ftn Associates Ltd.
water resources / environmental consultants

USE ATTAINABILITY ANALYSIS REPORT

DITCH NO. 27
DITCH NO. 6
Tyronza River

MISSISSIPPI COUNTY, ARKANSAS

October 12, 2005

FTN Associates, Ltd.
Water Resources/Environmental Consultants
3 Innwood Circle, Suite 220
Little Rock, AR 72211-2492
(501) 225-7779 Fax (501) 225-6738

Fayetteville, AR
(479) 571-3334

ftn-assoc.com www.ftn-assoc.com

Baton Rouge, LA
(225) 766-0586

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MISSISSIPPI COUNTY, ARKANSAS

Prepared for

Associated Electric Cooperative, Inc.
Springfield, MO

Prepared by

FTN Associates, Ltd.
3 Innwood Circle; Suite 220
Little Rock, AR 72211

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1.0 SUMMARY AND CONCLUSIONS

1.1 Summary

A use attainability analysis (UAA) was completed to determine existing and attainable uses for Ditch No. 27 (D27) and Ditch No. 6 (D6) south of Dell, Arkansas (AR) in north-central Mississippi County, AR (Figures 1.1a and 1.1b). D27 flows to D6, which empties into the Tyronza River. The UAA also evaluated modifying Arkansas Water Quality Standards (ARWQS) for temperature, total dissolved solids (TDS) and sulfate in these ditches as well as the sulfate ARWQS in the Tyronza River. Significant historical hydraulic modifications have occurred in these systems (i.e. channelization). The two drainage ditches and the upper portion of the Tyronza River are man-made channels that are part of a vast network of drainage ditches constructed in the early 1900s in order to drain the delta area for agricultural purposes. The Arkansas Department of Environmental Quality (ADEQ) classifies these water bodies as Delta Ecoregion Channel Altered Streams. The ditches and the upper portion of the Tyronza River (i.e. Ditch No. 31 – see Figure 1.1a) are regularly maintained by Subdistrict 3 of Grassy Lake and Tyronza Drainage District No. 9 with headquarters in Osceola, AR.

In mid 2005, Associated Electric Cooperative, Inc. (AECI) headquartered in Springfield, Missouri (MO), purchased a partially completed Steam Electric Power Plant in Dell, AR. The original owner of the plant, TECO, contemplated discharging effluent from the plant to a drainage ditch that originates at the south property boundary of the plant (D27). TECO ultimately committed to construct a 7 mile pipeline to route the Dell Power Plant effluent to a larger ditch (D3) with sufficient upstream flow to allow TECO to meet ARWQS (see Figure 1.1a). The pipeline was never constructed. AECI wished to further investigate the possibility of discharging Dell Plant effluent to D27 as a more environmentally acceptable and less costly alternative to constructing the pipeline. FTN Associates (FTN) of Little Rock, AR was contracted to conduct this investigation.

UAA activities followed the Final UAA Work Plan (FTN April 2005, Appendix A) that was reviewed by the ADEQ and the United States Environmental Protection Agency (USEPA) – Region 6, prior to beginning the fieldwork. The UAA included field studies, toxicity testing,

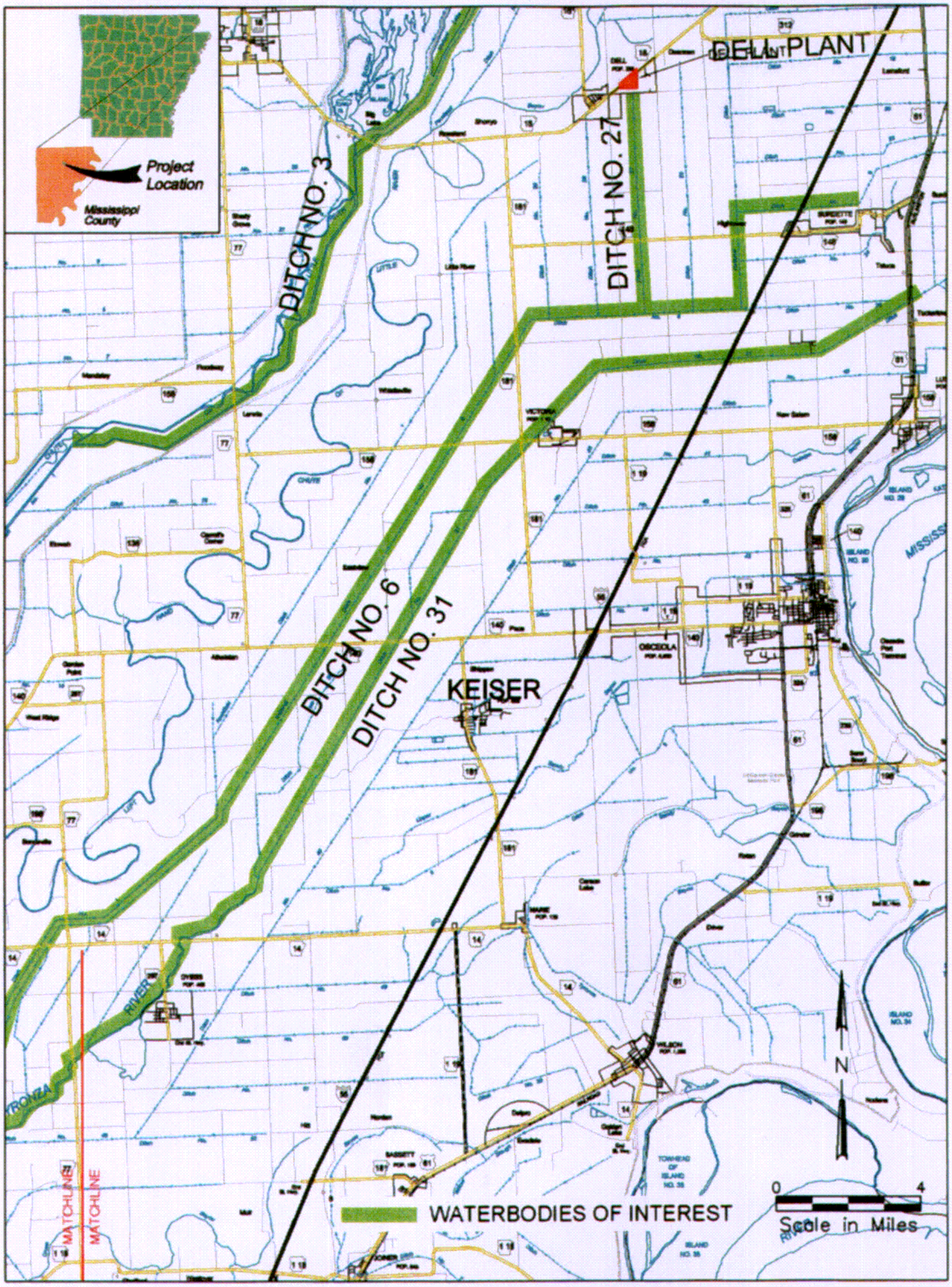

Figure 1.1a. Project location map.

