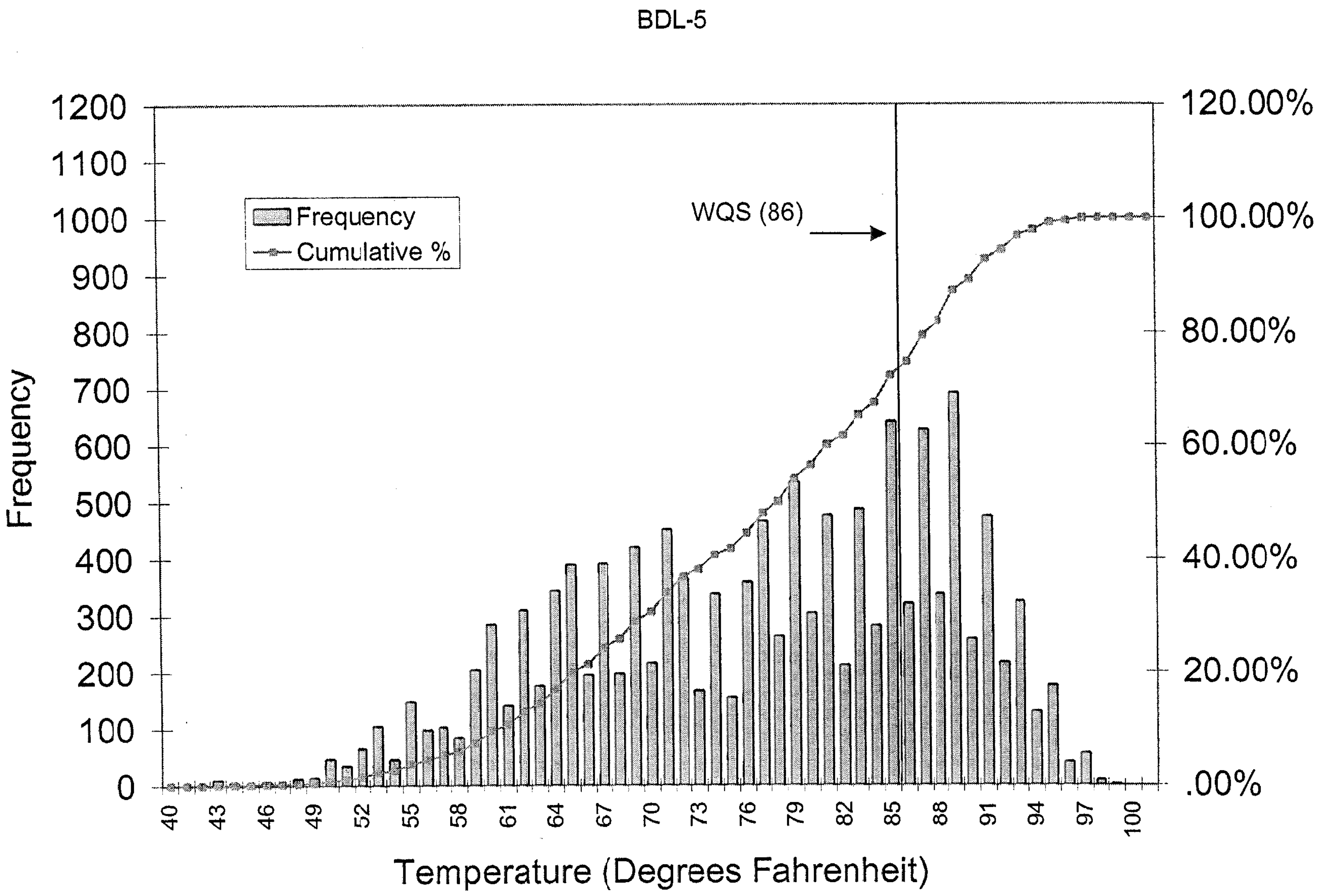


Figure 5.11. Frequency and distribution of hourly water temperatures at BDL-5. POR April 1999-October 2000.

5.4.1.6 Reach LC-1

The temperatures on Loutre Creek were measured upstream of its confluence with Bayou de Loutre. As described in Section 5.1, this reach is downstream of the discharge from Lion Oil Company and drains the majority of the City of El Dorado. During 1999, the water temperature exceeded the ecoregion WQS approximately 7% of the time. Eighty percent of the higher temperatures that exceeded the WQS were restricted to the July-August 1999 period. During this period, the water temperature exceeded the 86°F approximately 50% of the time (Table 5.6).

As demonstrated by Figure 5.12, storm events contributed to the variability and often reduced temperatures well below the WQS during the summer low flow, high temperature season. The storm events are reflected in the sudden decreases in water temperature followed by gradual increases to previous summer maximum temperatures.

Table 5.6. Summary of water temperatures from LC-1 as recorded by instream data loggers and adjusted to certified thermometer. POR April 1999-October 2000. GLCC-Central

Total Data Set		Hourly Data													
Average Temp °F	79.0	Parameter	Year	Month											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Max. Temp °F	95.5	No. of hourly data points >86.0°F	1999	--	--	--	0	21	86	378	381	102	0	0	0
			2000	0	0	0	18	165	293	480	423	124	0	--	--
Min. Temp °F	51.0	% of hourly data points >86.0°F	1999	--	--	--	0	2.8	11.9	50.8	51.2	14.2	0	0	0
Number	13221		2000	0	0	0	2.5	22.2	39.4	64.5	56.9	17.2	0	--	--
No. >86.0°F	2458														
% >86.0°F	18.6														

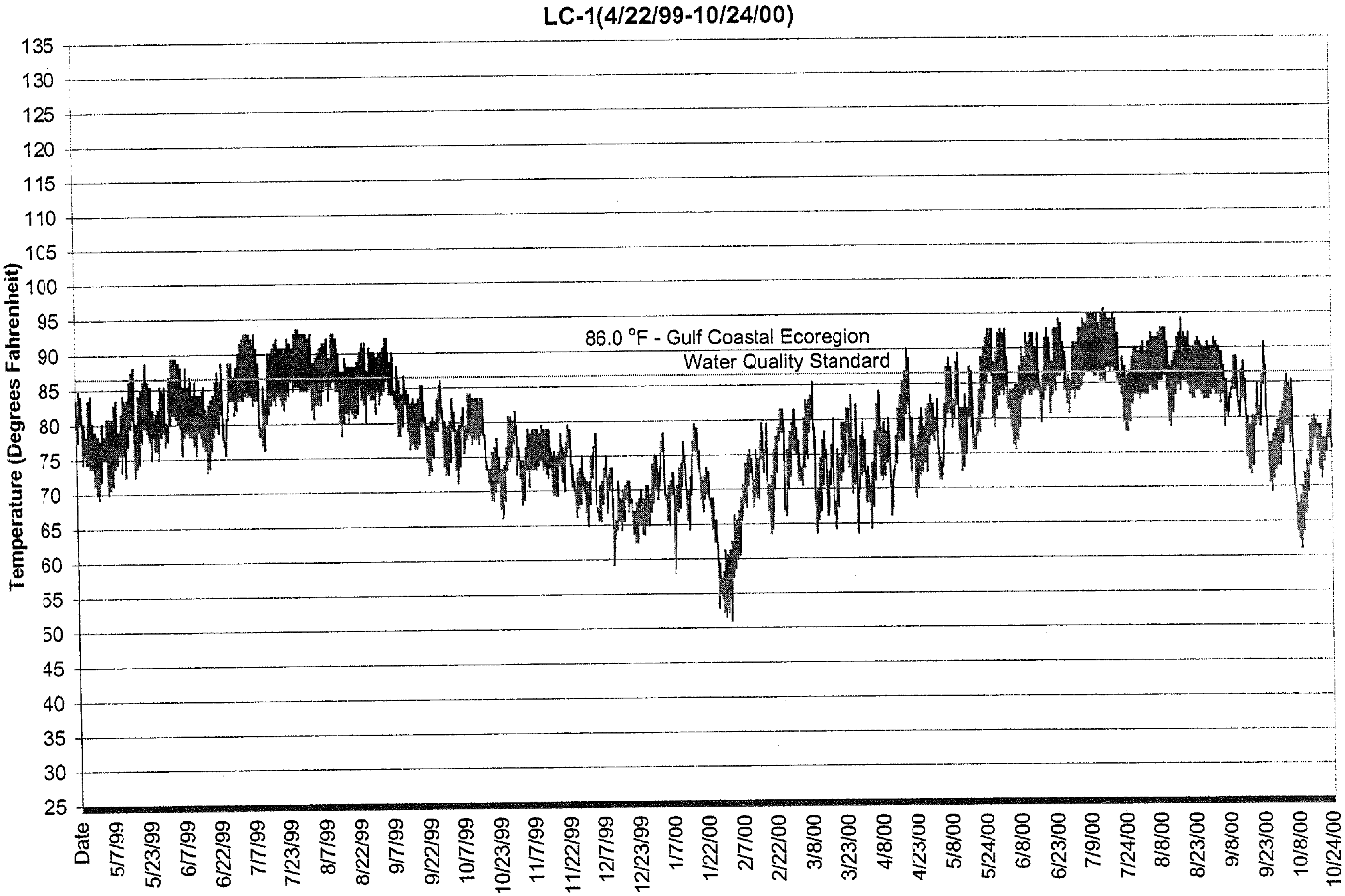


Figure 5.12. Water temperature of LC-1 pre and post transfer project. POR April 1999-October 2000.

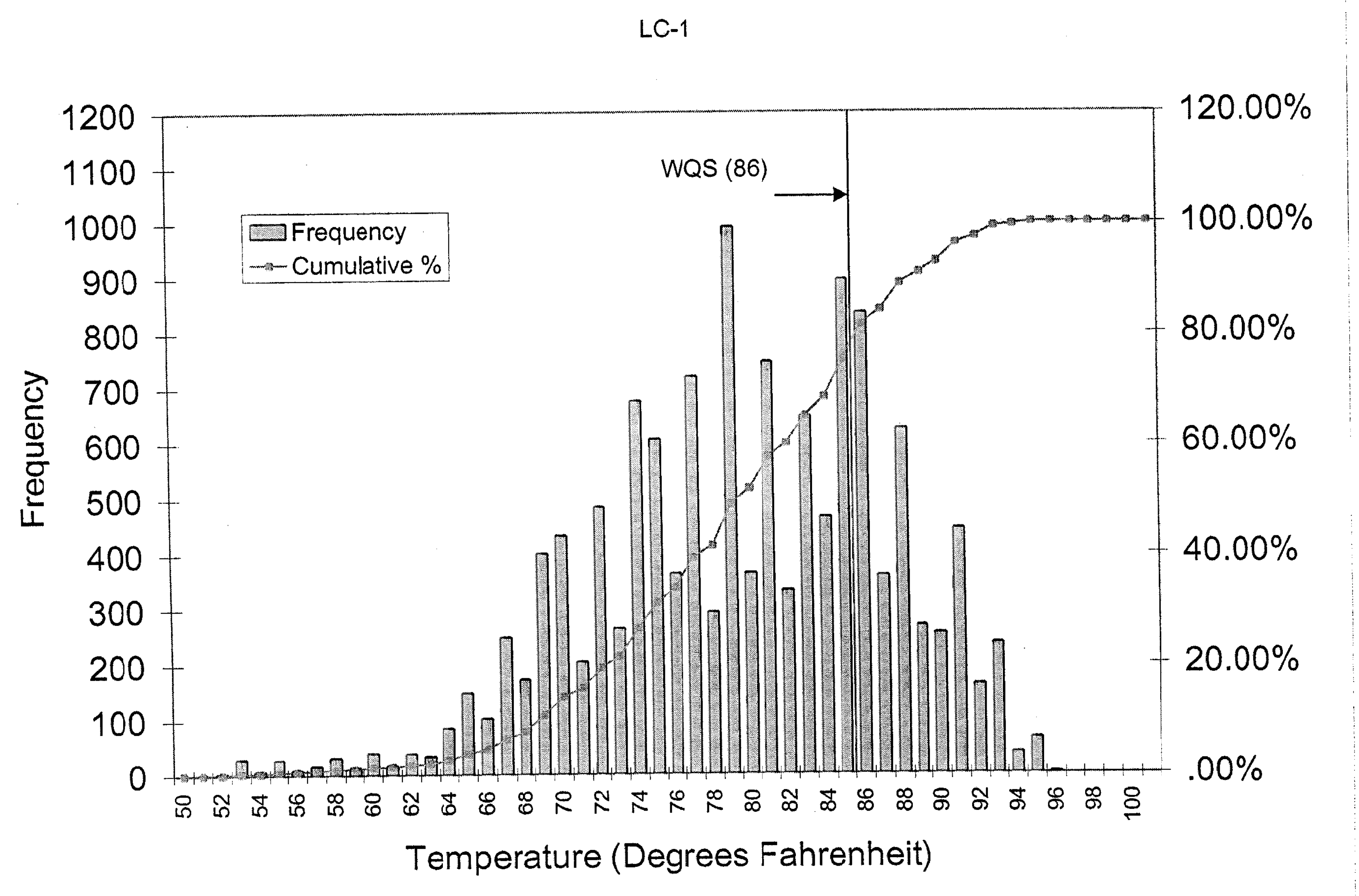


Figure 5.13. Frequency and distribution of hourly water temperatures at LC-1. POR April 1999-October 2000.

5.4.2 Bayou de Loutre Temperature Profiles After Transfer to Lion Oil Company

5.4.2.1 Overview

In addition to the comparison of individual summary tables of hourly temperatures on a per month basis that exceeded the ecoregion WQS, and the graphs of the individual reaches provided in Section 5.4.1, this section provides a comparison of water temperatures for the same period prior to and after the transfer of the Outfall 001 discharge. To facilitate these comparisons, the periods evaluated were from April 22 to October 10, 1999 and April 22 to October 10, 2000. These time frames encompass both the seasonal and critical low flow periods.

5.4.2.2 Reach BDL-1

Figure 5.14 illustrates the range of water temperatures prior to and after the transfer to Lion Oil. As indicated in Table 5.1, the water temperatures of Bayou de Loutre in this reach were not reduced in 2000 when compared to the same period in 1999. The water temperature at BDL-1 during the period from January through October 2000 demonstrated that the criterion for temperature for Bayou de Loutre in this location was not maintained during the low flow period, especially during July and August when 98% of the criterion exceedances were recorded (Table 5.1).

The water temperatures at BDL-1, upstream of Outfall 001, reflect the hotter than average summer during 2000 and illustrates why the existing ecoregion temperature criterion for Bayou de Loutre is not appropriate. Sixty-three percent of the BDL-1 water temperature measurements that exceeded the 86°F WQS occurred in 2000. During August 2000, the temperature criterion for the Gulf Coastal Ecoregion was exceeded approximately 25% of the time at BDL-1.

Also discussed in Section 3.5, the watershed of Bayou de Loutre at this location is less than 10 mi^2 and as indicated in Reg. 2., Bayou de Loutre should not be considered as having a perennial fishery use.

The temperature monitoring also reflected the variability in water temperatures as influenced by storm water contribution to the daily temperature cycle.

5.4.2.3 Reach BDL-1.5

Figure 5.15 illustrates the range of water temperatures before and after the transfer to Lion Oil. As indicated in Table 5.2, the water temperature of Bayou de Loutre in this reach was reduced in 2000 when compared to the same period in 1999. Following the discharge transfer to Lion Oil, the water temperatures were reduced in both range and magnitude.

As indicated in Figure 5.15, the distribution of the post transfer water temperature data at BDL-1.5 was typical of a natural bell curve with the majority of data points within the middle percentile of the range. Although the majority of the discharge was eliminated with the transfer to Lion Oil, the sporadic discharge from Outfall 001 does result in water temperatures that exceed the 86°F ecoregion WQS.

After the transfer of Outfall 001 discharge, the water temperatures in Bayou de Loutre were moderated from pre-discharge highs. Figure 5.4 demonstrates the response of instream temperatures to the sporadic discharges from Outfall 001. Instream temperatures increase temporarily, then return to pre-discharge temperatures as soon as the discharge is re-routed to Lion Oil. These events are reflected on Figure 5.4 as narrow spikes in temperature.

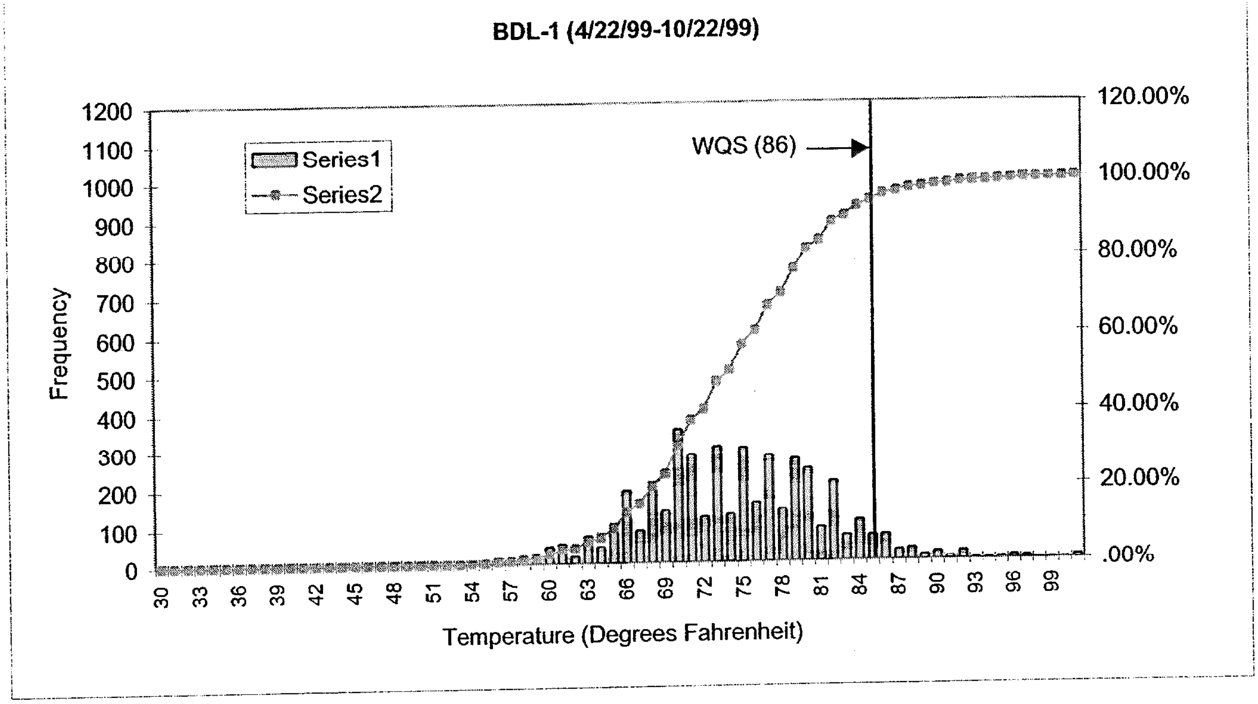
In addition to the sporadic larger discharge events created when Lion Oil cannot receive the Outfall 001 effluent, small volume discharges occur from Outfall 001 on a more routine basis. These discharges occur as a result of back pressure which results in weir box overflow. Table 3.3 summarizes the discharge events through Outfall 001 during the first seven-month period of transfer (February through October 2000). Based on the results of the aquatic life field survey completed in May 2000, the limited discharge does not preclude the designated uses for this reach of Bayou de Loutre.

5.4.2.4 Reach BDL-2

In contrast with pre-transfer conditions, the water temperatures in reach BDL-2 of Bayou de Loutre rarely exceeded the ecoregion temperature criterion after the transfer, despite periodic discharges from Outfall 001. This is a dramatic change from the nine-month period in 1999 prior to the transfer. As depicted in Table 5.3, during 2000, 86°F or greater was recorded approximately 1% of the time from January through October. During the critical season low flow high ambient temperature period (June through September 2000), 86°F was recorded a maximum of 6.3% of the time in any single month. The water temperature at BDL-2 during this period exceeded 86°F only for short periods of time which generally coincided with either the maximum ambient air temperature and/or when a large discharge event occurred from Outfall 001 (Figure 5.7).

Figure 5.16 compares the frequency distribution of 1-hour temperature data from 1999 and 2000. These figures demonstrate the effect of the sporadic discharge on water temperature at BDL-2.

The apex of the temperature distribution frequency curve decreased from 85°F to 81°F when compared to the same period in 1999. Also, the instantaneous maximum temperature recorded during the 2000 study period was 95°F compared to 98°F in 1999. The minimum temperatures were decreased from 69°F to 57°F. The temperature range was also expanded from 28 degrees (69°F - 98°F) to 38 degrees (58°F - 95°F). These shifts also reflect the minor decrease in minimum ambient air temperatures during the 2000 Winter/Spring period and a somewhat hotter average summer ambient air temperatures during the summer of 1999 (Figures 3.5 and 3.6).



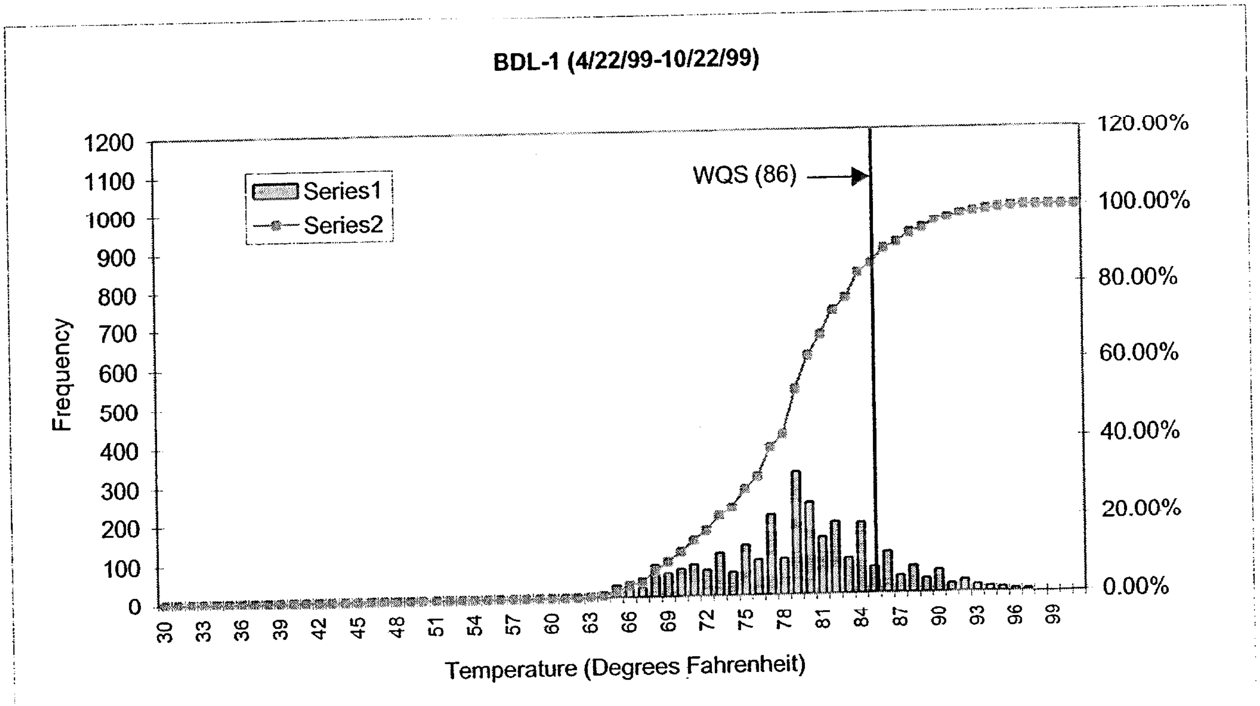
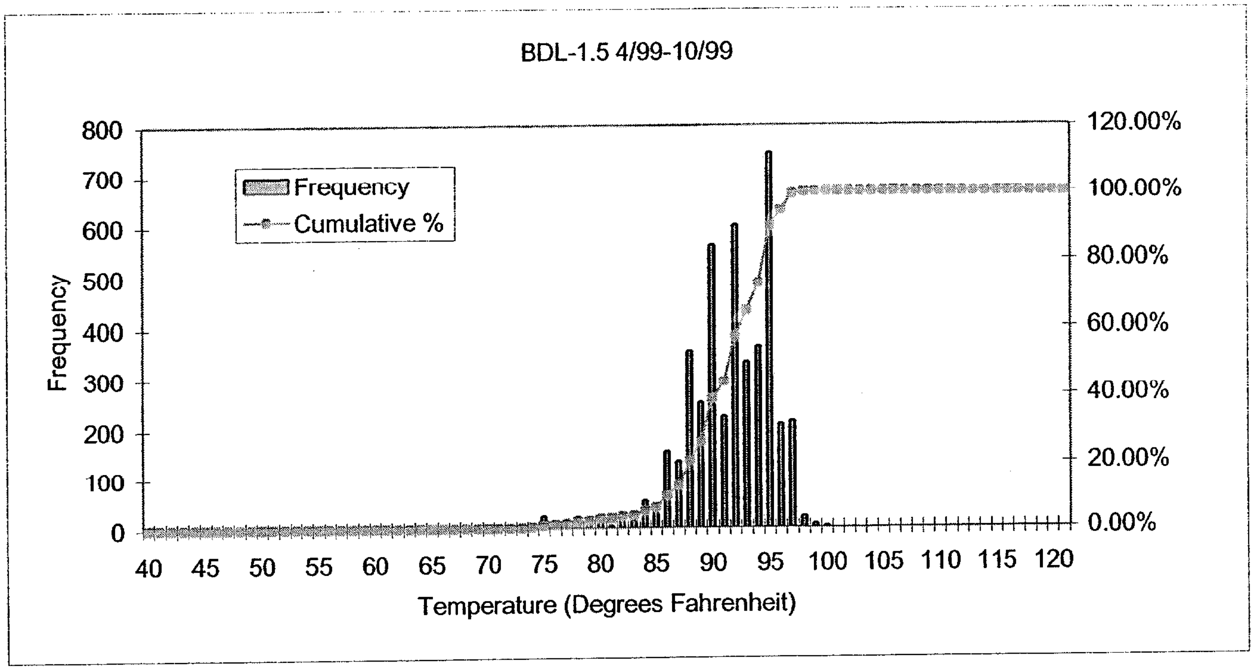


Figure 5.14. Comparison of hourly water temperature frequency distribution from BDL-1 before and after transfer of GLCC discharge to Lion Oil. POR April-October 1999 and April-October 2000.



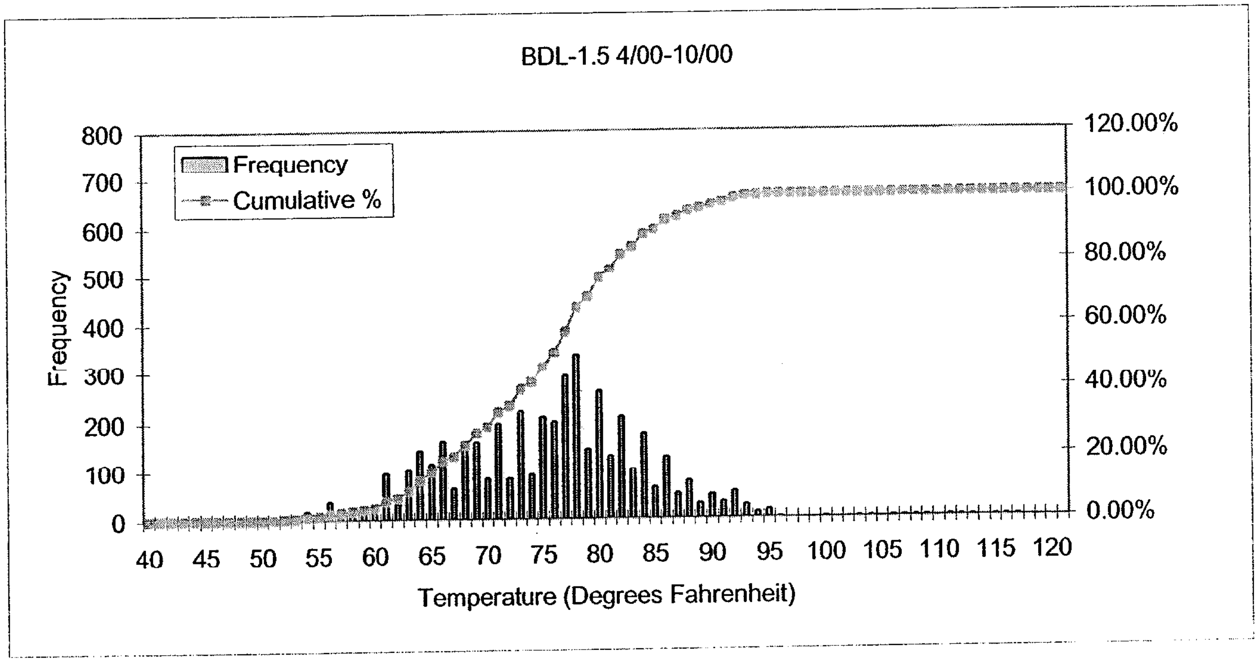
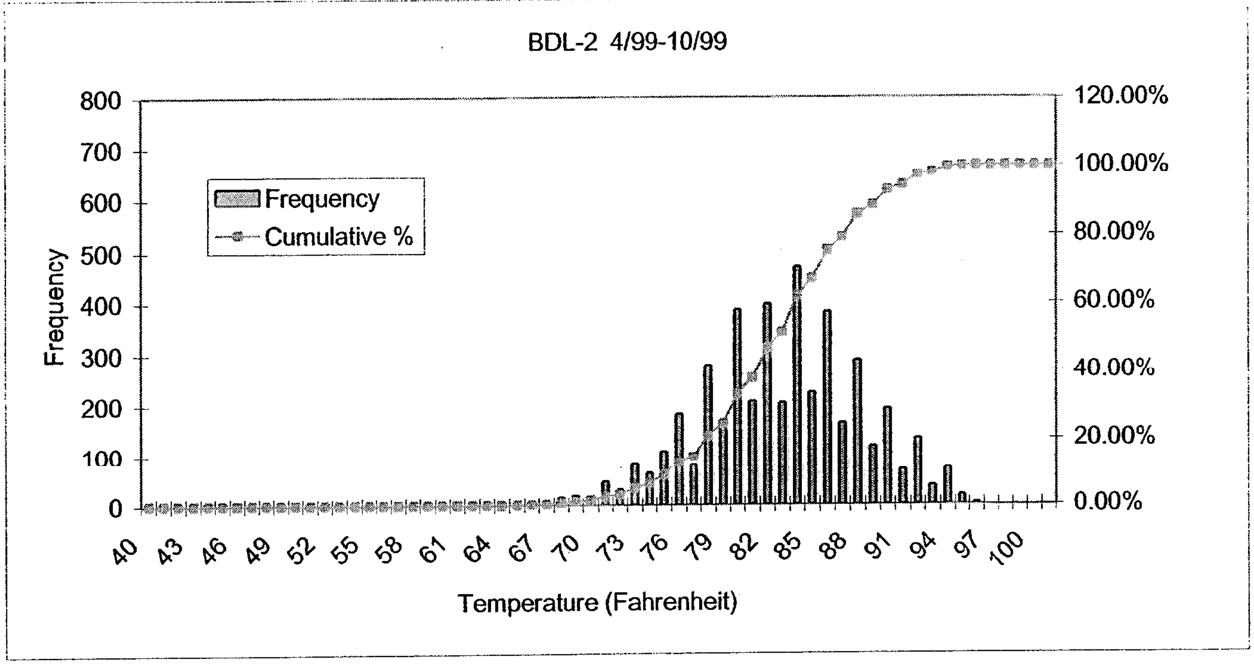


Figure 5.15. Comparison of hourly water temperature frequency distribution from BDL-1.5 before and after transfer of GLCC discharge to Lion Oil. POR April-October 1999 and April-October 2000.



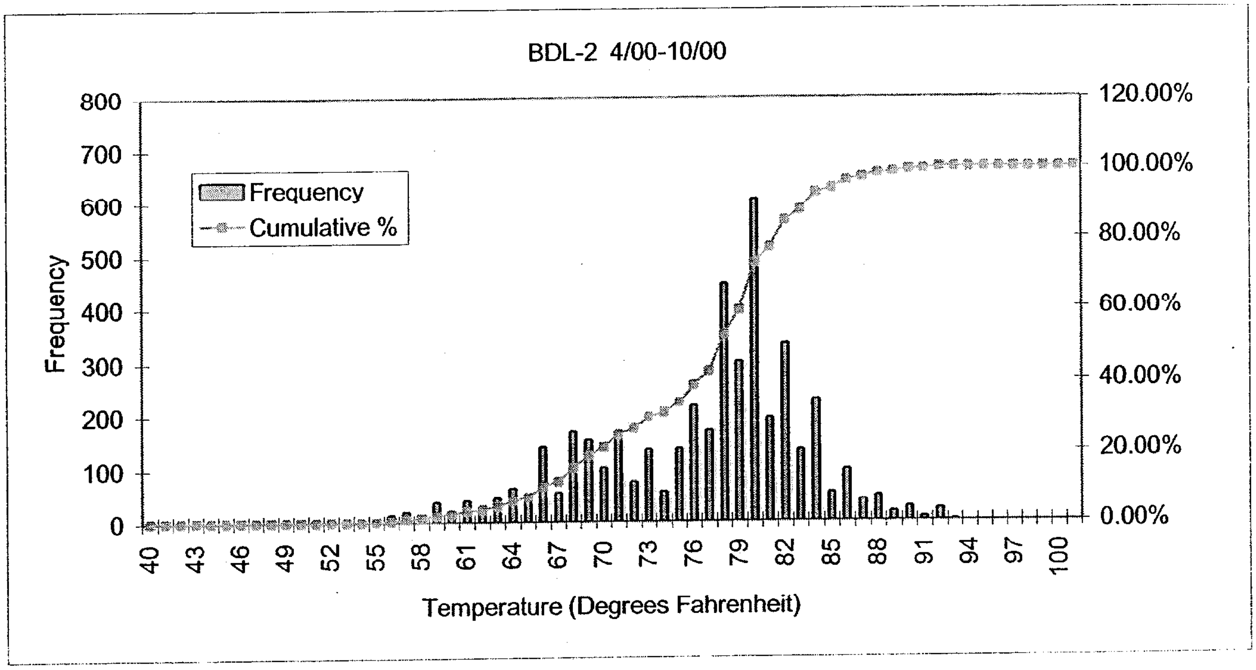


Figure 5.16. Comparison of hourly water temperature frequency distribution from BDL-2 before and after transfer of GLCC discharge to Lion Oil. POR April-October 1999 and April-October 2000.

5.4.2.5 Reach BDL-3

As indicated in Table 5.4, during 2000, water temperatures at BDL-3 did not exceed the Gulf Coastal Ecoregion standard of 86°F, even during the critical season from June through September. The maximum water temperature recorded during this period was 80°F.

Figure 5.8 reflects the temperature variation during the study period. The variability recorded at BDL-3 was greater than that demonstrated at BDL-1 or BDL-2. Based on review of storm event data, it appears the variability was strongly related to storm events and the contribution of storm water through Loutre Creek (Figure 5.11). As indicated in Figure 5.1, the BDL-3 monitoring point was just downstream of the mouth of Loutre Creek.

As discussed in Section 3.4, Loutre Creek drains a large part of the City of El Dorado and includes the point source discharge from Lion Oil Company.

Figure 5.17 illustrates the difference in water temperatures during the periods before and after the transfer of the GLCC-Central Outfall 001 effluent to Lion Oil. The shift in water temperatures reflects the transfer to Lion Oil Company. During the seven-month period from February through October 2000, the temperature range shifted downward, from a low of to 33°F to a maximum temperature of 93°F. When compared to the same period in 1999, the range of water temperatures at BDL-3 was 62°F to 97°F. A comparison of BDL-2, and BDL-3 demonstrates that the maximum water temperatures in Bayou de Loutre, downstream of Loutre Creek, were dominated during 1999 by Bayou de Loutre. However, the frequency distribution is determined by storm water inflows. After the transfer, the BDL-3 water temperatures were clearly dominated by the inflows from Loutre Creek both in frequency and magnitude.

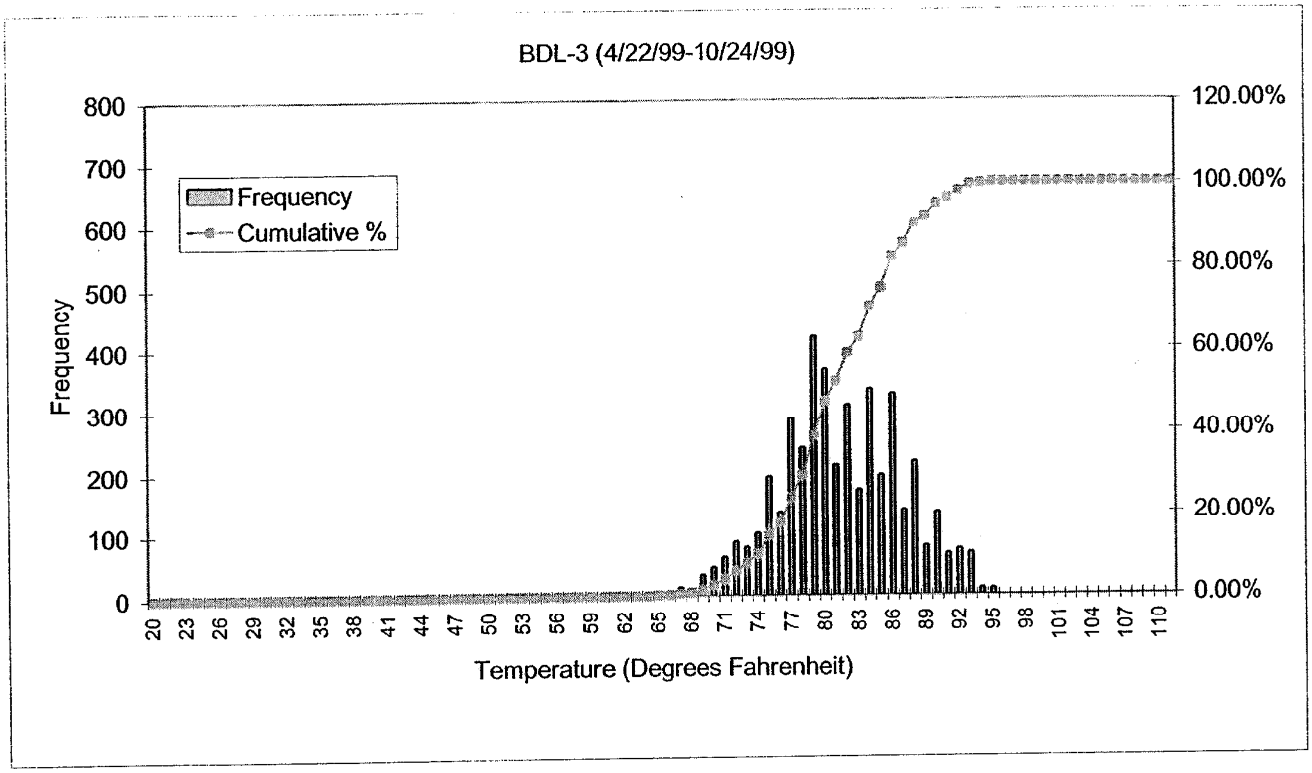
5.4.2.6 Reach BDL-5

In contrast to BDL-3, BDL-5 reflected an increase in the number of water temperature measurements greater than 86°F when compared to the same period in 1999 (Table 5.5). BDL-5 is located 2.0 miles downstream of the discharge from GLCC Outfall 001 and is approximately 0.5 mile downstream of the City of El Dorado's WWTP discharge. The increase demonstrated that the continuous discharge from GLCC-Central had little, if any, effect on the water temperatures on Bayou de Loutre, except for the near field reaches above BDL-2.

The summer maximum temperatures appear to be controlled by ambient air temperatures and solar influx. This condition is interrupted for short periods when storm events contribute increased flows in the watershed (Figure 5.10).

The water temperatures as recorded at BDL-5 support the conclusion that the Gulf Coastal Ecoregion water quality standard is not attainable for Bayou de Loutre, regardless of any contribution from GLCC-Central Outfall 001.

Figure 5.18 depicts a comparison of the pre and post transfer water temperatures of Bayou de Loutre at BDL-5. As indicated by the distribution of water temperatures, this reach had the smallest change in distribution and in temperature range between the periods prior to and after the transfer from Bayou de Loutre (ranges of 34°F vs. 38°F).



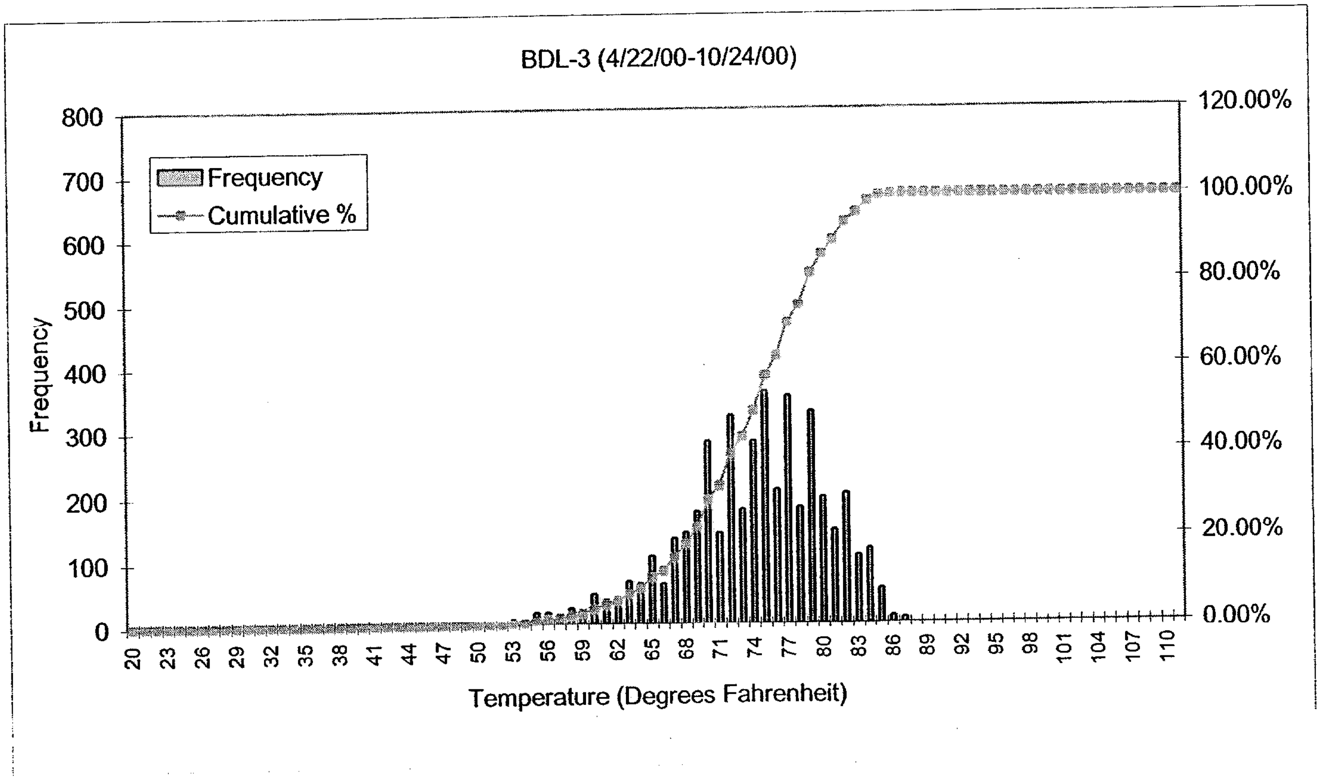
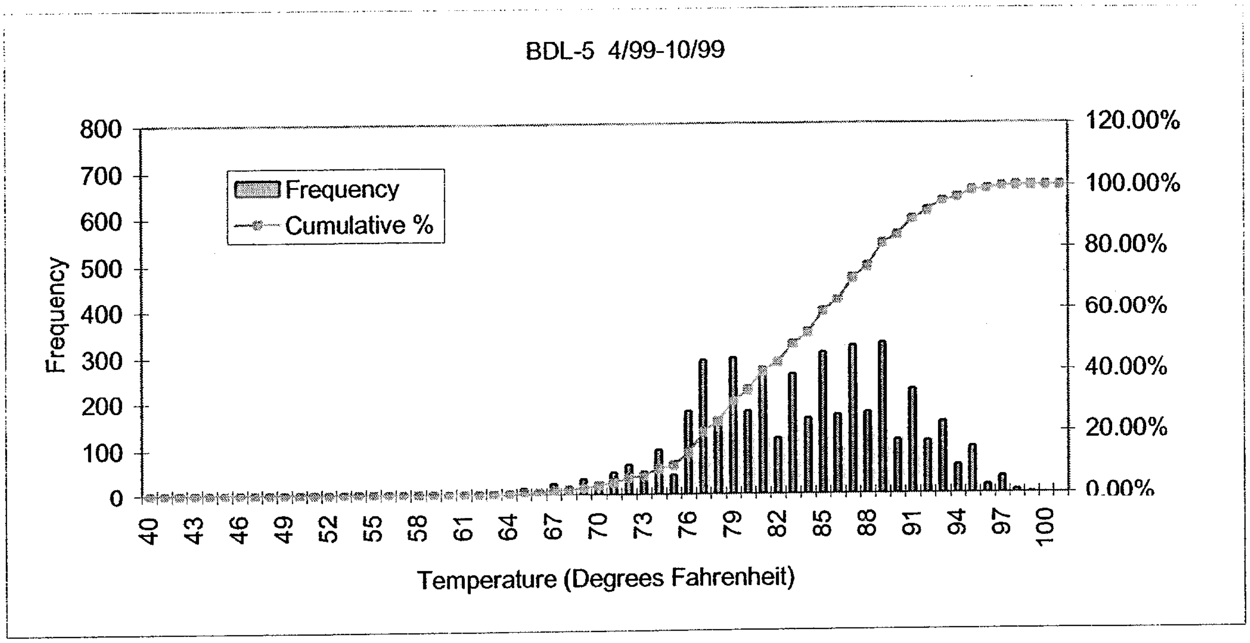


Figure 5.17. Comparison of hourly water temperature frequency distribution from BDL-3 before and after transfer of GLCC discharge to Lion Oil. POR April-October 1999 and April-October 2000.