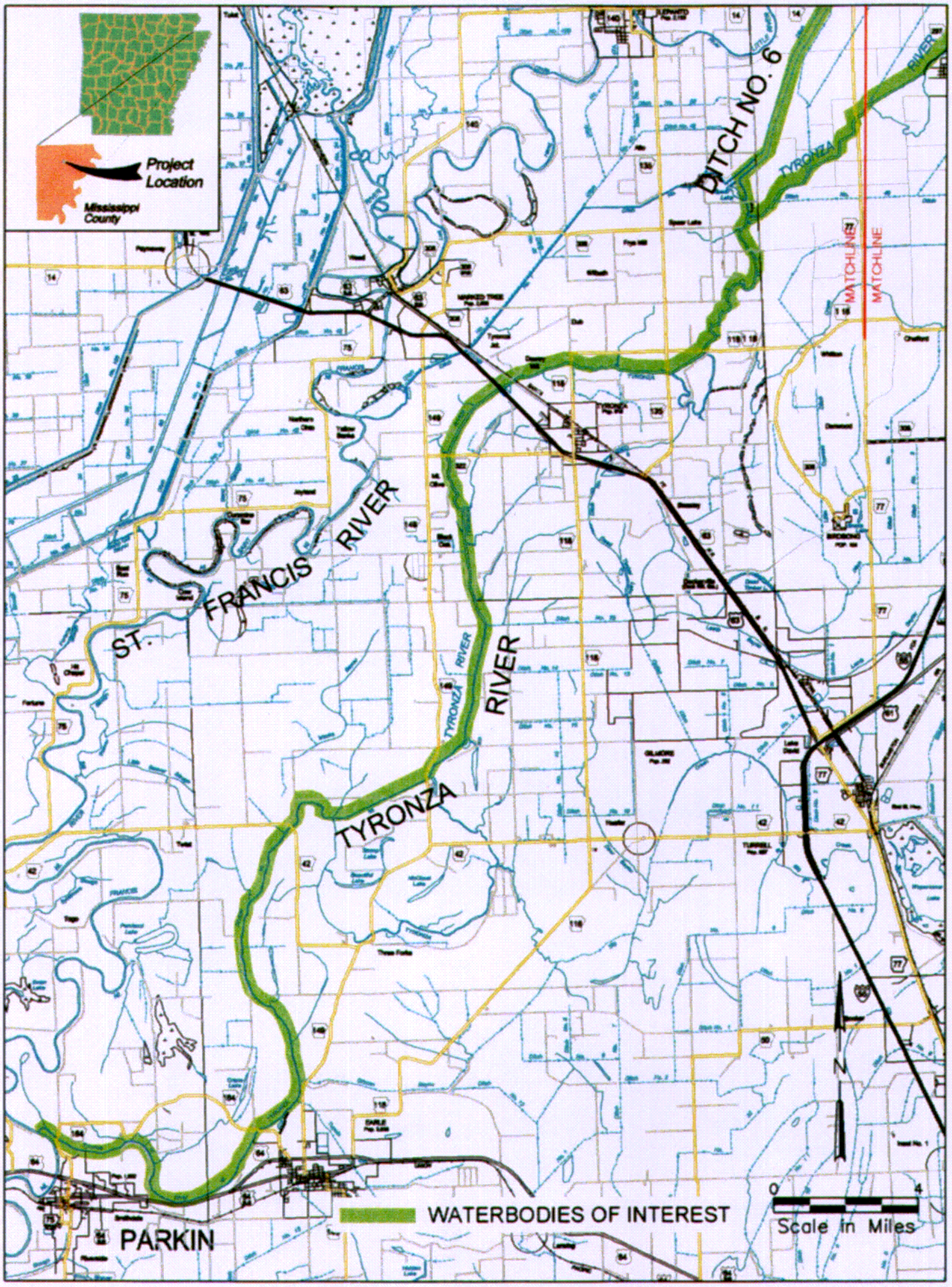

Figure 1.1b. Project location map.

mass budget modeling, engineering analysis of alternatives for discharge/treatment, and an analysis of designated uses and water quality criteria associated with these ditches.

The field studies evaluated physical, chemical, and biological characteristics of the ditches and occurred during Spring flow/temperature conditions (May 2005) and Summer flow/temperature conditions (July 2005). The biological assessment included toxicity testing and fish and benthic macroinvertebrate sampling during each field study. Water quality data (*in situ* measurements and chemical laboratory analyses) were collected concurrently with the biological data. A mass budget model was developed and used to evaluate downstream dissolved minerals concentrations under various flow and discharge scenarios. The engineering analysis of alternatives evaluated cost and feasibility of options to manage the discharge and meet ARWQS. The use analysis integrated the results from the field, the literature and modeling studies to develop recommendations for modifications to the ARWQS for the receiving streams.

The recommended modified ARWQS, presented below, were developed and evaluated according to requirements in the Arkansas Pollution Control & Ecology Commission (APCEC) Regulation No. 2 (Section 2.306); the Administrative Guidance Document (AGD) and the State of Arkansas Continuing Planning Process (CPP).

Per the AGD, letters have been sent to the Arkansas Natural Resources Conservation Commission (ANRCC) and Arkansas Department of Health (ADH) requesting (1) the ANRCC to verify if the proposed discharge conflicts with the State Water Plan and (2) the ADH to verify the D27 and D6 (from D27 to its mouth) are not domestic water supplies. Preliminary discussions with ANRCC and ADH staff and a review of these agencies' databases indicate there should be no issues with these certifications. The official letter responses from these agencies will be forwarded to the APCEC, ADEQ, and EPA Region 6 when they are received.

1.2 Conclusions

1. Physical Habitat/Flows
   - D27, D6 and portions of the Tyronza River are heavily impacted by channelization and routine maintenance activities.

- Relatively uniform biological habitat exists across D27 and D6 with respect to channel morphology, riparian vegetation and substrate characteristics. The habitat in these ditches consists of pools with soft substrate.
- Flows in D27 are seasonal due primarily to the fact that its watershed is <10 mi^2. Flows in D6 and the Tyronza River are perennial due to their larger watershed sizes (approximately 89 mi^2 and 650 mi^2 for D6 and the Tyronza River, respectively).

2. Biology

- Fisheries exist in the ditch systems sampled during this study. These fisheries are representative of conditions in man-made, regularly maintained agricultural drainage ditches. The fish communities are dominated by sunfish and minnows. The benthic communities in these ditch systems are dominated by freshwater shrimp, snails and crayfish.
- Based on data collected by others, the Tyronza River maintains a fishery that would be expected based on its size and geographical location.
- The Dell Power Plant discharge, if directed to D27, will not affect the existing fisheries in D27, D6 or the Tyronza River.

3. Chemistry/Toxicity

- The aquatic chemistry of the ditch systems studied exhibits no point source impacts or unusual/toxic conditions.
- The dissolved oxygen levels in these ditches are dominated by photosynthetic activity and, therefore, display wide daily fluctuations.
- The Arkansas Delta Ecoregion ARWQS for temperature of 89.6°F (32°C) that applies to D27 and D6 is exceeded due to ambient Summer heating conditions.
- Water samples collected from D27 and D6 in May and July 2005 were not toxic and the Dell Power Plant effluent is not toxic based on testing of simulated effluent, other available toxicity data and experience with similar streams.
- The discharge will not create a public health hazard or nuisance conditions and will not negatively affect groundwater.

1.3 Mass Budget Modeling

With the Dell Power Plant discharge (maximum flow and concentration) directed to D27:

1. TDS and sulfate concentrations in D27 will exceed ecoregion based ARWQS under wet or dry weather flow conditions. The highest predicted in-stream concentrations are TDS-1,200 mg/L and sulfate-478 mg/L.
2. TDS and sulfate concentrations in D6 will exceed ARWQS under dry weather flow conditions. The highest predicted in-stream concentrations would occur immediately below the D27/D6 confluence and are TDS-623 mg/L and sulfate-201 mg/L.
3. The sulfate concentration in the Tyronza River, immediately below the D6/Tyronza River confluence may exceed its ARWQS under extremely dry weather flow conditions. The highest predicted in-stream sulfate concentration, assuming extremely conservative conditions, is 59 mg/L.
4. Neither TDS nor sulfate ARWQS in the St. Francis River will be exceeded due to the Dell Power Plant discharge.

1.4 Alternative Evaluations

1. Reverse Osmosis (RO) represents the most effective treatment option available for removing TDS and sulfate from the Dell Power Plant discharge. RO will treat the discharge to meet ARWQS, however, RO is prohibitively expensive and produces a concentrated brine reject that is environmentally difficult to dispose.
2. Constructing a 7 mile pipeline to convey the discharge to D3 would meet ARWQS in D3 due to upstream dilution, however, construction costs of the pipeline are over $1,000,000. Also, D3 flows into the Right Hand Chute of the Little River which is an Ecologically Sensitive Waterbody.
3. Monitoring data verify that ambient water temperatures in the Delta exceed Ecoregion criteria and treating the effluent to cool the discharge will result in no environmental benefit.
4. Routing the Dell Power Plant discharge to D27 is economically and environmentally more acceptable than treating the discharge or constructing a 7 mile pipeline to route the effluent to Ditch No. 3 and the right hand chute of the Little River, a designated Ecologically Sensitive Waterbody.
5. The local benefits of the Dell Power Plant include salaries of $2 million to $2.5 million, technical training and advancement opportunities for future employees.

1.5 Use Analysis

The following Designated Uses are also Existing Uses (per 40 CFR 131.3):

1. D27-Seasonal Channel Altered Delta fishery
2. D27-Secondary Contact (assumed)
3. D6 and Tyronza River - Perennial Channel Altered Delta fisheries
4. D6 and Tyronza River- Agricultural Water Supply
5. D6 and Tyronza River - Primary and Secondary Contact (assumed)

For the purpose of this analysis, it is assumed that contact recreation may occur in these ditch systems although physical conditions are not conducive to it and evidence of such contact was not discovered during the UAA.

The following Designated Uses are not Existing Uses (Per 40 CFR 131.3).

1. D27 – Industrial, Agricultural or Domestic Water Supply (not attainable even with the discharge)
2. D6 and Tyronza River- Industrial, Domestic Water Supply

1.6 Recommendations

In accordance with APCEC Regulation No. 2 (Section 2.306), 40 CFR 131.10 and the ADEQ CPP, the following recommendations are made for modifications to ARWQS found in APCEC Regulation No. 2 for these ditches:

1. Revise the following ARWQS for D27:
   - Temperature – from 89.6°F (32°C) to 95°F (35°C)
   - TDS – from 411 mg/L to 1,200 mg/L
   - Sulfate – from 37 mg/L to 480 mg/L
2. Revise the following ARWQS for D6 from the D27/D6 confluence to its mouth:
   - Temperature - from 89.6°F (32°C) to 95°F (35°C)
   - TDS – from 411 mg/L to 630 mg/L
   - Sulfate – from 37 mg/L to 210 mg/L
3. Remove the Domestic Drinking Water Supply designated use from D27 and D6.

4. Revise the following ARWQS for the Tyronza River from the D6/Tyronza River confluence to its mouth:
   - Sulfate – from 30 mg/L to 60 mg/L

The following sections of the UAA Report demonstrate that these proposed modifications protect the existing and attainable uses of the receiving ditches and also allow the Dell Power Plant discharge to occur to D27.

2.0 INTRODUCTION

2.1 Overview

AECI, headquartered in Springfield, MO, purchased a partially completed Gas Fired Combined Cycle electric generating plant in Dell, Arkansas (Dell Power Plant) (Figure 1.1a). TECO started construction on the plant in 2002 but for various reasons, construction was halted when the plant was approximately 65% complete.

AECI plans to complete construction of the Dell Power Plant by early 2007. Groundwater from the Wilcox Aquifer will be used to supply raw water for the Dell Power Plant. Evaporation and concentration of cooling water due to operation of large cooling towers (CTs) will result in elevated concentrations of TDS and sulfate that will exceed downstream ARWQS. Temperature of the effluent will, at times, also exceed the 89.6°F ARWQS for the Delta Ecoregion. The original application for a National Pollutant Discharge Elimination System (NPDES) Permit submitted by TECO included discharging plant effluent to D27 which is part of a regularly maintained, vast drainage ditch network in northeast Arkansas and Southeast Missouri constructed in the early 1900s. D27 originates at the southern property boundary of the Dell Power Plant and flows 4.3 miles to D6 which, in turn, flows approximately 25 miles to the Tyronza River (Figures 1.1a and 1.1b). In order to meet ARWQS, the NPDES permit held by TECO for the Dell Power Plant (effective on July 1, 2002) included a pipeline to route effluent approximately 7 miles west to a large drainage ditch (D3) in order to take advantage of its perennial upstream flow.

The pipeline was never constructed and the environmental and economic benefits of this pipeline are questionable. D3 flows to the Right Hand Chute of the Little River that ADEQ classifies as an Ecologically Sensitive Waterbody at its confluence with the St. Francis River. Also, the land across which the pipeline would have to be constructed is heavily used for agricultural purposes. Land disturbing activities in a corridor necessary to construct the pipeline would significantly affect local agricultural interests.

AECI wished to further investigate the possibility of discharging Dell Plant effluent to D27 as a more environmentally acceptable and less costly alternative to constructing the pipeline. FTN Associates, Ltd. (FTN) was contracted to conduct the UAA.