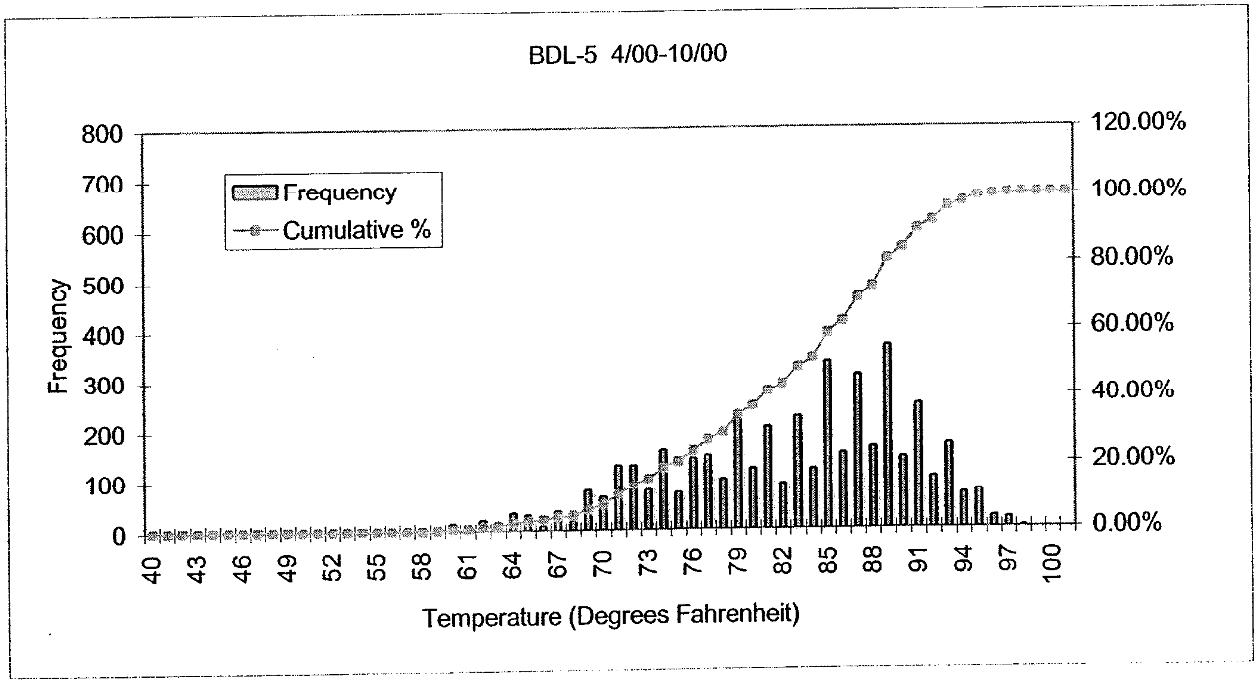


Figure 5.18. Comparison of hourly water temperature frequency distribution from BDL-5 before and after transfer of GLCC discharge to Lion Oil. POR April-October 1999 and April-October 2000.

5.4.2.7 Reach LC-1

The water temperatures in Loutre Creek during the 2000 monitoring period demonstrated a slight increase when compared to the same period in 1999 (Table 5.6). Sixty-one percent of the temperatures greater than 86°F were measured during the critical 2000 season. This increase reflects the hotter and dryer critical 2000 season relative to the same period in 1999 (Figure 3.5). The Lion Oil Company discharge was within its existing permit limits after the transfer from GLCC was initiated.

As indicated by Figure 5.13 (averages for 5/7/99 through 2/22/00), prior to the transfer project, the water temperatures in Bayou de Loutre were controlled by the discharge from GLCC-Central Outfall 001 upstream of the confluence with Loutre Creek. However downstream of Loutre Creek, the temperature regime of Bayou de Loutre is driven by the Loutre Creek contribution.

Also, flows from Lion Oil were not increased as a result of the transfer from GLCC-Central. Figure 5.19 provides a summary of the instream temperature monitoring in Loutre Creek. The general trends do not appear to be effected as a result of the transfer.

5.4.3 Seasonal, Daily and Storm Induced Effects

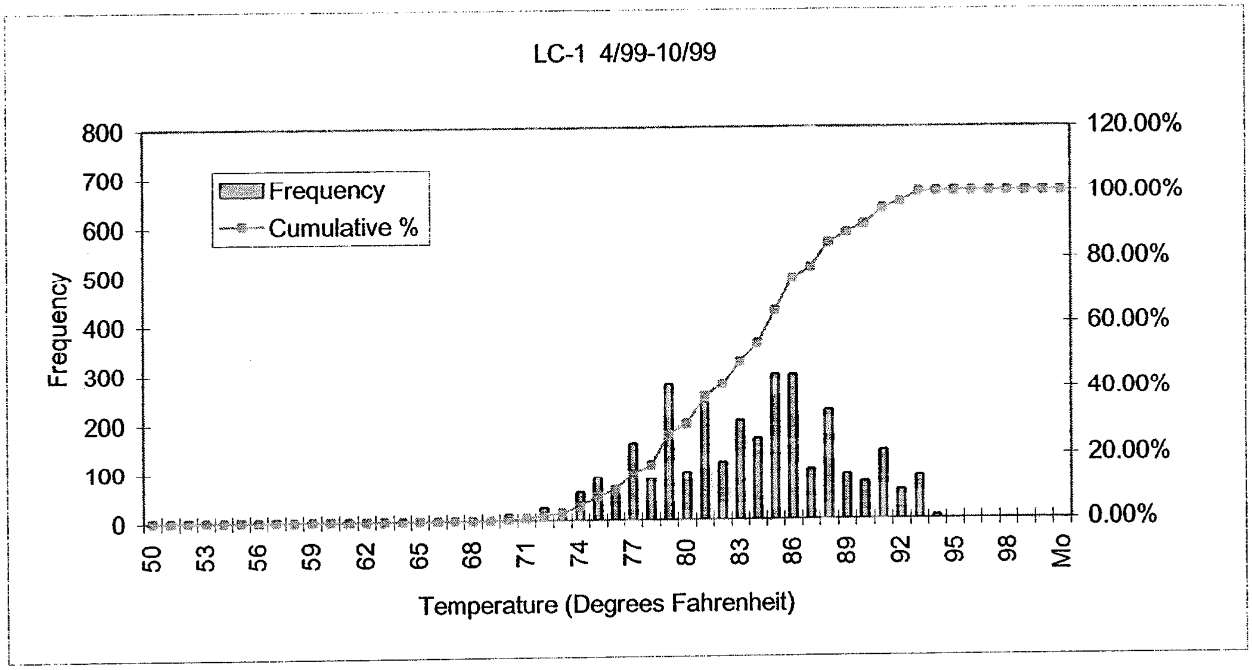
5.4.3.1 Seasonal Temperature Cycle

Seasonal temperature fluctuations are reflected in the data set presented in Appendix F (F1-F12). The seasonal cycle is depicted in all locations and reflects temperature cycles typical for gulf coastal streams. The continued discharges from GLCC-Central Outfall 001 did not interrupt the seasonal cycles. The temperature monitoring program supports the aquatic life field survey findings that the designated uses are being maintained despite the sporadic discharge from GLCC-Central that exceeds the existing ecoregion standard.

5.4.3.2 Storm Water Influence on the Temperature Cycle

Figures F-1 through F-6 (Appendix F) illustrate the effect of storm inflows to the daily water temperatures. The period selected represents a 1-day period during the summer low flow conditions. Figures F-1 through F-6 represent daily variation at individual stations from upstream most (BDL-1) to downstream (BDL-5). The storm event occurred on July 10, 1999. Figure F-1 represents upstream conditions with maximum temperatures just under 80°F. The storm event decreased water temperatures to 72°F. Daily variation was reestablished four days later on July 14, 1999.

Figure F-2 reflects the effects of the storm event at BDL-1.5. Water temperatures at this reach do not reflect a typical daily fluctuation as a result of the GLCC-Central discharge. The water temperatures were reduced to almost 75°F with the storm event. Pre storm water temperatures were not reestablished until July 15, 1999, five days after the start of the storm event.



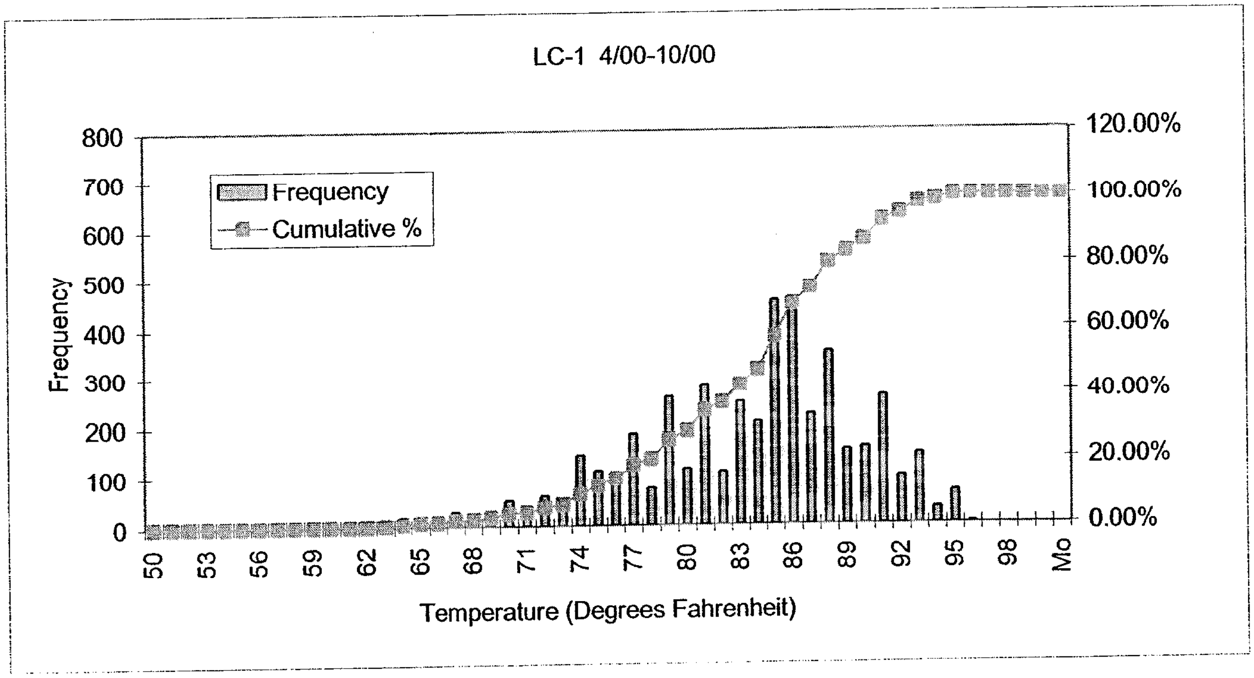


Figure 5.19. Comparison of hourly water temperature frequency distribution from LC-1 before and after transfer of GLCC discharge to Lion Oil. POR April-October 1999 and April-October 2000.

Figure F-3 depicts typical daily fluctuations typical of gulf coastal streams. The storm event depressed water temperatures approximately 10°F. The typical daily cycle was resumed on July 14, 1999.

Figure F-4 illustrates temperatures at BDL-3. As a result of the storm event, water temperatures were reduced to less than 80°F. A secondary decrease was captured as delayed inflows from Loutre Creek effected the typical daily cycle.

Figure F-5 demonstrates the effect at the downstream most reach (BDL-5). The initial reductions were extended and recovery of typical daily cycle was also extended.

Figure F-6 reflects the temperatures of Loutre Creek as a result of the storm event. The thermograph is almost identical to BDL-3, indicating that the storm flows from Loutre Creek control downstream water temperatures despite the continuous discharge from GLCC-Central Outfall 001.

Figures F-7 through F-12 characterize a typical 10-day cycle after the transfer to Lion Oil. Figure F-8 demonstrates a discharge event on July 10, 2000. This discharge disrupted the daily cycle typical of gulf coastal streams. However, as indicated by Figure F-8, the temperature cycle resumed after the discharge was eliminated. This daily cycle is different than that recorded during the same time period in 1999 (Figure F2). Figure F-9 (BDL-2) also demonstrates the spike created by the discharge. At BDL-3, (Figure F-10) the discharge spike did not effect the instream temperatures and the daily cycle was characteristic of the 10-day period. Also, the water temperatures during this period were less than 86°F. At BDL-5 (Figure F-11), the water temperatures were again exceeded the ecoregion temperature criterion.

5.5 Summary of Water Temperature in Bayou de Loutre

The following conclusions are provided based on the evaluation of the water temperature data collected during the 1999 monitoring period and the 2000 period. During 1999, prior to the transfer:

1) The water temperatures of Bayou de Loutre exceed the temperature criterion upstream of the discharge from GLCC-Central Outfall 001; therefore the temperature criterion for Bayou de Loutre is not attainable during the low flow critical season.

2) The water temperatures of Bayou de Loutre downstream of Loutre Creek are controlled by inflows from Loutre Creek, where the temperature criterion was exceeded 50% of the time during the critical season.

3) The temperature criterion was not maintained downstream of the confluence of Bayou de Loutre and Loutre Creek during the critical season from late May through mid-September as indicated by water temperatures at BDL-5.

4) Due to small watershed sizes and urbanization of the watershed, the water temperatures of both Bayou de Loutre and Loutre Creek are responsive to storm event inflows.

5) The water temperatures exceeded the temperature criterion downstream at BDL-5 more than twice as often than at BDL-3 because of ambient air temperature, lack of stream canopy, and limited shading (i.e., natural conditions).

During the 2000 monitoring period after the transfer to Lion Oil was completed:

1) The temperature criterion were exceeded at BDL-1 upstream of the discharge during the critical low flow season.

2) The frequency and duration of exceedances of the 86°F temperature criterion at BDL-1.5 were directly related to a discharge event during the August time period.

3) As a result of the continuing limited discharges from the Outfall 001, the water temperatures in Bayou de Loutre continued to exceed the current temperature criterion in a small section of Bayou de Loutre just downstream from the discharge from GLCC-Central Outfall 001 despite transfer of the majority of non-contact cooling water.

4) The water temperatures at BDL-1.5 and BDL-2.0 exceeded the temperature criterion at a reduced rate during the critical low flow, high temperature period as a result of the transfer.

5) At BDL-3, the temperature criterion was maintained during the low flow critical season 2000 period despite sporadic discharges from GLCC-Central Outfall 001.

6) The transfer of non-contact cooling water to Lion Oil did not significantly modify the temperature in Loutre Creek. There was no substantial increase in the frequency of water temperatures that exceed the temperature criterion.

7) The water temperatures at BDL-5 were not modified as a result of the transfer. However, the temperature criterion was exceeded in this reach of Bayou de Loutre.

6.0 ALTERNATIVE ANALYSES

This section summarizes the alternatives for the GLCC-Central facility to maintain the temperature criterion for Bayou de Loutre. As seen in Sections 3.0 and 5.0, the designated aquatic life use of Bayou de Loutre is being maintained. However, the WQS criterion for temperature is not being maintained, even with completion of the transfer project.

The following alternatives were considered to address the situation:

1) no action,
2) no discharge,
3) hydrograph controlled release,
4) treatment to reduce temperature prior to discharge at Outfall 001,
5) source reduction/pollution prevention,
6) cooling/holding pond construction and operation,
7) deep well injection, and
8) development of site specific temperature criterion.

6.1 No Action

This alternative would maintain the current discharge situation. It is projected that instream exceedences of the WQS criterion for temperature will continue to occur under critical conditions. For this reason, this alternative is not considered to be feasible.

6.2 No Discharge

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

As provided in Section 3.2, GLCC-Central employs approximately 800 workers (700 employees plus 100 on site contractors) with an annual payroll estimated at approximately $41 million. In addition, GLCC pays approximately $4.4 million in local and state taxes ($2.7 sales and use tax/$1.7 property tax). GLCC is a significant employer in Union County. This alternative would require the cessation of operations at GLCC, an action that would greatly effect the local economy.

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

6.3 Hydrograph Controlled Release (HCR)

The feasibility of a HCR was examined as an alternative for minimizing the impact of GLCC-Central's discharges with elevated temperatures. In GLCC-Central's situation, an HCR system would not achieve compliance with the ecoregion temperature water quality criterion, because the hydrology of the Bayou de Loutre is impacted by limited watershed size (<6 mi^2) at the outfall location. Also, the thermal cooling capacity of a collection and storage system needed to manage flows under a HCR discharge system would not provide the reduction in water temperature during the critical low flow season. The HCR discharge operational scenario is not considered to be feasible.

6.4 Treatment (Cooling Tower)

In conventional discharge situations the reduction of temperature may be accomplished through the use of cooling towers. However, the use of cooling towers is not feasible for Outfall 001 due to the wide variability of flow resulting from transfer project operations.

As detailed in Section 3.3.3, due to the transfer project, Outfall 001 discharges approximately 58% of the time. The volumes of these sporadic discharges range from trace (<500 gallons) to approximately 1.8 million gallons per day. Approximately 85% of the discharge events are less than 2,500 gallons per day.

An engineering analysis of a cooling tower sized to handle the historical pre-transfer flow of 1,500 gpm resulted in a capital cost of approximately $901,000 with an annual operating cost of about $452,000. These costs are not feasible for a treatment unit that would not be utilized 42% of the time and would be used at its design capacity less than 1% of the time. The detailed engineering cost analysis is provided in Appendix G.

Cooling tower design and function are not amenable to variable flow rates. During periods when the cooling tower was not being used for Outfall 001 discharges or when the discharge was not at peak rates, fresh water from the Sparta Aquifer would be required up to a maximum 1500 gpm to maintain circulation in the tower, thus negating the conservation benefits from the transfer project. Also, an additional 14 million gallons per year of fresh makeup water will be required for operation of the cooling tower. This will conflict with the success of the transfer project.

6.5 Source Reduction/Pollution Prevention

The elevation of the water temperature of discharges from Outfall 001 is primarily the result of non-contact cooling within the manufacturing process. The transfer project represents a significant source reduction effort, which GLCC-Central voluntarily completed.

As discussed previously, the completion of the transfer project resulted in substantial flow reductions from Outfall 001, both in terms of frequency and volume. It is estimated that the total volume of flow from Outfall 001 will be less than 10% of the historical pre-transfer flow on an annual basis.

Along with the direct Sparta Aquifer water conservation benefits, which resulted from the transfer project, there is an additional benefit in the form of energy savings, by Lion Oil through the utilization of the pre-heated water.

6.6 Cooling/Holding Pond Construction and Operation

The analysis for this alternative was conducted for two different pond-operating scenarios. These involve the use of a pond for a holding basin or for cooling of the Outfall 001 discharges. These are presented in this section after a discussion of pond siting and construction issues.

Pond Siting and Construction Issues

A major limitation in the use of ponds in relation to the Outfall 001 discharge is the availability of land at the site in relation to the physical location of the transfer facilities. As discussed in the following sections, the construction of ponds requires land that simply is not available in the immediate vicinity of the transfer facilities and the Outfall 001 location. Consequently, any ponds to be constructed would have to be located approximately one mile away from the discharge location. This would require additional piping and pumping equipment in addition to the cost of constructing the ponds as discussed below. We estimate the costs associated with the siting of a pond away from the Outfall area as $450,000 independent of the costs associated with the construction of the ponds themselves.

Holding Pond

There is a major limitation to the use of holding ponds for the purpose of recycling Outfall 001 discharges back to the GLCC-Central facility. This is simply the fact that the quality of the water discharged from Outfall 001 is such that it cannot be used in the manufacturing processes at the GLCC-Central facility without additional treatment.

Therefore, the only theoretical use of a holding pond would be to contain Outfall 001 discharges until such time as the water could be sent on to Lion Oil via the transfer pipeline. This is not feasible because GLCC-Central, which operates continuously, generates the water for transfer to Lion Oil every day. This daily flow would continue independent of whether stored water from the infrequent significant discharges from Outfall 001 would be available for future use by Lion Oil. Because the mechanism is not available for Lion Oil to utilize the surplus water (i.e., excess of 2 MGD), the infrequent discharges from Outfall 001 would remain in the GLCC holding pond which would accumulate precipitation and ultimately discharge in response to storm events.

A very large pond would be required to hold long periods of contribution from Outfall 001 without any discharge. For example, a pond to handle 30 days of Outfall 001 discharge would require a storage volume of 60 million gallons of water. This would require a pond that is 8 feet deep and one million square feet in area (23 acres). The construction cost for such a pond would be approximately $1.8 million including the required industrial grade liner.

As stated above, GLCC does not own enough property to allow construction of a 23-acre pond in the vicinity of the Outfall 001 discharge/transfer location and would have to site the pond at another location as discussed above. The piping and pumping construction costs would further add $450,000 to this option in addition to annual energy and operating/maintenance costs.

Cooling Pond

The cooling pond basis evaluated by GBM^{c} & Associates included construction of a shallow basin (to maximize atmospheric heat transfer) with approximately three days' retention time. The four-acre basin and associated pumping facilities would require an area approximately ten acres in size. Land tracts adjacent to Outfall 001 are not currently listed for sale. To entice an existing landowner into selling, a premium would have to be offered by Great Lakes. Previous experiences in acquiring land near El Dorado by Great Lakes indicate that there is no upper limit to land costs under this scenario. Realistically, a capture and transport system would be required for water not used by Lion Oil to be returned to Great Lakes approximately one mile away.

Regarding seasonal compliance with the temperature criterion, because the discharge to and from a cooling pond would not be steady state, it is difficult to predict the level of ambient cooling which may be achieved. Using the mean temperature for January/February, a four-acre basin could be expected to discharge 65°F water if used at 1,500 gallons per minute continuously, with cooler water possible if discharges occur intermittently and infrequently. Very limited cooling would occur during the period May–August, with projected temperatures exceeding 86°F. Thus, the most reasonable expectation of the outcome from a cooling basin would be some buffering of the warm influent by commingling it with ambient (likely cooler) water stored in the basin.

Nevertheless, assuming a land cost of $200,000, lined basin construction cost of $180,000 and surface facility construction cost of $250,000, the estimated minimum initial cost to provide a cooling impoundment is $630,000. Annual operating costs will be equal to those discussed for ponds in our January 25 letter.

6.7 Deep Well Injection

Based on Great Lakes' experience with deep-well injection systems in South Arkansas, it is technically possible to dispose of the cooling water via underground injection. Collection of excess water from Outfall 001 would require construction of systems to capture the water at the Outfall 001 location and transfer it away to another location for storage and/or processing prior to disposal by deep-well injection. Because of the intermittent nature of the need to dispose of cooling water, injection systems must be designed to dispose of the potential maximum daily discharge (1.8 million gallons per day).

The following are cost estimates based on the drilling and completion of six injection wells (five operational, one standby) in the Hosston Formation (approximately 5,000 feet subsurface) with a maximum disposal rate of 300 gallons per minute each. Included in the cost estimates are surface facilities, pumps, and transfer pipelines to the new wells considering that they must be located some distance from the existing wells near the Central Plant, and installed on a minimum two-mile spacing to mitigate the cumulative pressure buildup in the injection zone of the new and existing Hosston disposal wells.

In addition to capital costs, the annual operating costs associated with deep-well disposal include permitting and preparation of ADEQ reports, integrity testing, energy for injection pumps (250 HP each) and maintenance/labor. The summary of construction costs for the series of injection wells, connecting pipelines, storage tank and surface pumps to transport and subsurface inject the cooling water as well as annual operating costs is presented in the table below.

Estimated Costs for Deep-well Disposal of GLCC Cooling Water

Item	Capital Cost	Annual Cost
Drilling and completion of Hosston injection well X 6	$9,000,000	
Surface facilities including surge tank and injection pumps+cooling water capture & transport system	$10,000,000	
Pipelines (includes easements and construction @ 15 miles)	$15,000,000	
Permitting and reporting X 6		$240,000
Testing X 6		$60,000
Energy (58 % uptime based on current discharge frequency, @ $0.05/kWh)		$50,000
Maintenance/Labor		$195,000
Total	**$34,000,000**	**$545,000**

6.8 WQS Modifications

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

6.8.1 Uses and Protective Criteria

As discussed previously, the WQS consist of two elements: Designated Uses and Protective Criteria. Under the provisions of Section 2.106 of the WQS, the following definitions are applicable:

> "Designated Uses: Those uses specified in the water quality standards for each waterbody or stream segment whether or not they are being attained. "

As can be seen by this definition, waterbody uses are designated whether or not they are existing uses. The WQS defines an existing use as:

> "Existing Uses: Those uses listed in Section 303(c)(2) of the Act (i.e., public water supplies, propagation of fish and wildlife, recreational uses, agricultural and industrial water supplies and navigation) which were actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards. "

The following subsections present a discussion of designated uses, existing uses and the maintenance of protective criteria related to the aquatic life uses of Bayou de Loutre.

6.8.1.1 Designated Uses

Bayou de Loutre lies within the Gulf Coastal Ecoregion. At the Outfall 001 discharge location, it has the following designated uses under the WQS.

Seasonal fishery - streams which have less than 10 mi^2 watershed and average flows are less than 1 cfs.

Secondary contact recreation - "This beneficial use designates waters where secondary activities like boating, fishing, or wading are involved."

Domestic water supply - "This beneficial use designates water which will be protected for use in public or private water supplies. Conditioning or treatment may be necessary prior to use."

Industrial water supply - "This beneficial use designates water which will be protected for use as process or cooling water. Quality criteria may vary with the specific type of process involved and the water supply may require prior treatment or conditioning."

Agricultural Water Supply - "This beneficial use designates waters which will be protected for irrigation of crops and/or consumption by livestock."

6.8.1.2 Existing Uses

Only one of the designated uses was documented as existing for Bayou de Loutre in relation to the Outfall 001 location. This documented existing use was the Seasonal Gulf Coastal Fishery as discussed in Section 4.5.

None of the other designated uses was documented as existing, but are not precluded due to water quality. The domestic water supply, agricultural water supply, and industrial water supply designated uses may be limited due to volume of instream water because of the extremely small watershed size.

6.8.1.3 Protective Criteria for Bayou de Loutre

The current protective criterion for temperature for Bayou de Loutre is listed in Section 2.502 of the WQS, which reads as follows:

> *"Heat shall not be added to any water body in excess of the amount that will elevate the natural temperature, outside the mixing zone, by more than 5°F (2.8°C), based upon the monthly average of the maximum daily temperatures measured at mid-depth or three feet (whichever is less) in streams, lakes, or reservoirs. Maximum allowable temperatures from man-induced causes in Typical Gulf Coastal waters is 30°C (86°F)."*

This protective criterion for temperature has an ecoregion basis and is related to the maintenance of aquatic life uses.

As documented through the field studies and long-term ambient monitoring, this protective criterion for temperature is not consistently maintained on a seasonal basis.

However, as seen by the aquatic life studies, there is an existing Gulf Coastal Fishery use in Bayou de Loutre and the fishery downstream of the Outfall 001 location is better than the upstream condition.

6.9 Proposed Daily Maximum Criterion

The instream temperatures of Bayou de Loutre at Reach BDL-1.5 were used to develop the proposed site specific criteria. Three statistical approaches were used in the development of the proposed daily maximum criterion.

6.9.1 Mean Value Methodology

This methodology applies the mean of the data set, plus two standard deviations to determine the appropriate temperature criterion. Using this methodology, the site specific temperature criteria would be 96°F and was developed as follows:

Mean = 74.1°F
Standard Deviation = 10.7°F
Therefore: 74.1°F + 10.7°F(2)
74.1°F + 21.4°F
95.5°F (96°F)

6.9.2 99th Percentile Value Criterion

In an effort to determine an appropriate instream water quality standard for temperature in Bayou de Loutre a 99th percentile value for temperature was calculated for the data collected at station BDL-1.5. The 99th percentile value resulting from the calculation was 98.9°F. The total number of data points included in the analysis was 7,867 taken at hourly intervals between December 1, 1999 and October 24, 2000. Fifteen data points were considered to be outliers and were omitted from the analysis. The outliers occurred on May 25-26, 2000 for approximately fifteen hours. The temperature of the data set ranged from 48.1°F to 95.5°F with an average of 74.1°F (Table 6.1).

Table 6.1. Summary of hourly temperature data from BDL-1.5.
POR 12-1-99 to 10-24-00.

Statistic	Temperature (°F)
Average(mean)	74.1
Minimum	48.1
Maximum	95.5
Standard Deviation	10.7
N	7867
99%tile	98.9
95%tile	91.6

The 99th percentile was calculated according to the following formula:

99th Percentile $= \overline{X} + Zp * s$ (Gilbert, 1987)

Where: $\overline{X}$ = average temperature of data set,
Zp = pth quantile of the standard normal distribution (for a p of 0.99 Z = 2.326), and
s = standard deviation of temperature data set.

Calculations were based on the temperature data having a normal distribution as demonstrated in Figure 6.1. A data set can be assumed to be drawn from a normal distribution if n is sufficiently large and the underlying distribution can be assumed to be normally distributed, as would be the case with long term temperature data (Gilbert, 1987).

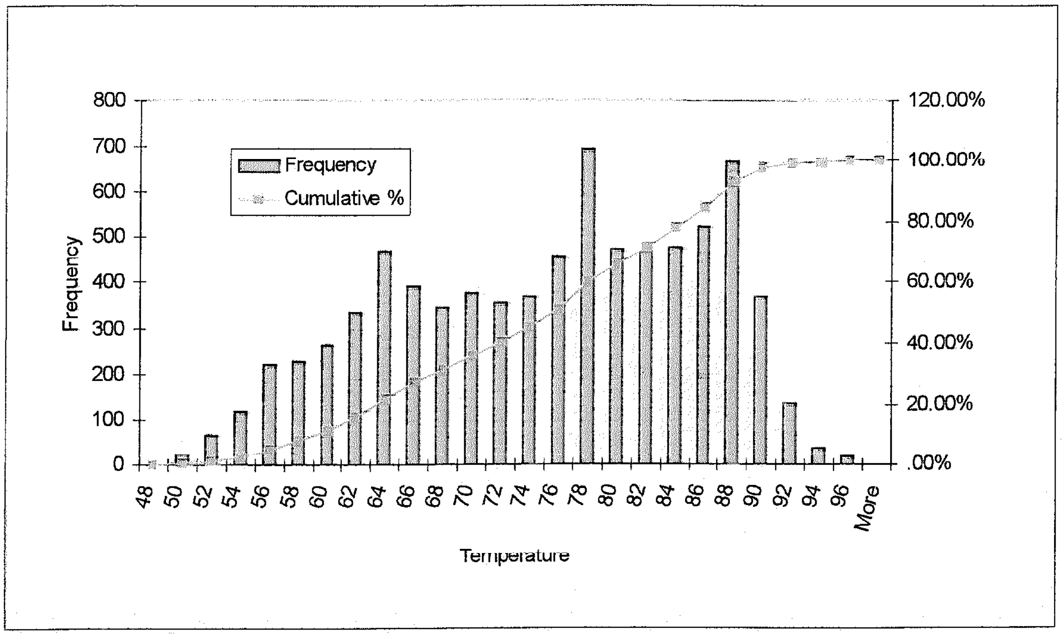


Figure 6.1. Distribution of temperature data for BDL-1.5 for December 1, 1999 to October 24, 2000.

6.9.3 Mean Daily Maximum Value

In addition to the previous statistical methods, a third statistical approach was used to determine an instream temperature criterion. This approach used the mean of the daily maximum values for BDL-1.5 recorded during the months of July, August, and September 2000. Using this methodology, the site specific criterion was 96°F and was developed as follows:

Mean = 83.0°F
Standard Deviation = 6.4°F
Therefore 83.0°F + 6.4°F(2)
83.0°F + 12.8°F
95.8°F (96.0°F)

This is the same value derived using the methodology in Section 6.9.1

6.10 Δ5°F Criterion Discussion

As discussed in Section 6.8.1.3, the temperature criterion under the WQS reads as follows:

> *"Heat shall not be added to any waterbody in excess of the amount that will elevate the natural temperature, outside the mixing zone, by more than 5°F (2.8°C) based upon the monthly average of the maximum daily temperatures...."*

In order to determine whether an amendment to the Δ5°F temperature criterion was required based on post-transfer operations, temperatures were calculated as instream waste concentrations (IWC). This was done for November 2000 through April 2001 (seasonal period) when the Δ would most likely be elevated. Daily average effluent temperatures and total flow were used in the analysis for Outfall 001. Upstream temperatures (BDL-1) were assumed to be equivalent to the monthly average of daily maximum temperatures recorded during corresponding months of the study (i.e., November 1999 through April 2000). Upstream flow was set at the 1 cfs default. For each day an IWC for temperature was calculated for BDL-1.5 using the temperatures and flows from BDL-1 and Outfall 001. The difference between the temperature at BDL-1 and BDL-1.5 was the Δ (Figure 6.2).

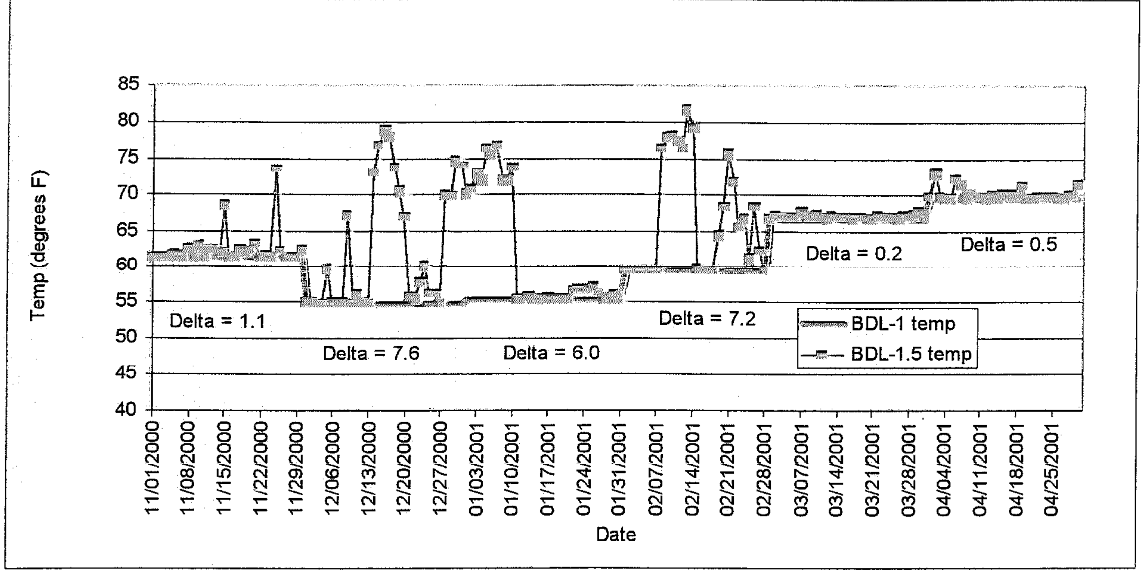


Figure 6.2. Temperature difference expected between BDL-1 and BDL-1.5 resulting from effects of Outfall 001.

Based on this analysis the average monthly Δ value was 3.76°F, which falls within the Δ5° criterion. Therefore, no amendment to the Δ5° criterion is proposed. It should be noted that this is a conservative analysis that does not factor in ambient cooling effects within the allowable mixing zone. As such, the actual Δ would be expected to be less than the calculated value.

6.11 Recommendation

Pursuant to Section 2.308 (Site Specific Criteria), it is recommended that a site specific protective criterion of 96°F for temperature be promulgated for Bayou de Loutre from the point where GLCC-Central's Outfall 001 discharges to the confluence with Loutre Creek.

This recommended criterion is less than the 99th percentile of the measured stream temperatures, which was shown on this site specific basis, to support the designated Seasonal Gulf Coastal Fishery use. In addition, due to the unique nature of the transfer project intended to conserve Sparta Aquifer groundwater, no method of temperature treatment is feasible due to the variability of Outfall 001 discharges.

Although, the information presented within this study demonstrates that the temperature criterion is exceeded during the critical season at points in Bayou de Loutre further downstream the above recommended site specific temperature criterion is requested only for the 0.5 mile reach of Bayou de Loutre from the existing GLCC-Central Outfall 001 downstream to the confluence with Loutre Creek (Figure 6.3). No change in designated uses is recommended, as the Seasonal Gulf Coastal fishery is being maintained.

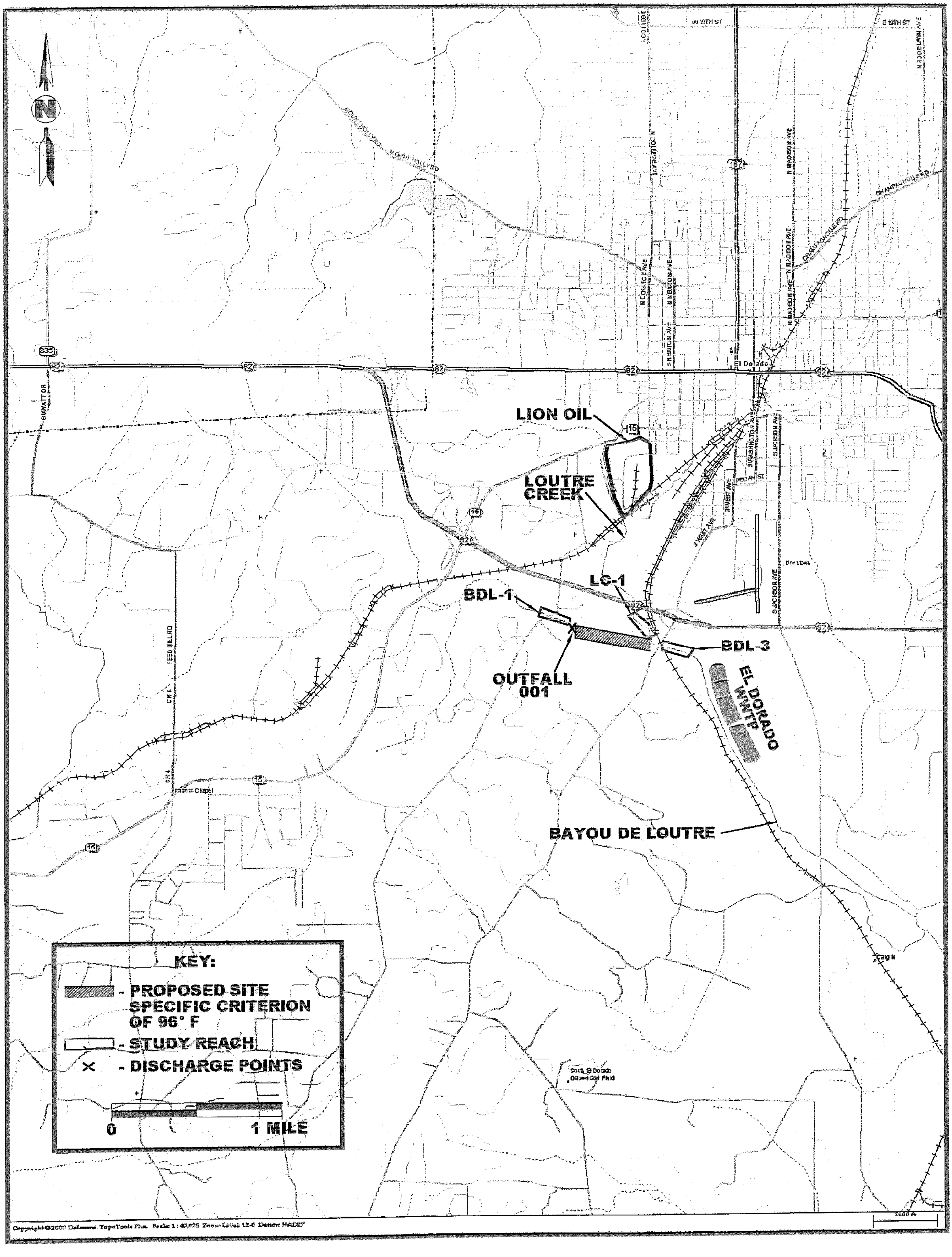


Figure 6.3. Reach of Bayou de Loutre encompassing proposed site specific temperature modifications.