2.2 Objectives

A UAA was conducted to:

- Define existing and attainable uses in D27 and D6,
- Determine if a direct discharge from the Dell Power Plant to D27 would negatively affect existing or attainable uses in the receiving ditches or other downstream water bodies (i.e. the Tyronza River or the St. Francis River),
- Develop modified water quality criteria for the receiving water bodies that protect existing and attainable uses <u>and</u> allow the discharge to occur, and,
- Remove non-attainable or inappropriate uses that were assigned to the ditches by default (e.g. domestic drinking water supply use).

2.3 Approach

For a UAA to justify modified designated uses and/or ARWQS, it is necessary to determine whether existing and attainable uses of these waterbodies can be protected with less stringent site specific minerals and temperature criteria. Demonstrating that discharge of the plant effluent protects existing and attainable uses in D27, D6 and the Tyronza River requires demonstrating that predicted effluent temperatures and effluent concentrations of sulfate, TDS, and flows do not affect aquatic life and will not impair existing or attainable uses.

The following were components of the approach to address these issues:

1. Waterbody surveys to document (spring and summer conditions) existing water quality, hydrology, biological and physical habitat conditions in D27, D6 and to gather information on other area ditches,
2. Toxicity testing of synthetic effluent samples prepared to mimic the expected ionic composition (based on chemical model simulation) of the plant effluent,
3. An evaluation of the technical, environmental, and economic feasibility of treatment to reduce TDS, sulfate, and discharge temperature, and

4. An evaluation of the technical, environmental, and economic feasibility of discharge to D3 via a pipeline for comparison purposes.

Development of the UAA approach was in accordance with:

1. The USEPA Water Quality Standards Handbook (USEPA 1994) Second Edition,
2. The USEPA Technical Support Document for Waterbody Surveys and Assessments for Conducting UAAs (USEPA 1983),
3. The Water Environment Research Foundation's (WERF) reports "Suggested Framework for Conducting UAAs and Interpreting Results" (WERF 1997a) and "A Comprehensive UAA Technical Reference" (WERF 1997b),
4. The State of Arkansas Continuing Planning Process document (ADEQ 2000),
5. APCEC Regulation No. 2 (2004, including Section Reg. 2.306),
6. 40 CFR 131.10(a) through (k).

The proposal for changes to APCEC Regulation No. 2 is in accordance with Regulation No. 2, Section 2.306, "Procedures for Removal of Any Designated Use Except Fishable/Swimmable, and Modifications of water quality criteria not Related to Fishable/Swimmable Uses" (APCEC 2004). The proposal for changes to APCEC Regulation No. 2 is also in accordance with the applicable sections of 40 CFR 131.10 including:

1. 40 CFR 131.10(b): In designating uses of a water body and the appropriate criteria for those uses, the State shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters.
2. 40 CFR 131.10(e): Prior to adding or removing any use, or establishing sub-categories of a use, the State shall provide notice and an opportunity for a public hearing under Sec. 131.20(b) of this regulation.
3. 40 CFR 131.10(g): States may remove a designated use which is not an existing use, as defined in Sec. 131.3, or establish sub-categories of a use if the State can demonstrate that attaining the designated use is not feasible because:
    - Naturally occurring pollutant concentrations prevent the attainment of the use;

- *Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met;*
- *Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;*
- *Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use;*
- *Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or*
- Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

(Note: Italics indicate applicable 40CFR131.10(g) criteria)

The UAA process included development of a UAA Study Plan prior to the field studies in order to document for ADEQ and USEPA review, the various strategies and planned tasks. The revised plan (April 28, 2005) incorporated comments from ADEQ and EPA and was provided to the Agencies. As part of this process, both ADEQ and EPA indicated conceptual agreement with the UAA approach that was proposed. The final UAA Study Plan is included as Appendix A.

3.0 BACKGROUND

TECO began construction of a gas fired combined-cycle plant (the Dell Power Plant) in 2002 in Dell, AR (Figure 1.1a). In a combined-cycle plant, there is a primary turbine driven by natural gas combustion. Exhaust from the combustion turbine heats a boiler and steam generated from this boiler also is routed to assist with power generation. The Plant has a maximum output rating of approximately 600 mw.

TECO obtained an NDPES Permit (AR0049425) on July 1, 2002, from the ADEQ for discharge of CT blowdown, filter backwash, and low volume waste (boiler blowdown, wastewater from water treatment and effluent from floor and yard drains).

The NPDES permit was necessary in order for TECO to obtain financing for the plant. During the permitting process, the ADEQ Permit engineer indicated ARWQS for dissolved minerals (sulfate, chloride, TDS), metals (copper, zinc) and temperature could be exceeded by this discharge if it was directed to D27 and suggested TECO consider piping the discharge to a stream/ditch with perennial upstream flow in order to meet ARWQS. To speed the permit approval, TECO agreed to construct an approximate 7 mile long pipeline to route Dell Power Plant effluent to D3 south of Big Lake Wildlife Management Area (west of Dell). D3 eventually flows into the Right Hand Chute of the Little River. The Right-Hand Chute of the Little River at the St. Francis River confluence is designated in APCEC Regulation No. 2 as an Ecologically Sensitive waterbody.

TECO did not complete construction of the Dell Power Plant (or the pipeline). The plant remained at approximately 65% complete until in late 2004/early 2005, when AECI expressed and interest in purchasing the plant.

3.1 Facility Process Description and Economic Impact on Local Area

The Dell Power Station design includes two gas turbine generators combined with heat recovery boilers, which power a steam turbine generator. A wet cooling tower is used to condense exhausted steam. AECI anticipates operating the plant intermittently, during periods when the demand for electrical power is the highest and depending upon economics of the required natural gas supply.

Makeup water for the Dell Power Plant will be provided by three on-site production wells. The wells were completed in the Wilcox formation, at a depth of approximately 1000 feet below ground surface. Expected groundwater usage will vary according to the plant operating mode. At maximum (design) operating conditions, groundwater makeup flow for the plant will be about 3500 gpm. About 15% of this flow is for low-volume uses, such as fire water, steam supply, and auxiliary cooling. Approximately 85% (3000 gpm) of this flow will be used as makeup water for the cooling tower to compensate for the high evaporation losses which occur in the cooling tower.

Makeup water will be aerated and filtered to remove solids and oxidized metals. Filtration will occur using granular filters, which will require occasional back-washing. The design back-wash flow will be approximately 150 gpm. This flow will be combined with other wastewater streams prior to discharge at the plant NPDES permitted outfall.

During peak construction approximately 100 people will be employed and working on the site which affects the local economies. Once the plant is operational, approximately 25 full time employees will be utilized to run the plant. This results in an annual payroll of $2 million to $2.5 million. AECI provides in-house technical training and an educational assistance program to employees wanting to improve their skills and to advance in their jobs. This program has proven effective in positioning former entry level employees into high level vocational and supervisory positions. The completion and operation of this power plant will provide important economic and social development in the area of Dell, AR.

3.2 Wastewater Sources and Treatment

Effluent at the plant will originate from cooling tower blowdown, boiler blowdown, low-volume wastewater, and oil/water separator discharges. Potable water and sanitary sewage services will be obtained from public systems. No sanitary wastewater will be treated or discharged at the plant.