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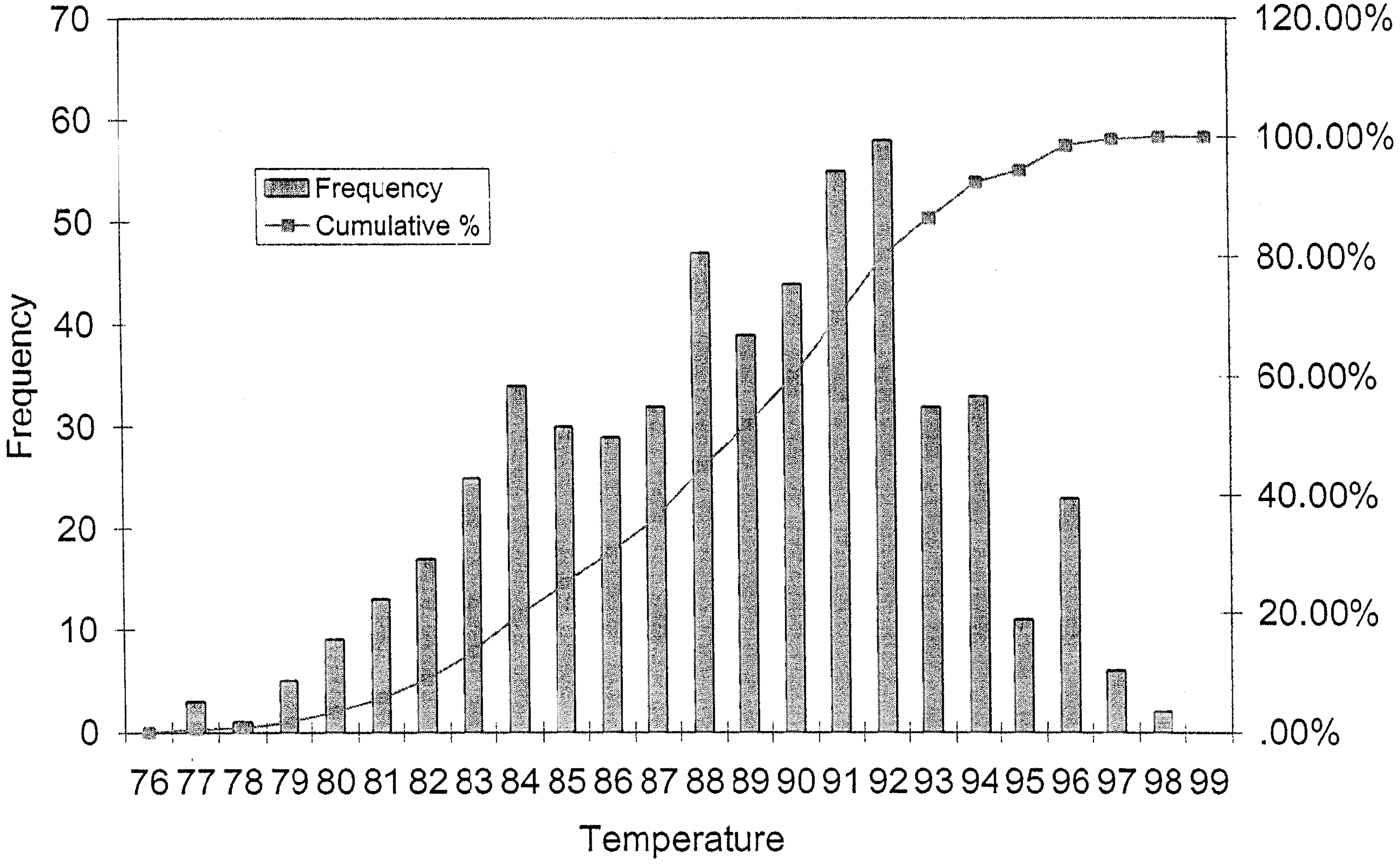
Appendix A

GLCC-Central Outfall 001
(Post Lion Oil Transfer Project)

GLCC-Central outfall 001 Discharge Chacteristics POR Nov 1999 to June 2001.

Date	Flow (mgd)	Temp. °F	Date	Flow (mgd)	Temp. °F	Date	Flow (mgd)	Temp. °F	Date	Flow (mgd)	Temp. °F	Date	Flow (mgd)	Temp. °F
11/01/00	0.001	88	12/20/00	0.632	79	02/07/01	0.001	87	03/28/01	0.012	81	05/16/01	2.314	85
11/02/00	0	88	12/21/00	0.023	83	02/08/01	1.212	85	03/29/01	0.02	84	05/17/01	2.293	86
11/03/00	0	87	12/22/00	0.011	84	02/09/01	1.945	84	03/30/01	0.034	84	05/18/01	1.063	88
11/04/00	0.002	88	12/23/00	0.073	85	02/10/01	2.027	84	03/31/01	0.012	83	05/19/01	0.335	86
11/05/00	0.012	87	12/24/00	0.148	84	02/11/01	1.946	83	04/01/01	0.004	87	05/20/01	2.325	83
11/06/00	0	89	12/25/00	0.034	83	02/12/01	1.898	82	04/02/01	0.15	87	05/21/01	2.668	82
11/07/00	0.007	87	12/26/00	0.03	84	02/13/01	1.967	89	04/03/01	0.006	89	05/22/01	2.635	79
11/08/00	0.034	86	12/27/00	0	85	02/14/01	1.272	89	04/04/01	0	86	05/23/01	2.084	81
11/09/00	0.011	84	12/28/00	0.722	83	02/15/01	0.009	89	04/05/01	0	90	05/24/01	1.932	81
11/10/00	0.052	83	12/29/00	0.657	84	02/16/01	0.002	83	04/06/01	0.093	90	05/25/01	1.309	81
11/11/00	0.009	87	12/30/00	0.96	88	02/17/01	0.001	87	04/07/01	0.058	90	05/26/01	0	80
11/12/00	0.023	92	12/31/00	0.801	89	02/18/01	0.002	85	04/08/01	0	88	05/27/01	0	81
11/13/00	0.029	87	01/01/01	0.626	85	02/19/01	0.17	83	04/09/01	0.014	91	05/28/01	0	84
11/14/00	0.025	80	01/02/01	1.528	77	02/20/01	0.302	87	04/10/01	0.005	87	05/29/01	0.267	85
11/15/00	0.226	89	01/03/01	1.366	81	02/21/01	1.104	85	04/11/01	0.003	86	05/30/01	0.595	84
11/16/00	0.001	86	01/04/01	1.163	81	02/22/01	0.755	82	04/12/01	0.001	80	05/31/01	0.952	82
11/17/00	0.003	85	01/05/01	1.73	84	02/23/01	0.248	81	04/13/01	0.01	88			
11/18/00	0.027	88	01/06/01	1.881	82	02/24/01	0.23	87	04/14/01	0.001	89			
11/19/00	0.015	92	01/07/01	1.832	84	02/25/01	0.044	89	04/15/01	0.017	88			
11/20/00	0.025	83	01/08/01	1.994	77	02/26/01	0.409	82	04/16/01	0.009	85			
11/21/00	0.056	84	01/09/01	1.999	77	02/27/01	0.088	82	04/17/01	0.034	80			
11/22/00	0.005	86	01/10/01	1.414	82	02/28/01	0	82	04/18/01	0.004	79			
11/23/00	0.005	91	01/11/01	0.001	83	03/01/01	0	85	04/19/01	0.105	81			
11/24/00	0.001	87	01/12/01	0	86	03/02/01	0.01	83	04/20/01	0	84			
11/25/00	0.576	87	01/13/01	0.009	85	03/03/01	0.008	84	04/21/01	0	88			
11/26/00	0.021	88	01/14/01	0.001	84	03/04/01	0.001	87	04/22/01	0.002	91			
11/27/00	0.001	85	01/15/01	0	85	03/05/01	0.001	85	04/23/01	0.002	88			
11/28/00	0	80	01/16/01	0	85	03/06/01	0.004	85	04/24/01	0.002	86			
11/29/00	0	84	01/17/01	0.002	80	03/07/01	0.041	83	04/25/01	0.005	85			
11/30/00	0.037	80	01/18/01	0.001	83	03/08/01	0.018	82	04/26/01	0.001	87			
12/01/00	0.004	87	01/19/01	0.001	85	03/09/01	0.002	83	04/27/01	0	88			
12/02/00	0.002	85	01/20/01	0	83	03/10/01	0.025	83	04/28/01	0.014	87			
12/03/00	0	87	01/21/01	0.001	86	03/11/01	0.003	84	04/29/01	0.005	88			
12/04/00	0	81	01/22/01	0.033	79	03/12/01	0	84	04/30/01	0.065	88			
12/05/00	0.112	88	01/23/01	0.033	83	03/13/01	0.018	82	05/01/01	0.037	88			
12/06/00	0.005	86	01/24/01	0.029	84	03/14/01	0.001	84	05/02/01	0.025	88			
12/07/00	0	88	01/25/01	0.034	82	03/15/01	0.001	81	05/03/01	0.03	88			
12/08/00	0.005	83	01/26/01	0.042	84	03/16/01	0.003	83	05/04/01	0.082	88			
12/09/00	0.516	82	01/27/01	0.017	85	03/17/01	0	88	05/05/01	0.019	88			
12/10/00	0.001	87	01/28/01	0.005	84	03/18/01	0.004	86	05/06/01	0.009	87			
12/11/00	0.029	85	01/29/01	0.001	84	03/19/01	0.002	85	05/07/01	0.112	89			
12/12/00	0.002	78	01/30/01	0.012	86	03/20/01	0	83	05/08/01	0.033	89			
12/13/00	0	83	01/31/01	0	88	03/21/01	0	81	05/09/01	0	91			
12/14/00	1.18	83	02/01/01	0.001	84	03/22/01	0.007	88	05/10/01	0	91			
12/15/00	2.175	83	02/02/01	0	86	03/23/01	0.002	84	05/11/01	0.09	94			
12/16/00	2.175	86	02/03/01	0	84	03/24/01	0.005	83	05/12/01	1.011	89			
12/17/00	2.424	84	02/04/01	0	86	03/25/01	0.001	82	05/13/01	2.198	87			
12/18/00	1.925	80	02/05/01	0.001	86	03/26/01	0	81	05/14/01	2.242	89			
12/19/00	1.186	79	02/06/01	0.001	85	03/27/01	0.009	84	05/15/01	2.271	86			

Distribution of GLCC Effluent Temperature Data
Dec 1999 thru May 2001



Appendix B

Field Data Sheets

FIELD EQUIPMENT CHECKLIST

Project No:__________________ **Crew:**________________________

Field Instruments

_____ Battery Charger
_____ DO (calibration kit, batts)
_____ pH (stds, bottle batts)
_____ Conductivity (batteries)
_____ Depth (chart, probe, batts)
_____ Hach Kit (batts, methods, chems, stds)
_____ Flow (batts, meter, rod, calc, forms, waders, tape/tag line)
_____ Isco (instruments, bottles, batts, tubing, strainers, clamps)

Miscellaneous

_____ Cash advance
_____ Credit card
_____ Pens
_____ Camera/film
_____ Small recorder
_____ Rubber boots
_____ Waders
_____ Rain suits
_____ Flashlight
_____ Knife, scissors
_____ Tape measure(s)
_____ Rope
_____ Tool box
_____ Backpack
_____ Wash bottles
_____ Crest gages
_____ Alconox/brush
_____ Trash bags
_____ Duct tape
_____ 5 gal. Bottle
_____ DI/tap water
_____ Flagging
_____ Keys (gate, gage, etc.)
_____ Extra vehicle key
_____ Range finder

Biological Sampling

_____ Tag line/tape measure (Habitat)
_____ Aquatic Dip net
_____ Seine
_____ Fish nets
_____ Containers
_____ Preservative (alcohol, formaldehyde)
_____ Sieves
_____ Sorting trays
_____ Forceps
_____ Electroshocker (pig tail, extra probe, extra conductors, rubber gloves, generator gas/mix, spark plugs)

Ground Water Sample Collection

_____ Water level indicator
_____ Pumps/batteries
_____ Tubing
_____ Turbidmeter
_____ Bailers (disp./other)
_____ Hexane
_____ Field forms
_____ 0.45 µm Filter apparatus
_____ Water level detector

Boat Usage

_____ Life jackets
_____ Paddles
_____ Boat cushions
_____ Anchor
_____ Motor battery
_____ Motor oil
_____ Gas tanks
_____ Trolling motor
_____ Depth finder (graph)
_____ Spare tire

Field Forms/Documentation

_____ Field forms - habitat
_____ Field forms - fish/bugs
_____ Field forms - chemistry
_____ Field log book
_____ COC forms
_____ Ziplock bags
_____ Maps
_____ Sampling plan
_____ Pens/pencils
_____ Clipboards

Safety

_____ Hard hats
_____ Safety glasses
_____ Face shields
_____ Eye wash bottle
_____ Gloves
_____ Steel toe boots
_____ Hazcomm materials
_____ Tyvex suits
_____ Sun protection
_____ Bug spray
_____ Water, drinks
_____ Soap, alcohol, bandages

Sample Collection (General)

_____ Sample bottles
_____ Extra sample bottles
_____ Sharpies, pens
_____ Clear tape/dispenser
_____ Bucket(s)/rope
_____ Ice chests/ice
_____ Horizontal water bottle
_____ Sediment spoons/bowls
_____ Dredge (hoist)
_____ Core sampler (handle, extensions, body, tips, cap, slip wrench, sleeves/caps)
_____ DI water
_____ Extra labels
_____ Decon. equipment

Wetlands Delineation

_____ Soil Probe
_____ Spade/shovel
_____ α,α-dipyridal
_____ Plant press
_____ Plant field books
_____ ACOE Data Forms
_____ Wetland Assessment Forms
_____ Munsell soil color charts
_____ Machete
_____ Magnifier loop

Hydraulic Studies

_____ Rhodamine WT dye
_____ Fluorometer/accessories
_____ Power inverter
_____ Auto samplers/batteries, bottles
_____ Sample vials
_____ 5 gal. glass container
_____ Graduated cylinder
_____ Dye standards
_____ Labeling tape
_____ Pipettes
_____ Beakers (600 mL)

Comments:____
____

V1.1-0698

Habitat Assessment Field Data Sheet

Station I.D:	Client:
Stream name:	Date/Time:
Location:	Form Completed By:

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 ____	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 ____	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 ____	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 ____	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 ____	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 Cont.

Station I.D:	Date/Time:
Stream name:	Form Completed By:

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 _____	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 _____	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 _____ LB	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE _____ 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 _____ LB	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE _____ 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 _____ LB	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE _____ RB	Right Bank 10 9	8 7 6	5 4 3	2 1

TOTAL SCORE: __________

AVERAGE SCORE: __________

Barbour, M.T. et.al., 1999. *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers.*

Discharge/Flow Measurement Form

Station:

Waterbody:

Date:

Crew:	Start Time:	Recorder:
	End Time:	GH. Change: ____________ in
	Staff/Gage:	____________ hrs.
Width:	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)
TOTALS							

Completed By________ Checked by__________ Reviewed by__________

V1.0 1096

Page ____ of ______

Field Data Form Continued

FIELD MEASUREMENT RECORD (Date____________________)

REVIEWED BY:__________________

Station/Depth	Date	Time	Field Crew	Temp C°	DO mg/l	Sp Cond uS	pH su	Sample # of Containers		Notes
								S=Sed	W=Wat	

* Indicates calibration check was made

V1 0 1096

GBMc & Associates
Strategic Environmental Services
219 Brown Ln.
Bryant, AR 72022
(501) 847-7077 Fax (501) 847-7943

Chain of Custody

CLIENT INFORMATION	BILLING INFORMATION	SPECIAL INSTRUCTIONS/PRECAUTIONS:
Company:	Bill To:	
Project Name/No.:	Company:	
Send Report To:	Address:	
Address:		Parameters for Analysis/Methods
	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										
Preservative	(Sulfuric acid =S, Nitric acid =N, NaOH =B, Ice =I)															

Sampler(s):	Shipment Method:	Turnaround Time Required:

COC Completed by:______________ Date: ___________ Time: _______

Relinquished by:______________ Date:___________ Time:_______

Relinquished by:______________ Date:___________ Time:_______

COC Checked by:____________ Date:__________ Time:_______

Received by: ______________ Date:__________ Time:_______

Received in lab by:____________ Date:__________ Time:_______

FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name:____________________.
Location: ____________________.
Client:____________________.
Ecoregion: ____________________.
Project no:____________________.
Weather: ____________________.
____________________.
Investigators: __________. __________.
__________. __________.

Date Sample Collected: ____________________.
Form Completed By: ______________.
Habitat Forms Completed: yes / no
Fish Sampling Completed: yes / no

Collection Site Observations		
	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:		
Shallow Pool:		
Deep Pool:		
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:		
Emergent Vegatation:		
Submerged Vegetation:		
Depositional Area:		
Overhanging Veg:		
Root Wads:		
Undercut Banks:		
Filamentous algae:		
Leafy Debris:		
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:

Rapid Bioassessment Field Sheet

Point Source ______________________________ Date ______________
Collector ______________ Sample Technique ____________ Sediment ? ______________
Habitat Description: ABOVE ______________________________

BELOW ______________________________

MACROINVERTEBRATE COMMUNITY

ABOVE Station #______________________

Cnt.	Taxa	Tally
	:TOTAL:	

BELOW Station #______________________

Cnt.	Taxa	Tally
	:TOTAL:	

Community Structure

	ABOVE	BELOW		ABOVE	BELOW
% Ephem.			% Odon.		
% Plecop.			% Cole.		
% Trichop.			% Crustacea		
% EPT					
% Chir.			# of Taxa:		
% Diptera			Biotic Score:		

Comments:

BIOMETRIC SCORE SHEET

Station: Above ________ Below________ NPDES Permit #_____________

Habitat Sampled ____________ Date/Time __________________ Biometric Score

Biometric (1) Dominants-In Common ________

DIC = __________

Dominants Above	%	Dominants Below	%	If DIC	Score
1.___________	____	1.___________	____	4-5	4
2.___________	____	2.___________	____	3	3
3.___________	____	3.___________	____	2	2
4.___________	____	4.___________	____	0-1	1
5.___________	____	5.___________	____		
Total % of Dom:	____	Total % of Dom:	____		

Biometric (2) Common Taxa Index ________

CTI: = __________ [TIC/MAX (T_a or T_b)]

If CTI	Score	If CTI	Score
> .70	4	0.30-.49	2
0.50-0.70	3	<0.29	1

Biometric (3) Quantitative Similarity Index ________

QSI: = __________ [Σ min (pi_a, pi_b)]

If QSI	Score	If QSI	Score
> 65	4	45-55	2
56-65	3	< 45	1

Biometric (4) Taxa Richness ________

# of Taxa Above = ______

# of Taxa Below = ______

% difference = ______

If % Diff.	Score	If % Diff.	Score
≤ 10%	4	31-45%	2
11-30%	3	> 45%	1

Biometric (5) Indicator Assemblage Index ________

$IAI = 0.50\ [(\%EPT_b/\%EPT_a) + (\%CA_a/\%CA_b)]$

	% EPT	%CA
Above	______	______
Below	______	______

IAI = ______________

If IAI	Score	If IAI	Score
> .80	4	0.50 - 0.64	2
0.65 - 0.80	3	<0.50	1

Biometric (6) Missing EPT Genera ________

Comments

If Missing	Score	If Missing	Score
≤ 1	4	2 from 2	2
2	3	>2 from 2	1

Biometric (7) Functional Group Percent Similarity ________

$FG = \Sigma \min (\%Sh_a, \%Sh_b + \%SC_a, SC_b, + \% CO_a, CO_b, + \% PR_a, PR_b)$

	Above	Below
% Shredders	______	______
% Scrapers	______	______
% Collectors	______	______
% Predators	______	______

If %	Score
> 85	4
75 – 85	3
65 – 74	2
< 65	1

FG % Similarity = ________

TOTAL BIOMETRIC SCORE = ________

MEAN BIOMETRIC SCORE = ________

AQUATIC LIFE USE STATUS ______________

POTENTIAL GENERIC CAUSE ______________

FIELD DATA SHEETS - FISH

Waterbody Name:____________________.

Client:____________________.

Project no:____________________.

Investigators: __________. __________.

__________. __________.

Date Sample Collected:____________________.

Habitat Forms Completed: yes / no

Location:____________________.

Ecoregion:____________________.

Weather:____________________.

____________________.

Form Completed By:____________________.

Fish Sampling Completed: yes / no

Collection Site Observations			
	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:			
Shallow Pool:			
Deep Pool:			
Backwaters:			
Chanelized:			
Microhabitats Sampled (%)			
Woody debris:			
Emergent Vegatation:			
Submerged Vegetation:			
Depositional Area:			
Overhanging Veg:			
Root Wads:			
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:	X 0.1		
Mud/Silt:	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: ______________________ 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: ______________________________________

____

Fish Species Observed

Above Station #	Below Station #

GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

STATION I.D.	LOCATION	
STREAM NAME	RIVER BASIN	
LAT LONG	CLIENT	
INVESTIGATORS		
FORM COMPLETED BY	DATE__________ TIME____________	REASON FOR SURVEY

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
__%☐	% cloud cover	☐_____%
☐	clear/sunny	☐

Has there been a heavy rain in the last 7 days?
☐ Yes ☐ No

Air Temperature___________°C/°F

Other_______________________

STREAM ATTRIBUTES

Stream Subsystem
☐ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _______________

Catchment Area _________mi^2

HYDROLOGY

Flows
☐ High ☐ Moderate ☐ Low ☐ None

Flows Measured?
☐ Yes ☐ No

WATERSHED FEATURES

Predominant Surrounding Landuse
☐ Forest ☐ Commercial
☐ Field/Pasture ☐ Industrial
☐ Agricultural ☐ Other ___________________
☐ Residential

Local Watershed NPS Pollution
☐ No evidence ☐ Some potential sources
☐ Obvious sources

Local Watershed Erosion
☐ None ☐ Moderate ☐ Heavy

INSTREAM FEATURES

Proportion of Reach Represented by Stream Morphology Types
☐ Riffle___________%
☐ Run____________%
☐ Pool____________%

Channelized ☐ Yes ☐ Some ☐ No

Dam Present ☐ Yes ☐ Some ☐ No

WATER/ OBSERVATIONS

Water Odors
☐ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other____________

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs
☐ Flecks ☐ None ☐ Other___________

Turbidity (if not measured)
☐ Clear ☐ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other______________

SEDIMENT/ OBSERVATIONS

Sediment Odor
☐ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other________________

Sediment Deposits
☐ Sludge ☐ Sawdust ☐ Oils
☐ Sand ☐ Relict shells
☐ Other____________________

Quantitative Habitat Characterization Field Form

Station I.D:		Transect # (circle): 1 2 3 4 5
Stream name:	Client:	Date/Time:
Location:	Investigators:	Reason For Survey:
Lat: Long:	Form Completed By:	

Stream Characteristics:			
Stream Wetted Width, ft:		Left Bank Height, ft	Pool ☐ Length, ft
Channel Width, ft:		Right Bank Height, ft:	Run ☐ Length, ft:
		Distance From Last Transect, ft:	Riffle ☐ Length, ft:
Periphyton Coverage/Abundance			
On Substrate:	0 1 2 3 4	On In-Stream Habitat:	0 1 2 3 4
Bank Cover/Habitat			
Left Bank (LB)		Right Bank (RB)	
Roots:	0 1 2 3 4	Roots:	0 1 2 3 4
Brush:	0 1 2 3 4	Brush:	0 1 2 3 4
Undercut Bank:	0 1 2 3 4	Undercut Bank:	0 1 2 3 4
Vegetation:	0 1 2 3 4	Vegetation:	0 1 2 3 4
Devoid:	0 1 2 3 4	Devoid:	0 1 2 3 4

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope			**Bank Stability**		
Left	Right		Left	Right	
		Flat (<8°)			Stable
		Mod (9-30°)			Moderately Stable
		Steep (>30°)			Unstable
Riparian Ground Cover (Total = 100%)			**Riparian Canopy Cover**		
Left	Right		Left	Right	
		%Vegetated, Herbs/Grasses			% Canopy Cover, Trees
		%Vegetated, Shrubs/Trees	Notes:		
		% Soil/Sand			
		% Rock			

Quantitative Habitat Characterization Field Form cont.

Statior I.D:

Transect # (circle): 1 2 3 4 5

Form Completed By:

Date/Time:

Form Checked By:

Date/Time:

Distance in ft. from (LB/RB)		Width (ft)	Depth (ft)	Area (ft^2)	Stream Habitat (Fish Cover)								Stream Substrate											%Canopy Cover
					Type & Abundance								Type										%Embedded	
					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
1.																								
2.																								
3.																								
4.																								
5.																								
6.																								
7.																								
8.																								
9.																								
10.																								
11.																								
12.																								
13.																								
14.																								
15.																								
16.																								
Calc																								

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary:

Substrate Type Summary (% Occurrence):

Appendix C

Photos

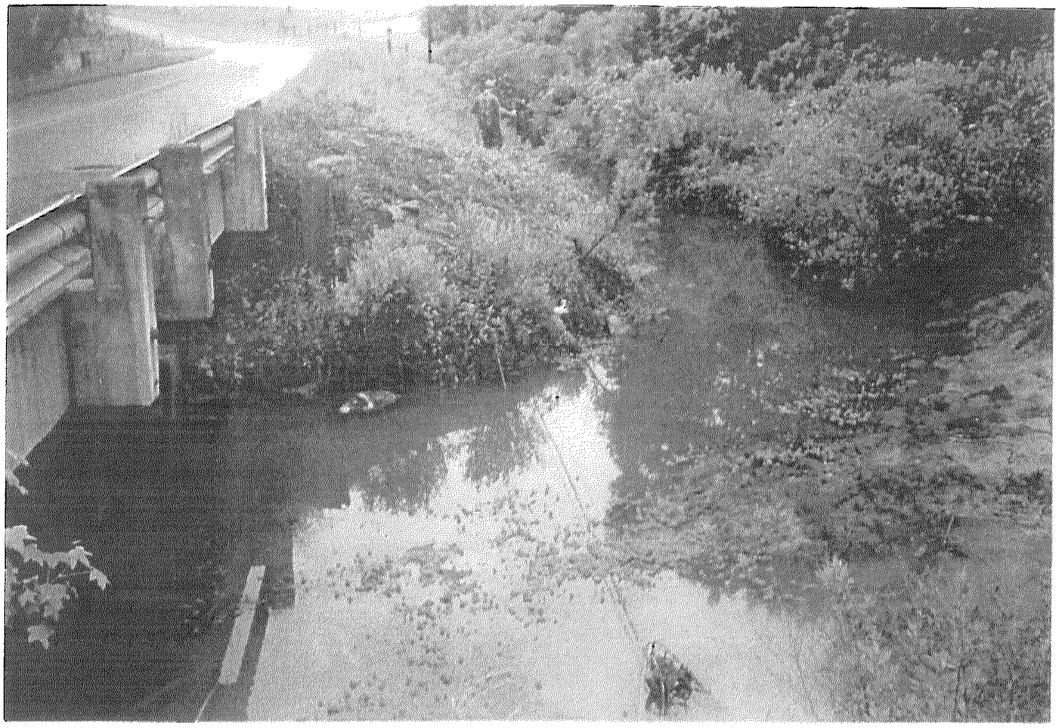


Figure C-1. BDL-1 upstream of County Road during Spring 1999.

Figure C-2. BDL-1 run upstream of GLCC-Central Outfall 001 during Spring 1999.

Figure C-3. BDL-1 pool upstream of GLCC-Central Outfall 001 on Bayou de Loutre.

Figure C-4. BDL-1 upstream of GLCC-Central Outfall 001 area with ill-defined channel wetland complex.

Figure C-5. BDL-1 bank habitat area upstream of Outfall 001 discharge.

Figure C-6. BDL-2 Spring 1999 with discharge from Outfall 001.

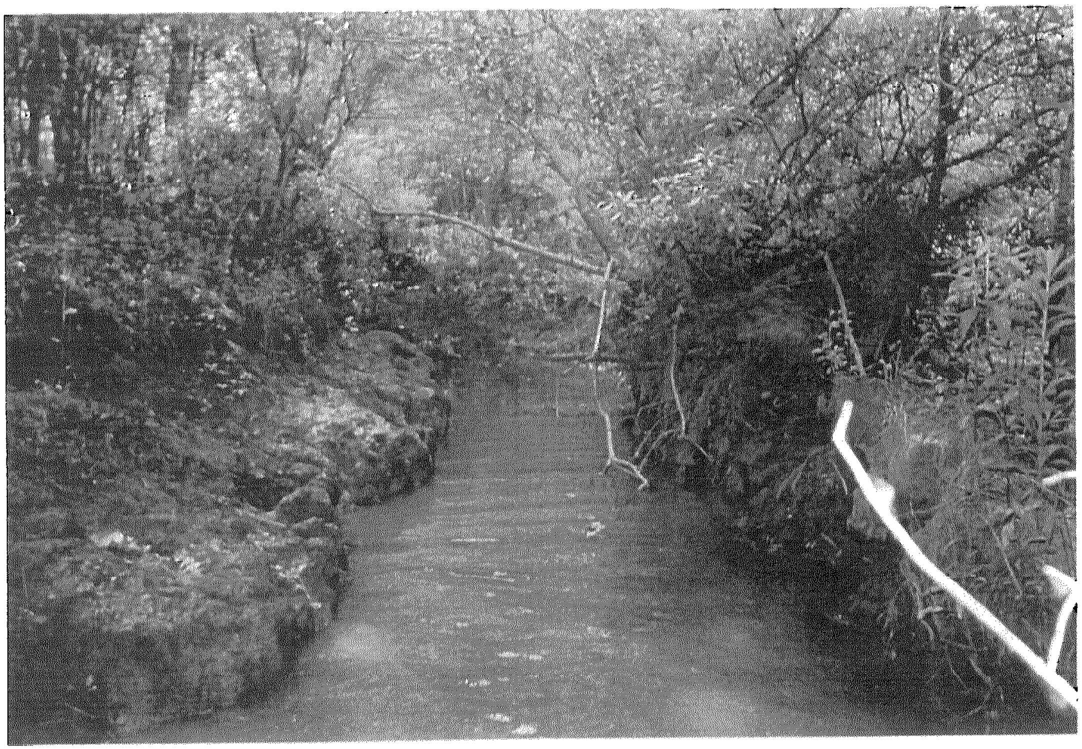


Figure C-7. BDL-2 Spring 1999. Note limited habitat and clay substrate.

Figure C-8. BDL-2 Spring 1999. Note typical stream bank composition and narrow stream width of Bayou de Loutre in this reach below 001 discharge.

Figure C-9. BDL-3 riffle run area downstream of bridge crossing. Flow combined Bayou de Loutre and Loutre Creek.

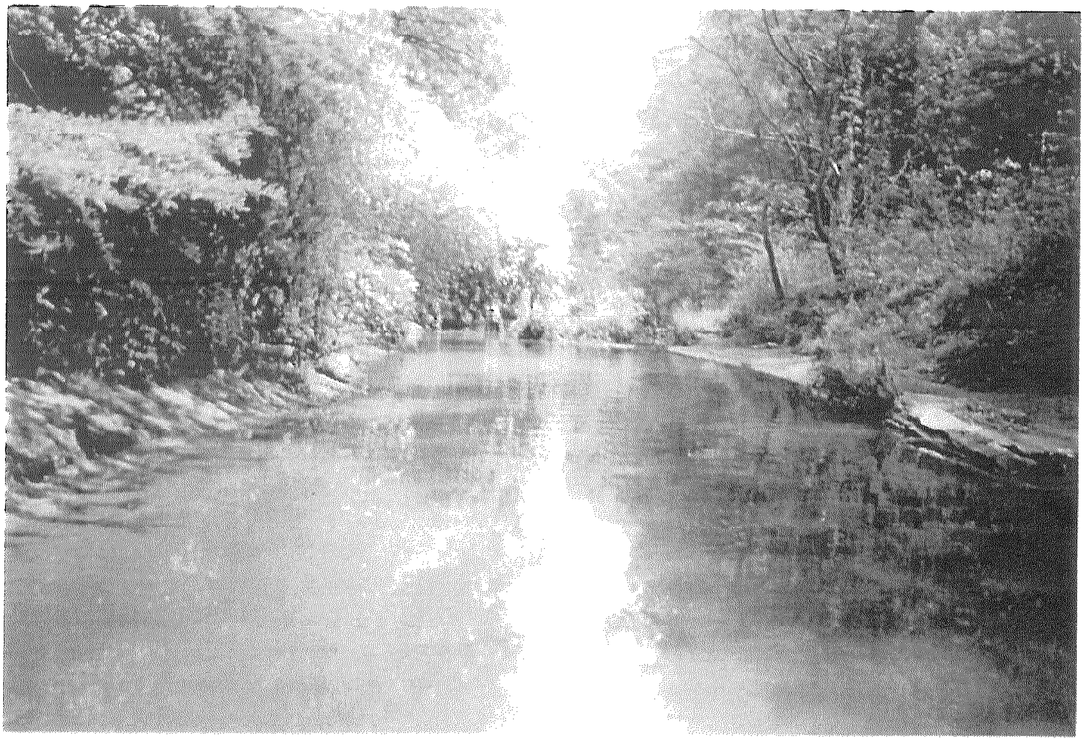


Figure C-10. BDL-3 Reach is a long channelized pool. Note streambed width and depth of pool. Spring 1999 with discharge from Outfall 001.

Figure C-11. BDL-3 Spring 1999 right descending bank of Bayou de Loutre. Note height and stability of stream bank.

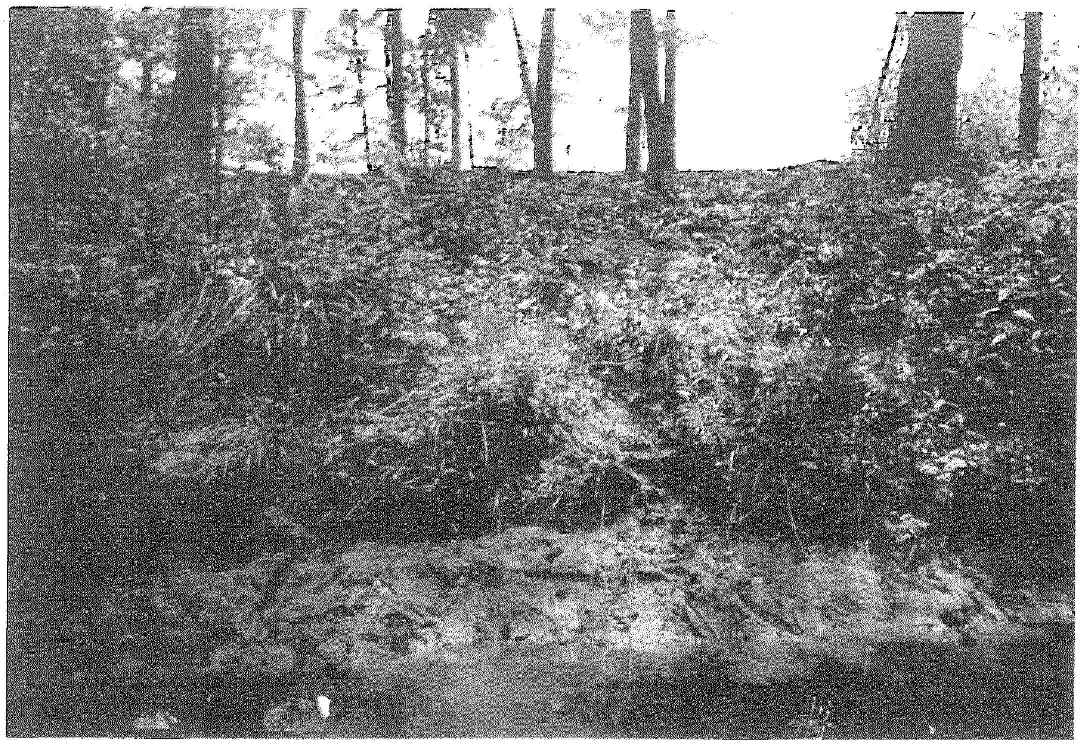


Figure C-12. Spring 1999 left descending bank of Bayou de Loutre. Note height and stability of stream bank.

Figure C-13. Riffle created downstream of road crossing in BDL-3.

Figure C-14. LC-1 Spring 1999. Note stream width and bank habitat development in pool area.

Figure C-15. LC-1 Spring 1999. Note stream habitat development and width of stream.

Figure C-16. LC-1 Spring 1999. Typical stream habitat.

Figure C-17. LC-1 Spring 1999. Run area in Loutre Creek.

Figure C-18. BDL-1 Spring 2000.

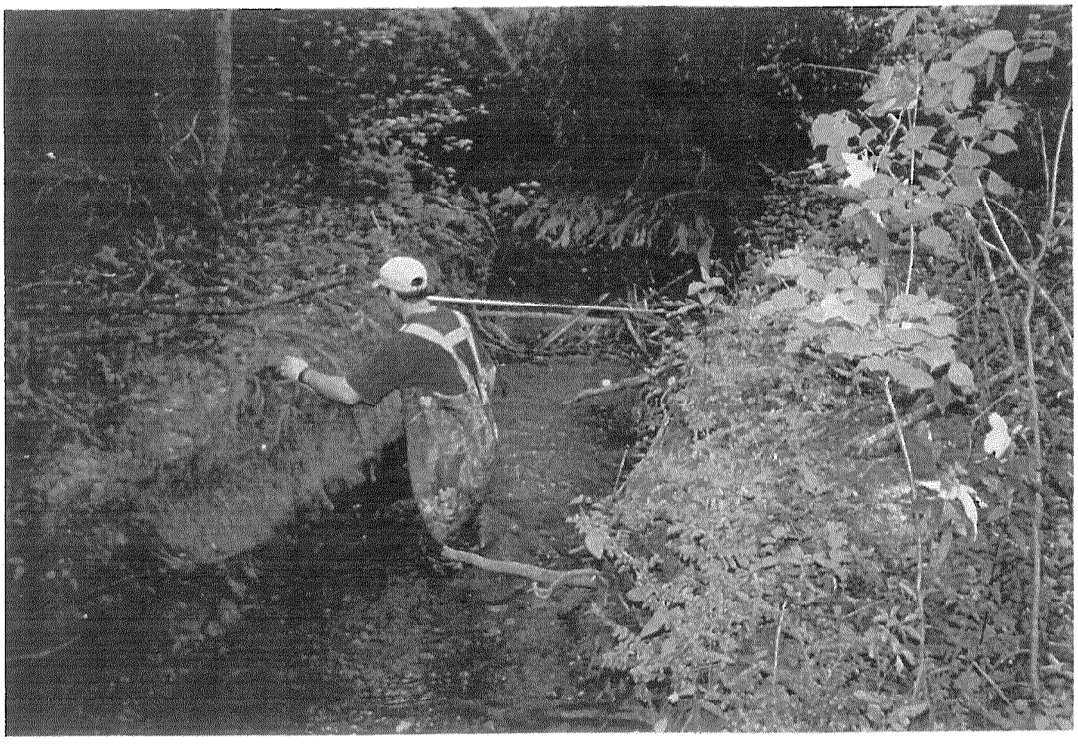


Figure C-19. BDL-2. Note reduced water level resulting from absence of GLCC-Central Outfall 001.

Figure C-20. BDL-3 Spring 2000 without flow from GLCC-Central-Central Outfall 001.

Figure C-21. BDL-3 Spring 2000, note reduced water depth.

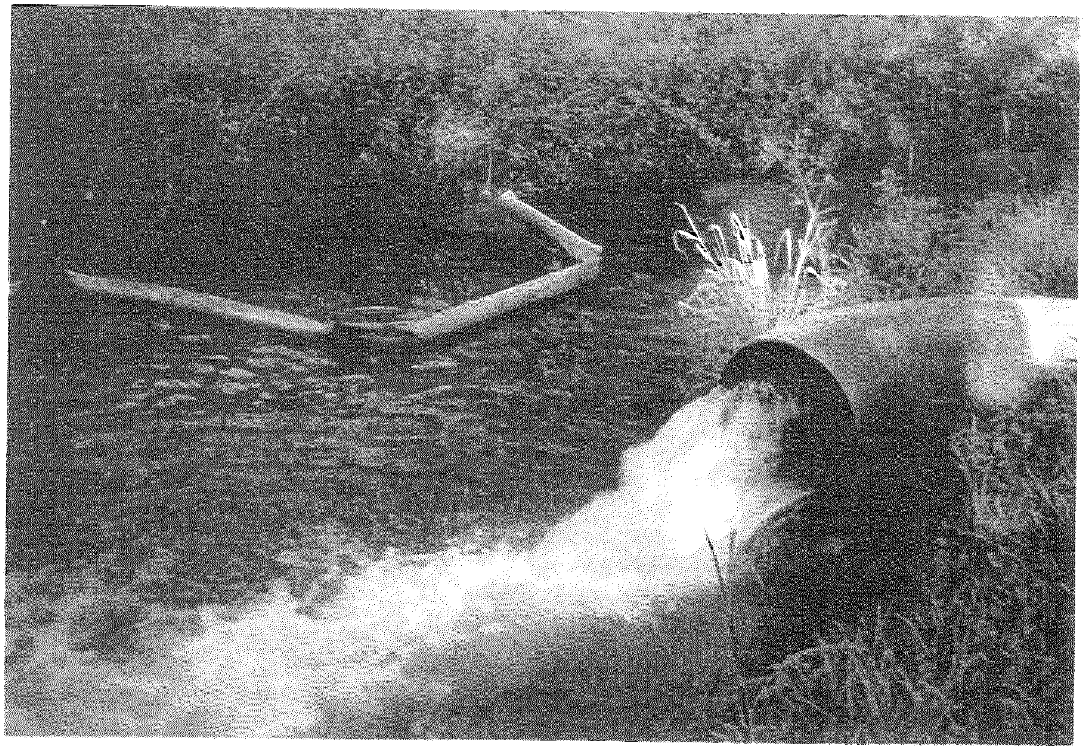


Figure C-22. GLCC-Central Outfall 001 while discharging.

Figure C-23. GLCC-Central Outfall 001 while discharging. Looking downstream to brine line in water.

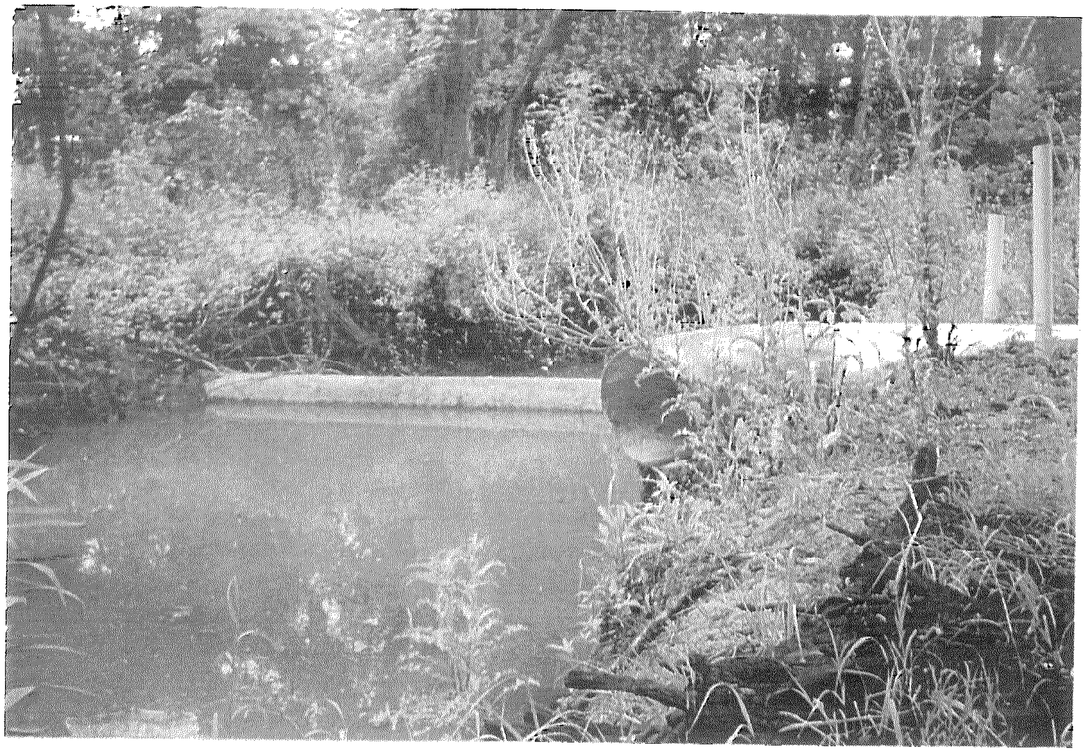


Figure C-24. GLCC-Central Outfall 001 with no discharge. Note brine line just upstream of discharge.