The discharge will not create a public health hazard or nuisance conditions based on the predicted effluent quality and flow rates. The discharge will not adversely affect groundwater in the vicinity of D27, D6 or the Tyronza River. Ditch systems such as D27 and D6 may communicate with the shallow alluvial aquifer (Mississippi Alluvial Sand). Drinking water is produced from much deeper aquifer that is present (e. g. Memphis Sand). Local agricultural interests use water from the alluvial aquifer and this UAA demonstrates that the effluent water quality will not negatively impact agricultural usage even if used undiluted.

Based on experience with similar gas-fired combined-cycle power plants, AECI plans to operate the facility periodically when the seasonal and daily demand for the electricity is highest. Wastewater discharges, especially from cooling tower blowdown, will likely be limited to these seasonal and daily peak periods of operation.

3.2.1 Cooling tower blowdown

The principle demand for water at a power plant is to condense low-pressure steam and remove waste heat from the power generation process. At the Dell Plant, cooling water will be circulated through a steam condenser and then cooled using an induced-draft wet cooling tower. AECI plans to drain (blowdown) approximately 700 gpm of water from the tower and operate the system at about 8 cycles of concentration.

3.2.2 Low Volume Wastewater

Low volume wastewater will be composed of granular filter backwash, boiler blowdown, chiller blowdown, and reverse osmosis (RO) reject. Granular filter backwash is generated during the aeration/filtration of well water. Boiler and chiller blowdown streams are releases to maintain water quality control in these high quality water systems. RO reject (approximately 23 gpm) is generated when the processing of well water is necessary for use in the boiler and chillers. The granular filter backwash design flow is 160 gpm. The remaining low volume waste streams will be combined and used as a makeup flow of approximately 275 gpm to the cooling tower system.

3.2.3 Oil Water Separator

This waste stream consists of water collected from floor drains, building sumps, and equipment drains with the turbine areas. The wastewater is routed to the oil water separator where oil is removed prior to discharge. The design flow for the separator is about 30 gpm.

3.3 NPDES Permit Limits

Outfall 001 will be made up of cooling tower blowdown, filter backwash and low volume waste. Permit limits for the existing NPDES permit (AR0049425) are provided in Table 3.1

Table 3.1 Current NPDES permit discharge limits for Outfall 001.

	Discharge Limitations				Monitoring Requirements	
Effluent Characteristics	Mass (lbs/day)		Other Units (specify)		Measurement Frequency	Sample Type
Flow (MGD)	N/A	N/A	N/A	N/A	Daily	Instantaneous
Chemical Oxygen Demand	Report	Report	Report, mg/L	Report, mg/L	3/month	Grab
Temperature	N/A	N/A	N/A	89.6°F	3/month	Grab
Oil and Grease (O&G)	83.4	125	10 mg/L	15 mg/L	3/month	Grab
TDS	Report	Report	Report, mg/L	Report, mg/L	3/month	Grab
Chronic Biomonitoring	N/A	N/A	N/A	N/A	Once/quarter	24-hr composite
pH	N/A	N/A	6 s.u.	9 s.u.	3/month	Grab

3.4 Discharge Characteristics

The ionic strength of the plant effluent was predicted based on sampling results from groundwater wells that will supply makeup water for the plant's blowdown and on anticipated plant operation (e.g. operating the blowdown at eight cycles of concentration and the use of sulfuric acid for pH control). The results of chemical analysis of the groundwater well and the predicted ion concentrations in the plant effluent (based on eight cycles of concentration) are presented in Table 3.2. Discharge flow during normal operations will be approximately 720 gpm. Cooling towers such as those in use at the Dell plant can cool process water to approximately 9°F to 15°F above the ambient wet bulb temperature (Cooling Tower Specifications and Equipment Data Sheet, Psychrometric Systems, Inc. 651 Corporate Circle, Golden CO 80401, 877-243-3945). The highest recorded wet bulb temperature from the Memphis monitoring station

Table 3.2 Predicted concentration of selected ions in cooling tower blow down based on measured makeup water (Well C) concentrations.*

Constituent (mg/l except as noted)	Measured Well C	Predicted Blowdown
Flow, gpm	2000.0	131.7
pH, standard units	7.7	8.6
Specific Conductance, 25°C, µmhos	150	1459
Alkalinity, "P", as $CaCO_3$	0.0	2.6
Alkalinity, "M", as $CaCO_3$	96.0	280.7
Sulfur, Total as SO_4	8.4	477.7
Chloride as Cl	1.4	11.2
Phosphate, Total as PO_4	0.5	14.7
Nitrate, as NO_3	<0.05	120
Silica, Total as SiO_2	13.3	106.4
Calcium, Total as $CaCO_3$	10.3	82.4
Magnesium, Total as $CaCO_3$	5.4	43.2
Sodium as Na	38.0	304.0
Aluminum, Total as Al	0.640	5.120
Barium as Ba	0.061	0.488
Boron as B	0.110	0.880
Cadmium as Cd	0.000	0.001
Chromium, as CrO_4	0.001	0.010
Copper, Total as Cu	0.001	0.011
Fluoride, as F	0.150	1.200
Iron, Total as Fe	1.600	12.800
Manganese, Total as Mn	0.071	0.568
Nickel as Ni	0.001	0.008
Potassium as K	2.700	21.600
Strontium as Sr	0.180	1.440
Zinc, Total as Zn	0.007	0.056
Total Suspended Solids	5.800	46.400
Polymeric Dispersants	0.000	5.100
Non-Oxidizing Biocides (shot dosage)	0.000	30.000
Fee Halogen Residual	0.000	0.200
Total Dissolved Solids	120	1200

*Calculated by GE/Betz (2005)

*No Pretreatment Included

(NCDC, 2005) for the period of 1984 – 2004 was 80°F. Therefore, maximum effluent temperatures are not expected to exceed approximately 89°F (32°C) to 95°F (35°C).

Naturally occurring metals in the groundwater will be removed by aeration and filtration. AECI operates other steam electric power plants in Missouri and Oklahoma and specifies that there will be no chemicals used in the CTs that contain a priority pollutant (emphasis on chromium or zinc). This policy will be applicable for Dell also.

3.5 Watershed and Waterway Description

3.5.1 Ditch No. 27

D27 (Figure 1.1a) is a man-made drainage ditch that was constructed in early 1900s as part of a vast ditch drainage system primarily in Northeast Arkansas, particularly in Mississippi County. The ditch lies within Delta Ecoregion according to APCEC Regulation No. 2 (Plate D-2) although D27 is not shown on the plate.

D27 is approximately 4.3 miles long and its watershed size is 3.2 mi^2. No seasonal flow data are available for D27. However, based on its watershed size, (<10 mi^2) and field observations, it is assumed that D27 flows seasonally and is dry during much of the year. Some flow observed near its mouth during the summer (July 2005) was due to irrigation activities near the D27/D6 confluence. These irrigation inflows are from groundwater. The lowest flow period for D27 probably begins in the late summer or early fall when inflows from agricultural irrigation activities cease.

3.5.2 Ditch No. 6

D6 (Figures 1.1a and 1.1b) is a man-made ditch that was constructed in Mississippi County Arkansas in the early 1900s. The ditch lies within Delta Ecoregion (Plate D-2 of APCEC Regulation No. 2).

D6 originates east of Blytheville, AR and runs for approximately 23 miles until it reaches D27. It flows for another approximately 25 miles before it joins with the Tyronza River. The watershed size for D6 above D27 is 55 mi^2 and a total of 89 mi^2 at its mouth. No seasonal flow data are available for D6. However, based on its watershed size, (>10 mi^2) it is assumed that the ditch maintains perennial flow. The low flow period for D6 probably begins in the late summer or early fall when inflows from agricultural irrigation activities cease.

3.5.3 Tyronza River

The upper reach of the Tyronza River is a man-made ditch (Ditch No. 31) that was constructed in Mississippi County Arkansas in the early 1900s. Ditch No. 31 (D31) originates south of Blytheville, AR as a fork off of D6. D31 runs approximately 27 miles to the south and west from Blytheville (roughly paralleling D6) until it joins the original channel of the Tyronza River (Figures 1.1a and 1.1b). D6 flows into the Tyronza River approximately 10 miles downstream of where D31 becomes the Tyronza River. The river runs approximately 36 miles below the D6 confluence before it flows into the St. Francis River north of Parkin, AR. The Tyronza River and D31 lie within Delta Ecoregion (Plates D-2 and D-4 of APCEC Regulation No. 2).

The Tyronza River watershed is 650 mi^2 and it is assumed that the stream maintains perennial flow based on this large watershed size. The low flow period for the Tyronza River probably begins in the late summer or early fall when inflows from agricultural irrigation activities cease.

3.6 ARWQS and Designated Uses (APCEC Regulation No. 2)

3.6.1 Ditch No. 27

Designated Uses (assumed by default):

1. Channel-Altered Delta Ecoregion Stream
2. Secondary Contact Recreation
3. Domestic, Industrial, and Agricultural Supply (questionable)
4. Seasonal Channel-Altered Delta Fishery.

Applicable ARWQS:

1. Temperature: 89.6°F (32°C)
2. Minerals
   - Chloride 48 mg/L

- Sulfate 37 mg/L
- TDS 411 mg/L

3.6.2 Ditch No. 6

Designated Uses (assumed by default):

1. Channel-Altered Delta Ecoregion Stream
2. Primary Contact Recreation
3. Secondary Contact Recreation
4. Domestic, Industrial, and Agricultural Supply
5. Perennial Channel-Altered Delta Fishery

Applicable ARWQS:

1. Temperature: 89.6°F (32°C)
2. Minerals
    - Chloride 48 mg/L
    - Sulfate 37 mg/L
    - TDS 411 mg/L

3.6.3 Tyronza River (and D31)

Designated Uses (assumed by default):

1. Channel-Altered Delta Ecoregion Stream
2. Primary Contact Recreation
3. Secondary Contact Recreation
4. Domestic, Industrial, and Agricultural Supply
5. Perennial Channel-Altered Delta Fishery

Applicable ARWQS:

1. Minerals
    - Sulfate 30 mg/L

3.6.4 Other Point and Non-point Sources

The man-made drainage ditches that are the focus of this UAA are in an intensely agricultural area of northeast Arkansas with the most common crops being cotton, rice, and soybeans. Non-point source runoff and irrigation returns from agricultural activities to these ditch systems are the predominant non-stormwater contributors to ditch flows and water quality. Irrigation return flows primarily are an issue between May and September of each year. The most recent version of the Arkansas 305(b) report (ADEQ 2002) lists one upstream NPDES discharger to D6 and no dischargers to D27. The Town of Burdette, AR (NPDES Permit No. AR0044237) discharges treated municipal wastewater to D6 approximately 3 miles upstream of the D6/D27 confluence. The Arkansas 305(b) report also lists a discharge point to D31, an NPDES General Permit (ARG160029) for the Mississippi County Sanitary Landfill. This is a Class I landfill that is located south of Blytheville near Luxora, AR. The City of Keiser discharges to Ditch 47 (D47) as authorized by NPDES Permit No. AR0034754. D47 flows west to Ditch 40, which, in turn, flows into the Tyronza River approximately 1 mile upstream of the D6/Tyronza River confluence. The Tyronza River is also listed on the current ADEQ 303(d) list for siltation.

4.0 FIELD SURVEYS

The field surveys included sampling during the spring high flow primary period (May 2 and 3, 2005) and the summer low flow critical period (July 26 through July 28, 2005). The purpose of the field surveys was to establish the range of chemical, physical, habitat and biological conditions present in D27, D6 and other ditch environments near the site.

Sampling locations (Figure 4.1) included those specified in the UAA Work Plan (FTN 2005) that was reviewed by ADEQ and the USEPA Region 6 in addition to other stations established during the study. These "primary" stations were chosen to characterize representative lower and upper reaches of D27 (D27-0 and D27-3) and reaches of D6 immediately upstream (Station D6-3) and downstream (Station D6-2) of the confluence with D27. The length of each reach sampled was approximately 40 stream widths per Barbour *et al.* (1999).

A reach in D28 (Figure 4.1) was selected to provide data on baseline physical, chemical, biological and habitat conditions in a ditch system with watershed size similar to D27. For the July 26 through 28 sampling, an additional reach in Ditch No. 41 (D41) (Figure 4.1) was selected to provide additional information on the physical, chemical, biological and habitat conditions in man-made ditch systems in the area with watershed size similar to D27. Another sampling location "Rice Field Ditch" (Figure 4.1) was sampled to provide an estimate of chemistry associated with drainage from an agricultural field. Additional locations (Section 4.3.1) were selected in order to evaluate diurnal variations in DO as well as through-time changes in temperature, pH, or conductivity.

Detailed description of sampling locations and methods are provided in the following sections. Table 4.1 provides a summary of sampling locations and the type(s) of data collected from each. Photographs of sampling and monitoring locations are provided in Appendix A.