Figure C-25. GLCC-Central Outfall 001 with no discharge. Note brine line downstream of discharge.

Appendix D

Completed Field Data Sheets

Appendix D-1

Habitat Assessment Field Data Forms

GBMc & Associates
Strategic Environmental Services

PHYSICAL CHARACTERIZATION FIELD FORM

START / END

Date/Time: 22 April 99 / 1035 / 1100
Observer(s): REM / SKH
Project No:
Stream: Bayou De Loutre BDL-1
Transect No: all 3
Picture No:

	Distance from ([✓ LB]/RB)			Width (ft)			Depth (ft)			Area (ft²)			Bank Habitat			Stream Habitat			Sub.			Canopy Cover (Y/N)		
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1.	1	1.5	1	1.4	1.0	1.0	1.0	0.5	0.5	1.0	0.5	0.5	u	u	u	L	L	L	G	G	M	Y	Y	Y
2.	2	2	2	1.0	1.0	1.0	0.7	0.7	1.0	0.7	0.7	1.0	x	x	x	x	L	L	G	G	M	Y	Y	Y
3.	3	3	3	1.0	1.0	1.0	0.3	0.6	1.8	0.3	0.6	1.8	x	X	X	x	L	L	6	M/G	M	Y	Y	Y
4.	4*	4	4	0.5	1.0	1.0	0.0	0.8	1.5	0	0.8	1.5	x	X	X	x	L	L	6	M	M	Y	Y	Y
5.		5	5		1.0	1.0		0.7	1.6		0.7	1.6		X	X		L	L		M	M		Y	Y
6.		6	6		1.0	1.0		0.6	1.4		0.6	1.4		X	X		L	L		M	M		Y	Y
7.		7	7		1.0	1.0		1.0	1.5		1.0	1.5		X	X		L	L		M	M		Y	Y
8.		8	8		1.0	1.0		1.1	1.8		1.1	1.8		u	X		L	L		M	M/G		Y	Y
9.		8.5 RB	9			1.0			1.7			1.7			X			L			G			Y
10.			10			1.0			1.3			1.3			X			L			G			Y
11.			11			1.0			1.2			1.2			X			L			C			Y
12.			12			1.0			1.1			1.1			u			L			C			Y
13.																								
14.																								
15.																								
16.																								
17.																								
18.																								
19.																								
20.																								
Calculations										2.0	6.0	16.4												

Bank Habitat
R = Roots
U = Undercut Bank
V = Vegetation
X = Devoid

Stream Habitat
D = Depressions
L = Logs, Debris
V = Vegetation
X = Devoid

Substrate
M = Mud <.04 mm
S = Sand .06-6 mm
G = Gravel 6-60 mm
B = Boulders 25-45 cm
R = Rubble 6-25 cm
L = Lithified

PHYSICAL CHARACTERIZATION FIELD FORM
Continued

Dissolved Oxygen, mg/l ____________

Temperature, °C ____________

Conductivity, uhmos ____________

pH, su ____________

Stream Width, ft 3.5' / 8'5" / 12' /

Channel Width, ft 16 / 13.5' / 13 /

Pool Top. ____ Length, ft 16 16' 16

Riffle/[✓ Run] ____ Length, ft ____

1 - Ri/RUN ~50' ② Pool ~30' ③ Pool 150'

Riparian Ground Cover

Left			Right			
5	25	50	25	10	25	% Vegetated
75	15	50	75	90	75	% Soil/Sand
–	–	–	–	–	–	% Rock

Riparian Canopy Cover

Left			Right			
75			75			% Canopy Cover
	90	90		100	75	

Bank Slope

Left			Right			
						Flat (<8°)
			✓	✓		Mod (9-30°)
✓	✓	✓			✓	Steep (>30°)

Bank Stability

Left			Right			
✓	✓	✓	✓	✓	✓	Stable
						Moderately Stable
						Unstable

Bank Height (ft)

Left			Right		
3	4	5	4	4	5

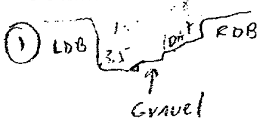
Percent Embedded

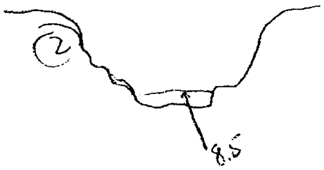
_____ Sands __100__ Gravel / 2nd / 3rd /

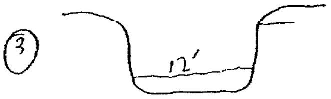
No Embedded / Yes / 100% /

75%

COMMENTS:







V1.0 1096

JMc & Associates
Strategic Environmental Services

Discharge/Flow Measurement Form

Station: BDL1 Trans 1
Waterbody: Bayou De Loutre
Date: 4/22/99

Crew: SKH / REW	Start Time: 1025	Recorder: REW
	End Time:	GH. Change: ______ in ______ hrs.
	Staff/Gage:	
Width: ~~8~~ 3.5	Area:	Velocity: 0.16 FPS
Disch/Flow: 0.338 CFS	Method:	No Secs:
Meter No: MMB	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 cloudy / Humid
Other_______________ Air_______ °F @ _______
Gage_______________ Water_______ °F @ _______

Observer _______________

Control down stream Channel pool. Instream gravel bottom - w- lot Rond debris.

Remarks Area of channel braided, cypress Knees in stream channel ~~[illegible]~~ Brown stained H_2O, stream bed (IRON)

(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)
LEW 0.0	0.0	0.4		0.0		0.0	0
0.5	0.5	1.0		0.16		0.5	0.08
1.0	0.5	1.0		0.26		0.5	0.13
1.5	0.5	0.8		0.22		0.4	0.088
2.0	0.5	0.6		0.11		0.3	0.033
2.5	0.5	0.5		0.03		0.25	0.0075
3.0	0.5	0.3		0.00			
REW 3.5	0.5	0.00		0.00			
TOTALS				~~0.22~~			
				0.16 FPS			0.3385

Completed By REW Checked by___________ Reviewed by___________

V1.0 1096

Discharge Flow Measurement Form
Continued

(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)
TOTALS							

(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)
TOTALS							

Completed By________ Checked by___________ Reviewed by____________

GDM & Associates
Strategic Environmental Services

BDL-1 u/s

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed	Substrate unstable lacking.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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
4. 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 6	20 19 18 17 16	15 14 13 12 11	10 9 ~~8~~ 7 [✓ 6]	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks, channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 14	20 19 18 17 16	15 [✓ 14] ~~13~~ 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7 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 2 to 1 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
8. 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 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
9 Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1

TOTAL SCORE 132

$\bar{X} = 11.0$

Barbour and Stribling. An evaluation of a visual-based technique for assessing stream habitat structure.

GBMc & Associates
Strategic Environmental Services

REM
BDL-1

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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
4. 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 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1

64 ÷ 10.6 $\bar{x}$

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
8. 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 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian -Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	[✓ 5] 4 3 2 1

TOTAL SCORE 10.1 = $\bar{X}$

57 ÷ 6 = 9.5

64 ÷ 6 = 10.6

121 ÷ 12 = 10.1 = X

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GBMc & Associates
Strategic Environmental Services

BDL-1 5/19/99 SKH

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted	Extensive channelization; shored with gabion 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
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools 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

55

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 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
8. 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 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	[✓ 5] 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1

TOTAL SCORE 55+ 48 = 103

MEAN = 8.6

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GBMc & Associates
Strategic Environmental Services

PHYSICAL CHARACTERIZATION FIELD FORM

Date/Time: 7/21/99	Stream: BDL No 2
Observer(s): SKH/ REW	Transect No: All 3 transects
Project No:	Picture No:

Distance from ([✓ LB]/RB)	Width (ft) 1 2	Depth (ft) 1 2 3	Area (ft²)	Bank Habitat 1 2 3	Stream Habitat 1 2 3	Sub.	Canopy Cover (Y/N)
1. 0 0		F		R	X		Y
2. 1 b 1	1 1.0 1	1 55 0.6		X U U	X D/L L	c c C	Y
3. 2 2 2	1 1.0 1	0 2.1 0.9		X U U	X D/L –	c c C	Y
4. 3 3 3	1 1.0 1	0 1.9 1.2		X M U	X D/L —	c c C	Y
5. 4 4 4	1 1.0 1	e 1.6 1.0		X U U	X L L	c c C	Y
6. 5 9 5	1 1.0 1	f 1.2 1.4		X M U	X L L	c c C	Y
7. 6 6 6	1 1.0 1	8 0.7 1.4		X M U	X D/L L	c c C	Y
8. 7 7 7	1.0 1	5 0.3 1.1		M U	L L	C C C	Y
9. 7.5 8	1 1.0 1	0 1.0		U U	— L	C C	Y
10. 9	1	0.9		M U	L	C	Y
11. 10	1	0.4		M U	L	C	Y
12. 11	1	0.2		U	L	C	Y
13.							
14.							
15.							
16.							
17.							
18.							
19.							
20.							
Calculations			3.9 8.3 10.1				

Bank Habitat
R = Roots
U = Undercut Bank
V = Vegetation
X = Devoid

Stream Habitat
D = Depressions
L = Logs, Debris
V = Vegetation
X = Devoid

Substrate
M = Mud <.04 mm
S = Sand .06-6 mm
G = Gravel 6-60 mm
B = Boulders 25-45 cm
R = Rubble 6-25 cm
L = Lithified

PHYSICAL CHARACTERIZATION FIELD FORM
Continued

Dissolved Oxygen, mg/l ____
Temperature, °C ____
Conductivity, uhmos ____
pH, su ____

Stream Width, ft 75ft/7.5/11
Channel Width, ft 106 ft/11.5/19.5
Pool T3 Length, ft ____
Riffle/Run T1/T2 Length, ft ____

Riparian Ground Cover						
Left			Right			
20	20	40	50	20	40	% Vegetated
80	80	60	50	80	60	% Soil/Sand
						% Rock
Bank Slope						
Left			Right			
						Flat (<8°)
						Mod (9-30°)
✓	✓	✓	✓	✓	✓	Steep (>30°)
Bank Height (ft)						
Left			Right			
4	5.5	3.5	4	3.5	6	

Riparian Canopy Cover						
1 Left 2	3		1 Right 2	3		
50	75	25	5	35	100	% Canopy Cover
Bank Stability						
1 Left 2	3		1 Right 2	3		
✓			✓			Stable
	✓	✓		✓	✓	Moderately Stable
						Unstable
Percent Embedded						
____Sands			____Gravel			
1			GlAy			

COMMENTS:

V1.0 1096

JM^c & Associates
Strategic Environmental Services

Discharge/Flow Measurement Form

Station: BDL No2 Trans

Waterbody: Bayou De Loutre

Date: 4/21/99

Crew: SKH/REM

Start Time: 1703

Recorder: REM

End Time: 1714

GH. Change: ______ in ______ hrs.

Staff/Gage:

Width: 7 Ft

Area:

Velocity: 0.70 CFS

Disch/Flow: 4.55 CFS

Method:

No Secs:

Meter No: MMB

Max Vel:

Min Vel:

ORIENTATION:
[✓ Wading] Boat, [✓ Upstream], Downstream, Side [✓ Bridge] 300 (ft)/mi, above, below gage, and South Field Rd

Measurement rated: excellent [✓ good] fair poor based on the following conditions: Cross section with pitted clay substrate

Flow ______ Weather sunny windy

Other ______ Air ______ °F @ ______

Gage ______ Water ______ °F @ ______

Observer good Flow - Bottom very Rough pitted clay.

Control AT Bridge on South Field Rd ~ 300yds d/s(?)

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)
DB 0.0							
1.0	1.0	0.5		0.66		0.5	0.33
2.0	1.0	0.9		0.83		0.9	0.75
3.0	1.0	1.2		0.92		1.2	1.10
4.0	1.0	1.3		0.96		1.3	1.25
5.0	1.0	0.9		0.68		0.9	0.61
6.0	1.0	0.7		0.55		0.7	0.38
~~6.5~~ 7.0	RW ~~0.5~~ 1.0	0.4		0.32		0.4	0.13
REW ~~7.0~~ 7.5	0.5	0.0		0.00		0.0	
TOTALS		0.84		0.70 CFS		5.9 sq/ft	4.55 CFS

Completed By REM Checked by ______ Reviewed by ______

V1.0 1096

Discharge Flow Measurement Form
Continued

(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)
TOTALS							

(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)
TOTALS							

Completed By________ Checked by___________ Reviewed by____________

V1.0 1096

JMᶜ & Associates
Strategic Environmental Services

Discharge/Flow Measurement Form

Station: BDL-2 Transect #2
Waterbody: Bayou Delowtre
Date: 4/22/99
Crew: DLP/SKH
Start Time:
End Time:
Staff/Gage:
Recorder:
GH. Change: ______ in ______ hrs.
Width:
Area:
Velocity: 0.48
Disch/Flow: 4.27
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 LB							
1		0.5		0.56		0.5	0.28
2		2.1		0.74		2.1	1.55
3		1.9		0.34		1.9	0.65
4		1.6		0.41		1.6	0.66
5		1.2		0.49		1.2	0.59
6		0.7		0.71		0.7	0.50
SLP 7 ~~RB~~		0.31		0.14		0.31	0.048
7.5RB		0		ND			
TOTALS				0.48 CFS			4.27 CFS

Completed By______ Checked by______ Reviewed by______

#1 Vel. = 0.70 #1 Flow 4.5
#2 Vel. = 0.48 #2 Flow 4.2
Avg. = 0.59 Avg = 4.4

V1.0 1096

Discharge Flow Measurement Form
Continued

(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)
TOTALS							

(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)
TOTALS							

Completed By_______ Checked by_________ Reviewed by__________

GBM^c & Associates
Strategic Environmental Services

BDL 2
REM

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 18	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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
4. 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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion 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
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1

x = 15,2 = 91

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
8. 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 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 165 ÷ 12 = 13.75

74 = 12.3

91 = 15.2

165   7.5

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GBMc & Associates
Strategic Environmental Services

BDL-2 5/17/77 JKH

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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
4. 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 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands, and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion 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
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 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
8. 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 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 80 +70 150

Mean 12.5

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GBM^c & Associates
Strategic Environmental Services

BOL-2

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE ~~13~~ 12	20 19 18 17 16	15 14 ~~13~~ [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion 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
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. 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 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 16	20 19 18 17 [✓ 16]	~~15~~ 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 17	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 162 $\bar{X} = 13.5$

Barbour and Stribling. An evaluation of a visual-based technique for assessing stream habitat structure.

GBMc & Associates
Strategic Environmental Services

PHYSICAL CHARACTERIZATION FIELD FORM

Date/Time: 4/21/99	Stream: Bayou De Loutre BDL-3
Observer(s): DLP/REM/SKH	Transect No: 1.0
Project No: GLCC	Picture No:

Distance from ([✓ LB]/RB)	Width (ft)	Depth (ft)	Area (ft^2)	Bank Habitat	Stream Habitat	Sub.	Canopy Cover (Y/N)
1.	1.0	0.3	1.0	u	S	S	N
2.	1.0	0.3	1.0	x	X	G	N
3.	1.0	0.4	1.0	X	X	G	N
4.	1.0	0.4	1.0	X	X	G	N
5.	1.0	0.4	1.0	X	X	G	N
6.	1.0	0.4	1.0	X	X	G	N
7.	1.0	0.3	1.0	X	X	G	N
8.	1.0	0.4	1.0	X	X	R	N
9.	1.0	0.6	1.0	X	X	R	N
10.	1.0	0.9	1.0	X	X	R	Y
11.	1.0	1.4	1.0	X	X	Clay	Y
12.	1.0	0.8	1.	X	X	Clay	Y
13.							
14.							
15.							
16.							
17.							
18.							
19.							
20.							
Calculations							

Bank Habitat
R = Roots
U = Undercut Bank
V = Vegetation
X = Devoid

Stream Habitat
D = Depressions
L = Logs, Debris
V = Vegetation
X = Devoid

Substrate
M = Mud <.04 mm
S = Sand .06-6 mm
G = Gravel 6-60 mm
C - Clay
B = Boulders 25-45 cm
R = Rubble 6-25 cm
L = Lithified

PHYSICAL CHARACTERIZATION FIELD FORM
Continued

Dissolved Oxygen, mg/l

Temperature, °C

Conductivity, uhmos

pH, su

Stream Width, ft 12 ft.

Channel Width, ft 21 ft.

Pool ______ Length, ft ______

Riffle/Run 100% Length, ft 50.6 ft

Riparian Ground Cover

Left	Right	
<10	<10	% Vegetated
>90	>90	% Soil/Sand
	%	% Rock

Riparian Canopy Cover

Left	Right	
25	75	% Canopy Cover

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
✓	✓	Steep (>30°)

Bank Stability

Left	Right	
✓		Stable
	✓	Moderately Stable
		Unstable

Bank Height (ft)

Left	Right	
12	10	

Percent Embedded

40% Sands 50% Gravel

COMMENTS:

V1.0 1096

GBM^c & Associates
Strategic Environmental Services

PHYSICAL CHARACTERIZATION FIELD FORM

Date/Time: 21 April 1999	Stream: Bayou de Loutre BDL3
Observer(s): REN/SKH	Transect No: No2
Project No:	Picture No:

21 Ft width

Distance from ([✓ LB]/RB)	Width (ft)	Depth (ft)	Area (ft^2)	Bank Habitat	Stream Habitat	Sub.	Canopy Cover (Y/N)
1. 0.0	3.0	0.0		X	✓	C	N
2. 4.0	1.0	0.1		X	D	C	N
3. 6.0	2.0	0.4		X	X	C	N
4. 7.0	1.0	0.0		X	X	C	N
5. 8.0	1.0	0.0		X	X	C	N
6. 9.0	1.0	0.0		X	X	C	N
7. 10.	1.0	0.0		X	X	C	N
8. 11.	1.0	0.0		X	✓	C	N
9. 12	1.0	0.0		X	✓	C	N
10. 13	1.0	0.8		X	X	C	N
11. 14	1.0	0.8		X	X	C	N
12. 15	1.0	0.8		X	X	C	N
13. 16	1.0	0.8		X	X	G	Y
14. 17	1.0	0.6		X	X	R	Y
15. 18	1.0	0.5		X	X	G	Y
16. 19	1.0	0.6		X	X	G	Y
17. 20	0.5	0.7		X	X	G	Y
18.							
19.							
20.							
Calculations							

Bank Habitat
R = Roots
U = Undercut Bank
V = Vegetation
X = Devoid

Stream Habitat
D = Depressions
L = Logs, Debris
V = Vegetation
X = Devoid

Substrate
M = Mud <.04 mm
S = Sand .06-6 mm
G = Gravel 6-60 mm
B = Boulders 25-45 cm
R = Rubble 6-25 cm
L = Lithified

PHYSICAL CHARACTERIZATION FIELD FORM
Continued

Dissolved Oxygen, mg/l __________
Temperature, °C __________
Conductivity, uhmos __________
pH, su __________

Stream Width, ft 21 ft.
Channel Width, ft 32.ft
Pool ______ Length, ft ______
Riffle/Run 100% Length, ft ______

Riparian Ground Cover		
Left	Right	
10	10	% Vegetated
90	90	% Soil/Sand
—	—	% Rock
Bank Slope		
Left	Right	
		Flat (<8°)
✓		Mod (9-30°)
	✓	Steep (>30°)
Bank Height (ft)		
Left	Right	
8	12	Right 90 degree slope

Riparian Canopy Cover		
Left	Right	
75	50	% Canopy Cover
Bank Stability		
Left	Right	
✓	✓	Stable
		Moderately Stable
		Unstable
Percent Embedded 0%		
____ Sands	____ Gravel	

COMMENTS:

GBMc & Associates
Strategic Environmental Services

PHYSICAL CHARACTERIZATION FIELD FORM

Date/Time: 9/21/99	Stream: BDL BDL-3
Observer(s): REM/SKH/GLP	Transect No: No 3.
Project No:	Picture No:

24 ft

Distance from [✓ LB]/RB)	Width (ft)	Depth (ft)	Area (ft²)	Bank Habitat	Stream Habitat	Sub.	Canopy Cover (Y/N)
1. 1.0	1.0	0.3	0.3	X	L	G	Y
2. 3.0	2.0	0.7	1.4	X	X	C	Y
3. 5.0	2.0	1.2	2.4				
4. 7.0	2.0	2.0	4.0	X	X	C	N
5. 9.0	2.0	3.1	6.2	X	X	C	N
6. 11	2.0	3.2	6.4	X	X	G	N
7. 13	2.0	3.2	6.4	X	X	G	Y
8. 15	2.6	3.3	6.6	X	X	G	Y
9. 17	2.0	2.3	4.6	X	X	G	Y
10. 19	2.0	2.8	5.6	X	X	C	Y
11. 21	2.0	1.4	2.8	X	X	C	Y
12. 23	2.0	1.0	2.0	X	X	S	Y
13. 25	2.0	0.0		X	X	C	Y
14.							
15.							
16.							
17.							
18.							
19.							
20.							
Calculations			48.7				

Bank Habitat
R = Roots
U = Undercut Bank
V = Vegetation
X = Devoid

Stream Habitat
D = Depressions
L = Logs, Debris
V = Vegetation
X = Devoid

Substrate
M = Mud <.04 mm
S = Sand .06-6 mm
G = Gravel 6-60 mm
B = Boulders 25-45 cm
R = Rubble 6-25 cm
L = Lithified

V1.0 1096

PHYSICAL CHARACTERIZATION FIELD FORM
Continued

Dissolved Oxygen, mg/l ____________
Temperature, °C ____________
Conductivity, uhmos ____________
pH, su ____________

Stream Width, ft 21
Channel Width, ft 33 ft / Top 49'
Pool 100% Length, ft 150'
Riffle/Run ________ Length, ft ________

Riparian Ground Cover

Left	Right	
50	20	% Vegetated
50	70	% Soil/Sand
		% Rock

Bank Slope

Left	Right	
		Flat (<8°)
✓	~~✓~~	Mod (9-30°)
	✓	Steep (>30°)

Bank Height (ft)

Left	Right	
10	15	

Riparian Canopy Cover

Left	Right	
25	60	% Canopy Cover

Bank Stability

Left	Right	
✓	✓	Stable
		Moderately Stable
		Unstable

Percent Embedded NONE

_____ Sands _____ Gravel

COMMENTS:

V1.0 1096

JMc & Associates
Strategic Environmental Services

Discharge/Flow Measurement Form

Station: BDL-3
Waterbody: Bayou de Loutre
Date: 21 April 1999
Crew: REM/SKH
Start Time: 1425
Recorder: RGM
End Time: 1440
GH. Change: ______ in
______ hrs.
Staff/Gage:
Width: 12'
Area:
Velocity: 1.39 FPS
Disch/Flow: 8.49 CFS
Method: MMB
No Secs:
Meter No: 1.0
Max Vel:
Min Vel: 1.88

ORIENTATION:
[✓ Wading,] Boat, Upstream, [✓ Downstream,] Side Bridge 500 yds ft/mi,
above, [✓ below gage,] and Railroad tressell

Measurement rated: [✓ excellent] good fair poor based on the following
conditions: Cross section ______
Flow ______ Weather Clear/sunny/windy
Other ______ Air ______ °F @ ______
Gage ______ Water ______ °F @ ______

Observer SUBSTRATE - ROCK/gravel - w - periphyton
SOME EMbeddedness. < 50%

Control Braided channel - w - small beaver dam ~6"

Remarks Good measurment

(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)
LDB 0.0	0.0			0.08#			
1.0	1.0	0.2		0.03		0.2	0.006
2.0	1.0	0.3		1.06		0.3	0.48
3.0	1.0	0.4		1.65		0.4	0.66
4.0	1.0	0.4		1.96		0.4	0.78
5.0	1.0	0.3		1.93		0.3	0.58
6.0	1.0	0.3		1.75		0.3	0.52
7.0	1.0	0.3		1.22		0.3	0.37
8.0	1.0	0.4		1.03		0.4	0.41
9.0	1.0	0.6		1.23		0.6	0.74
10.0	1.0	0.9		1.51		0.9	1.36
11.0	1.0	1.3		1.41		1.3	1.83
RDB 11.5	0.5	0.8		1.88		0.4	0.75
12.0	0.0	0.0		ND			
TOTALS				1.39 FPS			8.49 CFS

Completed By______ Checked by______ Reviewed by______

V1.0 1096

Discharge Flow Measurement Form
Continued

(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)
TOTALS							

(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)
TOTALS							

Completed By________ Checked by___________ Reviewed by____________

GBM^{c} & Associates
Strategic Environmental Services

BDC-3 OFH 5/17/11

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat, rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
3. 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
4. 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 18	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1

83

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
8. 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
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 [✓ 7] 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 17	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

74

TOTAL SCORE 83 +74 157

Mean = 13.1

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GBM^c & Associates
Strategic Environmental Services

BDL3
REW

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	[✓ 5] 4 3 2 1
4. 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 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	[✓ 5] 4 3 2 1
8. 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
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 124

58

66/6 = 11

124/12 = 10.33

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GBM^c & Associates
Strategic Environmental Services

BDL-3 d/s

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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
4. 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 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted, embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
8. 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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 154 $\bar{X} = 12.8$

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GBMc & Associates
Strategic Environmental Services

PHYSICAL CHARACTERIZATION FIELD FORM

Date/Time: 22 April 1999	Stream: Louvre Creek (LC-1)
Observer(s): SKH / REM / GLP	Transect No: 1 2 & 3
Project No:	Picture No:

3

Distance from ([✓ LB]/RB)	Width (ft) 1.0 15.6			Depth (ft)			Area (ft²)			Bank Habitat			Stream Habitat			Sub.			Canopy Cover (Y/N)		
LDB 1. 0.0	1.0	0.0	0.0	0.2	0.3	0.8				X	V	U	X	V	V/L	C	S	S	Y	Y	Y
2. 1.0	1	1.0	1.0	0.7	0.7	0.6				X	X	X	X	V	X	C	S	S	N	Y	Y
3. 2.0	1	1.0	1.0	1.0	1.2	0.3				Y	X	Y	X	X	Y	C	S	S	N	Y	Y
4. 3.0	1	1.0	1.0	1.0	1.6	0.2				X	R	X	X	L	V	C	S	S	N	N	Y
5. 4.0	1.0	1.0	1.0	1.3	1.8	0.5				X	R	X	L	L	V	C	S	S	N	N	N
6. 5.0	1.0	1.0	1.0	1.3	2.1	0.6				X	R	X	L	L	L	C	C	S	N	N	N
7. 6.0	1.0	1.0	1.0	1.6	2.3	0.8				X	N	X	L	N	L	C	C	S	N	N	N
8. 7.0	1.0	1.0	1.0	0.6	2.4	1.1				X	W	X	L	X	L	C	C	S	N	N	N
9. 8.0	1.0	1.0	1.0	1.1	2.4	1.2				X	X	X	D	X	L	C	C	S	N	N	N
10. 9.0	1.0	1.0	1.0	1.0	2.6	1.3				X	X	X	X	X	L	C	C	S	N	N	N
RDB 11. 10.0	1.0	1.0	1.0	0.5	2.6	1.5				X	X	X	U	X	L	C	C	S	N	Y	N
12. 11.0		1.0	1.8	1.0	2.4	1.9					X	X	X	X	L		C	S		Y	N
13. 12.0		1.0	1.0		2.0	1.5					X	X		X	L		C	S		Y	N
14. 13.0		1.0	1.0		1.5	1.0					R	X		L	L		C	S		Y	N
15. 14.0		1.0	1.0		0.8	0.8					R	X		L	L		C	S		Y	N
16. 15		1.0	1.0		0.3	0.6	[illegible]				R			L	L		S	S		Y	N
17. 15.6		0.5			0.0						R			L			S			Y	
18.																					
19.																					
20.																					
Calculations							103	27.0	19.8												

103

L V

Bank Habitat R = Roots U = Undercut Bank V = Vegetation X = Devoid	**Stream Habitat** D = Depressions L = Logs, Debris V = Vegetation X = Devoid
Substrate M = Mud <.04 mm S = Sand .06-6 mm G = Gravel 6-60 mm	B = Boulders 25-45 cm R = Rubble 6-25 cm L = Lithified

PHYSICAL CHARACTERIZATION FIELD FORM
Continued

Dissolved Oxygen, mg/l __________

Temperature, °C __________

Conductivity, uhmos __________

pH, su __________

Stream Width, ft 8' / 15.'6" / 14'.6"

Channel Width, ft 20' / 20' / 22'

Pool 2nd 48ft / 3rd Length, ft __________

Riffle/[✓ Run] __________ Length, ft __________

Riparian Ground Cover

Left 1	Left 2	Left 3	Right 1	Right 2	Right 3	
50	50	25	80	75	75	% Vegetated
50	50	75	20	25	25	% Soil/Sand
–	–	–	–	–	–	% Rock

Riparian Canopy Cover

Left			Right			
10	10	10	0	0	0	% Canopy Cover
~~10~~			~~0~~			

Bank Slope

Left			Right			
						Flat (<8°)
						Mod (9-30°)
✓	✓	✓	✓	✓	✓	Steep (>30°)

Bank Stability

Left			Right			
✓			✓		✓	Stable
●	✓	✓		✓		Moderately Stable
						Unstable

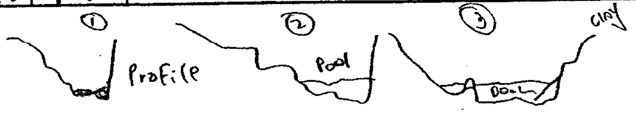
Bank Height (ft)

Left			Right		
6	6	6	8	8	8

Percent Embedded

_____ Sands _____ Gravel

0	20	50	0	80	50	GlAY



COMMENTS:

JMc & Associates
Strategic Environmental Services

Discharge/Flow Measurement Form

Station: LC-1		
Waterbody: Loutre Creek		
Date: 22April 99		
Crew: SKH/ REM	Start Time: 0750	Recorder: REM
	End Time:	GH. Change: ____ n
	Staff/Gage:	____ hrs.
Width: 9'	Area:	Velocity: 0.53 FPS
Disch/Flow: 3.14 CFS	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 cloudy 60% chance RAIN, Humid

Control d/s beaver dam

Remarks BOTTOM Rough - clay pitted - u/s 10 ft log JAM, LOCATION off brine Rd EAST of OLCC-discharge

obstruction AT 3.0 ft, moved to 3.5, Also Eddy on REW which is d/s of sloughing RDB.

(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)
LEW 0.0							
0.5	0.5	0.7		0.65		0.35	0.23
1.0	0.5	0.7		0.35		0.35	0.12
2.0	1.0	1.0		0.38		1.0	0.38
3.5 3.5obs	1.5 1.5	1.3		0.75		1.95	1.46
4.0	0.5	1.6		0.51		0.8	0.41
5.0	1.0	0.5		1.07		0.5	0.54
6.0	1.0	0.9		0.00		0.9	0
REW 8.0	2.0	0.0		0.00		0	
TOTALS				0.53FPS			3.14 CFS

Completed By REM Checked by ____ Reviewed by ____

V1.0 1096

Discharge Flow Measurement Form
Continued

(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)
TOTALS							

(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)
TOTALS							

Completed By________ Checked by__________ Reviewed by__________

LC-1 5/19/99 SKH

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1

78

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
8. 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
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 78 +52 130

MEAN = 10.8

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GBMc & Associates
Strategic Environmental Services

LC-1
REM

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently distrubed or removed.	Substrate unstable lacking.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1

65/6 = 10.8

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
8. 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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 142 $\bar{x}=12$

65
77
142 ÷ 12 = 11.8

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GDM & Associates
Strategic Environmental Services

LC-1

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
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SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mid, 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
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >80% of steam reach channelized and disrupted.	Extensive channelization; shored with gabion cement; heavily urbanized areas; in steam habitat greatly altered or removed entirely.
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6. Sediment Disposition	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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 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
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SCORE 14	20 19 18 17 16	15 [✓ 14] ~~13~~ 12 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
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SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 168 $\bar{X} = 14.0$

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

STATION I.D. BDL-1	**LOCATION** u/s of outfall 001	
STREAM NAME Bayou de Lanter	**RIVER BASIN**	
LAT **LONG**	**CLIENT** GLCC-Central	
INVESTIGATORS		
FORM COMPLETED BY REM	**DATE** 5/2/2000 **TIME** 200pm	**REASON FOR SURVEY** Temp UAA

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☑
☐	showers (intermittent)	☑
100 % ☑	% cloud cover	☐ ____%
☐	clear/sunny	☐

Has there been a heavy rain in the last 7 days? ☐ Yes ☑ No

Air Temperature__________°C/°F

Other____________________

STREAM ATTRIBUTES

Stream Subsystem: ☑ Perennial ☐ Intermittent ☐ Tidal

Stream Type: ☐ Coldwater ☑ Warmwater

Stream Origin: ☐ Glacial ☐ Non-glacial montane ☐ Swamp and bog ☑ Spring-fed ☐ Mixture of origins ☑ Other stormH2O discharg

Catchment Area ________mi^2

HYDROLOGY

Flows: ☐ High ☐ Moderate ☑ Low ☐ None

Flows Measured? ☑ Yes ☐ No

WATERSHED FEATURES

Predominant Surrounding Landuse: ☑ Forest ☑ Field/Pasture ☐ Agricultural ☐ Residential ☐ Commercial ☑ Industrial ☐ Other ____________

Local Watershed NPS Pollution: ☐ No evidence ☑ Some potential sources ☑ Obvious sources

Local Watershed Erosion: ☐ None ☑ Moderate ☐ Heavy

INSTREAM FEATURES

Proportion of Reach Represented by Stream Morphology Types

☐ Riffle 10 %
☐ Run 50 %
☐ Pool 40 %

Channelized ☐ Yes ☐ Some ☑ No

Dam Present ☐ Yes ☐ Some ☑ No

WATER/ OBSERVATIONS

Water Odors: ☐ Normal/None ☑ Petroleum ☐ Fishy ☐ Sewage ☑ Chemical ☐ Other__________

Water Surface Oils: ☐ Slick ☐ Flecks ☑ Sheen ☐ None ☐ Globs ☐ Other__________

* in pools

Turbidity (if not measured): ☐ Clear ☐ Opaque ☐ Slightly turbid ☐ Stained ☑ Turbid ☐ Other heavy iron Floc on all surfaces

SEDIMENT/ OBSERVATIONS

Sediment Odor: ☐ Normal ☑ Chemical ☐ Other__________ ☐ Sewage ☐ Anaerobic ☑ Petroleum ☐ None

Sediment Deposits: ☐ Sludge ☑ Sand ☑ Other silt ☐ Sawdust ☐ Relict shells ☐ Oils

Quantitative Habitat Characterization Field Form

Station I.D: BDL-1		Transect # (circle): [✓ 1] 2 3 4 5
Stream name: Bayou de Loutre	Client: GLCC-Central	Date/Time: 5/2/2000
Location: u/s of outfall 001	Investigators: REM / SKH	Reason For Survey: Temp UAA
Lat: 33 11 11 N Long: 92 40 58 W (106 ft)	Form Completed By: REM	

Stream Characteristics:

Stream Wetted Width, ft: 3 Ft	Left Bank Height, ft 4.0 ft.	Pool ☐ Length, ft
Channel Width, ft: 17 Ft x3 = 41 ft	Right Bank Height, ft: 3.5 ft	Run ☐ Length, ft
	Distance From Last Transect, ft: 1st	Riffle ☑ Length, ft: 130 ft

Periphyton Coverage/Abundance

On Substrate:	[✓ 0] 1 2 3 4	On In-Stream Habitat:	[✓ 0] 1 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	[✓ 0] 1 2 3 4	Roots:	0 [✓ 1] 2 3 4
Brush:	[✓ 0] 1 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	0 1 [✓ 2] 3 4	Undercut Bank:	[✓ 0] 1 2 3 4
Vegetation:	[✓ 0] 1 2 3 4	Vegetation:	[✓ 0] 1 2 3 4
Devoid:	0 1 2 3 [✓ 4]	Devoid:	0 1 2 3 [✓ 4]

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
✓	✓	Steep (>30°)

Bank Stability

Left	Right	
✓	✓	Stable
		Moderately Stable
		Unstable

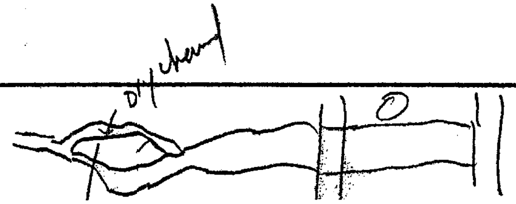
Riparian Ground Cover (Total = 100%)

Left	Right	
30	30	%Vegetated, Herbs/Grasses
20	40	%Vegetated, Shrubs/Trees
50	30	% Soil/Sand
—	—	% Rock

Riparian Canopy Cover

Left	Right	
75	70	% Canopy Cover, Trees

Notes:



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V1.2 0400

Quantitative Habitat Chara_cterization Field Form cont.

Station I.D: BDC 1		Transect # (circle): [✓ 1] 2 3 4 5	
Form Completed By: REW	Date/Time: 5/2/2000 1255	Form Checked By: SKH	Date/Time: 6/6/00 1500

Distance in ft. from ([✓ LB]/RB)	Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover) Type & Abundance: Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Stream Substrate Type: Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)	%Embedded	%Canopy Cover
1. 0.0	0.0	1	0.0					1								✓	✓					85	✓
2. 0.5	0.5	2	1.0					1								✓	✓					25	✓
3. 1.0	0.5	2	1.0								4					✓	✓						✓
4. 1.5	0.5	3	1.5								4					✓	✓						✓
5. 2.0	0.5	2	1.0								4					✓	✓						✓
6. 2.5	0.5	2	1.0								4					✓	✓						✓
7. 3.0	0.5	1	0.5								4					✓	✓						✓
8.																							
9.																							
10.																							
11.																							
12.																							
13.																							
14.																							
15.																							
16.																							
Calc 3.0	0.5	1.9	~~0.9~~ SKH Total = 6.0					1 (7%)			3 (71%)					50	50					21	100

REW

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Leafy Debris - Sparse ; Devoid - Heavy

Substrate Type Summary (% Occurrence): Coarse Gravel - 50% ; Fine Gravel - 50%

Quantitative Habitat Characterization Field Form cont.

Station I.D: BDL-1
Transect # (circle): 1 [✓ 2] 3 4 5
Form Completed By: REW Date/Time: 5/2/2000 1:10pm
Form Checked By: SKH Date/Time: 6/6/00 1500

Distance in ft. from (LB/RB)		Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											
					Type & Abundance								Type											
LEW	0.0				Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)	%Embedded	%Canopy Cover
1.	1.0	1.0	0.5	0.5			1		1									✓					100	✓
2.	2.0	1.0	0.7	0.7			1		1									✓					✓	✓
3.	3.0	1.0	0.7	0.7			1		1								✓	✓					✓	✓
4.	4.0	1.0	0.5	0.5			1	1	1								✓						✓	✓
5.	5.0	1.0	0.4	0.4			1					SKH					✓	✓					✓	✓
6.	6.0	1.0	0.6	0.6			1		1			~~✓~~						✓					✓	✓
7.	7.0	1.0	0.7	0.7			1		1									✓					✓	✓
8.	8.0	1.0	0.7	0.7			1		1									✓					✓	✓
9.	8.5	0.5	0.4	0.2			1		1									✓		✓			✓	✓
10.																								
11.																								
12.																								
13.																								
14.																								
15.																								
16.																								
Calc	SKH ~~4.9~~	0.9	0.6	0.6			2	1	2			~~2~~ SKH					33	56		11			100	100
Total = 8.5			Total = 5.0				(25%)	(2.8%)	(22%)			(11%)												

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Woody Debris (small) - Moderate ; Aquatic Vegetation - Sparse ; Leaf Debris - Moderate ; Devoid - Moderate

Substrate Type Summary (% Occurrence): Coarse Gravel - 33% ; Fine Gravel - 56% ; Silt/Mud/Clay - 11%

PAGE 2 OF 2
V1.2 0400

Quantitative Habitat Characterization Field Form

Station I.D: BDL-1
Transect # (circle): 1 [✓ 2] 3 4 5
Stream name: Bayou de Loutre
Client: GLLG C
Date/Time: 5/2/2000 1:10 pm
Location:
Investigators:
Reason For Survey: Temp UAA
Lat: 33 11 13 Long: 92 41 01
Form Completed By: REM

Stream Characteristics:

Stream Wetted Width, ft: 8.5 ft	Left Bank Height, ft 4.0	Pool ☐ Length, ft
Channel Width, ft: 18 ft	Right Bank Height, ft: 3.0	Run ☑ Length, ft:
	Distance From Last Transect, ft: 68	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate: [✓ 0] 1 2 3 4
On In-Stream Habitat: [✓ 0] 1 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 [✓ 1] 2 3 4	Roots:	0 1 [✓ 2] 3 4
Brush:	[✓ 0] 1 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	[✓ 0] 1 2 3 4	Undercut Bank:	0 [✓ 1] 2 3 4
Vegetation:	[✓ 0] 1 2 3 4	Vegetation:	[✓ 0] 1 2 3 4
Devoid:	0 1 2 3 [✓ 4]	Devoid:	0 1 2 3 [✓ 4]

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
✓	✓	Mod (9-30°)
		Steep (>30°)

Bank Stability

Left	Right	
	✓	Stable
✓		Moderately Stable
		Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
50	60	%Vegetated, Herbs/Grasses
30	20	%Vegetated, Shrubs/Trees
20	20	% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
30	50	% Canopy Cover, Trees

Notes:

Quantitative Habitat Characterization Field Form cont.

Station I.D: BDC-1

Transect # (circle): 1 2 [✓ 3] 4 5

Form Completed By: RGW

Date/Time: 5/2/2000 1330

Form Checked By: SKH

Date/Time: 6/6/00 1500

	Distance in ft. from (LB/RB)	Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											
					Type & Abundance								Type											
	LEW				Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)	%Embedded	%Canopy Cover
1.	0.0	0.0	0.9	0.0			1		1											✓				Yes
2.	2.0	2.0	1.3	2.6								4								✓				NO
3.	4.0	2.0	1.9	3.8								4						✓		✓				✓
4.	6.0	2.0	2.3	4.6			1					SKH ~~4~~						✓		✓				✓
5.	8.0	2.0	3.0	6.0			1					~~4~~						✓		✓				✓
6.	10.0	2.0	2.9	5.8								4								✓				✓
7.	12.0	2.0	3.2	6.4			1													✓				✓
8.	14.0	2.0	2.9	5.8			1													✓				✓
9.	16.0	2.0	2.9	5.8			1													✓				✓
10.	18.0	2.0	0.5	1.0			1		1											✓				Yes
REW 11.	19.0	1.0	0.1	0.1			1		1															Yes
12.																								
13.																								
14.																								
15.																								
16.																								
Calc	SKH 9.9	1.9	2.0	SKH 3.8			2		1			2						30		70			0	91
	Total = 19.0		2.2 Total =	41.9			(18%)		(6.8%)			(27%)												

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Woody Debris (small) - Moderate ; Leafy Debris - Sparse ; Devoid - ~~Heavy~~ SKH Moderate

Substrate Type Summary (% Occurrence): Fine Gravel - 30% ; Silt/Mud/Clay - 70%

PAGE 2 OF 2
V1.2 0400

Quantitative Habitat Characterization Field Form

Station I.D: BDL-1		Transect # (circle): 1 2 [✓ 3] 4 5
Stream name: Bayou la Loutre	Client: GLCC-C	Date/Time: 5/2/2000
Location:	Investigators: SKH/REW	Reason For Survey:
Lat: Long:	Form Completed By: REW	Rep

Stream Characteristics:

Stream Wetted Width, ft: 19 ft	Left Bank Height, ft 4.0	Pool ☑ Length, ft ~175
Channel Width, ft: 23 ft	Right Bank Height, ft: 3.0	Run ☐ Length, ft:
	Distance From Last Transect, ft: 70	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	[✓ 0] 1 2 3 4	On In-Stream Habitat:	[✓ 0] 1 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 [✓ 1] 2 [✓ 3] 4	Roots:	0 [✓ 1] 2 3 4
Brush:	0 [✓ 1] 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	0 [✓ 1] 2 3 4	Undercut Bank:	0 [✓ 1] 2 3 4
Vegetation:	[✓ 0] 1 2 3 4	Vegetation:	[✓ 0] 1 2 3 4
Devoid:	0 1 2 3 4	Devoid:	0 1 2 3 4

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
✓	✓	Steep (>30°)

Bank Stability

Left	Right	
		Stable
✓	✓	Moderately Stable
		Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
30	10	%Vegetated, Herbs/Grasses
40	50	%Vegetated, Shrubs/Trees
30	40	% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
25	5	% Canopy Cover, Trees

Notes:

Big Pool Just off Bridge.