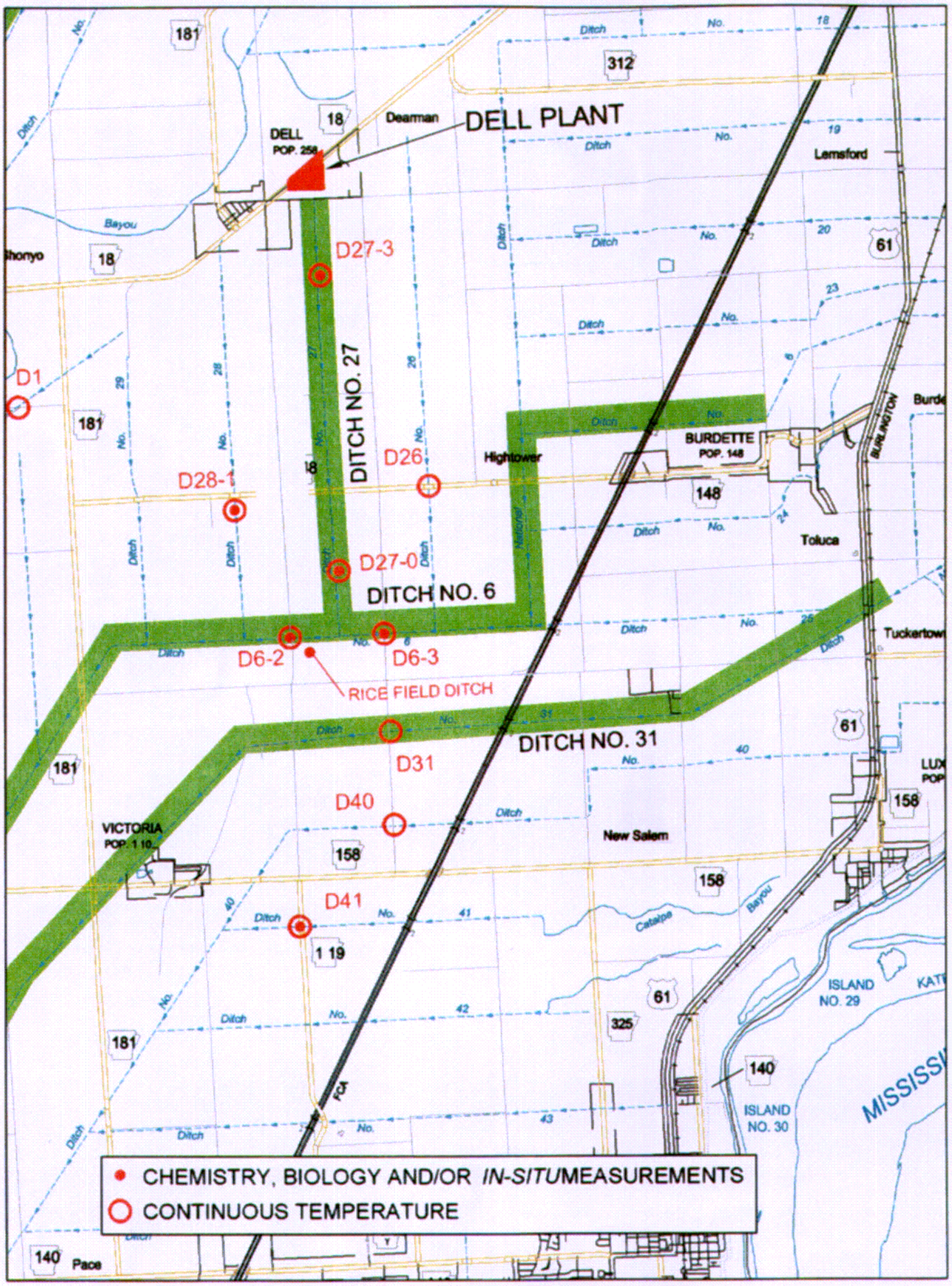

Figure 4.1. Sampling station locations.

Table 4.1. Sampling station and data collection summary.

Station	Chemistry *in situ*		Biology		pH, Temperature, DO (Diurnal)		Continuous Temperature	
	May	July	May	July	May	July	May	July
D27-0	X	X	X	X	X	X	-	-
D27-3	X	Dry	X	Dry	-	-	-	-
D6-2	X	X	X	X	X	X	-	-
D6-3	X	X	X	X	X	X	-	-
D28-1	X	X	X	X	-	-	-	X
D41	-	X	-	X	-	-	-	X
Rice Field Ditch	X	-	-	-	-	-	-	-
D40	-	-	-	-	-	-	-	X
D31	-	-	-	-	-	-	-	X
D26	-	-	-	-	-	-	-	X
D1	-	-	-	-	-	-	-	X

4.1 Chemical Measurements

4.1.1 Chemical Measurement Methods

Grab samples for analysis of selected chemical parameters were collected from near the upstream end of each sampling reach and analyzed for the parameters indicated in Table 4.2. An additional aliquot of sample was collected from D27 on May 3, 2005 to perform 48-hour acute static renewal toxicity tests using *Daphnia pulex* and *Pimephales promelas* per USEPA (1991). Grab samples were collected from the surface at each sampling location at mid current using a clean plastic bucket and placed in labeled sample bottles containing appropriate preservative and placed on ice immediately upon collection. Samples and chain of custody documents for chemical analyses and toxicity tests were delivered to American Interplex (AI) Laboratory (8600 Kanis Rd., Little Rock AR 72204) for analysis.

4.1.2 Chemical Measurement Results

In situ and analytical data collected on May 3, 2005 (Table 4.3) indicate chloride, sulfate and TDS concentrations below ecoregion criteria with the exception of the D27-3 sulfate concentration (39 mg/L). Concentrations of selected metals were all below detection limits.

Table 4.2 Analytical methods used for chemical analysis of water samples collected during the field survey.

Analyte	Method	Detection Limit (mg/L)
TDS	EPA 160.1	10
TSS	EPA 160.2	4
Alkalinity as CaCO3	EPA 310.1	1
Chromium, Hexavalent	SM 3500-Cr B	0.007
Beryllium	EPA 200.8	0.0003
Cadmium	EPA 200.8	0.004
Chromium, Total	EPA 200.8	0.007
Chromium, Trivalent	EPA 200.8	0.007
Copper	EPA 200.8	0.006
Hardness as CaCO3	EPA 200.8	1
Iron	EPA 200.8	0.02
Lead	EPA 200.8	0.001
Nickel	EPA 200.8	0.01
Selenium	EPA 200.8	0.002
Silver	EPA 200.8	0.007
Zinc	EPA 200.8	0.002
Mercury	EPA 245.2	0.0002
Chloride	EPA 300.0	0.2
Sulfate	EPA 300.0	0.2

In situ and analytical data collected on July 26, 2005 (Table 4.4) indicate chloride, sulfate and TDS concentrations below ecoregion criteria with the exception of the D27-0 sulfate concentration (45 mg/L). Concentrations of selected metals were all below detection limits. Supersaturated DO concentrations were apparent at sampling locations that were sampled in the afternoon (D27-0, D27-3, D28-1).

In situ and analytical data collected on July 26, 2005 (Table 4.4) indicate chloride, sulfate and TDS concentrations below ecoregion criteria with the exception of the D27-0 sulfate

Table 4.3 Summary of results of chemical analyses of grab samples and *in situ* measurements taken on May 3, 2005.