PAGE 1 OF 2
V1.2 0400

Quantitative Habitat Characterization Field Form

Station I.D: BDL-1		Transect # (circle): 1 2 3 [✓ 4] 5
Stream name: Bayou de Loutre	Client: GLCC- Central	Date/Time: 5/2/2000 1345
Location:	Investigators: REM / SKH	Reason For Survey:
Lat: Long:	Form Completed By: REM	Temp UAA

Stream Characteristics:

Stream Wetted Width, ft: 7.0 ft.	Left Bank Height, ft 1.0	Pool ☑ Length, ft
Channel Width, ft: 7.0 ft	Right Bank Height, ft: 1.0 (22ft- Rd)	Run ☐ Length, ft:
	Distance From Last Transect, ft:	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	[✓ 0] 1 2 3 4	On In-Stream Habitat:	[✓ 0] 1 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 1 2 [✓ 3] 4	Roots:	0 1 [✓ 2] [✓ 3] 4
Brush:	[✓ 0] 1 2 3 4	Brush:	0 [✓ 1] 2 3 4
Undercut Bank:	0 [✓ 1] 2 3 4	Undercut Bank:	0 [✓ 1] 2 3 4
Vegetation:	0 1 2 [✓ 3] 4	Vegetation:	0 ~~1~~ 2 [✓ 3] 4
Devoid:	[✓ 0] 1 2 3 4	Devoid:	[✓ 0] 1 2 3 4

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
✓		Flat (<8°)
		Mod (9-30°)
	✓	Steep (>30°)

Bank Stability

Left	Right	
✓	✓	Stable
		Moderately Stable
		Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
90	90	%Vegetated, Herbs/Grasses
–	–	%Vegetated, Shrubs/Trees
10	10	% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
10	-0-	% Canopy Cover, Trees

Notes:
continuation from Big Pool at bridge.
Ditch on w/s side of Road total 350' (200 ft)

PAGE 1 OF 2
V1.2 0400

Quantitative Habitat Characterization Field Form cont.

Station I.D: BDL-1

Transect # (circle): 1 2 3 [✓ 4] 5

Form Completed By: REM

Date/Time: 5/2/2000 1345

Form Checked By: SKY

Date/Time: 6/6/00 1500

	Distance in ft. from ([✓ LB]/RB) LEW	Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover) Type & Abundance								Stream Substrate Type										%Embedded	%Canopy Cover
					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
1.	0.0	0.0	0.5	0.0			1		1	2										✓				No
2.	1.0	1.0	1.1	1.1			1		1											✓				✓
3.	2.0	1.0	1.5	1.5			1		1											✓				✓
4.	3.0	1.0	1.5	1.5			1		1											✓				✓
5.	4.0	1.0	1.6	1.6			1		1											✓				✓
6.	5.0	1.0	1.4	1.4			1		1											✓				✓
7.	6.0	1.0	1.5	1.5			1		1	1										✓				✓
8.	7.0	1.0	0.3	0.3			1		1	2										✓				✓
9.																								
10.																								
11.																								
12.																								
13.																								
14.																								
15.																								
16.																								
Calc	~~3.5~~	~~0.9~~	1.2	1.1			2		2	2										100			0	87.5
	Total: 7.0	1.0		Total = 8.9			(25%)		(19%)	(16%)														

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Woody Debris (small) - Moderate ; Leafy Debris - Moderate ; Overhanging Vegetation - Moderate

Substrate Type Summary (% Occurrence): Silt/Mud/Clay - 100%

Discharge/Flow Measurement Form

Station: BDL-1

Waterbody: Bayou de Loutre

Date: 5/2/2000

Crew: SKH/REW	Start Time: 1240	Recorder: REW
	End Time: 1255	GH. Change: ____ in ____ hrs.
	Staff/Gage:	
Width: 3.0'	Area: 0.6 ft²	Velocity: 0.83 fps
Disch/Flow: 0.582cfs	Method: 0.6	No Secs:
Meter No: MMcB	Max Vel: 1.65	Min Vel: ND

ORIENTATION:
[✓ Wading,] Boat, Upstream, [✓ Downstream] Side [✓ Bridge] 250 [✓ 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 Good

(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)
LEW 0.0	0.0	0.1		0.0		—	—
0.5	0.5	0.2		0.49		0.1	0.049
1.0	0.5	0.2		1.22		0.1	0.122
1.5	0.5	0.3		1.65		0.15	0.248
2.0	0.5	0.2		1.45		0.1	0.145
2.5	0.5	0.2		0.18		0.1	0.018
REW 3.0	0.5	0.1		ND		0.05	0.0
TOTALS				4.99		0.6	0.582
Avg.=				0.83		0.1	0.097

Completed By REW Checked by SKH Reviewed by ______

V1.0 1096

GLCC-UNR
2072-99-070

BDL-1
5/2/00

KEM
DATE:

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
3. 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 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
4. 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
5. Channel . Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted, embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1

72 ÷ 6 = 12

Habitat Parameter	CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
8. 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 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE $\bar{x} = 11.5$

$66 \div 6 = 11$

$66 + 72 = 138 \div 12 = 11.5$

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GLCC-UAA
2072-99-070

BDL-1
5/2/00

GLP
DATE:

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE ~~12~~ 11	20 19 18 17 16	15 14 13 ~~12~~ 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE ~~12~~ 11	20 19 18 17 16	15 14 13 ~~12~~ 11	10 9 8 7 6	5 4 3 2 1
3. 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
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 10	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 10	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
8. 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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1

TOTAL SCORE ____________

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GLCC-UAA
2072-99-070

BDL-1
5/2/00

SKM
DATE: 5/2/00

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
3. 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
4. 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 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 [✓ 7] 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 [✓ 7] 6	5 4 3 2 1
8. 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
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 113 ÷ 12 $\boxed{9.4}$

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GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

STATION I.D. BDL - 2	LOCATION
STREAM NAME Bayou de Loutre	RIVER BASIN Ouachita
LAT LONG	CLIENT LLC - Central
INVESTIGATORS CKH/REM/LLP	
FORM COMPLETED BY SKH	DATE_________ TIME_________
	REASON FOR SURVEY Temp MAA

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☒
☐	showers (intermittent)	☒
100 % ☒	% cloud cover	☐ ____%
☐	clear/sunny	☐

Has there been a heavy rain in the last 7 days? ☐ Yes ☒ No

Air Temperature_________°C/°F

Other__________________

STREAM ATTRIBUTES

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial ☒ Spring-fed
☐ Non-glacial montane ☒ Mixture of origins
☐ Swamp and bog ☐ Other __________

Catchment Area _______ mi^2

HYDROLOGY

Flows
☐ High ☐ Moderate ☒ Low ☐ None

Flows Measured?
☒ Yes ☐ No

WATERSHED FEATURES

Predominant Surrounding Landuse
☒ Forest ☐ Commercial
☐ Field/Pasture ☐ Industrial
☐ Agricultural ☐ Other __________
☐ Residential

Local Watershed NPS Pollution
☐ No evidence ☒ Some potential sources
☒ Obvious sources

Local Watershed Erosion
☐ None ☒ Moderate ☐ Heavy

INSTREAM FEATURES

Proportion of Reach Represented by Stream Morphology Types
☐ Riffle 5 %
☐ Run 30 %
☐ Pool 65 %

Channelized ☐ Yes ☐ Some ☒ No

Dam Present ☐ Yes ☐ Some ☒ No

WATER/ OBSERVATIONS

Water Odors
☐ Normal/None ☐ Sewage
☒ Petroleum ☒ Chemical
☐ Fishy ☐ Other________

Water Surface Oils
☐ Slick ☒ Sheen ☐ Globs
☐ Flecks ☐ None ☐ Other________

Turbidity (if not measured)
☐ Clear ☐ Slightly turbid ☒ Turbid
☐ Opaque ☐ Stained ☐ Other________

SEDIMENT/ OBSERVATIONS

Sediment Odor
☐ Normal ☐ Sewage ☒ Petroleum
☒ Chemical ☐ Anaerobic ☐ None
☐ Other__________

Sediment Deposits
☐ Sludge ☐ Sawdust ☒ Oils
☒ Sand ☐ Relict shells
☒ Other Silt

Quantitative Habitat Characterization Field Form

Station I.D: BDL-2		Transect # (circle): [✓ 1] 2 3 4 5
Stream name: Bayou de Loutre	Client: GLCC-C	Date/Time: 5/1/2000 1530
Location: Transect 1	Investigators: REM | SKH	Reason For Survey: Temp UAA
Lat: 33 11 15 N Long: 92 40 38 W	Form Completed By: REM	

Stream Characteristics:		
Stream Wetted Width, ft: 5'	Left Bank Height, ft 3.5	Pool ☑ Length, ft 125 ft
Channel Width, ft: 12'	Right Bank Height, ft: 5.0	Run ☐ Length, ft:
	Distance From Last Transect, ft: 1st transect	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	[✓ 0] 1 2 3 4	On In-Stream Habitat:	[✓ 0] 1 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 [✓ 1] 2 3 4	Roots:	[✓ 0] 1 2 3 4
Brush:	0 [✓ 1] 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	[✓ 0] 1 2 3 4	Undercut Bank:	[✓ 0] 1 2 3 4
Vegetation:	[✓ 0] 1 2 3 4	Vegetation:	[✓ 0] 1 2 3 4
Devoid:	0 1 2 3 [✓ 4]	Devoid:	0 1 2 3 [✓ 4]

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
✓	✓	Steep (>30°)

Bank Stability

Left	Right	
		Stable
✓		Moderately Stable
	✓	Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
50	25	%Vegetated, Herbs/Grasses
30	50	%Vegetated, Shrubs/Trees
20	25	% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
45	50	% Canopy Cover, Trees

Notes:

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Quantitative Habitat Characterization Field Form cont.

Station I.D:	BDL-2			Transect # (circle):	[✓ 1] 2 3 4 5	
Form Completed By:	REM	Date/Time:	5/1/2000	Form Checked By:	SKH	Date/Time: 6/7/00(0830)

Distance in ft. from ([✓ LB]/RB)		Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											%Canopy Cover
					Type & Abundance								Type										%Embedded	
LEW					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
1.	1.0	1.0	0.5	0.5	2		1					~~✓~~ SKH								✓				✓
2.	2.0	1.0	1.1	1.1	1															✓				✓
3.	3.0	1.0	1.3	1.3	1															✓				
4.	4.0	1.0	0.9	0.9	1															✓				✓
REW 5.	5.0	1.0	~~0.0~~ SKH 0.1	SKH ~~0.0~~ 0.1								SKH ✓								✓				✓
6.																								
7.																								
8.																								
9.																								
10.																								
11.																								
12.																								
13.																								
14.																								
15.																								
16.																								
Calc	SKH ~~3.0~~ 5.0	1.0	0.8	0.8 Total: 3.9	2 (25%)		1 (5%)					2								100			0	80

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Depressions - Moderate ; Woody Debris (small) = Sparse ; Devoid - Moderate

Substrate Type Summary (% Occurrence): Silt/Mud/Clay - 100%

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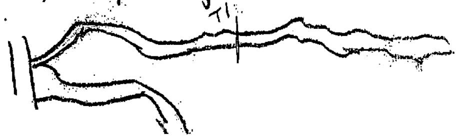

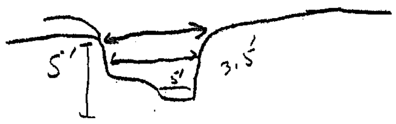

Quantitative Habitat Characterization Field Form cont.

Station I.D: BDL-2		Transect # (circle): 1 [✓ 2] 3 4 5	
Form Completed By: RGW	Date/Time: 5/1/2000 1600	Form Checked By: SKY	Date/Time: 6/7/00 0840

Distance in ft from ([✓ LB]/RB)		Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											%Canopy Cover
					Type & Abundance								Type										%Embedded	
	0.0				Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
1.	1.0	1.0	1.0	1.0	2							SKY ~~✓~~								✓				✓
2.	2.0	1.0	1.4	1.4	2							~~✓~~								✓				✓
3	3.0	1.0	1.5	1.5	2		1					~~✓~~								✓				✓
4	4.0	1.0	1.4	1.4	1		1					~~✓~~								✓				
5.	5.0	1.0	1.2	1.2	1		1					~~✓~~								✓				✓
6.	6.0	1.0	0.5	0.5								SKY ✓ 4								✓				
7.																								
8.																								
9.																								
10.																								
11.																								
12.																								
13.																								
14.																								
15.																								
16.																								
Calc	3.5	1.0	1.2	1.2	2 (33%)		2 (12.5%)					SKY ~~4~~ 2 (16.7%)								100			0	67

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Depressions - Moderate ; Woody Debris (small) - Moderate ; Devoid - ~~Very Heavy~~ SKY Moderate

Substrate Type Summary (% Occurrence): Silt/Mud/Clay - 100%

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Quantitative Habitat Characterization Field Form

Station I.D: BDL-2		Transect # (circle): 1 [✓ 2] 3 4 5
Stream name: Bayou de Loutre	Client: GLCC-C	Date/Time: 5/1/2000 1600
Location: BDL El Dorado	Investigators: REM / SKH	Reason For Survey: Temp UAA
Lat: Long:	Form Completed By: REM	

Stream Characteristics:

Stream Wetted Width, ft: 10	Left Bank Height, ft 4'	Pool ☐ Length, ft
Channel Width, ft: 22'	Right Bank Height, ft: 4'	Run ☑ Length, ft: 71'
	Distance From Last Transect, ft: 48'	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	[✓ 0] 1 2 3 4	On In-Stream Habitat:	[✓ 0] 1 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 1 [✓ 2] 3 4	Roots:	[✓ 0] 1 2 3 4
Brush:	0 [✓ 1] 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	0 [✓ 1] 2 3 4	Undercut Bank:	[✓ 0] 1 2 3 4
Vegetation:	[✓ 0] 1 2 3 4	Vegetation:	[✓ 0] 1 2 3 4
Devoid:	0 1 [✓ 2] 3 4	Devoid:	0 1 2 3 [✓ 4]

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
	✓	Mod (9-30°)
✓		Steep (>30°)

Bank Stability

Left	Right	
		Stable
	✓	Moderately Stable
✓		Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
20	10	%Vegetated, Herbs/Grasses
70	30	%Vegetated, Shrubs/Trees
10	60	% [✓ Soil]/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
25	80	% Canopy Cover, Trees

Notes: channel -w- old split of LDB - now stagnant

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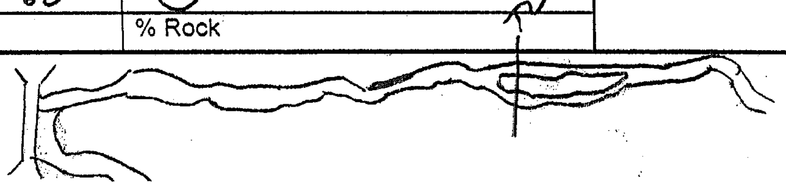
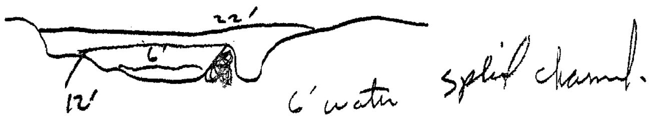




Quantitative Habitat Characterization Field Form

Station I.D: BDL-2		Transecct # (circle): 1 2 [✓ 3] 4 5
Stream name: Bayou de Loutre	Client: GLCC-C	Date/Time: 5/1/2000 1620
Location:	Investigators: REM/SKH	Reason For Survey: Targ UAA
Lat: Long:	Form Completed By: REM	

Stream Characteristics:

Stream Wetted Width, ft: 13'	Left Bank Height, ft 4.5	Pool ☐ Length, ft
Channel Width, ft: 25'	Right Bank Height, ft: 4.	Run ☐ Length, ft:
	Distance From Last Transect, ft: 80'	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	[✓ 0] 1 2 3 4	On In-Stream Habitat:	[✓ 0] 1 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 1 2 [✓ 3] 4	Roots:	0 [✓ 1] 2 3 4
Brush:	0 [✓ 1] 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	0 1 [✓ 2] 3 4	Undercut Bank:	[✓ 0] 1 2 3 4
Vegetation:	[✓ 0] 1 2 3 4	Vegetation:	[✓ 0] 1 2 3 4
Devoid:	0 [✓ 1] 2 3 4	Devoid:	0 1 2 3 [✓ 4]

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
✓	✓	Steep (>30°)

Bank Stability

Left	Right	
		Stable
	✓	Moderately Stable
✓		Unstable

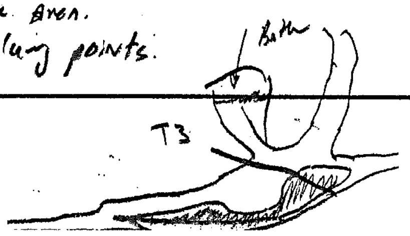
Riparian Ground Cover (Total = 100%)

Left	Right	
10	10	%Vegetated, Herbs/Grasses
70	25	%Vegetated, Shrubs/Trees
20	65	% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
20	80	% Canopy Cover, Trees

Notes: very unique area.
wash out plung points.



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Quantitative Habitat Characterization Field Form cont.

Station I.D: RDL- 2

Transect # (circle): 1 2 [✓ 3] 4 5

Form Completed By: REN

Date/Time: 5/1/2000 1620

Form Checked By: SKH

Date/Time: (0850) 6/7/00

	Distance in ft. from ([✓ LB]/RB)	Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover) Type & Abundance								Stream Substrate Type										%Embedded	%Canopy Cover
					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
	0.0	0.0	1.1	0.0					2															
1.	1.0	1.0	0.9	0.9			2													✓			[illegible]	100
2.	2.0	1.0	0.8	0.8			2													✓				"
3.	3.0	1.0	1.1	1.1	1	2															✓			"
4.	4.0	1.0	0.7	0.7	1		1														✓			"
5.	5.0	1.0	1.0	1.0	1		1														✓			
6.	6.0	1.0	0.9	0.9	1		1														✓			
7.	7.0	1.0	0.8	0.8	1																✓			
8.	8.0	1.0	1.0	1.0	1		1														✓			
9.	9.0	1.0	1.0	1.0	1		1														✓			
10.	10	1.0	0.9	0.9	1		1														✓			
11.	11	1.0	0.9	0.9	1		1														✓			
12.	12	1.0	0.4	0.4			1														✓			
13.	13	1.0 SKH ~~0.0~~	~~0.0~~ SKH 0.1	0.1 ~~0.0~~								4 SKH												
14.																								
15.																								
16.																								
Calc	~~7.0~~ SKH	0.9	0.8	0.8 SKH	2	1	2		1			1								17	83		0	100
	Total ~ 13.0			Total = 10.5	(16%)	(3.6%)	(21%)		(3.6%)															

REN

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Depressions - Moderate ; Woody Debris (large) = Sparse ; Woody Debris (small) - Moderate ; Leafy Debris - Sparse

Substrate Type Summary (% Occurrence): Silt/Mud/Clay - 17% ; Hardpan - 83%

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Quantitative Habitat Characterization Field Form

Station I.D: BDL-2		Transect # (circle): 1 2 3 [✓ 4] 5
Stream name:	Client: GCCC-Centur	Date/Time: 5/1/2000 1635
Location: El Dorado AR	Investigators: SKH/REW	Reason For Survey: Temp UAA
Lat: Long:	Form Completed By: REW	

Stream Characteristics:		
Stream Wetted Width, ft: 4.5	Left Bank Height, ft 3'	Pool ☐ Length, ft
Channel Width, ft: 6	Right Bank Height, ft: 2.5	Run ☑ Length, ft: 25'
	Distance From Last Transect, ft: 55'	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance			
On Substrate:	[✓ 0] 1 2 3 4	On In-Stream Habitat:	[✓ 0] 1 2 3 4
Bank Cover/Habitat			
Left Bank (LB)		Right Bank (RB)	
Roots:	0 1 [✓ 2] 3 4	Roots:	0 [✓ 1] 2 3 4
Brush:	[✓ 0] 1 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	0 [✓ 1] 2 3 4	Undercut Bank:	[✓ 0] 1 2 3 4
Vegetation:	[✓ 0] 1 2 3 4	Vegetation:	[✓ 0] 1 2 3 4
Devoid:	0 1 2 3 [✓ 4]	Devoid:	0 1 2 3 [✓ 4]

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
✓	✓	Steep (>30°)

Bank Stability

Left	Right	
		Stable
✓	~~✓~~ REW	Moderately Stable
	✓	Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
15	25	%Vegetated, Herbs/Grasses
10	25	%Vegetated, Shrubs/Trees
75	50	% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
80	80	% Canopy Cover, Trees

Notes:

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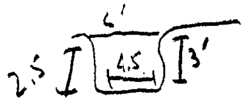

Quantitative Habitat Characterization Field Form cont.

Station I.D: BDL-2

Transect # (circle): 1 2 3 [✓ 4] 5

Form Completed By: REM

Date/Time: 5/1/2000

Form Checked By: SAY

Date/Time: 6/7/00 (0855)

Distance in ft. from ([✓ LB]/RB)		Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate												
					Type & Abundance								Type										%Embedded	%Canopy Cover
					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
	0.0	0.0	0.3	0.0																				
1.	1.0	1.0	0.9	0.9	1		1														1			100
2.	2.0	1.0	1.6	1.6			|														1			″
3.	3.0	1.0	1.1	1.1	1		|													1			″
4.	4.0	1.0	0.5	0.5			1														1			″
5.	5.0	1.0	SEW ~~0.0~~ 0.1	0.1								✓									1			″
6.																								
7.																								
8.																								
9.																								
10.																								
11.																								
12.																								
13.																								
14.																								
15.																								
16.																								
Calc	SEW ~~3.5~~	0.8	SEW 0.6 ~~0.7~~	0.6	1		2					2									100		0	100
	5.0			Total 3.3	(13%)		(25%)					(16.7%)												

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Depressions - Sparse ; Woody Debris (small) - Moderate

Substrate Type Summary (% Occurrence): Hardpan - 100%

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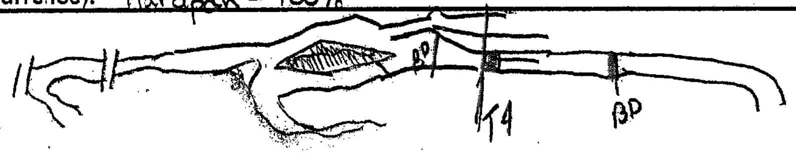

Quantitative Habitat Characterization Field Form

Station I.D: BDL-2		Transect # (circle): 1 2 3 4 [✓ 5]
Stream name: Bayou de Loutre	Client: GLCC-Central	Date/Time:
Location:	Investigators: SKH/REM	Reason For Survey:
Lat: Long:	Form Completed By: REM	

Stream Characteristics:		
Stream Wetted Width, ft: 7'	Left Bank Height, ft 3'	Pool ☑ Length, ft 130'
Channel Width, ft: 9'	Right Bank Height, ft: 3.5	Run ☐ Length, ft:
	Distance From Last Transect, ft: 48'	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	[✓ 0] 1 2 3 4	On In-Stream Habitat:	[✓ 0] 1 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 1 [✓ 2] 3 4	Roots:	0 1 [✓ 2] 3 4
Brush:	[✓ 0] 1 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	0 1 [✓ 2] 3 4	Undercut Bank:	0 1 [✓ 2] 3 4
Vegetation:	[✓ 0] 1 2 3 4	Vegetation:	0 [✓ 1] 2 3 4
Devoid:	0 1 2 3 [✓ 4]	Devoid:	0 1 [✓ 2] 3 4

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
✓	✓	Steep (>30°)

Bank Stability

Left	Right	
		Stable
✓		Moderately Stable
	✓	Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
15	50	%Vegetated, Herbs/Grasses
50	30	%Vegetated, Shrubs/Trees
35	20	% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
80	10	% Canopy Cover, Trees

Notes:

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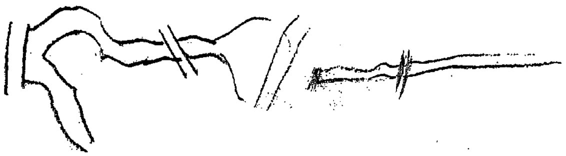


Quantitative Habitat Characterization Field Form cont.

Station I.D: BDL-2

Transect # (circle): 1 2 3 4 [✓ 5]

Form Completed By: RGN

Date/Time: 5/1/2000 1645

Form Checked By: SKP

Date/Time: 6/7/00 0855

	Distance ~~in ft.~~ from ([✓ LB]/RB)	Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											%Canopy Cover
					Type & Abundance								Type										%Embedded	
					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
1.	0.0	0.0	0.2	0.0		~~4~~	2														✓			100
2.	1.0	1.0	0.4	0.4	1	~~2~~	1														✓			〃
3.	2.0	1.0	1.0	1.0	1							~~✓~~									✓			〃
4.	3.0	1.0	1.3	1.3	1		1					~~✓~~									✓			〃
5.	4.0	1.0	1.0	1.0			1				SKP	~~✓~~									✓			〃
6.	5.0	1.0	0.9	0.9			1					~~✓~~									✓			〃
7.	6.0	1.0	0.7	0.7			1					~~✓~~									✓			〃
8.	7.0	1.0	0.1	0.1			1					~~✓~~									✓			〃
9.																								
10.																								
11.																								
12.																								
13.																								
14.																								
15.																								
16.												SKP												
Calc	SKP ~~5.5~~ 7.0	0.8	0.7	0.7 Total=5.4	1 (9%)		2 (25%)					~~4~~ ~~(75%)~~									100		0	100

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Depressions - Sparse ; Woody Debris (small) - Moderate ; ~~Devoid - Very Heavy~~ SKP

Substrate Type Summary (% Occurrence): Hardpan - 100%

Discharge/Flow Measurement Form

Station: BDL-2

Waterbody: Bayou la Loutre

Date: 5/1/2000

Crew: SKH/REM

Start Time: 15:30

Recorder: REM

End Time:

GH. Change: ______ in ______ hrs.

Staff/Gage:

Width: 5'

Area: 4.2 ft²

Velocity: 0.05 fps

Disch/Flow: 0.241 cfs

Method: 0.6

No Secs:

Meter No: MMB

Max Vel:

Min Vel:

ORIENTATION:

Wading, Boat, [✓ Upstream], Downstream, [✓ Side Bridge] 150 [✓ 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 very low flow

(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)
0.0	0.0	0.0		0.0	—	—	—
1.0	1.0	0.6		0.04		0.6	0.024
2.0	1.0	1.1		0.06		1.1	0.066
3.0	1.0	1.3		0.07		1.3	0.091
4.0	1.0	1.0		0.06		1.0	0.060
5.0	1.0	0.2		0.00		0.2	0.0
TOTALS		4.2		0.23		4.2	0.241

x̄ = 0.84 x̄ = 0.05

Completed By REM Checked by ______ Reviewed by ______

V1.0 1096

GLCC-URA
2072-99-070

BDL-2
5/1/00

RCM
DATE:

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. 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
4. 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 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	[✓ 5] 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
8. 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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 18	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 18	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE __________

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

2072-99-070 5/1-2/00 DATE:

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
3. 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
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 15	20 19 18 17 ~~16~~	[✓ 15] ~~14~~ 13 12 11	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 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
8. 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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE ___________

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

2072-99-070

BDL-2
5/1-2/00

DATE: 5/8/00

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 19	20 [✓ 19] 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
3. 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
4. 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 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools 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 Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
8. 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 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 149 ÷ 12 = 12.4

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

STATION I.D. BDL-3	**LOCATION**
STREAM NAME Bayou de Loutre	**RIVER BASIN** Ouachita
LAT 371108 **LONG** 933148	**CLIENT** GLLC-Central
INVESTIGATORS SKH/Ren	
FORM COMPLETED BY RBM	**DATE** 1 May 2000 **TIME** 1405 **REASON FOR SURVEY** Temp UAA

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
70 % ☑	% cloud cover	☐ ____%
☐	clear/sunny	☑

Has there been a heavy rain in the last 7 days? ☐ Yes ☑ No

Air Temperature ________ °C/°F

Other ________________

STREAM ATTRIBUTES

Stream Subsystem ☑ Perennial ☐ Intermittent ☐ Tidal

Stream Type ☐ Coldwater ☑ Warmwater

Stream Origin ☐ Glacial ☐ Non-glacial montane ☐ Swamp and bog ☑ Spring-fed ☑ Mixture of origins ☐ Other Lion Oil effluent/sw from City

Catchment Area ________ mi^2

HYDROLOGY

Flows ☐ High ☐ Moderate ☑ Low ☐ None

Flows Measured? ☑ Yes ☐ No

WATERSHED FEATURES

Predominant Surrounding Landuse ☑ Forest ☑ Field/Pasture ☐ Agricultural ☐ Residential ☐ Commercial ☐ Industrial ☐ Other ________________

Local Watershed NPS Pollution ☐ No evidence ☑ Some potential sources ☑ Obvious sources

Local Watershed Erosion ☐ None ☑ Moderate ☐ Heavy

INSTREAM FEATURES

Proportion of Reach Represented by Stream Morphology Types

☐ Riffle 10 %

☐ Run 25 %

☐ Pool 60 shallow %

deep Pool 5

Channelized ☑ Yes ☐ Some ☐ No very old

Dam Present ☐ Yes ☐ Some ☒ No

WATER/ OBSERVATIONS

Water Odors ☐ Normal/None ☐ Petroleum ☐ Fishy ☐ Sewage ☑ Chemical ☐ Other ________

Water Surface Oils ☐ Slick ☐ Flecks ☐ Sheen ☑ None ☐ Globs ☐ Other ________

Turbidity (if not measured) ☑ Clear ☐ Opaque ☐ Slightly turbid ☐ Stained ☐ Turbid ☐ Other silt/clay

SEDIMENT/ OBSERVATIONS

Sediment Odor ☐ Normal ☑ Chemical ☐ Other ________ ☐ Sewage ☐ Anaerobic ☐ Petroleum ☐ None

Sediment Deposits ☐ Sludge ☐ Sand ☐ Other ________ ☐ Sawdust ☐ Relict shells ☐ Oils

Quantitative Habitat Characterization Field Form

Station I.D: BDL-3		Transect # (circle): [✓ 1] 2 3 4 5
Stream name: Bayou de Loutre	Client: GCCC-Central	Date/Time: 5/1/2000
Location: T1	Investigators: SKH/REM/SLP	Reason For Survey: Temp UAA
Lat: Long:	Form Completed By: REM	

Stream Characteristics:

Stream Wetted Width, ft: 10.5	Left Bank Height, ft 6'	Pool ☐ Length, ft
Channel Width, ft: 22.0	Right Bank Height, ft: 9	Run ☑ Length, ft: ~~33~~ 64'
Top of Bank Chan 33.0	Distance From Last Transect, ft:	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	0 1 [✓ 2] 3 4	On In-Stream Habitat:	0 1 2 [✓ 3] 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	[✓ 0] 1 2 3 4	Roots:	0 ~~1~~ [✓ 2] 3 4 REM
Brush:	[✓ 0] 1 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	[✓ 0] 1 2 3 4	Undercut Bank:	0 ~~1~~ [✓ 2] 3 4
Vegetation:	0 [✓ 1] 2 3 4	Vegetation:	[✓ 0] [✓ 1] 2 3 4
Devoid:	~~0~~ 1 2 3 [✓ 4]	Devoid:	0 1 2 [✓ 3] 4

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
✓		Mod (9-30°)
	✓	Steep (>30°)

Bank Stability

Left	Right	
		Stable
✓	✓	Moderately Stable
		Unstable

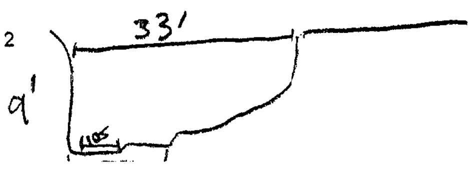
Riparian Ground Cover (Total = 100%)

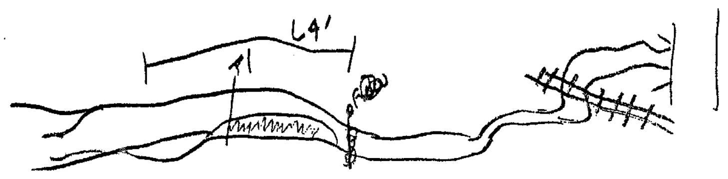
Left	Right	
10	25	%Vegetated, Herbs/Grasses
70	50	%Vegetated, Shrubs/Trees
20	25	% Soil/Sand
–		% Rock

Riparian Canopy Cover

Left	Right	
10	30	% Canopy Cover, Trees

Notes:





Quantitative Habitat Characterization Field Form cont.

Station I.D: BDC-3

Transect # (circle): [✓ 1] 2 3 4 5

Form Completed By: REW

Date/Time: 1415

Form Checked By:

Date/Time:

Distance in ft. from ([✓ LB] RB)		Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											%Canopy Cover
					Type & Abundance								Type										%Embedded	
					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
1.	1.0	1.0	0.3	0.3	1																X			N
2.	2.0	1.0	0.5	0.5								[illegible]						1	1		④			N
3.	3.0	1.0	0.5	0.5			1					[illegible]						1	1		④			N
4.	4.0	1.0	0.6	0.6			1					~~4~~						1	1		④			N
5.	5.0	1.0	0.7	0.7			1					~~4~~						1	1		④			Y
6.	6.0	1.0	0.6	0.6		1	1					4						1	1		④			Y
7.	7.0	1.0	0.7	0.7		1	1					4						1	1		④			Y
8.	8.0	1.0	0.6	0.6			1					4						1	X		④			Y
9.	9.0	1.0	0.6	0.6			1										1				④			Y
10.	10.0	1.0	0.6	0.6		1		1		1		4					1			④				Y
REW	10.5	1.0	0.3	0.3	1	1						~~4~~					1	1		④				Y
12.												[illegible]												
13.																								
14.																								
15.																								
16.																								
Calc	~~6.0~~	1.0	0.5	0.5	1	1	2	1		1		31								18	82		0	64
Total	10.5	Total-6.0	Total 6.0		(4.5%)	(9.1%)	(16%)	(2.3%)		(2.3%)		~~55%~~ (9.09%)												

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Depressions - Sparse; Woody Debris (large) - Sparse; Woody Debris (small) - Moderate; Aquatic Veg. - Sparse; Overhanging Veg. - Spar Devoid - Heavy

Substrate Type Summary (% Occurrence): Silt/Mud/Clay - 18%; Hardpan - 82%

Quantitative Habitat Characterization Field Form

85
67
152

Station I.D: BDL-3		Transect # (circle): 1 [✓ 2] 3 4 5
Stream name: BDL-3 Bayou Deloute	Client: GLCC-C	Date/Time: 1/5/2000 1430
Location: Transect 2	Investigators: SKH- RGW	Reason For Survey: Temp UAA
Lat: Long:	Form Completed By: RGW	

Stream Characteristics:

Stream Wetted Width, ft: 20' - Total 26' Cdry	Left Bank Height, ft 4.25	Pool ☑ Length, ft 152
Channel Width, ft: [illegible]' 44'	Right Bank Height, ft: 9.0'	Run ☐ Length, ft:
	Distance From Last Transect, ft: 99'	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	[✓ 0]	1	2	3	4	On In-Stream Habitat:	[✓ 0]	1	2	3	4

Bank Cover/Habitat

Left Bank (LB)						Right Bank (RB)					
Roots:	0	[✓ 1]	2	3	4	Roots:	[✓ 0]	1	2	3	4
Brush:	0	1	2	[✓ 3]	4	Brush:	0	[✓ 1]	2	3	4
Undercut Bank:	[✓ 0]	1	2	3	4	Undercut Bank:	[✓ 0]	1	2	3	4
Vegetation:	0	[✓ 1]	2	3	4	Vegetation:	0	[✓ 1]	2	3	4
Devoid:	0	1	2	3	[✓ 4]	Devoid:	~~0~~	1	2	3	[✓ 4]

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
✓	✓	Steep (>30°)

Bank Stability

Left	Right	
		Stable
✓		Moderately Stable
	✓	Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
50	5	%Vegetated, Herbs/Grasses
40	20	%Vegetated, Shrubs/Trees
10	75	% Soil/Sand
X	X	% Rock

Riparian Canopy Cover

Left	Right	
75	30	% Canopy Cover, Trees

Notes:

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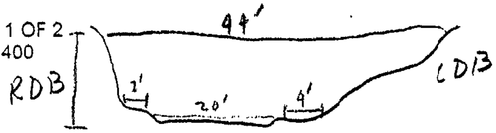

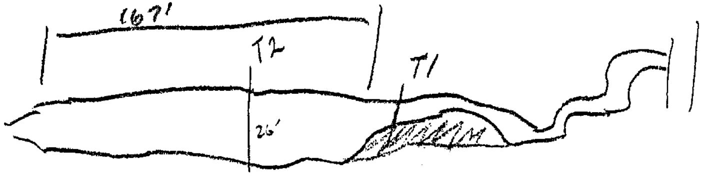

Quantitative Habitat Characterization Field Form cont.

Station I.D: BDL-3

Transect # (circle): 1 [✓ 2] 3 4 5

Form Completed By: RGM

Date/Time: 5/1/2000 / 1135

Form Checked By:

Date/Time:

	Distance in ft. from [✓ LB]/RB)	Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											%Canopy Cover
					Type & Abundance								Type										%Embedded	
	0.0				Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
1.	1.0	1.0	0.2	0.2								✓							✓	✓				20
2.	2.0	1.0	0.5	0.5								✓								✓				"
3.	3.0	1.0	0.5	0.5								✓								✓				"
4.	4.0	1.0	0.6	0.6								✓								✓				"
5.	5.0	1.0	0.6	0.6								✓								✓				"
6.	6.0	1.0	0.7	0.7								✓								✓				"
7.	7.0	1.0	0.9	0.9								✓								✓				"
8.	8.0	1.0	1.1	1.1								✓								✓				"
9.	9.0	1.0	1.2	1.2								✓								✓				"
10.	10.0	1.0	1.3	1.3								✓								✓				"
11.	12	2.0	1.4	2.8								✓								✓				"
12.	14	2.0	1.7	3.4								✓								✓				"
13.	16	2.0	1.7	3.4								✓								✓				"
14.	18	2.0	0.6	1.2								✓								✓				"
LB ~~15.~~	20	2.0	~~0.0~~	SW ~~0.0~~								✓								✓				"
16.			0.1	0.2																				"
Calc	SW ~~1.0~~	1.3	0.9	1.2								4							7	93			0	"
	200		Total=18.4									(100%)												

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Devoid - Very Heavy

Substrate Type Summary (% Occurrence): Sand - 7%; Silt/Mud/Clay - 93%

Quantitative Habitat Characterization Field Form

Station I.D: BDL-3		Transect # (circle): 1 2 [✓ 3] 4 5
Stream name: Bayou de Lourne	Client: GLCC	Date/Time: 5/1/2000 1450
Location: T3	Investigators: REM / SKH	Reason For Survey: Tmp UAA
Lat: Long:	Form Completed By: REM	

Stream Characteristics:

Stream Wetted Width, ft: 21'	Left Bank Height, ft 5.5	Pool ☐ Length, ft
Channel Width, ft: 47'	Right Bank Height, ft: 9.0	Run ☑ Length, ft: 90 ft
	Distance From Last Transect, ft: 99+8	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	0 [✓ 1] 2 3 4	On In-Stream Habitat:	0 [✓ 1] 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 1 [✓ 2] 3 4	Roots:	0 [✓ 1] 2 3 4
Brush:	0 [✓ 1] 2 3 4	Brush:	0 [✓ 1] 2 3 4
Undercut Bank:	0 1 [✓ 2] 3 4	Undercut Bank:	0 [✓ 1] 2 3 4
Vegetation:	0 [✓ 1] 2 3 4	Vegetation:	0 1 [✓ 2] 3 4
Devoid:	0 1 2 3 [✓ 4]	Devoid:	0 1 2 3 [✓ 4]

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
✓	✓	Steep (>30°)

Bank Stability

Left	Right	
		Stable
		Moderately Stable
✓	✓	Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
15	30	%Vegetated, Herbs/Grasses
10	20	%Vegetated, Shrubs/Trees
75	50	% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
75	75	% Canopy Cover, Trees

Notes:

32
39

Quantitative Habitat Characterization Field Form cont.

Station I.D: BDC-3
Transect # (circle): 1 2 [✓ 3] 4 5
Form Completed By: REW
Date/Time: 5/1/2000 1450
Form Checked By:
Date/Time:

	Distance in ft. from (LB/RB)	Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											
					Type & Abundance								Type											
	LRW				Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)	%Embedded	%Canopy Cover
1.	1.0	1.0	0.5	0.5								✓					2			3.			100	Y
2.	2.0	1.0	0.5	0.5								✓					3			2			100	Y
3.	3.0	1.0	0.5	0.5								✓					4			1			100	Y
4.	5.0	2.0	0.4	0.8								✓					1			4			"	"
5.	7.0	2.0	0.6	1.2								✓					1	1		4			"	"
6.	9.0	2.0	0.8	1.6								✓					1	4		1			"	"
7.	11.0	2.0	1.0	2.0								✓					3	3		1			"	"
8.	13.0	2.0	0.6	1.2					1			SKIP ✓							2	2			"	"
9.	15.0	2.0	1.0	2.0					1			✓								4			"	"
10.	17.0	2.0	1.0	2.0								✓								4			"	"
11.	19.0	2.0	0.4	0.8								✓								4			"	"
12.	21.0	2.0	~~0.0~~	SKIP ~~2.0~~								✓												
13.			0.1	0.2																				
14.																								
15.																								
16.																								
Calc	~~10.3~~ SKIP 21.0	1.8	0.6	1.1 Total 13.3					1 (4%)			4					27	9		64			100	100

100%

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) [✓ 4] = Very Heavy (>75%)

Stream Habitat Summary: Leafy Debris - Sparse ; Devoid - Very Heavy

Substrate Type Summary (% Occurrence): Coarse Gravel - 27% ; Fine Gravel - 9% ; Silt/Mud/Clay - 64%

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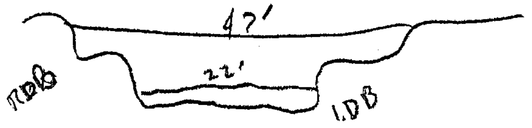

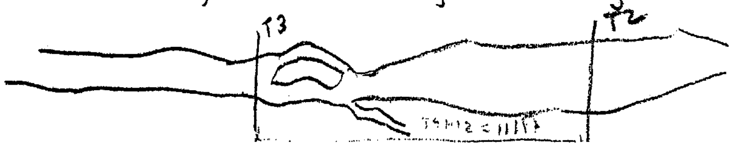

Discharge/Flow Measurement Form

Station BDL-3

Waterbody: Bayou de Loutre d/s Loutre Cr

Date: 1 May 2000

Crew: SKH/REM

Start Time: 1345

Recorder: REM

End Time: 1400

GH. Change: ______ in ______ hrs.

Staff/Gage:

Width: 10.5

Area:

Velocity:

Disch/Flow:

Method:

No Secs:

Meter No: MMB-1

Max Vel: 1.31

Min Vel: 0.11

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 good X-section

Remarks ______

Coord 33 11 35N, 92 40 30W

(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)
LEW 0.0							
1.0	1.0	0.3		0.11		0.3	0.033
2.0	1.0	0.5		0.86		0.5	0.43
3.0	1.0	0.5		0.83		0.5	0.415
4.0	1.0	0.6		1.13		0.6	0.678
5.0	1.0	0.7		1.06		0.7	0.042
6.0	1.0	0.6		1.31		0.6	0.786
7.0	1.0	0.7		0.93		0.7	0.651
8.0	1.0	0.6		0.97		0.6	0.582
9.0	1.0	0.6		0.98		0.6	0.538
10.0	1.0	0.6		0.22		0.6	0.132
REW 10.5	0.5	0.3		0.24		0.15	0.036
TOTALS	10.5	6.0		7.64		5.85	4.373
Avg.	0.95	0.55		0.69		0.53	0.40

Completed By REM Checked by ______ Reviewed by ______

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[illegible] BDL-2 [illegible]
2072-99-070 5/1-2/00 DATE:

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
3. 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
4. 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 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1

58 ÷ 6 = 9.6

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
8. 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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE $10.1 = \bar{x}$

$64 \div 6 = 10.67$

$64 + 58 = 10.1$

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

2072-99-070

BDC-5
5/1/00

DATE:

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
3. 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
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
8. 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 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE ___________

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

2072-99-070

5/1/00

DATE: 5/8/00

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 17	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
3. 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 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
8. 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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 17	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 164 ÷ 12 = $\boxed{13.7}$

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GENERAL PHYSICAL CHARACTERIZATION FIELD FORM

STATION I.D. LC-1	LOCATION Union Co. AR
STREAM NAME Loutre Crk.	RIVER BASIN Ouachita
LAT LONG	CLIENT GLCC

INVESTIGATORS GLP/SKH/REM

FORM COMPLETED BY DH	DATE 5/2/00 TIME 1345	REASON FOR SURVEY UAA

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☒	showers (intermittent)	☒
100% ☐	% cloud cover	☐ 75 %
☐	clear/sunny	☐

Has there been a 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
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☒ Mixture of origins
☐ Other ________

Catchment Area ________ mi^2

HYDROLOGY

Flows
☐ High ☒ Moderate ☐ Low ☐ None

Flows Measured?
☒ Yes ☐ No

WATERSHED FEATURES

Predominant Surrounding Landuse
☐ Forest
☒ Field/Pasture
☐ Agricultural
☐ Residential
☐ Commercial
☐ Industrial
☐ Other ________

Local Watershed NPS Pollution
☐ No evidence ☒ Some potential sources
☐ Obvious sources

Local Watershed Erosion
☐ None ☒ Moderate ☐ Heavy

INSTREAM FEATURES

Proportion of Reach Represented by Stream Morphology Types
☐ Riffle 5 %
☐ Run 35 %
☐ Pool 60 %

Channelized ☐ Yes ☐ Some ☒ No

Dam Present ☐ Yes ☐ Some ☒ No

WATER/ OBSERVATIONS

Water Odors
☐ Normal/None
☒ Petroleum
☐ Fishy
☐ Sewage
☐ Chemical
☐ Other________

Water Surface Oils
☐ Slick ☒ Sheen Some spots ☐ Globs
☐ Flecks ☐ None ☐ Other________

Turbidity (if not measured)
☐ Clear ☒ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other________

SEDIMENT/ OBSERVATIONS

Sediment Odor
☐ Normal ☐ Sewage ☒ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other________

Sediment Deposits
☐ Sludge ☐ Sawdust ☐ Oils
☐ Sand ☐ Relict shells
☐ Other NONE

Quantitative Habitat Characterization Field Form

Station I.D: LC-1		Transect # (circle): [✓ 1] 2 3 4 5
Stream name: Loutre Creek	Client:	Date/Time: 5/2/00 0955
Location:	Investigators: GLP/SKH/REM	Reason For Survey:
Lat: 33 11 08 Long: 92 40 28	Form Completed By: GLP	UAA

Stream Characteristics:		
Stream Wetted Width, ft: 11.5'	Left Bank Height, ft 8'	Pool ☐ Length, ft
Channel Width, ft: 20'	Right Bank Height, ft: 7'	Run ☒ Length, ft: 410'
	Distance From Last Transect, ft: 0.0'	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	0 1 [✓ 2] 3 4	On In-Stream Habitat:	0 1 [✓ 2] 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 1 [✓ 2] 3 4	Roots:	0 1 [✓ 2] 3 4
Brush:	[✓ 0] 1 2 3 4	Brush:	[✓ 0] 1 2 3 4
Undercut Bank:	[✓ 0] 1 2 3 4	Undercut Bank:	0 1 [✓ 2] 3 4
Vegetation:	0 1 [✓ 2] 3 4	Vegetation:	0 1 [✓ 2] 3 4
Devoid:	0 1 [✓ 2] 3 4	Devoid:	0 1 [✓ 2] 3 4

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
	X	Mod (9-30°)
X		Steep (>30°)

Bank Stability

Left	Right	
		Stable
	X	Moderately Stable
X		Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
40	40	%Vegetated, Herbs/Grasses
60	60	%Vegetated, Shrubs/Trees
		% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
0.0	10	% Canopy Cover, Trees

Notes: Cleared area, Heavy under brush

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Quantitative Habitat Characterization Field Form cont.

Station I.D: LC-1

Transect # (circle): [✓ 1] 2 3 4 5

Form Completed By: JJP

Date/Time: 5/2/00

Form Checked By:

Date/Time: 5/-

Distance in ft. from (LB/RB)		Width (ft)	Depth (ft) SEE Flow PAGE	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											
					Type & Abundance								Type										%Embedded	%Canopy Cover
					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
1.RB	0											X									X		—	50
2.	1											X									X		—	50
3.	2											X									X		—	50
4.	3											X									X		—	40
5.	4											X									X		—	30
6.	5											X									X		—	30
7.	6											X									X		—	30
8.	7				1																X		—	30
9.	8											X									X		—	20
10.	9				1																X		—	20
11.	10											X									X		—	20
12.	11											X									X		—	30
13.LB	11.2											X									X		—	40
14.																								
15.																								
16.																								
Calc	5.9	—	—	—	1 (4%)							4 (85%)									100		0	34

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Depressions - Sparse ; Devoid - Very Heavy

Substrate Type Summary (% Occurrence): Hardpan - 100%

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V1.2 0400

77 ''
92 90 27

Quantitative Habitat Characterization Field Form

Station I.D: LC-1		Transect # (circle): 1 [✓ 2] 3 4 5
Stream name: Loutre Creek	Client:: GLCC	Date/Time: 5/2/00 1010
Location:	Investigators:	Reason For Survey:
Lat: 33 11 08 Long: 92 40 28	Form Completed By: GLP	

Stream Characteristics:

Stream Wetted Width, ft: 10'	Left Bank Height, ft 10'	Pool ☒ Length, ft 50'
Channel Width, ft: 10'	Right Bank Height, ft: 10'	Run ☐ Length, ft:
	Distance From Last Transect, ft: 80'	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance

On Substrate:	0 1 [✓ 2] 3 4	On In-Stream Habitat:	0 [✓ 1] 2 3 4

Bank Cover/Habitat

Left Bank (LB)		Right Bank (RB)	
Roots:	0 [✓ 1] [✓ 2] 3 4	Roots:	0 1 [✓ 2] 3 4
Brush:	0 [✓ 1] 2 3 4	Brush:	0 1 [✓ 2] 3 4
Undercut Bank:	0 1 [✓ 2] 3 4	Undercut Bank:	0 [✓ 1] 2 3 4
Vegetation:	0 1 [✓ 2] 3 4	Vegetation:	0 [✓ 1] 2 3 4
Devoid:	0 1 [✓ 2] 3 4	Devoid:	0 1 [✓ 2] 3 4

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
X	X	Steep (>30°)

Bank Stability

Left	Right	
		Stable
	X	Moderately Stable
X		Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
30	35	%Vegetated, Herbs/Grasses
50	50	%Vegetated, Shrubs/Trees
20	15	% Soil/Sand
		% Rock

Riparian Canopy Cover

Left	Right	
0.0	0.0	% Canopy Cover, Trees

Notes: Unders brush not as dense as Trans. 1

Quantitative Habitat Characterization Field Form cont.

Station I.D: LC-1		Transect # (circle): 1 [✓ 2] 3 4 5	
Form Completed By: GLP	Date/Time: 5/2/00	Form Checked By:	Date/Time:

	Distance in ft. from (LB/RB)	Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											%Canopy Cover
					Type & Abundance								Type										%Embedded	
					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)		
1LB	0	1.0		0.0						1											X		—	40
2.	1	1.3		1.3	1				1												X		—	30
3.	2	1.4		1.4	-		1														X		—	30
4.	3	1.5		1.5								X									X		—	30
5.	4	1.5		1.5								X									X		—	20
6.	5	1.1		1.1	1																X		/	30
7.	6	1.1		1.1								X									X		/	40
8.	7	1.0		1.0	1																X		/	40
9.	8	0.7		0.7								X									X		/	50
10.	9	0.4		0.4								X									X		/	50
11RB	10	0.1		0.1								X									X		/	60
12.																								
13.																								
14.																								
15.																								
16.																								
Calc	5.0	1.0	—	0.9	1		1		1	1		3									100		0	38
				10.1	(7%)		(2.3%)		(2.3%)	(2.3%)		(55%)												

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Depressions – Sparse ; Woody Debris (small) – Sparse ; Leafy Debris – Sparse ; Overhanging Vegetation – Sparse ; Devoid – Heavy

Substrate Type Summary (% Occurrence): Hardpan – 100%

Quantitative Habitat Characterization Field Form

Station I.D: LC-1		Transect # (circle): 1 2 [✓ 3] 4 5
Stream name: Loutre Crk.	Client:	Date/Time: 5/2/00 (1020)
Location:	Investigators:	Reason For Survey:
Lat: 331107 Long: 924027	Form Completed By: GKP	

Stream Characteristics:		
Stream Wetted Width, ft: 9'	Left Bank Height, ft 10'	Pool ☒ Length, ft 54'
Channel Width, ft: 15'	Right Bank Height, ft: 10'	Run ☐ Length, ft:
	Distance From Last Transect, ft: 64	Riffle ☐ Length, ft:

Periphyton Coverage/Abundance			
Or Substrate:	0 1 2 [✓ 3] 4	On In-Stream Habitat:	0 1 [✓ 2] 3 4
Bank Cover/Habitat			
Left Bank (LB)		Right Bank (RB)	
Roots:	0 1 [✓ 2] 3 4	Roots:	0 1 [✓ 2] 3 4
Brush:	0 [✓ 1] 2 3 4	Brush:	0 [✓ 1] 2 3 4
Undercut Bank:	0 1 [✓ 2] 3 4	Undercut Bank:	0 1 [✓ 2] 3 4
Vegetation:	0 1 2 [✓ 3] 4	Vegetation:	0 [✓ 1] 2 3 4
Devoid:	0 [✓ 1] 2 3 4	Devoid:	0 1 [✓ 2] 3 4

Periphyton & Cover Scores: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Bank Slope

Left	Right	
		Flat (<8°)
		Mod (9-30°)
X	X	Steep (>30°)

Bank Stability

Left	Right	
		Stable
X		Moderately Stable
	X	Unstable

Riparian Ground Cover (Total = 100%)

Left	Right	
30	70	%Vegetated, Herbs/Grasses
70	20	%Vegetated, Shrubs/Trees
—	10	% Soil/Sand
—		% Rock

Riparian Canopy Cover

Left	Right	
0	0	% Canopy Cover, Trees

Notes: Dense underbrush on left
Open to Grasses on right

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Quantitative Habitat Characterization Field Form cont.

Station I.D: LC-1		Transect # (circle): 1 2 [✓ 3] 4 5	
Form Completed By: SHP	Date/Time: 5/2/00	Form Checked By:	Date/Time:

Distance in ft. from (LB/RB)		Width (ft)	Depth (ft)	Area (ft²)	Stream Habitat (Fish Cover)								Stream Substrate											%Canopy Cover
					Type & Abundance								Type											
					Depressions	Woody Debris, large (>.3m)	Woody Debris, small (<.3m)	Aquatic Vegetation	Leafy Debris	Overhanging Vegetation	Boulders / Outcroppings	Devoid (check if true)	Bedrock (smooth)	Bedrock (rough)	Boulder (>25cm)	Cobble (6-25cm)	Coarse Gravel (1.6-6.0cm)	Fine Gravel (0.2-6.0cm)	Sand (<0.2cm, gritty)	Silt/Mud/Clay (not gritty)	Hardpan (firm/consolidated)	Organic Matter (ground)	%Embedded	
1.LB	0		0.8	0					2											X				
2.	1		1.5	1.5					2											X				
3.	2		1.8	1.8			2		2											X				
4.	3		2.0	2.0			2		1												X			
5.	4		2.2	2.2					1											X				
6.	5		2.1	2.1	2															X				
7.	6		1.9	1.9	2															X				
8.	7		1.8	1.8	2																X			
9.	8		0.5	0.5	1																X			
10.RB	9		0.1	0.1								X									X			
11.																								
12.																								
13.																								
14.																								
15.																								
16.																								
Calc	4.5	—	1.5	1.4	2		1		2			1								60	40		0	0
			Total	13.9	(18%)		(10%)		(20%)			(10%)												

Habitat Abundance: 1 = Sparse (1%-10%) 2 = Moderate (10%-40%) 3 = Heavy (40%-75%) 4 = Very Heavy (>75%)

Stream Habitat Summary: Depressions – Moderate; Woody Debris (small) – Sparse; Leafy Debris – Moderate; Devoid – Sparse

Substrate Type Summary (% Occurrence): Silt/Mud/Clay – 60%; Hardpan – 40%

PAGE 2 OF 2
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JMc & Associates
Strategic Environmental Services

Discharge/Flow Measurement Form

Station: LC-1 Trans ①

Waterbody: Lotre Creek

Date: 5/2/00

Crew: GLP/SKH/ KEM

Start Time: 0950

End Time: 1005

Staff/Gage: NA

Recorder: GLP

GH. Change: NA in

________ hrs

Width: 11.2

Area:

Velocity: $\bar{v}$=0.62 fps

Disch/Flow: 4.31 cfs

Method: 0.6

No Secs:

Meter No: MMB

Max Vel: 0.95 fps

Min Vel:

ORIENTATION:

[✓ Wading], Boat, Upstream, Downstream, Side Bridge ______ ft/mi,

above, below gage, and ________

Measurement rated: excelent [✓ good] fair poor based on the following

conditions: Cross section ________

Flow ________ Weather cloudy Rainy – warm

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)
RB	0	—	—		—	0.6	—	—
	1	1	0.5		0.14		0.5	0.07
	2	1	0.7		0.95		0.7	0.67
	3	1	0.6		0.84		0.6	0.50
	4	1	0.7		0.38		0.7	0.27
	5	1	0.6		0.51		0.6	0.31
	6	1	0.8		0.63		0.8	0.50
	7	1	0.8		0.69		0.8	0.55
	8	1	0.8		0.66		0.8	0.53
	9	1	0.6		0.82		0.6	0.49
	10	1	0.5		0.76		0.5	0.38
	11	1	0.1		0.43		0.1	0.04
LB	11.2	0.2	0		0	0.6	0	0
	TOTALS	11.2	6.7		6.78		6.7	4.31
	Calc. Avg.	0.9	0.6		0.6		0.6	cfs

Avg. Q.

= 2.78 mgd

Completed By______ Checked by______ Reviewed by______

V1.0 1096

Discharge Flow Measurement Form
Continued

(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)
TOTALS							

(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)
TOTALS							

Completed By________ Checked by___________ Reviewed by____________

[illegible]
2072-99-070

5/2/00

DATE:

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
3. 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
4. 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 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow. heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools 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

1.2 ÷ 6 = 10.3

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 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
8. 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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE $\bar{x} = 10.92$

$69 \div 6 = 11.5$

$62 + 69 = 10.9 = 11$

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

[illegible]
2072-99-070

5/2/00

DATE:

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
3. 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 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools 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 Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 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
8. 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
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE ~~10~~ 11	20 19 18 17 16	15 14 13 12 [✓ 11]	~~10~~ 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 ~~10~~ 8	20 19 18 17 16	15 14 13 12 11	~~10~~ 9 [✓ 8] 7 6	5 4 3 2 1

TOTAL SCORE ___________

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

GLCC UAA
2072-99-070

LC-1
5/2/00

GLP
DATE:

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1
3. 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 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
4. 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
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools 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 Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 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
8. 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
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 11	20 19 18 17 16	15 14 13 ~~12~~ [✓ 11]	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 12	20 19 18 17 16	15 14 ~~13~~ [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE ~~10~~ 11	20 19 18 17 16	15 14 13 12 [✓ 11]	~~10 9~~ 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 ~~10~~ 8	20 19 18 17 16	15 14 13 12 11	~~10~~ 9 [✓ 8] 7 6	5 4 3 2 1

TOTAL SCORE ___________

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

2072-99-070

5/2/00

DATE: 6/8/00

Habitat Assessment Field Data Sheet

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of population.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
SCORE 18	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Preferred benthic substrate (to be sampled) abundant throughout stream site and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed.	Substrate unstable lacking.
SCORE 17	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. 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 17	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. 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 18	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	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.	New embankments present on both banks; channelization may be extensive, usually in urban areas or drainage areas of agriculture lands; and >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
6. 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; moderate accumulation; substantial sediment movement only during major storm even; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial sediment movement during storm events.	Channelized; movement and/or sand in bank or nonbraided channels; pools absent due to deposition.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	CATEGORY			
	Optimal	Suboptimal	Marginal	Poor
7. 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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a distance.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1
8. 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
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along stable sections and bend side slopes 60-100% has erosion scars.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surfaces covered by vegetation.	70-90% of the streambank surfaces covered by vegetation.	50-70% of the streambank surfaces covered by vegetation.	Less than 50% of streambank surfaces covered by vegetation.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetation disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption minimal or not evident; almost all plants allowed to grow naturally.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation very high; vegetation has been removed; 2 inches or less average stubble height.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width (Least Buffered Side)	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 impactaed 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 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL SCORE 184 ÷ 12 = $\boxed{15.3}$

Barbour and Stribling: An evaluation of a visual-based technique for assessing stream habitat structure.

Appendix D-2

Field Data Forms
In-situ Water Quality

Page 1 of

Field Data Form Continued

FIELD MEASUREMENT RECORD (Date 4/21/99)
GLCC main Central

REVIEWED BY: REW

Station/Depth	Date	Time	Field Crew	Temp C°	DO mg/l	Sp Cond uS	pH su	Sample # of Containers		Notes
								S=Sed	W=Wat	
BDL-1	4/21/99	0815	REM GLP SKH	18.4	4.3	899.0	5.61	—	—	Arrived @ 0805
BDL-~~2~~ 1.5 REM	4/21/99	0825	REM GLP SKH	31.2	6.6	644.0	7.29	—	—	Grab sample at BDL 1.5 J/ d/s of GLCC-001
BDL-3	4/21/99	1300	REM GLP SKH	26.5	7.8	1724	7.36	—	—	Arrived @ 1300
LC-1	4/22/99	0730	REM GLP SKH	22.7	5.8	3105	7.36	—	—	Arrived @ 0725
BDL-1	4/22/99	1205	REM SKH GLP	19.9°	3.5	1302	4.5			grab sample from u/s of GLCC-e discharge. Iron stain on all surface areas
BDL 1.5	4/22/9	1210	GLP REM SKH	33.1°c	6.5	657	7.92	–	–	Grab sample From d/s discharge 001 into BDL
BDL-2	4/22/99	1430	GLP REM SKH	29.5	6.2	638	7.8			

* Indicates calibration check was made

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Page 1 of 1

Field Data Form Continued

FIELD MEASUREMENT RECORD (Date 5/13/99) REVIEWED BY: REM

GLCC - Central

Station/Depth	Date	Time	Field Crew	Temp C°	DO mg/l	Sp. Cond uS	pH su	Sample # of Containers S=Sed	W=Wat	Notes
BDL-3	5/13/99	0730	REM, SKH, AAS	24.9	5.8	1046	7.54			Sample Taken Down Stream Side of Bridge
BDL-2	5/13/99	1015	REM, SKH, AAS	25.9	6.3	624	7.42			Hot Sunny ~50 yard upstream From Confluence
LC-1	5/13/99	1020	REM SKH, AAS	23.9	7.0	2126	7.33			Hot Sunny ~50 yards upstream From Confluence
BDL-1	5/13/99	1415	REM SKH, AAS	29.1	7.2	720	7.57			20 yard Above Discharge

* Indicates calibration check was made

V1.0 1096

Page 1 of 1

Field Data Form Continued

FIELD MEASUREMENT RECORD (Date 5/1/00) REVIEWED BY: REM

Station/Depth	Date	Time	Field Crew	Temp C°	DO mg/l	Sp. Cond. uS	pH su	Sample # of Containers		Notes
								S=Sed.	W=Wat.	
BDL-3	5/1/00	1120	SKH/GLP/REM	22.2	4.4	1719	7.41	—	—	d/s of Southwest St. Bridge
BDL-2	5/2/00	0725	SKH/GLP/REM	19.5	3.5	1008	6.1	—	—	u/s of confluence with ~~Bayou~~ Loutre Creek
LC-1	5/2/00	0725	SKH/GLP/REM	21.7	3.7	1576	7.3	—	—	u/s of confluence with Bayou DeLoutre
BDL-1	5/2/00	11:25	SKH/GLP/REM	19,0	3.5	1146	3.7	-	—	u/s of LLCC old Discharge

* Indicates calibration check was made

V1.0 1096

FIELD EQUIPMENT CHECKLIST

Project No: 2072-99-070
GLCC -Temp. UAA

Crew: REM/GLP/SKH

Field Instruments

- ___ Battery Charger
- ✓ X DO (calibration kit, batts)
- ✓ X pH (stds, bottle batts)
- ✓ X Conductivity (batteries)
- ___ Depth (chart, probe, batts)
- ___ Hach Kit (batts, methods, chems, stds)
- ✓ X Flow ([✓ batts], [✓ meter], [✓ rod], [✓ calc], [✓ forms], [✓ waders], [✓ tape/tag line])
- ___ Isco (instruments, bottles, batts, tubing, strainers, clamps)

Miscellaneous

- ___ Cash advance
- ✓ X Credit card
- ✓ X Pens
- ✓ X Camera/film
- ___ Small recorder
- ✓ X Rubber boots
- ✓ X Waders
- ✓ X Rain suits
- ___ Flashlight
- X Knife, scissors
- ✓ X Tape measure(s)
- ✓ X Rope
- ✓ X Tool box
- ✓ X Backpack
- ___ Wash bottles
- ___ Crest gages
- ___ Alconox/brush
- ___ Trash bags
- ✓ X Duct tape
- ___ 5 gal. Bottle
- ___ DI/tap water
- ✓ X Flagging
- ___ Keys (gate, gage, etc.)
- [✓ X] Extra vehicle key
- ✓ X Range finder

Plastic Buckets in situ grabs. ✓

Biological Sampling

- ✓ X Tag line/tape measure (Habitat)
- ✓ X Aquatic Dip net
- ✓ X Seine
- ✓ X Fish nets
- ✓ X Containers
- ✓ X ~~Preservative~~ ([✓ alcohol,] [✓ formaldehyde])
- ✓ X Sieves
- ✓ X Sorting trays
- ✓ X Forceps
- ✓ X Electroshocker ([✓ pig tail], [✓ extra probe], extra conductors, [✓ rubber gloves], [✓ generator gas/mix], spark plugs)

Gound Water/Sample Collection

- ___ Water level indicator
- ___ Pumps/batteries
- ___ Tubing
- ___ Turbidmeter
- ___ Bailers (disp./other)
- ___ Hexane
- ___ Field forms

Boat Usage

- ___ Life jackets
- ___ Paddles
- ___ Boat cushions
- ___ Anchor
- ___ Motor battery
- ___ Motor oil
- ___ Gas tanks
- ___ Depth finder (graph)
- ___ Spare tire

Field Forms/Documentation

- X Field forms - habitat ✓
- X Field forms - fish/bugs ✓
- X Field forms - chemistry ✓
- X Field log book ✓
- ___ COC forms
- ___ Ziplock bags
- [X] Maps ✓
- [X] Sampling plan ✓
- X Pens/pencils ✓
- X Clipboards ✓

Safety

- [X] Hard hats
- [X] Safety glasses
- ___ Face shields
- ___ Eye wash bottle
- ___ Gloves
- ___ Steel toe boots
- ___ Hazcomm materials
- ___ Tyvex suits
- X Sun protection ✓
- X Bug spray ✓
- X Water, drinks ✓
- X Soap, alcohol, bandages ✓

Sample Collection (General)

- ___ Sample bottles
- ___ Extra sample bottles
- ___ Sharpies, pens
- ___ Clear tape/dispenser
- ___ Bucket(s)/rope
- ___ Ice chests/ice
- ___ Horizontal water bottle
- ___ Sediment spoons/bowls
- ___ Dredge (hoist)
- ___ Core sampler (handle, extensions, body, tips, cap, slip wrench, sleeves/caps)
- ___ DI water
- ___ Extra labels

Wetlands Delineation

- ___ Soil Probe
- ___ Spade/shovel
- ___ α,α-dipyridal
- ___ Plant press
- ___ Plant field books
- ___ ACOE Data Forms
- ___ Wetland Assessement forms
- ___ Munsell soil color charts
- ___ Machette
- ___ Magnifier loop

- Temp monitors ✓
- cable wraps ✓
- Software ✓
- ice chest ✓

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Appendix D-3

Field Data Sheets Benthic Invertebrates

BDL-1 / LC-1

FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: Loutre Creek

Client: GLCC (central)

Project no:

Investigators: GLP, SKH, REM

Date Sample Collected: 4/22/99

Habitat Forms Completed: [✓ yes] / no

Location: N. of Bypass @ Eldorado, AR

Ecoregion: Gulf Coastal

Weather: Partly Cloud/Breezy/Warm

Form Completed By: GLP

Fish Sampling Completed: yes / [✓ no] shaker malfunc.

Collection Site Observations

	BDL-1 Above Station	LC-1 Below Station
Total Time Sampled:		3 mP
Relative Abundance of Aquatic Biota		
Periphyton:	GLP 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:	20	
Shallow Pool:	80	100
Deep Pool:		
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:	20	~~30~~ 20
Emergent Vegatation:	20	—
Submerged Vegetation:		—
Depositional Area:		10
Overhanging Veg:	~~30~~ 10	30
Root Wads:	25	20
Undercut Banks:	20	20
Filamentous algae:	5	
Leafy Debris:		
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:

Rapid Bioassessment Field Sheet

Point Source Lion Oil / urban runoff City of El Dorado - GLCC - Central Temperature Study Date 4/22/99
Collector GLP Sample Technique 3 m Pool Sediment ?
tat Description: ABOVE
BELOW
Start Time (~~0845~~) (1100) — Stop Time (~~0940~~) Start Time - 0845 - 09

MACROINVERTEBRATE COMMUNITY

ABOVE Station # BDL-1

Cnt.	Taxa	Tally
71	Chironidae	卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 |||| 卌 卌 卌
	~~Enallagma~~	~~/~~
8	Oligachatae	卌 |||
1	~~Libellula~~ Sympetrum	~~//~~ |
+		
4	Ishnurua	||||
4	Uvaris	~~卌~~ ||||
1	~~Driopod~~ lacustris	|
3	Cambarinae	|||
3	Chaborous	|||
4	? ~~Cordulidae~~ Pachydiplax	||||
1	Peltodytes	|

TOTAL 100

BELOW Station # LC-1

Cnt.	Taxa	Tally
	Argia	卌 卌 卌 ||||
	Chironomidae	卌 卌 卌 卌 卌 卌 卌 | 卌 卌 卌
	Enallagma	||||
	Oligachatae	卌
	Nematoda	||
	Stratiomys (Horsefly larva)	|
	Ferrissia	|
	? Typhlidae	|
	Belastoma	|
	Hydrophylidae (Beetle)	|
	Libellulia	|
	Bezzia	|
	Ishnurida	|

TOTAL

Dominants - ABOVE	%
1. Chironomidae	71
2. Oligochaete	8
3. Pachydiplax	4
4. Ischnura	4
5. Uvarus	4

Total

Dominants - BELOW	%
1. Chironomidae	68
2. Argia	22
3. Oligochaete	4
4. —	—
5. —	—

Total

	ABOVE (BDL-1)	BELOW (LC-1)
% Ephem.	0	0
% Trichop.	0	0
% Chir.	71	68
% Odon.	9	27
% Cole.	6	0
% Annel.	8	4
tic Score:		
of taxa	10	9
~~D.O.~~		
~~Temp.~~		

QSI =
DIC =
TIC =
CTI =

COMMENTS

FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: Bayou de Loutre.
Location: BDL No2 /BDL3
Client: GCCC-Central
Ecoregion: Gulf Coastal
Project no:
Weather: clear/sunny windy
Investigators: REM SKH GLP
Date Sample Collected: 4/21/99
Form Completed By: REM
Habitat Forms Completed: [✓ yes] / no
Fish Sampling Completed: yes / [✓ no]

Collection Site Observations

	BDL-2 Above Station	BDL-3 Below Station
Total Time Sampled:	3 mP	3MP
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:		30
Shallow Pool:	100	70
Deep Pool:		
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:	20%	
Emergent Vegatation:		—
Submerged Vegetation:		—
Depositional Area:		10
Overhanging Veg:		20
Root Wads:	20	20
Undercut Banks:	✓ 60%	20
Filamentous algae:		
Leafy Debris:		30
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:

Rapid Bioassessment Field Sheet

Point Source VAROUS - Project GLCC-Central Facility Temperature Study Date 4/21/99

Collector GLP Sample Technique 3mpool Sediment ? ______

Habitat Description: ABOVE u/s SouthField Rd

BELOW d/s SouthField Rd

Start Time (1730) Stop Time (1845)

MACROINVERTEBRATE COMMUNITY Time:

ABOVE Station # BDL NO2

Cnt.	Taxa	Tally
	Argia	卌 卌 |
	Chironomidae	卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 | 卌
	Cambarinae	卌
	Physa	卌 |||
	Isopoda	
	Palemonetes	
	Corixidae	
	Belostoma	||
	Caenis	|||
	Oligochatae	卌
	Ischnurua	||
	Hydrovatus (Dytisid Beetle)	卌
	Uvarus (Dytisis Betle)	||
	Boyeravinosa	|

TOTAL

BELOW Station # BDL NO3

Cnt.	Taxa	Tally
	ArgiA	卌 卌 卌 ||
	Chironomidae	卌 卌 卌 卌 卌 卌 卌 卌 卌 卌
	Cambarinae	卌 |||
	PhysA	|
	Isopoda	||
	Palemonetes	|
	Corixidae	|
	BelostomA	|
	BezziA (Ceratopogon)	|
	Caenis	|
	Oligochatae	|||
	Ischnurua	|

TOTAL

Dominants - ABOVE %
1. ______ ______
2. ______ ______
3. ______ ______
4. ______ ______
5. ______ ______

Total

Dominants - BELOW %
1. ______ ______
2. ______ ______
3. ______ ______
4. ______ ______
5. ______ ______

Total

	ABOVE	BELOW
% Ephem.		
% Trichop.		
% Chir.		
% Odon.		
% Cole.		
% Annel.		
Biotic Score:		
# of taxa		
D.O.		
Temp.		

QSI = ______

DIC = ______

TIC = ______

CTI = ______

COMMENTS

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2=1

BIOMETRIC SCORE SHEET

Station: Above BDL 2 Below BDL 1 NPDES Permit #________

Habitat Sampled 3mP Date _______ Time_______

Biometric Score

Biometric (1) Dominants-In Common — 2

DIC = 2

2 Dominants Above	%	1 Dominants Below	%	If DIC	Score
1. Chironomidae	59	1. Chironomidae	71	4-5	4
2. Argyra	9	2. Oligochaete	8	3	3
3. Physa	7	3. Uvarus	4	[✓ 2]	2
4. Cambarinae	5	4. Pachydiplax	4	0-1	1
5. Oligochaete	5	5. Ischnura	4		
	85		91		

Biometric (2) Common Taxa Index — 2

CTI: = 0.42 [TIC/MAX (T_a or T_b)]

卌 5/12

If CTI	Score	If CTI	Score
> .70	4	[✓ 0.30-.49]	2
0.50-0.70	3	<0.29	1

Biometric (3) Quantitative Similarity Index — 4

QSI: = 72 [Σ min (pi_a, pi_b)]

3+5+59+2+3=72

If QSI	Score	If QSI	Score
[✓ > 65]	4	45-55	2
56-65	3	< 45	1

Biometric (4) Taxa Richness — 3

\# of Taxa Above = 12

\# of Taxa Below = 10

% difference = 17%

If % Diff.	Score	If % Diff.	Score
< 10%	4	31-45%	2
[✓ 11-30%]	3	> 45%	1

Biometric (5) Indicator Assemblage Index — 1

	% EPT	%CA
Above	3	64
Below	0	79
IAI =	0.41	

IAI = -.50 [(%EPT_b/%EPT_a) + (%CA_a/%CA_b)]

0.50[(0/3) + (64/79)] = 0.41

If IAI	Score	If IAI	Score
> .80	4	0.50 - 0.64	2
0.65 - 0.80	3	[✓ <0.50]	1

Biometric (6) Missing EPT Genera Comments — 4

If Missing	Score	If Missing	Score
[✓ ≤ 1]	4	2 from 2	2
2	3	>2 from 2	1

Biometric (7) Functional Group Percent Similarity — 4

FG = Σ min (%Sh_a, %Sh_b + %SC_a, SC_b, + % CO_a, CO_b, + % PR_a, PR_b)

	2 Above	1 Below
% Shredders	5	4
% Scrapers	7	0
% Collectors	67	80
% Predators	21	16
FG % Similarity =		

If %	Score
[✓ > 85]	4
75 - 85	3
65 - 74	2
< 65	1

total=20

MEAN BIOMETRIC SCORE = 2.9

4+0+67+16=87

AQUATIC LIFE USE STATUS minimal diff./maintains

POTENTIAL GENERIC CAUSE __________

2 = 3

BIOMETRIC SCORE SHEET

Station: Above BDL 2 Below BDL3 NPDES Permit #________

Habitat Sampled 3mP Date 7/21/99 Time_______

Biometric Score

Biometric (1) Dominants-In Common 4

DIC = 4

Dominants Above	%	Dominants Below	%	If DIC	Score
1. Chironomidae	59	1. Chironomidae	68	[✓ 4-5]	[✓ 4]
2. Argia	9	2. Argia	16	3	3
3. Gastropoda (physa)	7	3. Cambaranae	8	2	2
4. Cambarinae	5	4. Oligochaete	3	0-1	1
5. Oligochaete	5	5. Isopoda	2		
			97		

Biometric (2) Common Taxa Index 3

CTI: = 0.50 [TIC/MAX (T_a or T_b)]

卌 I 6/12

If CTI	Score	If CTI	Score
> .70	4	0.30-.49	2
[✓ 0.50-0.70]	[✓ 3]	<0.29	1

Biometric (3) Quantitative Similarity Index 4

QSI: = 78 [Σ min (pi_a, pi_b)]

If QSI	Score	If QSI	Score
[✓ > 65]	4	45-55	2
56-65	3	< 45	1

Biometric (4) Taxa Richness 2

of Taxa Above = 12
of Taxa Below = 8
% difference = 33%

If % Diff.	Score	~~If % Diff.~~	Score
≤ 10%	4	[✓ 31-45%]	2
11-30%	3	> 45%	1

Biometric (5) Indicator Assemblage Index 1

	% EPT	%CA
Above	3	64
Below	0	71

IAI = 0.45

IAI = -.50 [(%EPT_b/%EPT_a) + (%CA_a/%CA_b)]

0.5[(0/3) + (64/71)] = 0.45

If IAI	Score	If IAI	Score
> .80	4	0.50 - 0.64	2
0.65 - 0.80	3	[✓ <0.50]	[✓ 1]

Biometric (6) Missing Genera ✓ 4

Comments EPT

If Missing	Score	If Missing	Score
[✓ ≤ 1]	[✓ 4]	2 from 2	2
2	3	>2 from 2	1

Biometric (7) Functional Group Percent Similarity 4

FG = Σ min (%Sh_a, %Sh_b + %SC_a, SC_b, + % CO_a, CO_b, + % PR_a, PR_b)

	2 Above	3 Below	If %	Score
% Shredders	5	8	[✓ > 85]	4
% Scrapers	7	1	75 - 85	3
% Collectors	67	73	65 - 74	2
% Predators	21	18	< 65	1

FG % Similarity = ________

Total = 22

Σmin = 5 + 1 + 67 + 18 = 91

MEAN BIOMETRIC SCORE = 3.1

AQUATIC LIFE USE STATUS Minimal Diff./Maintain

POTENTIAL GENERIC CAUSE ____________

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Page 3 of 3

2:LC

BIOMETRIC SCORE SHEET

Station: Above BOL2 Below LC1 NPDES Permit #_________

Habitat Sampled 3mP Date _______ Time_______

Biometric Score

Biometric (1) Dominants-In Common 3

DIC = 3

Dominants Above	%	Dominants Below	%	If DIC	Score
1. Chironomidae	59	1. Chironomidae	68	4-5	4
2. Argia	9	2. Argia	22	[✓ 3]	[✓ 3]
3. Physa	7	3. Oligochaete	4	2	2
4. Cambarinae	5	4. —		0-1	1
5. Oligochaete	5	5. —			

~~96~~94(+2)

Biometric (2) Common Taxa Index 2

CTI: = 0.42 [TIC/MAX (T_a or T_b)]

If CTI	Score	If CTI	Score
> .70	4	[✓ 0.30-.49]	2
0.50-0.70	3	<0.29	1

𝍸 5/12 = 0.42

Biometric (3) Quantitative Similarity Index 4

QSI: = 74 [Σ min (pi_a, pi_b)]

If QSI	Score	If QSI	Score
[✓ > 65]	4	45-55	2
56-65	3	< 45	1

59+4+1+1+9± = 74

Biometric (4) Taxa Richness 3

\# of Taxa Above = 12

\# of Taxa Below = 9

% difference = 25

If % Diff.	Score	If % Diff.	Score
< 10%	4	31-45%	2
[✓ 11-30%]	3	> 45%	1

Biometric (5) Indicator Assemblage Index 1

	% EPT	%CA
Above	3	64
Below	0	72

IAI = ________

IAI = -.50 [($\%EPT_b/\%EPT_a$) + ($\%CA_a/\%CA_b$)]

0.5[(0/3)+(64/72)] = 0.44

If IAI	Score	If IAI	Score
> .80	4	0.50 - 0.64	2
0.65 - 0.80	3	[✓ <0.50]	1

Biometric (6) Missing EPT Genera 4

Comments

If Missing	Score	If Missing	Score
[✓ ≤ 1]	4	2 from 2	2
2	3	>2 from 2	1

Biometric (7) Functional Group Percent Similarity 4

FG = Σ min ($\%Sh_a$, $\%Sh_b$ + $\%SC_a$, SC_b, + % CO_a, CO_b, + % PR_a, PR_b)

	2 Above	LC Below
% Shredders	5	1
% Scrapers	7	1
% Collectors	67	73
% Predators	21	25
FG % Similarity =		

If %	Score
[✓ > 85]	4
75 - 85	3
65 - 74	2
< 65	1

Total = 21

1+1+67+21 = 90

MEAN BIOMETRIC SCORE = 3.0

AQUATIC LIFE USE STATUS Minimal Difference; Maintains

POTENTIAL GENERIC CAUSE __________

LC: 3

BIOMETRIC SCORE SHEET

Station: Above LC1 Below BDL3 NPDES Permit #________

Habitat Sampled 3MP Date _______ Time_______

Biometric Score

Biometric (1) Dominants-In Common

DIC = 3

Score: 3

Dominants Above	%	Dominants Below	%	If DIC	Score
1. Chironomidae	68	1. chironomidae	68	4-5	4
2. Argia	22	2. Argia	16	[✓ 3]	3
3. Oligochaete	4	3. Cambaranae	8	2	2
4. —		4. Oligochaete	3	0-1	1
5. —		5. Isopoda	2		

Biometric (2) Common Taxa Index

CTI: = 0.49 [TIC/MAX (T_a or T_b)]

IIII 4/9 = 0.49

Score: 2

If CTI	Score	If CTI	Score
> .70	4	[✓ 0.30-.49]	2
0.50-0.70	3	<0.29	1

Biometric (3) Quantitative Similarity Index

QSI: = 88 [Σ min (pi_a, pi_b)]

68+3+16+1 = 88

Score: 4

If QSI	Score	If QSI	Score
[✓ > 65]	4	45-55	2
56-65	3	< 45	1

Biometric (4) Taxa Richness

\# of Taxa Above = 9

\# of Taxa Below = 8

% difference = 11

Score: 3

If % Diff.	Score	If % Diff.	Score
< 10%	4	31-45%	2
[✓ 11-30%]	3	> 45%	1

Biometric (5) Indicator Assemblage Index

IAI = -.50 [(%EPT_b/%EPT_a) + (%CA_a/%CA_b)]

	% EPT	%CA
Above	0	72
Below	0	71

IAI = ________

0.5[(0/0)+(72/71)] = 0.51

Score: 2

If IAI	Score	If IAI	Score
> .80	4	[✓ 0.50 - 0.64]	2
0.65 - 0.80	3	<0.50	1

Biometric (6) Missing Genera EPT

Comments

Score: 4

If Missing	Score	If Missing	Score
[✓ ≤ 1]	4	2 from 2	2
2	3	>2 from 2	1

Biometric (7) Functional Group Percent Similarity

FG = Σ min (%Sh_a, %Sh_b + %SC_a, SC_b, + % CO_a, CO_b, + % PR_a, PR_b)

Score: 4

total = 22

	LC Above	3 Below
% Shredders	1	8
% Scrapers	1	1
% Collectors	73	73
% Predators	25	18

FG % Similarity = 93

If %	Score
[✓ > 85]	4
75 - 85	3
65 - 74	2
< 65	1

1 + 1 + 73 + 18 =

MEAN BIOMETRIC SCORE = ~~2~~3.1

AQUATIC LIFE USE STATUS minimal diff. / maintains

POTENTIAL GENERIC CAUSE ___________

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FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: BDL-1 Bayou Deloutre

Location: Union Co. AR

Client: GLCC

Ecoregion: GCP

Project no: 2072-070

Weather: Cloudy - Rainy - Warm

Investigators: GLP, REM, SVH

Date Sample Collected: 5/2/00

Form Completed By: GLP

Habitat Forms Completed: [✓ yes] / no

Fish Sampling Completed: [✓ yes] / no

Collection Site Observations

	BDL-1 Above Station	Below Station
Total Time Sampled	3m	
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:	~~45~~ 40	
Shallow Pool:	~~55~~ 60	
Deep Pool:		
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:	10	
Emergent Vegatation:	10	
Submerged Vegetation:		
Depositional Area:		
Overhanging Veg:	15	
Root Wads:	40	
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:

Rapid Bioassessment Field Sheet

Point Source NONE (Westream area) Date 5/2/00

Collector ______ Sample Technique ______ Sediment ? ______

›bitat Description. ABOVE ______

BELOW ______

MACROINVERTEBRATE COMMUNITY

ABOVE Station # BDL-1

BELOW Station # ______

Cnt.	Taxa	Tally	Cnt.	Taxa	Tally
✓	Aeshnidae	卌 卌 ||			
✓ |||| 卌	Chironomidae	卌 卌 卌 卌 卌 卌 卌 卌			
✓	Ischnura	|			
✓	Uvarus	卌 |			
✓	Oligochaeta	卌			
✓	Pelostoma	|			
○	Chemutopsyche	|			
✓	Cambarinae	||||			
✓	Enallagma	卌 |			
✓	Libelludae	卌 ||			
✓	Uvarus lv.	|||			
✓	Colembola ?	|			
✓	Argia	|			
	:TOTAL:			:TOTAL:	

Community Structure

	ABOVE	BELOW		ABOVE	BELOW
% Ephem.			% Odon.		
% Plecop.			% Cole.		
% Trichop.			% Crustacea		
% EPT					
% Chir.			# of Taxa:		
% Diptera			Biotic Score:		

Comments:

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Page 2 of 3

FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: LC-1 BDL-2 Bayou DeLoute
Client: GLCC
Project no: 2072-070
Investigators: GLP, SKH
RCM
Date Sample Collected: 5/12/00
Habitat Forms Completed: [✓ yes] / no

Location: Union Co. AR
Ecoregion: GCP
Weather: overcast - rainy
warm
Form Completed By: GLP
Fish Sampling Completed: [✓ yes] / no

Collection Site Observations

	3 mp Above Station	3 mp Below Station
Total Time Sampled:	BDL-2	LC-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:	30	30
Shallow Pool:	70	70
Deep Pool:		
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:	5	15
Emergent Vegatation:		
Submerged Vegetation:		
Depositional Area:		
Overhanging Veg:	10	10
Root Wads:	60	40
Undercut Banks:	15	20
Filamentous algae:		
Leafy Debris:	10	15
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:

Rapid Bioassessment Field Sheet

Point Source Lyon ~~Oil~~ LC + None - BDL Date 5/2/10
Collector DHP Sample Technique ____ Sediment ? ____
·bitat Description: ABOVE ____
BELOW ____

MACROINVERTEBRATE COMMUNITY

ABOVE Station # BDL-2

Cnt.	Taxa	Tally
	Argia	| 卌 卌 卌 卌 卌 卌
	Cambarinae	||
	Chironomidae	卌 卌 卌 卌 卌 卌 卌 卌
	Oligachaeta	卌
	Bezia	卌
	Caenis	卌 卌 卌 |
	Cheamatopsyche	||
	Curculnodae	|
	Amphypoda	|
	Aeshnidae	|
	Hirundae	|
	:TOTAL:	

BELOW Station # LC-1

Cnt.	Taxa	Tally
	Argia	卌 卌 卌 |||
	Cambarinae	||| 卌
卌 ||||	Chironomidae	卌 卌 卌 卌 卌 卌 卌
	Enalegmal	||
	Colepelerasp	|
	Uvarus	|
	Oligocheeta	卌 卌 ||
	Corixidae	|
	:TOTAL:	

Community Structure

	ABOVE	BELOW
% Ephem.		
% Plecop.		
% Trichop.		
% EPT		
% Chir.		
, Diptera		

	ABOVE	BELOW
% Odon.		
% Cole.		
% Crustacea		
# of Taxa:		
Biotic Score:		

Comments:

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FIELD DATA SHEETS - BENTHIC INVERTEBRATES

Waterbody Name: BDL-3 / Bayou Deloutre
Location: Union Co. AR
Client: GCCC
Ecoregion: GCP
Project no: 2672-070
Weather: Overcast - warm - humid Breezy
Investigators: GLP SKH REM
Date Sample Collected: 5/1/00
Form Completed By: GLP
Habitat Forms Completed: [✓ yes] / no
Fish Sampling Completed: [✓ yes] / no

Collection Site Observations		
	Above Station	BDL-3 Below Station
Total Time Sampled:		SMP
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:	30	30
Shallow Pool:	70	70
Deep Pool:		
Backwaters:		
Chanelized:		
Microhabitats Sampled (%)		
Woody Debris:		
Emergent Vegatation:	~~15~~	15
Submerged Vegetation:		
Depositional Area:		
Overhanging Veg:	~~10~~	10
Root Wads:	~~30~~ ~~25~~	25
Undercut Banks:	~~25~~ ~~15~~	15
Filamentous algae:	~~10~~	10
Leafy Debris:		
Other Gravel:	~~25~~	~~25~~

GLP

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:

2072-070
GLCC

Rapid Bioassessment Field Sheet

Point Source Lion Oil - upstream Loutre Creek Date 5/1/00

Collector GLF Sample Technique 3mP Sediment ? ______

bitat Description: ABOVE ______

BELOW ______

MACROINVERTEBRATE COMMUNITY

ABOVE Station # BDL-3 Dup.

Cnt.	Taxa	Tally
	Hexamite	|
	Paleomonetes	𝍸
	Cambaranae	𝍸 |||
	Argia	𝍸 𝍸 𝍸 𝍸 |
	Chironomidae	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸
	Bezia	||||
	Caenis	|||
	Olygochaeta	𝍸 |||
	Diptera SP-1	|||
	Enalagma	||||
JHD	~~[illegible]~~	~~|~~
	Macromia	|
	Belostoma	|
	Physa	||
	Amphipoda	|
	~~Typulidae~~ Tipulida	|
	Leech ?	||
	:TOTAL:	

BELOW Station # BDL-3

Cnt.	Taxa	Tally
	Hexgamite	|
	Paleomonetes	𝍸
	Cambaranae	𝍸 |
	Argia	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸
	Chironomidae	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸
	~~Co~~ Agrionidae	|
	Bezia	𝍸 |
	Caenis	||
	Oligochaeta	||
	Diptera sp.1	𝍸
	Enalagma	||
	:TOTAL:	

Community Structure

	ABOVE	BELOW		ABOVE	BELOW
% Ephem.			% Odon.		
% Plecop.			% Cole.		
% Trichop.			% Crustacea		
% EPT					
% Chir.			# of Taxa:		
Diptera			Biotic Score:		

Comments:

FIELD DATA SHEETS - FISH

Waterbody Name: Bayou De Loutre

Client: GLCC - Central

Project no: ________

Investigators: SKH, REM, MAS

Date Sample Collected: ________

Habitat Forms Completed: [✓ yes] / no

Location: BDL-1

Ecoregion: Gulf Coastal

Weather: Sunny Hot

Form Completed By: SKH/REM

Fish Sampling Completed: [✓ yes] / no

Collection Site Observations

	BDL-1 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:	25		
Shallow Pool:	50		
Deep Pool:	25		
Backwaters:			
Chanelized:			
Microhabitats Sampled (%)			
Woody debris:	20%		
Emergent Vegatation:			
Submerged Vegetation:			
Depositional Area:	15%		
Overhanging Veg:			
Root Wads:	40%		
Undercut Banks:	20%		
Filamentous algae:			
Leafy debris:	5%		
Substrate Type and Scoring			
Substrate	Score	Adj. Score	
Bedrock:	X 0.1		
~~Lg. Boulder:~~ CLAY	10 0.1 X 1.0	1	
Boulders:	0 X 1.0	0	
Rubble:	0 X 1.0	0	
Gravel:	15 X 0.5	7.5	
Sand:	X 0.1	0	
Mud/Silt:	75 X 0.1	7.5	
Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0			

5/19/99

Sampling Gear Type: [✓ Electrofishing] Seine Gill nets

Unit of Effort: Above: ____________ 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: BDL-1 PDT = 1161

Below Station: ____________

Fish Species Observed

Above Station #		Below Station #
Bluegill	||	
Warmouth	||||	
Redear	|||	
Green	|	
Spotted	|||	
Grass pickerel	|	
Gambusia	𝍸 ||	

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FIELD DATA SHEETS - FISH

Waterbody Name: Bayou de Loutre

Client: GCCL-Central

Project no: ____

Investigators: SKH, REM, AAS

Date Sample Collected: 05/13/99

Habitat Forms Completed: [✓ yes] / no

Location: BDL 2.0

Ecoregion: Gulf COASTAL

Weather: Sunny / Hot

Form Completed By: REM

Fish Sampling Completed: [✓ yes] / no

Collection Site Observations

	BDL 2.0 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:	45		
Shallow Pool:	45		
Deep Pool:	10		
Backwaters:			
Chanelized:			
Microhabitats Sampled (%)			
Woody debris:	30		
Emergent Vegatation:	5		
Submerged Vegetation:			
Depositional Area:	15		
Overhanging Veg:	10		
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~~: Clay	(75)	13)	X 0.5	6.0
Sand:	(10)	(6)	X 0.1	0.6
Mud/Silt:	(15)	10	X 0.1	1.0

Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0 7.6

5/13/99

Sampling Gear Type: [✓ Electrofishing] Seine Gill nets

Unit of Effort: Above: 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: BDL-2 PDT 183Le

Below Station:

Fish Species Observed

	Above Station #	Below Station #
	Gambusia 𝍸𝍸𝍸𝍸𝍸𝍸𝍸 𝍷𝍷𝍷𝍷	
	Bluegill 𝍷𝍷	
	Green 𝍷𝍷𝍷𝍷	
	Spotted 𝍷𝍷𝍷𝍷	
	Longear 𝍸𝍸𝍸𝍸𝍸𝍸 𝍷𝍷	
	Pirate Perch 𝍷𝍷𝍷	
	Redfin Shinner 𝍷	
ð ?	Bluntnose minnow 𝍷𝍷𝍷	
	Yellow Bullhead 𝍸 𝍷	
	Golden Topminnow 𝍷𝍷	
?	Darter 𝍷 Slough Darter	Etheostoma gracile

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FIELD DATA SHEETS - FISH

Waterbody Name: BDL-3

Client: GLCC-Central

Project no: ______

Investigators: REM, ADS, SKL

Date Sample Collected: 13 May 1999

Habitat Forms Completed: [✓ yes] / no
Previous sampling

Location: Bayou de Loutre

Ecoregion: Gulf Coastal

Weather: Sunny - Mild

Form Completed By: REM

Fish Sampling Completed: [✓ yes] / no

Collection Site Observations

	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:	30		
Shallow Pool:	60		
Deep Pool:	10		
Backwaters:			
Chanelized:			
Microhabitats Sampled (%)			
Woody debris:	10		
Emergent Vegatation:	5		
Submerged Vegetation:	0		
Depositional Area:	5		
Overhanging Veg:	5		
Root Wads:	25		
Undercut Banks:	25		
~~Filamentous algae~~: Detrid	30		
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 6	X 0.5	3.0
Sand:	15 10	X 0.1	1.0
~~Mud/Silt~~: Clay	75 13	X 0.1	1.3

Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0 5.5

Sampling Gear Type: [✓ Electrofishing] Seine Gill nets

Unit of Effort: Above: 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: BDL-3 PDT 3657

Shock Time 0750 – 0950

Below Station:

Fish Species Observed

Above Station #	Below Station #
Longear 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌	卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 | Lepomis mega
~~Bluegill~~	
Warmouth ||||	Lepomis gulosus
Green 卌 ||||	Lepomis cyanellus
~~Dus~~ Spotted 卌 卌 卌 卌	Lepomis punctatus
Golden Topminnow |	Fundulus chrysotus
Pirate perch ||	Aphredoderus sayanus
Yellow Bullhead 卌 ||||	Ictalurus natalis
Bluntnose Minnow |	Pimephales notatus
Redfin Shiner ||	Notropis umbratilis
Gambusia 卌 卌 卌 卌 卌 卌 卌	Gambusia affinis
A ||||	
Black Bullhead |	Ictalurus melas
Lepomis X Lepomis |	

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FIELD DATA SHEETS - FISH

Waterbody Name: Loutre Creek

Client: GLCC-Central

Project no: ________

Investigators: SKH REN

AAS

Date Sample Collected: 13 May 1998

Habitat Forms Completed: [✓ yes] / no

Location: El Dorado LC-1

Ecoregion: Gulf Coastal

Weather: Clear Sunny

Form Completed By: REN

Fish Sampling Completed [✓ yes] no

Collection Site Observations			
1hr. 48 min	LC-1 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 more sp th	0 1 2 3 4	
Other ______:	0 1 2 3 4 other	0 1 2 3 4	
0=Not Observed, 1=Rare, 2=Common, 3=Abundant, 4=Dominant			
Major Habitat Sampled (%)			
Riffle/Run:	30		
Shallow Pool:	50		
Deep Pool:	20		
Backwaters:			
Chanelized:			
Microhabitats Sampled (%)			
Woody debris:	25		
Emergent Vegatation:	5		
Submerged Vegetation:			
Depositional Area:	5		
Overhanging Veg:	5		
Root Wads:	25		
Undercut Banks:	25		
Filamentous algae:			
Leafy debris:	10		
Substrate Type and Scoring			
Substrate	Score	Adj. Score	
Bedrock:	X 0.1		
Lg. Boulder:	X 1.0		
Boulders:	X 1.0		
~~Rubble:~~ Clay	(80%) 15 X 1.0	15	
~~Gravel~~ SiLT	(5) 3 X 0.5	0.15	
Sand:	(5) 3 X 0.1	0.3	
Mud/Silt:	(10) 10 X 0.1	1.0	
Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0			

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Sampling Gear Type: [✓ Electrofishing] Seine Gill nets

Unit of Effort: Above: 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: LC-1 PDT 2225

Below Station:

Fish Species Observed

Above Station #	Below Station #
Gambusia 𝍸 |	
Green 𝍸	
Spotted |||	
Longear 𝍸 𝍸 𝍸 𝍸 |	
Warmouth ||	
Redear |	
Yellow Bullhead 𝍸 |	
Golden Topminnow ||	

BDL-1 / LC-1

FIELD DATA SHEETS - FISH

Waterbody Name: ~~Bayou~~ Loutre Creek
Client: GLCC- Central
Project no:
Investigators: SKH REM
GLP
Date Sample Collected: 5/2/2000
Habitat Forms Completed: [✓ yes] / no

Location: ~~Bayou~~ Loutre Creek
Ecoregion: Gulf Coastal
Weather: Rain / Thundershowers
Form Completed By: REM
Fish Sampling Completed: [✓ yes] / no

Collection Site Observations

	Above Station	Below Station	Additional Observations:
Total Time Sampled:	LC-1	BDL-1	
Relative Abundance of Aquatic Biota:			
Periphyton:	0 1 2 3 [✓ 4]	0 1 2 3 4	Loutre Creek w/ large flow. Good mix of deep pool/shallow pool Run areas. mostly sub-hard pan clay.
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	60	
Shallow Pool:	40	20	
Deep Pool:	20	20	
Backwaters:			
Chanelized:	NONE		
Microhabitats Sampled (%)			
Woody debris:	20		
Emergent Vegatation:	5		
Submerged Vegetation:	5		
Depositional Area:	20		
Overhanging Veg:	5		
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:	5	X 1.0	
Gravel:	5	X 0.5	
Sand:	20	X 0.1	
Mud/Silt:	70	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: ______ Below: ______

Quantity of Available Fish Cover:

~~Above Station~~ LC-1: Very Abundant, [✓ Abundant], Moderate, Sparse, Absent

~~Below Station~~ BDL-1: Very Abundant, Abundant, [✓ Moderate, Sparse] Absent

Site Description & Notes:

~~Above Station~~: LC-1

~~Below Station~~: BDL-1

Fish Species Observed

~~Above Station~~ # LC-1	~~Below Station~~ # BDL-1
Longear 𝍸 𝍸 𝍸 𝍸 𝍸 ||	Grass Pickerel – |
Yellow bullhead 𝍸 (Fin Rot)	Green Sunfish – |||
Spotted sunfish 𝍸 𝍸 𝍸 𝍸 ||	Warmouth – |
~~Orangespotted~~	
Gambusia 𝍸 𝍸 𝍸	
Green Sunfish 𝍸 ||	
~~Golden Topminnow~~	
~~Pirate Perch~~	
Warmouth |	

Counts Lab Confirmed

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BDL-2/BDL-3

FIELD DATA SHEETS - FISH

Waterbody Name: Bayou D Lustre

Client: LCC

Project no: 2092-49-0

Investigators: GLD SKH. REM

Date Sample Collected: 5/1/00 /5/2/00

Habitat Forms Completed: [✓ yes] / no

Location: BDL-3 / BDL 2

Ecoregion: Gulf Costal

Weather: Cloudy

Form Completed By: SKH

Fish Sampling Completed: [✓ yes] / no

Collection Site Observations

	~~Above Station~~	~~Below Station~~	Additional Observations:
~~Total Time Sampled~~	BDL-3	BDL-2	
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:	~~30~~ ~~20~~ 30	35	
Shallow Pool:	~~70~~ SH 60	65	
Deep Pool:	~~20~~ ~~10~~ 5	—	
Backwaters:	—		
Chanelized:	—		
Microhabitats Sampled (%)			
Woody debris:			
Emergent Vegatation:			
Submerged Vegetation:			
Depositional Area:			
Overhanging Veg:			
Root Wads:			
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:	X 0.1	
Mud/Silt:	X 0.1	

Score: Abundant 11-15, Common 6-10, Sparce 1-5, Absent 0

BDL-2/BDL-3

FIELD DATA SHEETS - FISH

Waterbody Name: Bayou D Inde
Client: LLCC
Project no: 2092-49-0
Investigators: GLD SKH
REM
Date Sample Collected: 5/1/00 /5/2/00
Habitat Forms Completed: [✓ yes] / no

Location: BDL-3 / BDL 2
Ecoregion: Gulf Coastal
Weather: Cloudy
Form Completed By: SKH
Fish Sampling Completed: [✓ yes] / no

Collection Site Observations			
	~~Above Station~~	~~Below Station~~	Additional Observations:
Total Time Sampled:	BDL-3	BDL-2	
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:	~~30~~ ~~20~~ 30	35	
Shallow Pool:	~~70~~ ~~84~~ 60	65	
Deep Pool:	~~30~~ ~~10~~ 5	–	
Backwaters:	–		
Chanelized:	–		
Microhabitats Sampled (%)			
Woody debris:			
Emergent Vegatation:			
Submerged Vegetation:			
Depositional Area:			
Overhanging Veg:			
Root Wads:			
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:	X 0.1		
Mud/Silt:	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: ______________________ Below: ____________

Quantity of Available Fish Cover:

BDL-3 ~~Above Station~~: Very Abundant, ~~Abundant, M~~oderate, Sparse, Absent

BDL2 Below Station: Very Abundant, Abundant, Moderate, Sparse, Absent

Site Description & Notes:

~~Above Station:~~ BDL-3

Below Station: ______________________

BDL-3

Fish Species Observed

Above Station #	~~Below Station #~~ BDL-2
Longear (~~114~~) (116)	Yellow-Bullhead ||||
yellow Bullhead 卌 | (Finrot)	Pirate perch |||
Gambusia 卌 卌 卌 卌 卌 卌 卌 卌	Golden Topminnow 卌 |||
warmouth | || 卌 卌 卌 卌 卌	Gambusia 卌 卌 ||
Bowfin |	Green 卌 |
Golden Top Minnow 卌 ||||	Flier |||
Green 卌 |	GRASS pickerel ||
Grass pickerel ||	Spotted Bass |
Spotted SF 卌 卌 卌 卌 卌 卌	Orange Spotted Sunfish |
Pirate perch |	Spotted Sunfish 卌 卌 卌
||| ~~Notropis~~ umbratilis (Red fin)	Longear Sunfish 卌 卌 卌 卌 卌 卌 卌 卌 |
flier ||	Creek Chub sucker |
Aphredoderus ~~sayanus~~ |	Golden shiner ||||
~~Bluegill~~	Lepomis X Lepomis |
Banded pygmy Sunfish |	Lepomis YOY |
Lepomis YOY ||	

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Appendix E

Water Temperature Study Data

GLCC Temperature Study - Outfall 001

Site	Date	Therm. Time Out	Therm. Time In	Thermorreter Temp. (°F)	Actual Probe Time	Probe Temp. (°F)	Difference Therm. & Probe Temps. (°F)
BDL-1	9/7/99	12:38:00	12:40:00	80	11:45:26	79.94	0.06
BDL-1.5	9/7/99	12:49:00	12:51:00	95	11:56:26	96.97	1.97
BDL-2	9/7/99	13:21:00	13:24:00	88	12:29:10	88.47	0.47
BDL-2D	9/7/99	13:21:00	13:24:00	88	12:28:42	89.96	1.96
BDL-3	9/7/99	13:32:00	13:38:00	86	12:43:14	83.22	2.78
BDL-3D	9/7/99	13:32:00	13:38:00	86	12:39:50	83.89	2.11
BDL-5	9/7/99	13:55:00	13:57:00	87	13:02:02	88.02	1.02
LC-1	9/7/99	13:08:00	13:10:00	86	12:14:58	87.99	1.99

Site	Date	Therm. Time Out	Therm. Time In	Thermometer Temp. (°F)	Actual Probe Time	Probe Temp. (°F)	Difference Therm. & Probe Temps. (°F)
BDL-1	9/9/99	10:23:00	*	76	9:45:26	80.58	4.58

Site	Date	Therm. Time Out	Therm. Time In	Thermometer Temp. (°F)	Actual Probe Time	Probe Temp. (°F)	Difference Therm. & Probe Temps. (°F)
BDL-1	10/4/99	*	14:28:00	78	13:28:11	79.3	1.3
BDL-1.5	10/4/99	13:05:00	13:06:00	94	12:56:26	88.54	5.46
BDL-2	10/4/99	13:36:00	13:39:00	80	13:29:10	79.82	0.18
BDL-2D	10/4/99	13:36:00	13:39:00	80	13:28:42	81.3	1.3
BDL-2T	10/4/99	13:36:00	13:39:00	80	13:01:00	79.42	0.58
BDL-3	10/4/99	13:47:00	13:52:00	78	12:43:14	73.53	4.47
BDL-3D	10/4/99	13:47:00	13:52:00	78	12:39:50	73.55	4.45
BDL-3T	10/4/99	13:47:00	13:52:00	78	13:01:00	77.57	0.43
BDL-5	10/4/99	14:07:00	14:09:00	76	14:02:02	79.54	3.54
LC-1	10/4/99	13:16:00	13:19:00	76	13:14:58	81.42	5.42

Site	Date	Therm. Time Out	Therm. Time In	Thermometer Temp. (°F)	Actual Probe Time	Probe Temp. (°F)	Difference Therm. & Probe Temps. (°F)
BDL-1	12/2/99	12:40:00	12:42:00	53	11:31:02	53.98	0.98
BDL-1.5	12/2/99	12:52:00	12:54:00	92	12:09:56	91.3	0.7
BDL-2	12/2/99	13:14:00	13:18:00	68	12:41:18	67.06	0.94
BDL-2D	12/2/99	13:14:00	13:18:00	68	12:41:50	74.85	6.85
BDL-2T	12/2/99	13:14:00	13:18:00	68	12:42:14	66.74	1.26
BDL-3	12/2/99	13:25:00	13:30:00	65	12:53:30	60.33	4.67
BDL-3D	12/2/99	13:25:00	13:30:00	65	12:54:24	60.97	4.03
BDL-3T	12/2/99	13:25:00	13:30:00	65	12:53:54	66.8	1.8
BDL-5	12/2/99	13:44:00	13:46:00	58	13:13:10	59.97	1.97
LC-1	12/2/99	13:00:00	13:02:00	69	12:22:44	72.44	3.44

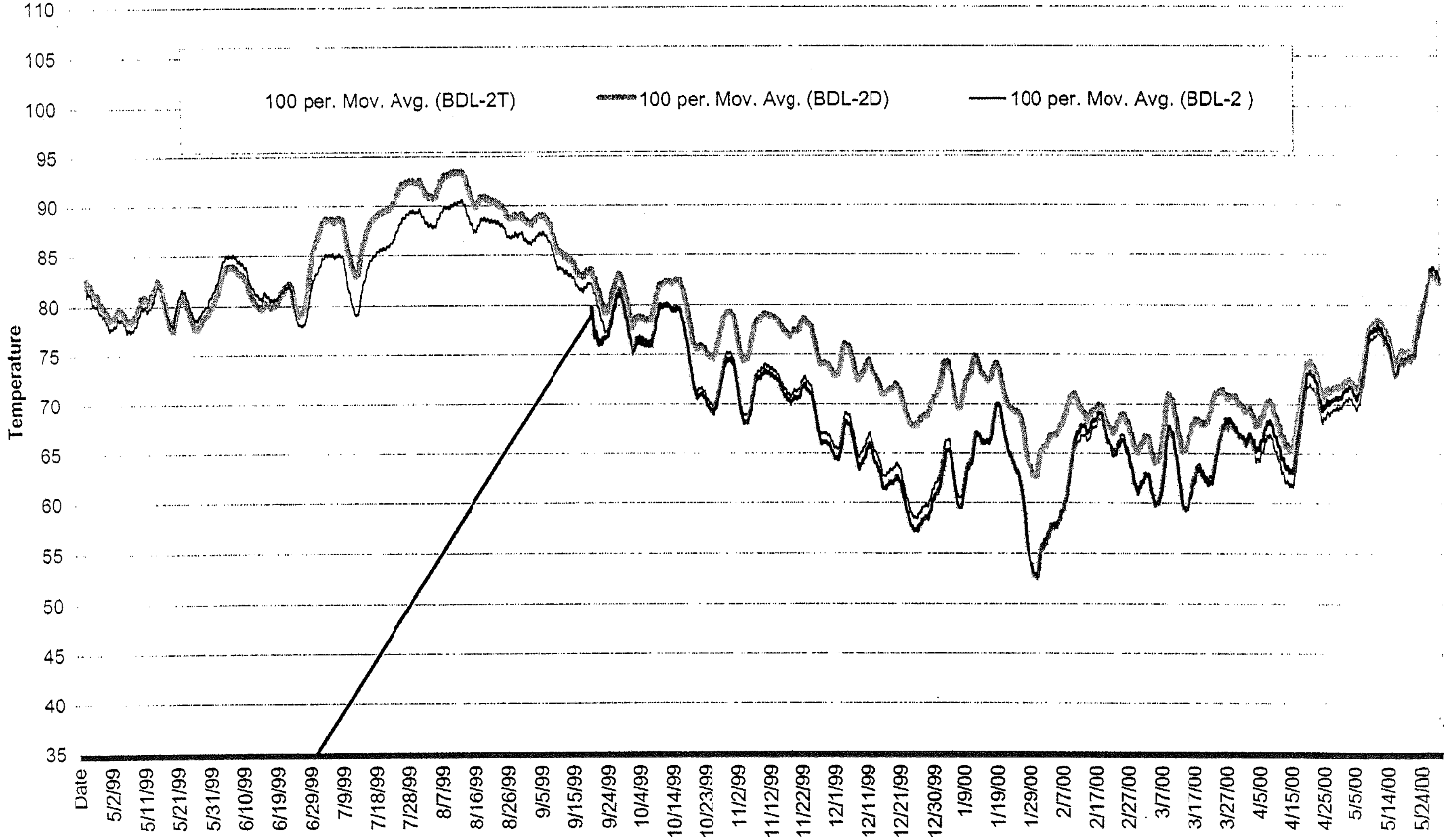
Site	Date	Therm. Time Out	Therm. Time In	Thermometer Temp. (°F)	Actual Probe Time	Probe Temp. (°F)	Difference Therm. & Probe Temps. (°F)
BDL-1	2/22/00	12:34:00	12:37:00	58	11:47:40	62.2	4.2
BDL-1.5	2/22/00	12:44:00	12:49:00	58	11:59:04	58.29	0.29
BDL-2	2/22/00	13:13:00	13:19:00	70	12:22:16	68.31	1.69
BDL-2D	2/22/00	13:13:00	13:19:00	70	12:23:32	69.79	0.21
BDL-2T	2/22/00	13:13:00	13:19:00	70	12:22:54	68	2
BDL-3	2/22/00	13:26:00	13:31:00	70	12:33:50	59.71	10.29
BDL-3D	2/22/00	10:54:00	11:00:00	72	9:34:24	55.93	16.07
BDL-3T	2/22/00	13:26:00	13:31:00	70	12:33:10	75	5
BDL-5	2/22/00	13:45:00	13:47:00	66	12:51:38	64.37	1.63
LC-1	2/22/00	12:58:00	13:00:00	62	12:07:38	73.07	11.07

Site	Date	Therm. Time Out	Therm. Time Ir	Thermometer Temp. (°F)	Actual Probe Time	Probe Temp. (°F)	Difference Therm. & Probe Temps. (°F)
BDL-1	5/30/00	10:32:00	10:34:00	73	9:40:59	75.43	2.43
BDL-1.5	5/30/00	10:44:00	10:47:00	72	9:49:45	70.87	1.13
BDL-2	5/30/00	12:44:00	12:50:00	78	11:19:43	78.53	0.53
BDL-2D	5/30/00	12:44:00	12:50:00	78	11:21:17	78.71	0.71
BDL-2T	5/30/00	12:44:00	12:50:00	78	11:20:29	79.42	1.42
BDL-3	5/30/00	13:00:00	13:08:00	80	11:33:15	64.11	15.89
BDL-3D	5/30/00	13:00:00	13:08:00	80	11:59:01	69.77	10.23
BDL-3T	5/30/00	13:00:00	13:08:00	80	11:34:01	76.93	3.07
BDL-5	5/30/00	13:30:00	13:32:00	85	11:51:11	86.69	1.69
LC-1	5/30/00	11:02:00	11:04:00	77	10:03:37	83.36	6.36

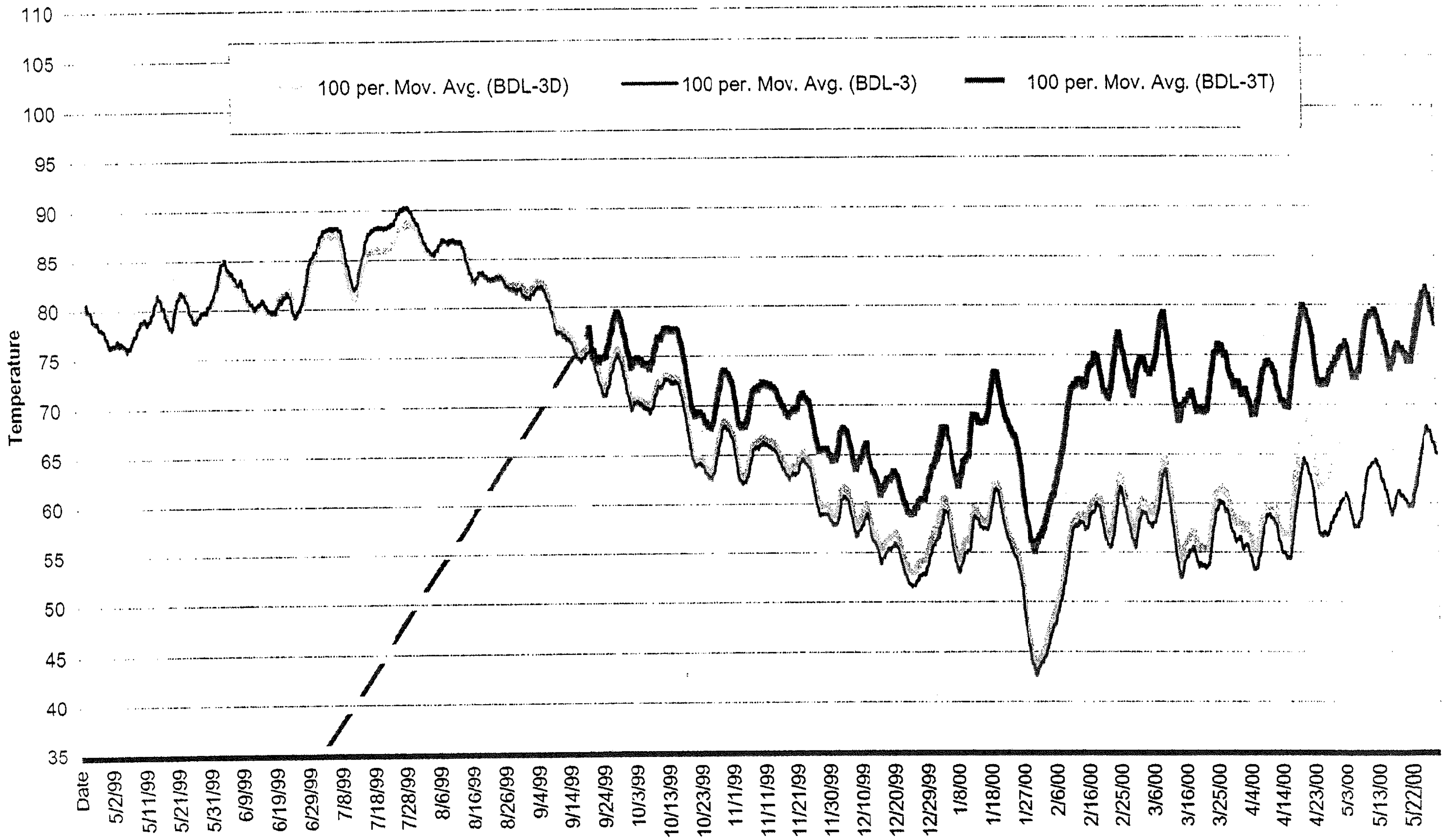
Appendix E-1

Stowaway® Probe Calibration Record and Plots

BDL-2 Comparison of Temperature Probes



Comparison of tripilicate probes at BDL-3



Appendix F

Plots of Water Temperatures
(Response to Storm Event and Sporadic Discharge)

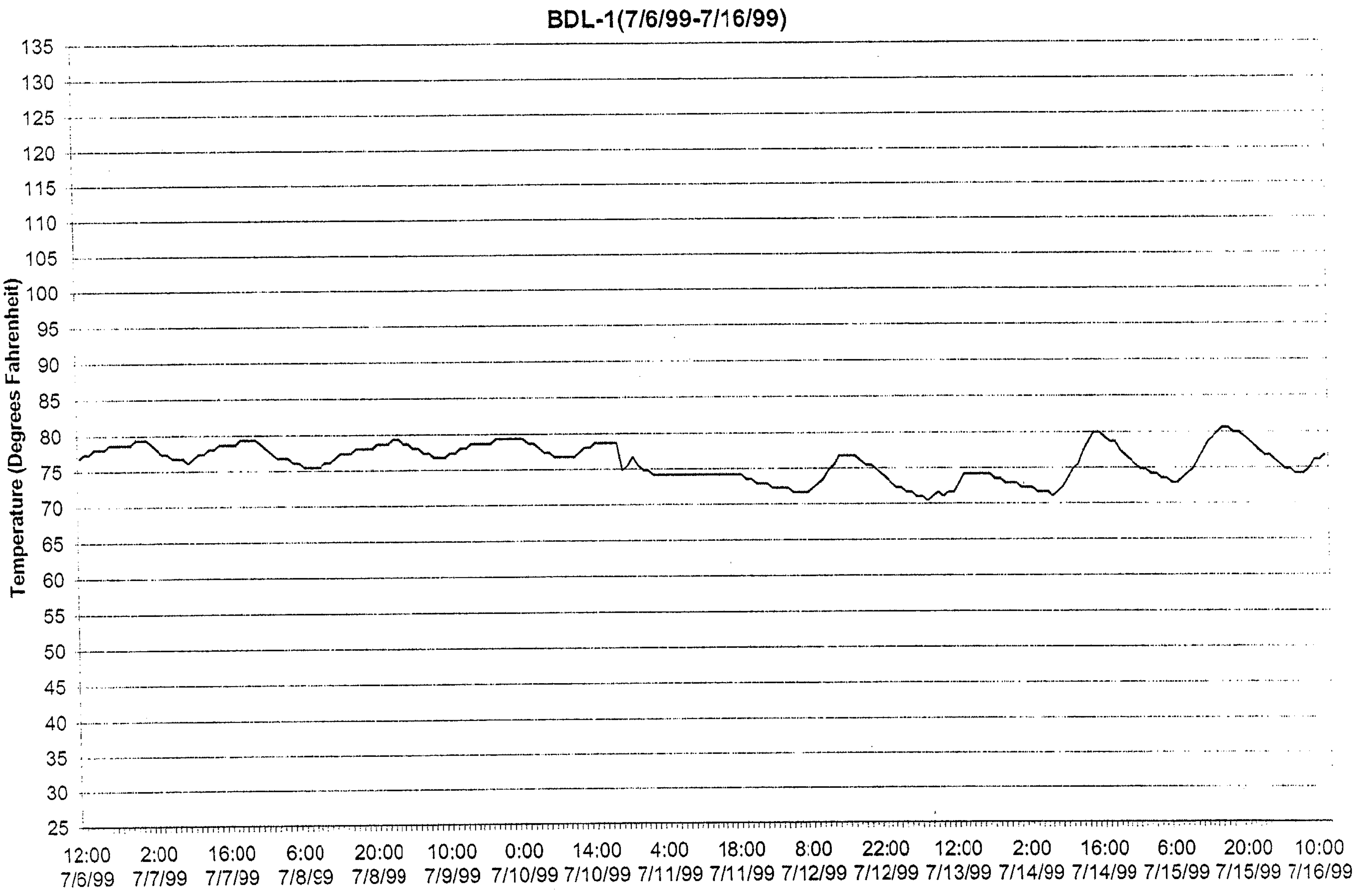


Figure F-1. Water temperature at BDL-1 and response to storm event on July 10, 1999.

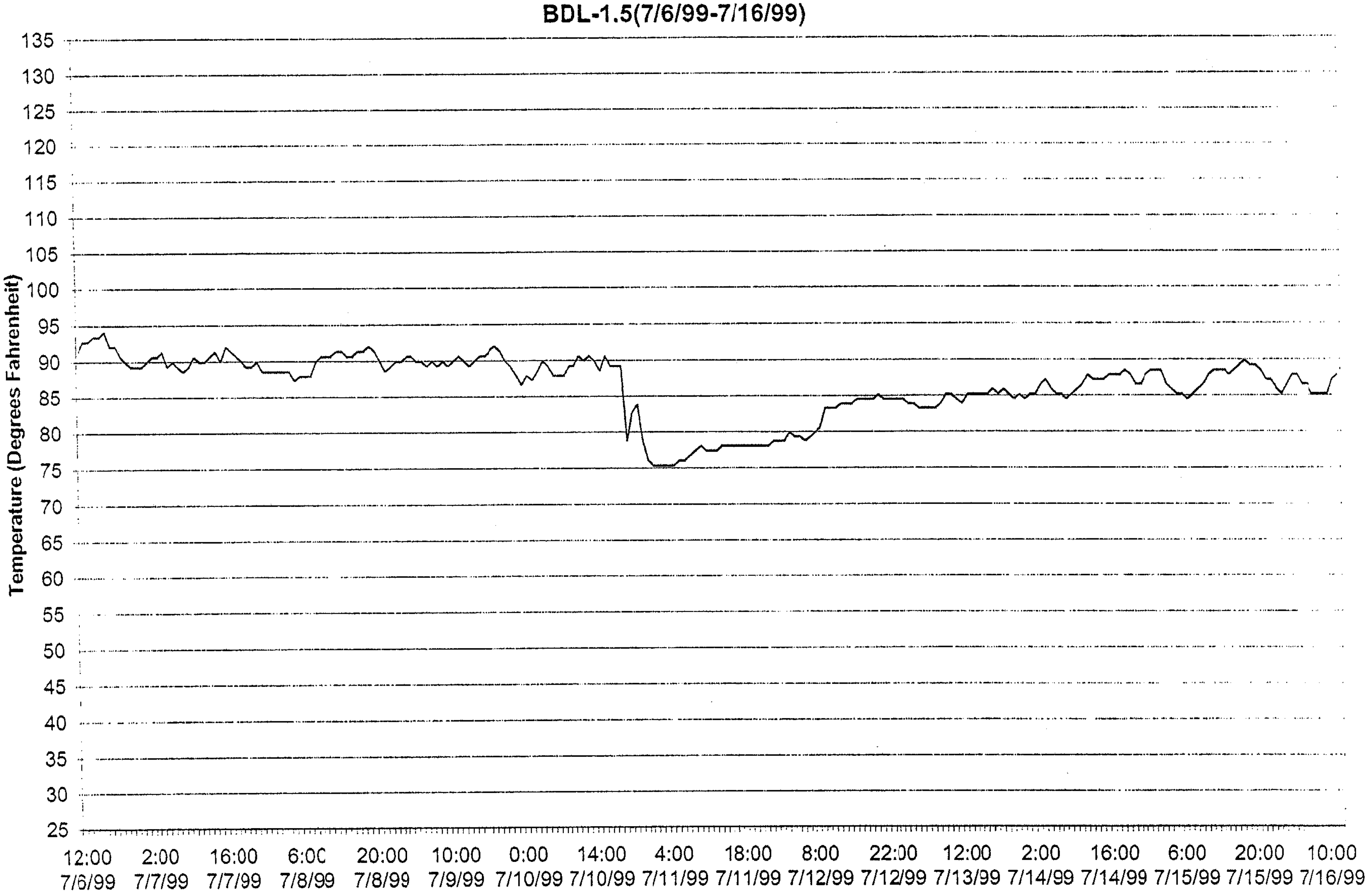


Figure F-2. Water temperature at BDL-1.5 and response to storm event on July 10, 1999.

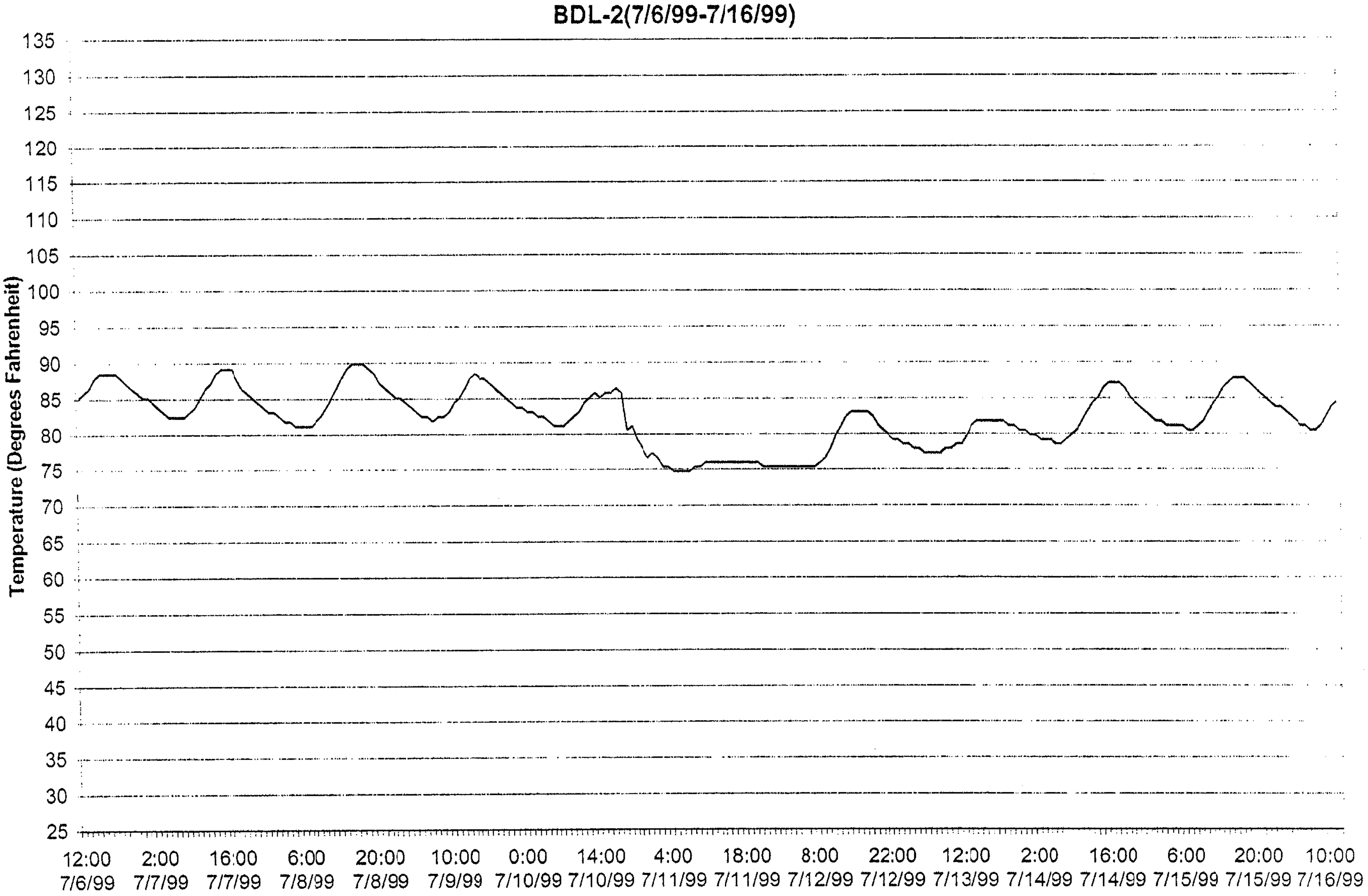


Figure F-3. Water temperature at BDL-2 and response to storm event on July 10, 1999.

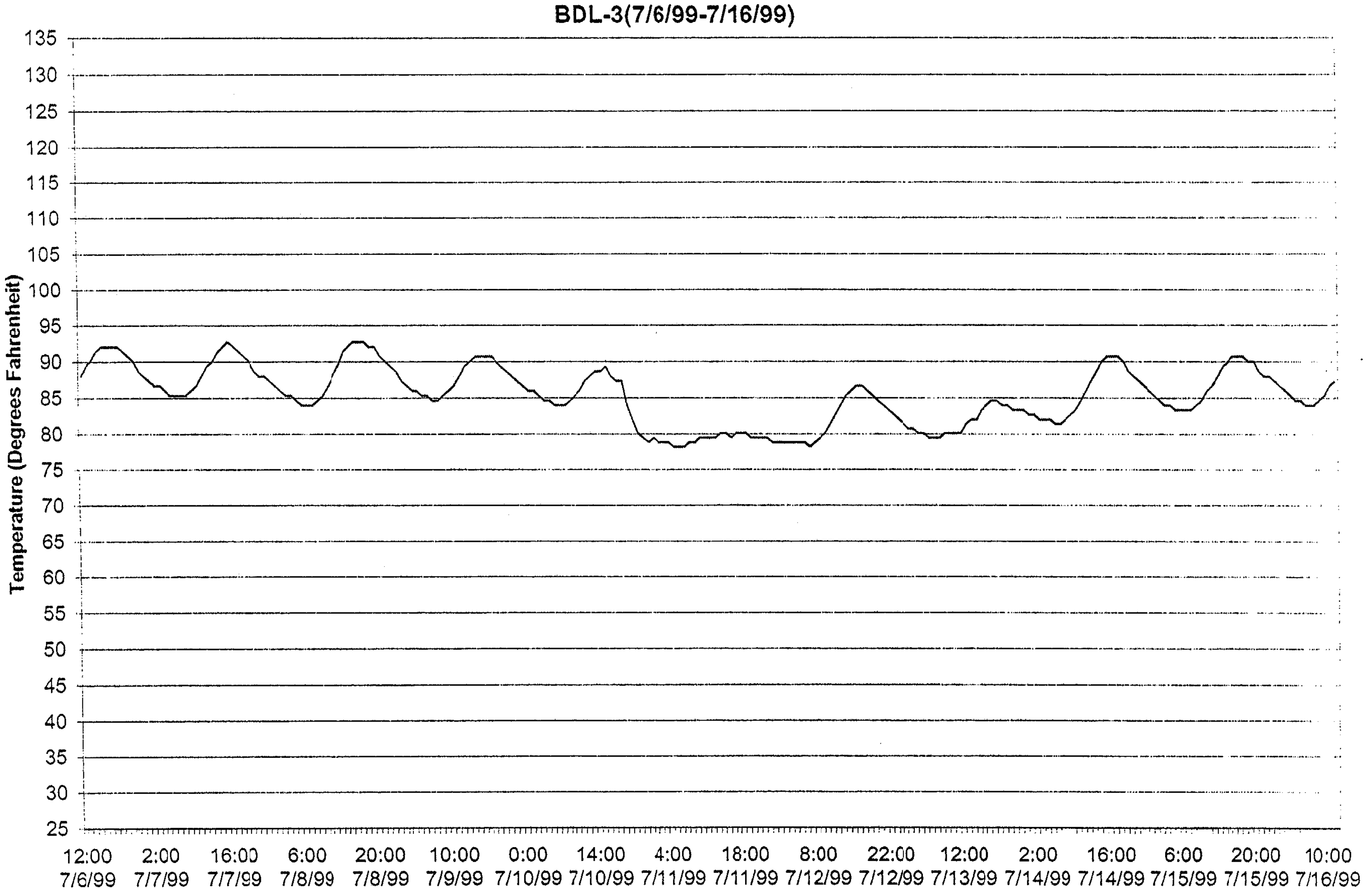


Figure F-4. Water temperature at BDL-3 and response to storm event on July 10, 1999.

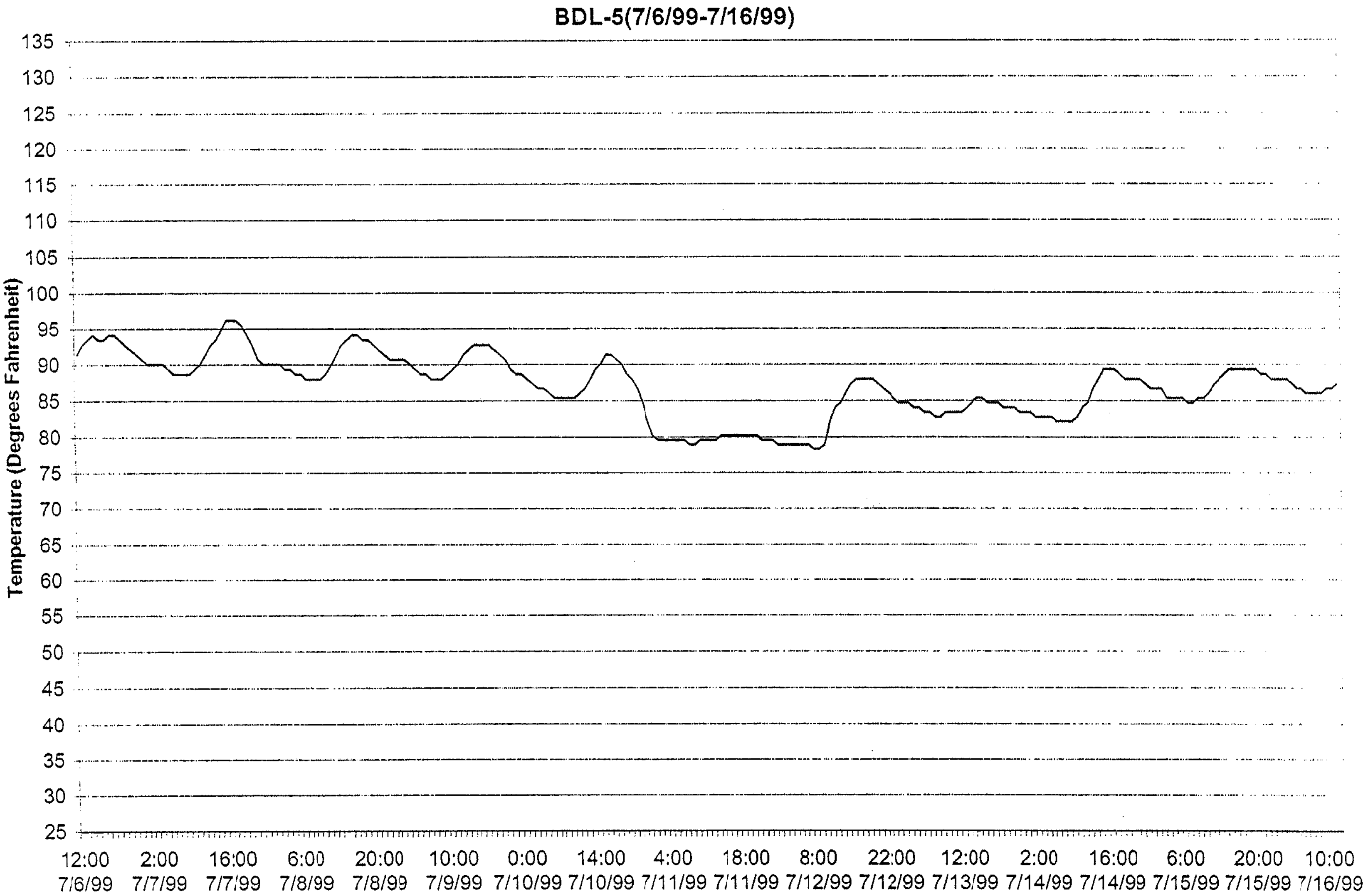


Figure F-5. Water temperature at BDL-5 and response to storm event on July 10, 1999. Note exceedance of temperature criterion of 86°F.

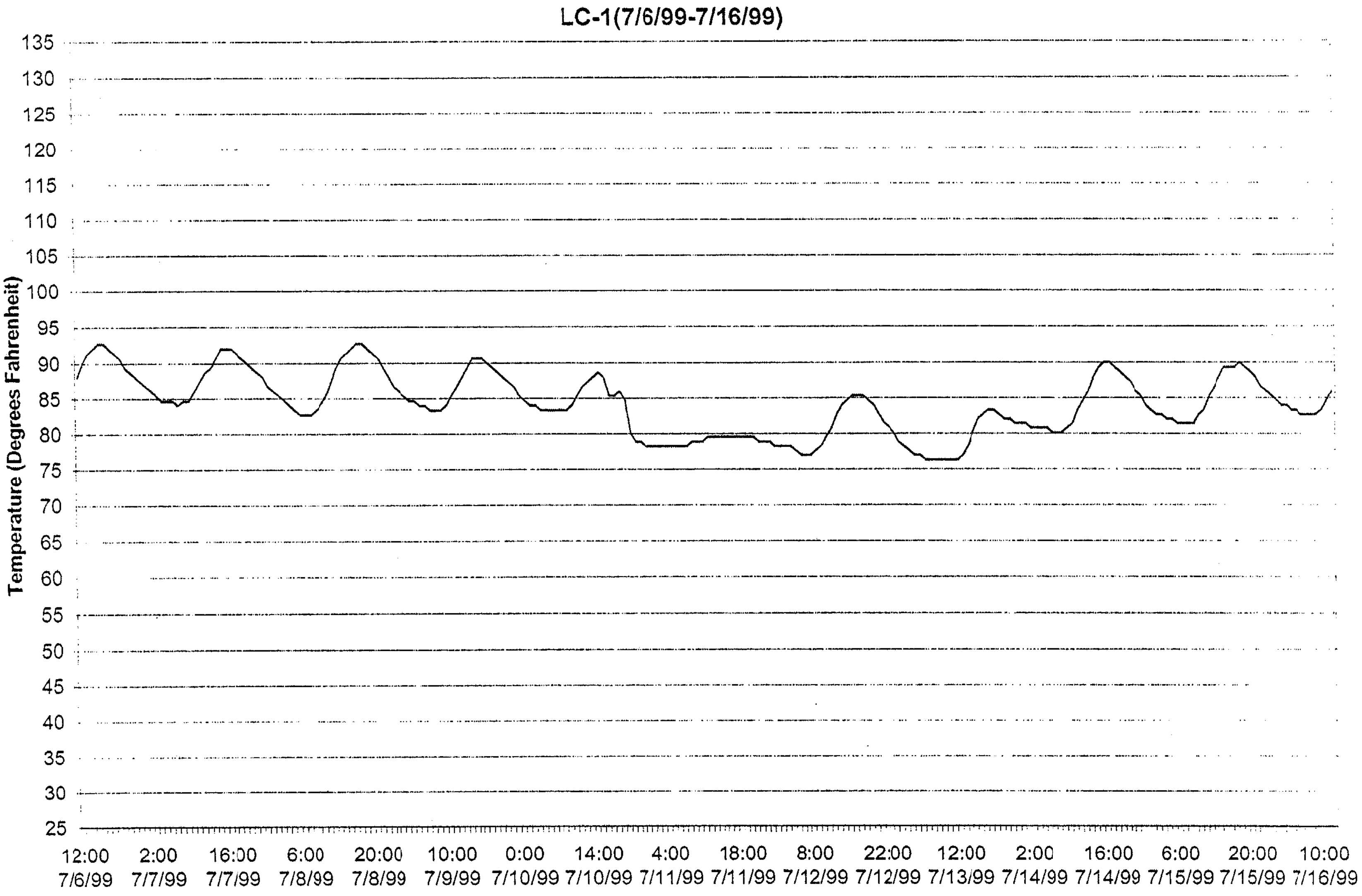


Figure F-6. Water temperature at LC-1 and response to storm event on July 10, 1999. Note exceedance of temperature criterion of 86°F.

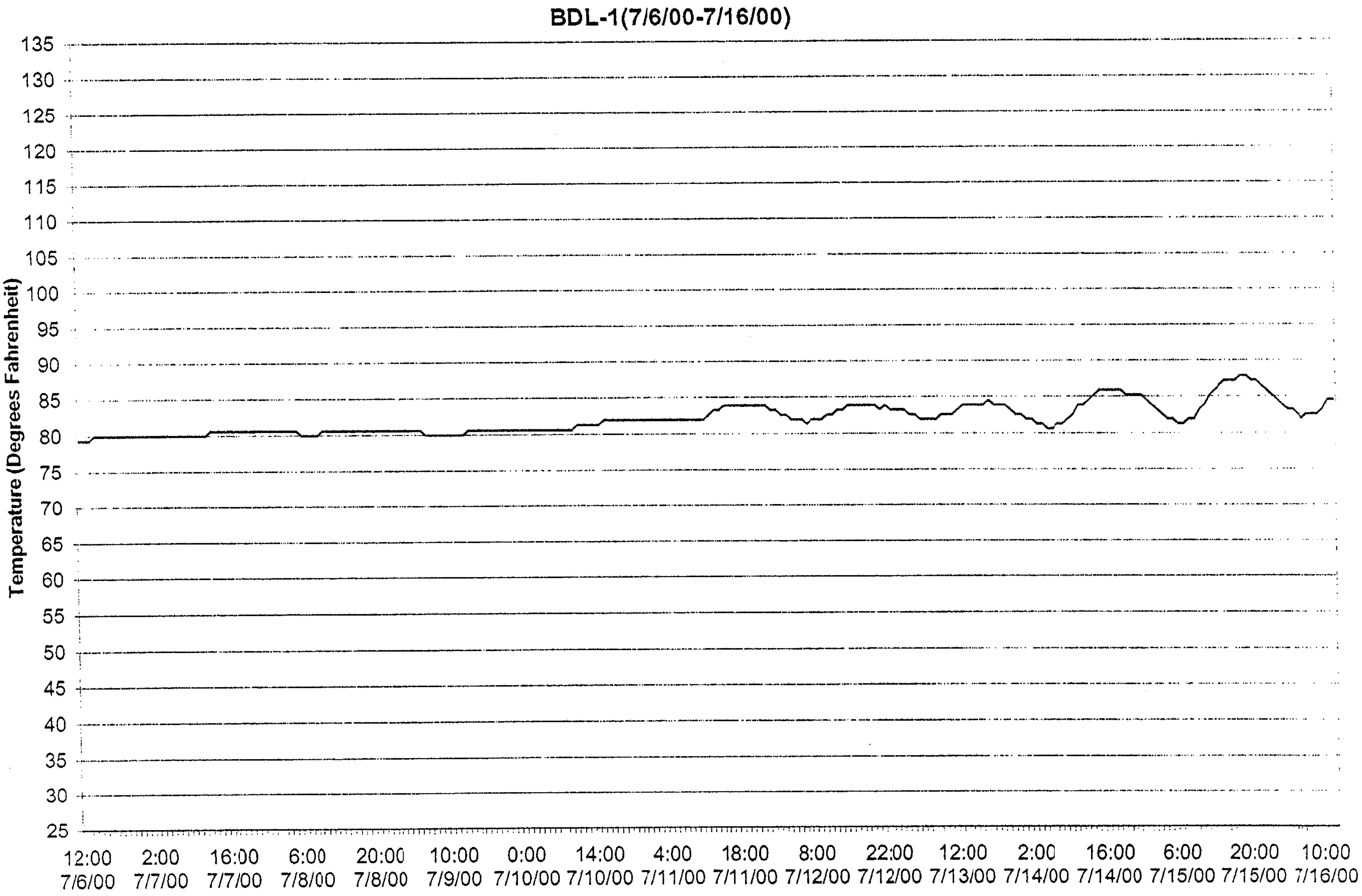


Figure F-7. Water temperature at BDL-1 upstream of GLCC-Central Outfall 001 discharge.

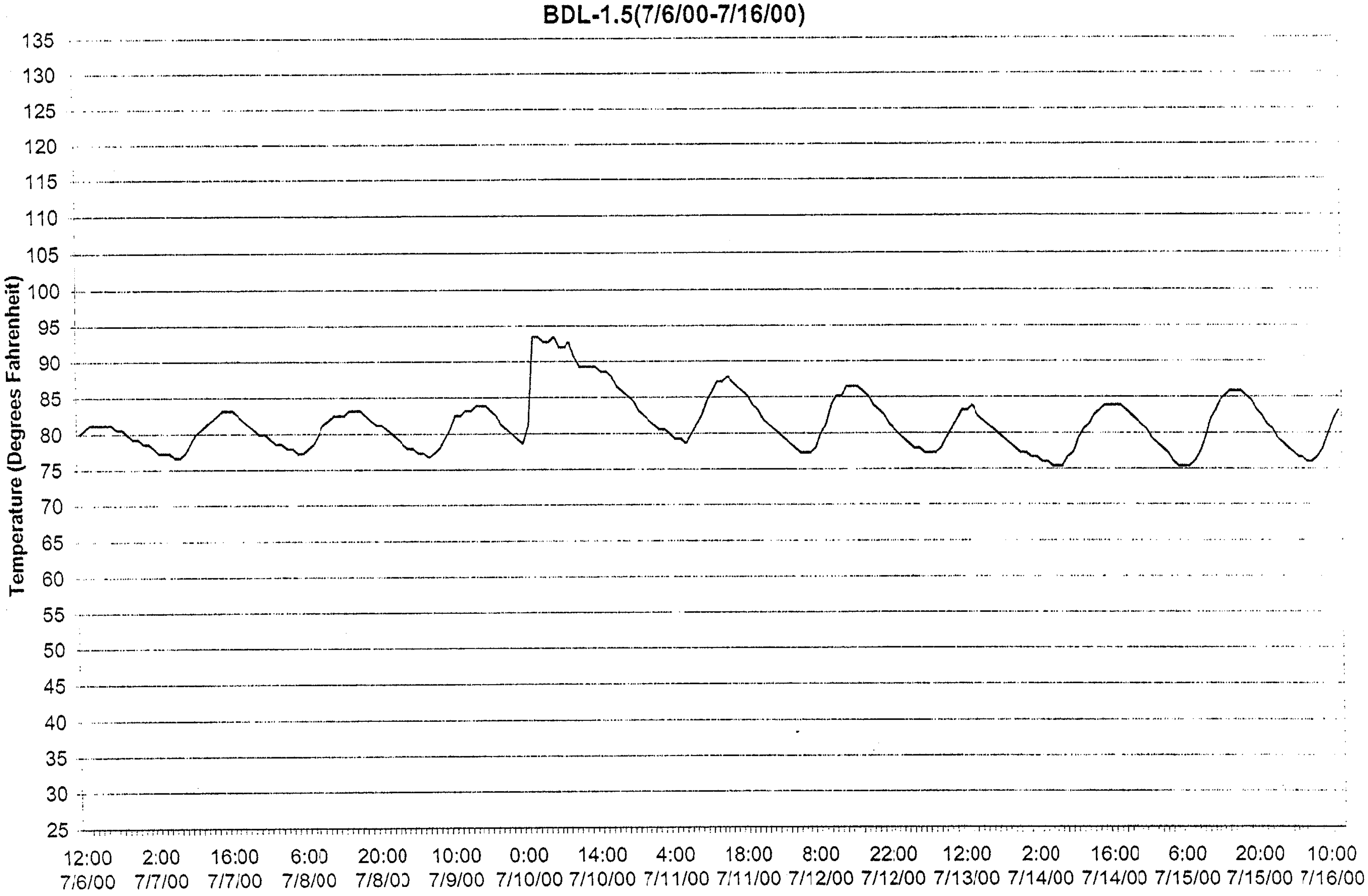


Figure F-8. Water temperature at BDL-1.5 just downstream of GLCC-Central Outfall 001. Note discharge event on July 10, 2000 and response.

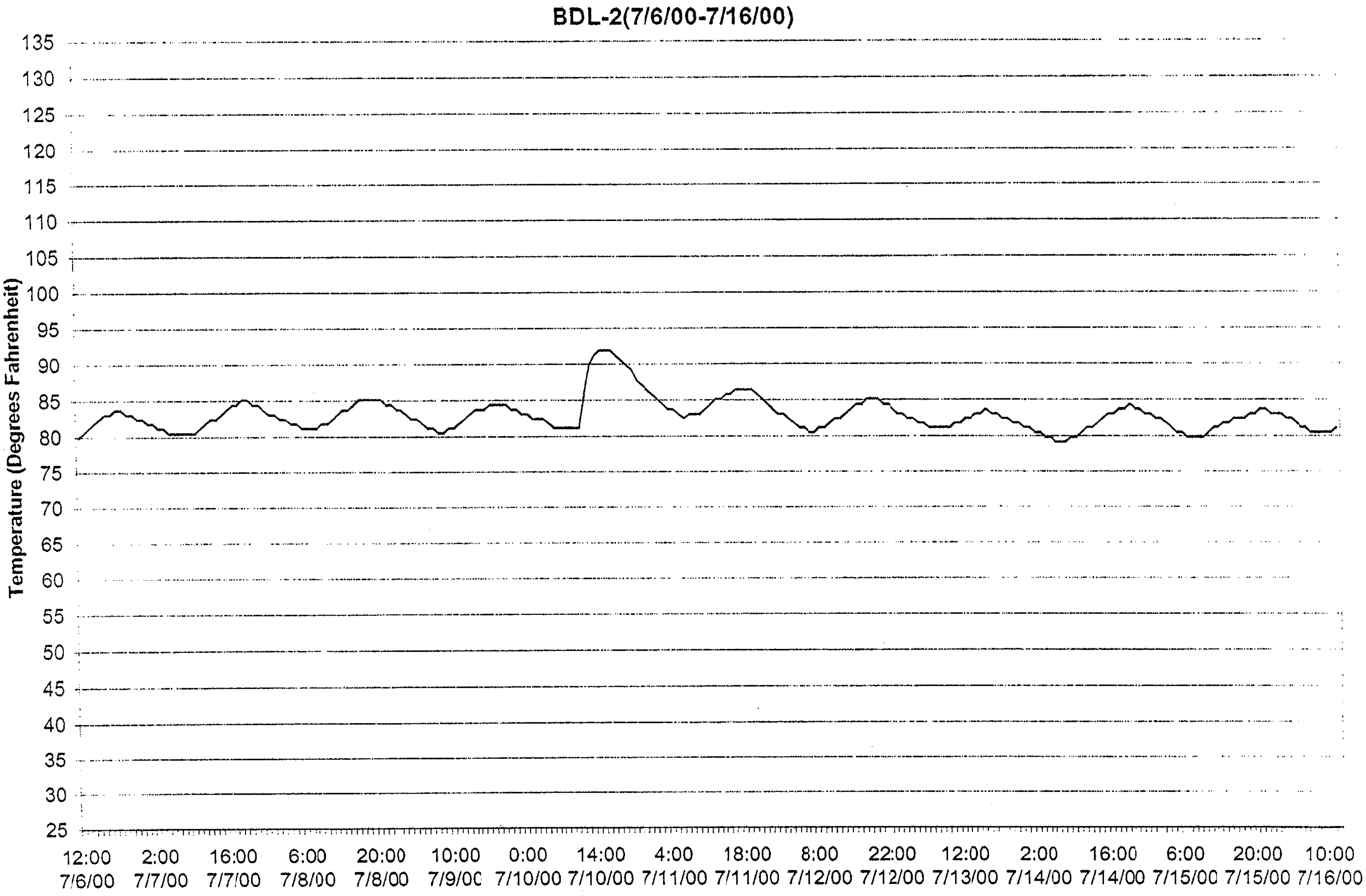


Figure F-9. Water temperature at BDL-2. Note short duration response to discharge event on July 10, 2000.

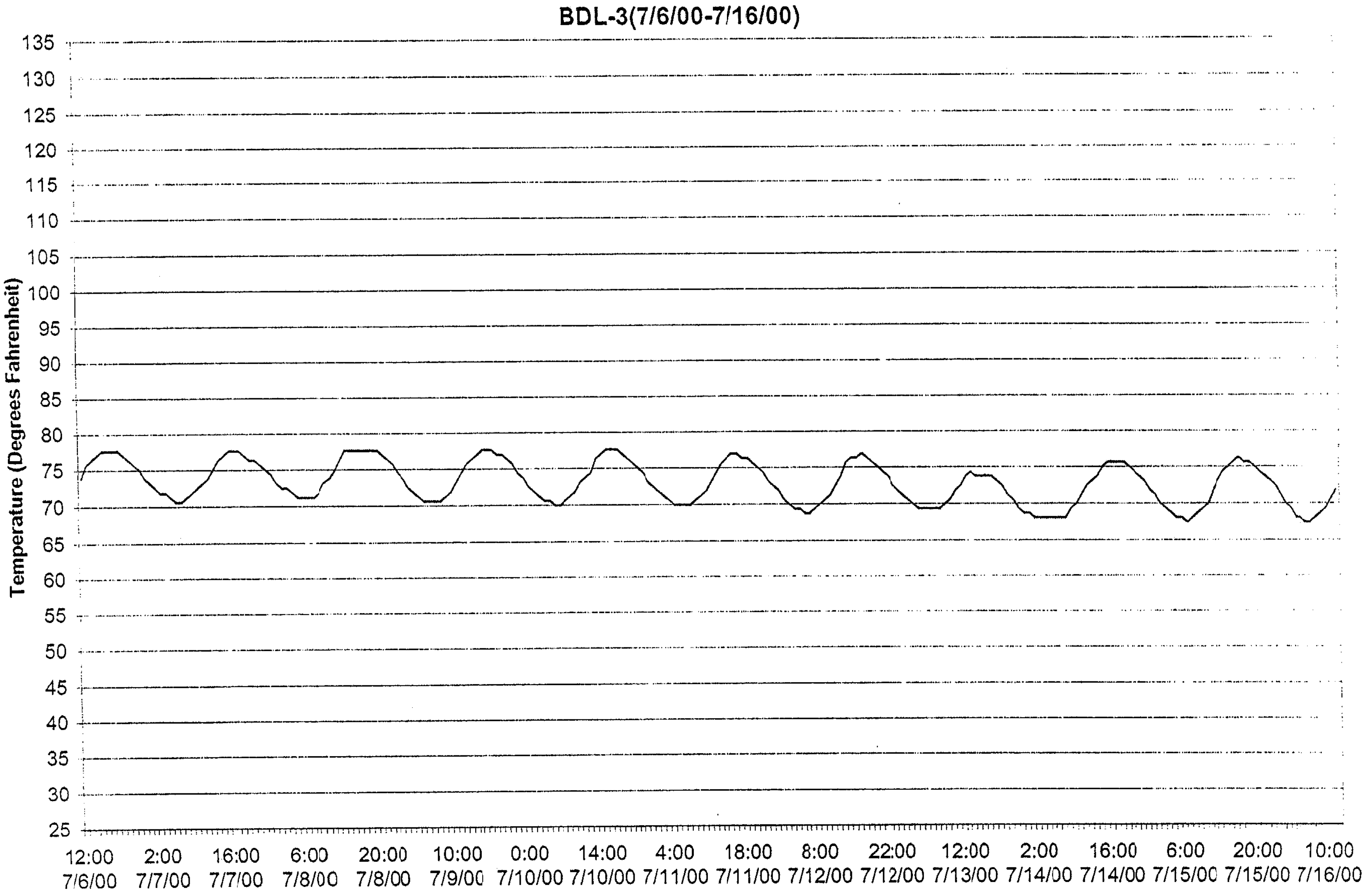


Figure F-10. Water temperature at BDL-3. Note lack of response to discharge event at GLCC-Central Outfall 001 on July 10, 2000.

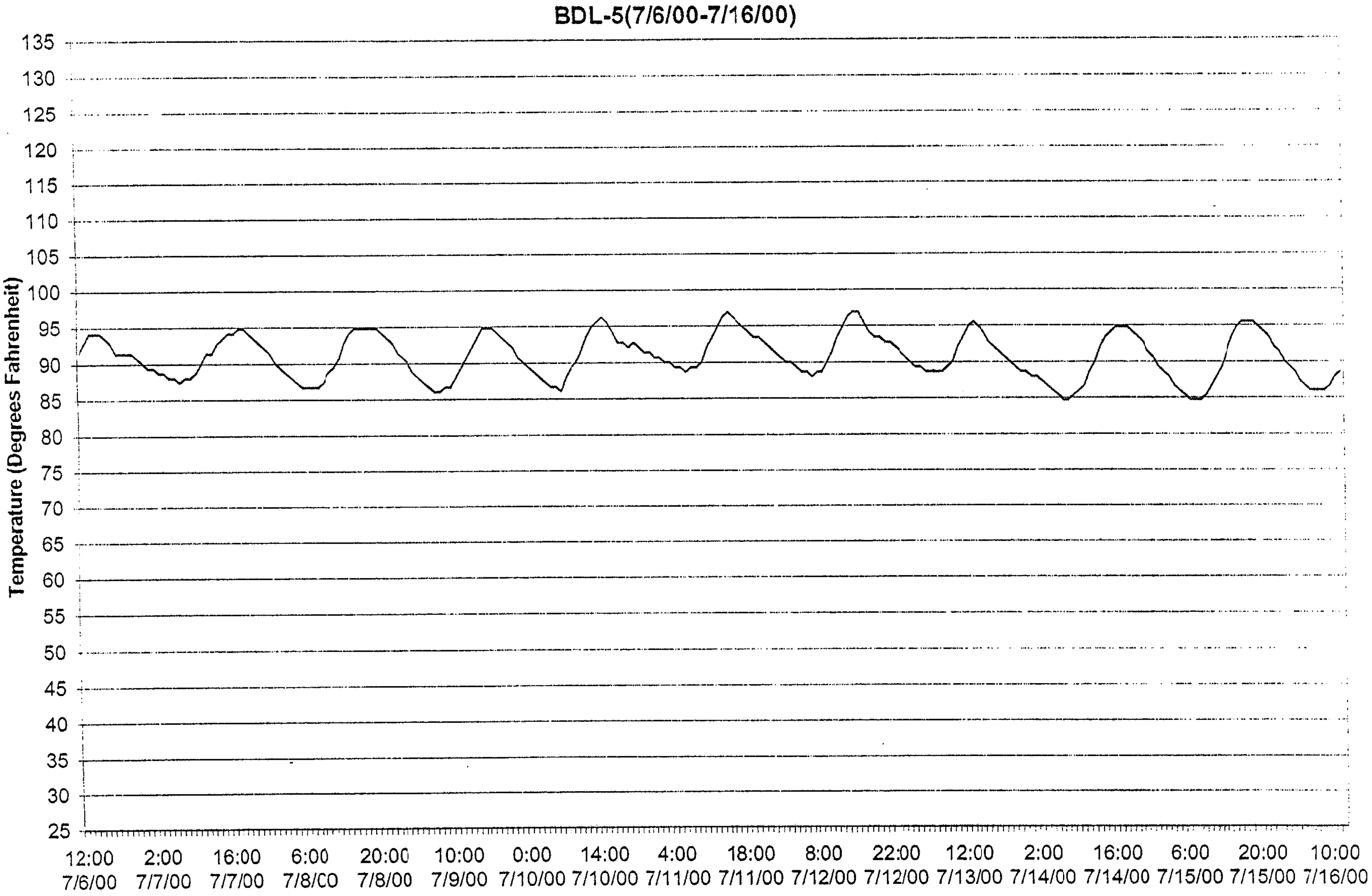


Figure F-11. Water temperature at BDL-5. Note lack of response to discharge event on July 10, 2000. Also, WQS temperature criterion exceeded majority of time.

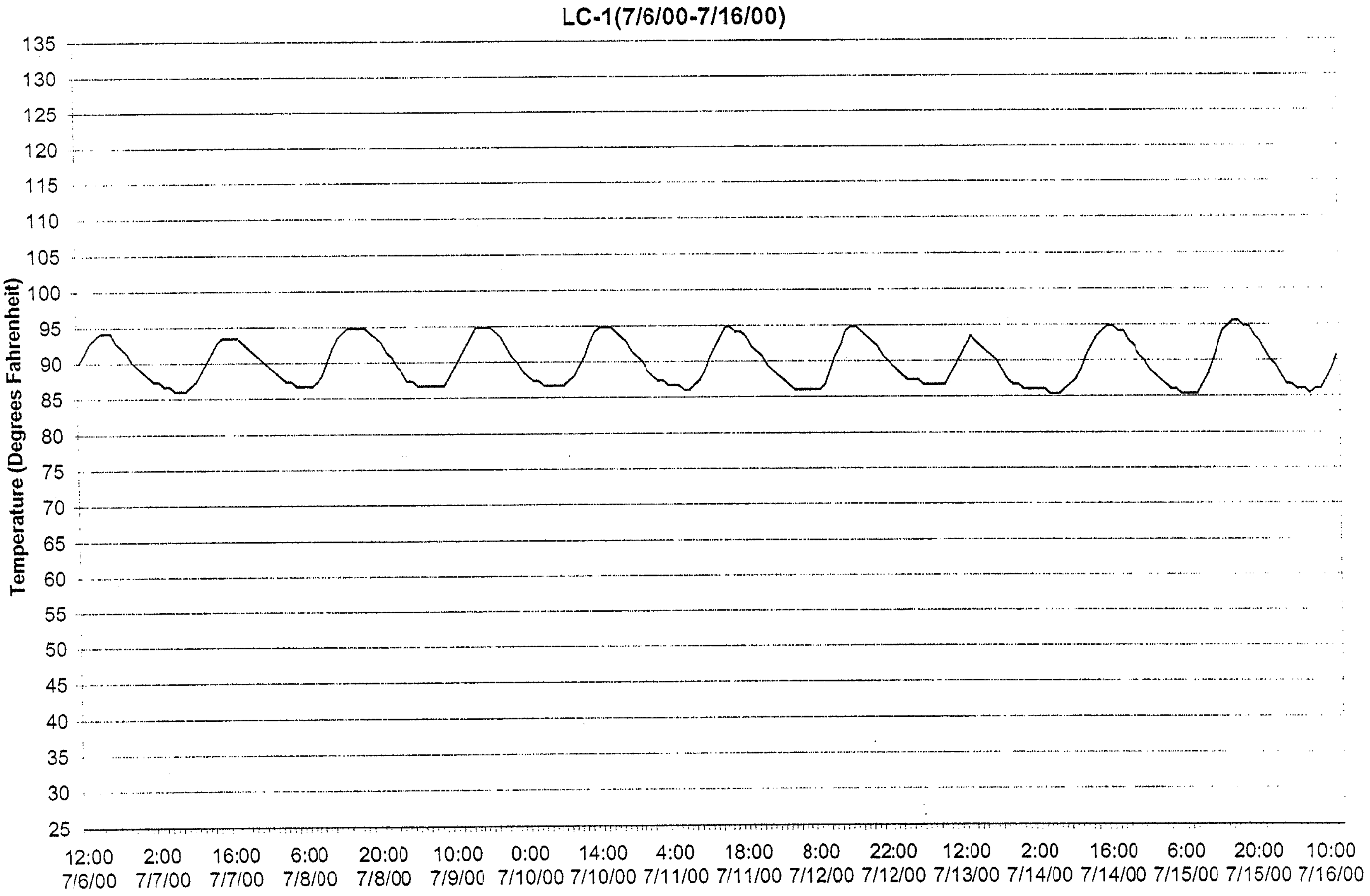


Figure F-12. Water temperature of Loutre Creek July 2000. Note comparisons to July 1999. (No change as a result of the transfer.)

Appendix G

Cooling Tower Cost Estimate

GBM^c & Associates
219 Brown Lane
Bryant, AR 72022

Sheet No. 1 of 2
Date 07/10/01
By Kale Hanner
Chkd ______ **Date** ________
Project No. 2072-99-070

SUBJECT: Cooling Tower Cost Estimation (100% of maximum conditions)

Graphical Method

Assumptions:
L/G ratio = 1.0
Counterflow induced-draft tower
Fan supplies 100% of tower performance
Drift Loss = 0.8%
Cycles = 3.5

Effluent Temp (°F) = 101
Target Water Temp (°F) = 86
Approx. Wet Bulb Temp (°F) = 80
Max Daily Flow (gal/day) = 1800000
Max Hourly Flow (gpm) = 1250

From Perry's Chemical Eng. Handbook; Fig. 12-13
KaV/L = 1.5

From Perry's Chemical Eng. Handbook; Fig. 12-14
H_2O Concentration (gal/min-ft^2) = 1.45

Tower Area (ft^2) = 862.1

From Perry's Chemical Eng. Handbook; Fig. 12-15
Unit Power (hp/ft^2 of tower area) = 0.0405
Total Fan Power (hp/fan) = 34.9
Total Fan Energy (kw/hr/fan) = 26.04

From Perry's Chemical Eng. Handbook; Fig. 12-15
Water Makeup
Evap. Loss, W_e (gpm) = 15.9
Drift Loss, W_d (gpm) = 0.1
Blowdown, W_b (gpm) = 6.4
Total Makeup, W_m (gpm) = 22.4
Total Makeup, W_m (gal/year) = 11780010

From Peters and Timmerhaus, Plant Design and Econ. For Chemical Engineers; Figure B 6

Purchased Cost (1/1/1990 dollars) $ 155,000.00 (Induced draft, cross-flow cooling tower)
Purchased Cost (1/1/2001 dollars) $ 197,233.15

Makeup Water Unit Cost ($/gal) = $ 0.00137
Annual Makeup Water Cost ($/year) = $ 16,138.61
Algae Treatment Unit Cost ($/gal) = $ 0.00080
Water Chemical Treatment ($/year) = $ 9,424.01

From Peters and Timmerhaus, Plant Design and Econ. For Chemical Engineers; Figure 6-8
Labor Unit (employee hr/day) = 14
Total Labor Hours per year = 5110
Operator Unit Cost ($/hr) = $ 28.00
Total Labor Cost = $ 143,080.00

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219 Brown Lane
Bryant, AR 72022

Sheet No. 2 of 2
Date 07/10/01
By Kale Hanner
Chkd ______ **Date** ______
Project No. 2072-99-070

SUBJECT: Cooling Tower Cost Estimation (100% of maximum conditions)

Electricity Unit Cost (per kwh) = $ 0.07
Annual Electricity Cost (3 fans) = $ 47,894.37

Total Cost Estimate (From Peters and Timmerhaus, Plant Design and Econ. For Chemical Engineers)

Capital Costs

		Cost
Cooling Tower w/ Delivery	$	197,233.15
Purchased equipment installation	$	100,588.90
Instrumentation and Controls (installed)	$	35,501.97
Piping (installed)	$	138,063.20
Electrical (installed)	$	29,584.97
Engineering and Supervision	$	74,948.60
Construction Expenses	$	80,865.59
Total Direct and Indirect Costs	$	656,786.38
Misc.	$	131,357.28
Total Capital Cost	$	788,143.65

Annual Costs

Makeup Water	$	16,138.61
Labor	$	143,080.00
Maintenance	$	29,555.39
Electricity	$	47,894.37
Chemical Treatment	$	9,424.01
Total Cost	**$**	**1,034,236.03**

Estimated Days of Operation		87
Estimated Cost per Day	**$**	**11,887.77**

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Sheet No. 1 **of** 2
Date 07/10/01
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Chkd ______ **Date** ______
Project No. 2072-99-070

SUBJECT: Cooling Tower Cost Estimation (95% of maximum conditions)

Graphical Method

Effluent Temp ($^{\circ}$F) = 101
95% of Effluent Temp (oF) = 95.95
Target Water Temp ($^{\circ}$F) = 86
Approx. Wet Bulb Temp ($^{\circ}$F) = 80
95% Max Daily Flow (gal/day) = 1710000
95% Max Hourly Flow (gpm) = 1188

Assumptions:
L/G ratio = 1.0
Counterflow induced-draft tower
Fan supplies 100% of tower performance
Drift Loss = 0.8%
Cycles = 3.5

From Perry's Chemical Eng. Handbook; Fig. 12-13
KaV/L = 1.4

From Perry's Chemical Eng. Handbook; Fig. 12-14
H_2O Concentration (gal/min-ft^2) = 1.35

Tower Area (ft^2) = 879.6

From Perry's Chemical Eng. Handbook; Fig. 12-15
Unit Power (hp/ft^2 of tower area) = 0.0405
Total Fan Power (hp/fan) = 35.6
Total Fan Energy (kw/hr/fan) = 26.57

From Perry's Chemical Eng. Handbook; Fig. 12-15
Water Makeup
Evap. Loss, W_e (gpm) = 10.0
Drift Loss, W_d (gpm) = 0.10
Blowdown, W_b (gpm) = 4.0
Total Makeup, W_m (gpm) = 14.2
Total Makeup, W_m (gal/year) = 7440180

From Peters and Timmerhaus, Plant Design and Econ. For Chemical Engineers; Figure B-6

Purchased Cost (1/1/1990 dollars) $ 140,000.00 (Induced draft, cross-flow cooling tower)
Purchased Cost (1/1/2001 dollars) $ 178,146.07

Makeup Water Unit Cost ($/gal) = $ 0.00137
Annual Makeup Water Cost ($/year) = $ 10,193.05
Algae Treatment Unit Cost ($/gal) = $ 0.00080
Water Chemical Treatment ($/year) = $ 5,952.14

From Peters and Timmerhaus, Plant Design and Econ. For Chemical Engineers; Figure 6-8
Labor Unit (employee hr/day) = 14
Total Labor Hours per year = 5110

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Sheet No. 2 of 2
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Project No. 2072-99-070

SUBJECT: Cooling Tower Cost Estimation (95% of maximum conditions)

Operator Unit Cost (\$/hr) = \$ 28.00
Total Labor Cost = \$ 143,080.00

Electricity Unit Cost (per kwh) = \$ 0.07
Annual Electricity Cost (3 fans) = \$ 48,870.00

Total Cost Estimate (From Peters and Timmerhaus, Plant Design and Econ. For Chemical Engineers)

Capital Costs

		Cost
Cooling Tower w/ Delivery	$	178,146.07
Purchased equipment installation	$	90,854.49
Instrumentation and Controls (installed)	$	32,066.29
Piping (installed)	$	124,702.25
Electrical (installed)	$	26,721.91
Engineering and Supervision	$	67,695.51
Construction Expenses	$	73,039.89
Total Direct and Indirect Costs	$	593,226.40
Misc.	$	118,645.28
Total Capital Cost	$	711,871.69

Annual Costs

Makeup Water	$	10,193.05
Labor	$	143,080.00
Maintenance	$	26,695.19
Electricity	$	48,870.00
Chemical Treatment	$	5,952.14
Total Cost	**$**	**946,662.06**

Estimated Days of Operation		87
Estimated Cost per Day	**$**	**10,881.17**