Analyte	Station (Time of day of sample collection and *in situ* measurements)					
	D6-2 (0710)	**D6-3 (0955)**	**D27-0 (1600)**	**D27-0 Duplicate**	**D27-3 (1645)**	**D28-1 (1415)**
Flow (gpm)	6,103	7,848	11	NA	30	0
Temperature (°C/°F)	16.9/62.4	16.6/62.1	25.3/77.5	NA	27.3/81.1	18.1/64.6
Dissolved Oxygen	9.14	7.3	12.4	NA	16.2	6.2
Percent Dissolved Oxygen Saturation	95	75	152	NA	205	66
PH (Standard Units)	7.2	7.1	8.0	NA	8.8	7.1
Specific Conductance (uS)	396	390	280	NA	375	210
Turbidity (NTU)	13.7	9.18	117	NA	27.8	135
Total Dissolved Solids (TDS)	180	240	180	190	210	150
Total Suspended Solids	14	5	82	79	27	73
Alkalinity as $CaCO_3$	170	180	110	110	150	40
Chromium, Hexavalent	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Beryllium	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Cadmium	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Chromium, Trivalent	<0.007	<0.007	<0.007	0.008	<0.007	0.012
Copper	<0.006	<0.006	0.0075	0.0075	0.0067	0.0097
Hardness as $CaCO_3$	170	180	110	120	160	60
Iron	1.2	1.2	3.9	3.8	1.2	7
Lead	<0.001	<0.001	0.0027	0.0028	0.001	0.0048
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01	0.011
Selenium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Silver	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Zinc	0.049	0.017	0.022	0.022	0.013	0.038
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloride	6	6.4	5.2	5.5	6.6	7.1
Sulfate	17	17	28	29	39	8.4

Units = mg/L unless otherwise noted.
NA = Not Applicable

Table 4.4 Results of chemical analyses of grab samples and *in situ* measurements taken on July 26, 2005.

Analyte	**Station (Time of day of sample collection and *in situ* measurements)**						
	27-0 (1000)	**D6-2 (1145)**	**D6-3 (1215)**	**D6-33* (1220)**	**D41 (1320)**	**D28-1 (1440)**	**Rice Field Ditch (1055)**
Flow (gpm)	5	4453	2082	2082	Not Measured	Not Measured	Not Measured
Temperature (°C/°F)	30.7/87.2	30.2/86.4	29.6/85.2	29.6/85.2	33.6/92.5	32.0/89.6	27.4/81.3
Dissolved Oxygen	6.5	1.3	1.8	1.8	9.0	6.0	9.9
Percent Dissolved Oxygen Saturation	110	24	29	24	127	61	126
pH (Standard Units)	7.9	6.7	6.9	6.9	7.1	7.2	8.1
Specific Conductance (uS)	490	278	370	370	320	194	460
Turbidity (NTU)	9.3	2.2	6.1	6.1	14	16	6.4
Total Dissolved Solids (TDS)	280	170	220	210	200	81	270
Total Suspended Solids	14	<4	<4	<4	24	22	7.2
Alkalinity as $CaCO_3$	190	130	170	170	130	44	220
Chromium, Hexavalent	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Beryllium	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Cadmium	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Chromium, Trivalent	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Copper	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Hardness as $CaCO_3$	150	110	140	140	110	38	170
Iron	0.33	0.23	0.44	0.41	1.4	1.2	0.54
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Silver	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Zinc	0.0053	0.0061	0.012	0.012	0.0053	0.0052	0.0084
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloride	4.6	3.8	4.0	4.1	2.2	2.2	1.3
Sulfate	45	6.6	11	11	15	5.7	14

Units = mg/L unless otherwise noted
*Duplicate of D6-3

concentration (45 mg/L). Concentrations of selected metals were all below detection limits. DO concentrations below ecoregion criteria were apparent at sampling locations that were sampled in earlier in the day (D27-0, D6-2, D6-3, D6-33). Higher DO concentrations were observed at sampling locations samples late in the day (D41, D28-1, rice field ditch). Water temperatures near or exceeding the Delta ecoregion criterion (32°C, 89.6°F) were observed at all locations.

4.1.3 Chemical Measurement Conclusions

The chemical data collected in the May and July samples indicate baseline conditions for D6 and D27. The data show that sulfate concentrations and temperatures sometimes exceed the ecoregion criteria in D27. Supersaturated daytime DO values in July measurements at D27 indicate high levels of primary productivity. Low minimum DO values in both D6 and D27 are consistent with large amount of fine particulate organic matter observed in evaluation of physical and habitat characteristics (see below). Low metal concentrations indicate that there are no significant point or non-point sources for those parameters.

4.2 Flow Measurements

4.2.1 Flow Measurement Methods

Stream flow was measured at the upstream end of each sampling reach indicated in Figure 4.1. Flows were measured by measuring stream width, depth and current velocity per the United States Geological Survey (USGS) (1982) using a calibrated wading rod and a Marsh-McBirney (Flow Mate Model 2000) flow meter.

4.2.2 Flow Measurement Results

Flows, discreet *in situ* measurements and results of chemical analyses are provided in Tables 4.3 and 4.4 for the May and July sampling, respectively. Flows were 6,103, 7,818 and 11 gpm at D6-2, D6-3 and D27-0, respectively on May 2, 2005 (Table 4.3). Flows on July 27, 2005 were approximately one half of the May flows (Table 4.4). Field personnel reported that flows during the July sampling appeared to originate from irrigation drainage from adjacent agricultural fields.

4.2.3 Flow Measurement Conclusions

Although July flows were approximately 50% of the May flows, the flows present during the July sampling were still significant and probably do not represent lowest flow conditions. Agricultural activities such as irrigation clearly play a major role in the seasonal flow regime in the ditch environments.

4.3 Diurnal *In situ* Measurements

4.3.1 Diurnal *In situ* Measurement Methods

Diurnal *in situ* measurements of dissolved oxygen (DO), temperature, pH and conductivity were taken as discreet measurements concurrently with grab sample collection and as semi-continuous measurements during a complete 24-hr period (Figures 4.2 through 4.11). Semi-continuous monitoring stations were located near the mouth of D27 and in D6 immediately upstream and downstream of the confluence with D27 (Figure 4.1). Both discreet and semi-continuous recording of *in situ* parameters was performed using Hydrolab Minisonde Multiprobe water quality monitors. Instruments were calibrated on the day of use or deployment. Calibration of the DO function on all instruments was performed using air calibration. Calibration of conductivity and pH functions was performed using standard buffers (pH) and calibration standards (conductivity). Calibration was checked upon completion of each day's measurements or at the end of each the continuous monitoring period by comparing instrument readings with readings in standard buffers, calibration standards or saturated air, as appropriate. All calibration information was documented and retained as part of the project records. Semi-continuous monitors were deployed by attaching the monitor to a stake driven into the substrate such that the sensors were at a depth of approximately 1 foot at mid-current. Discreet *in situ* measurements were taken in mid-current at a depth of approximately 1 foot.

Additional semi-continuous temperature monitoring was conducted at selected locations (Figure 4.12) during July 26 through July 28, 2005. Locations were selected to be similar to D27 with respect to channel size and morphology. The purpose of these measurements was to evaluate the range of maximum temperatures occurring in ditch environments similar to D27.

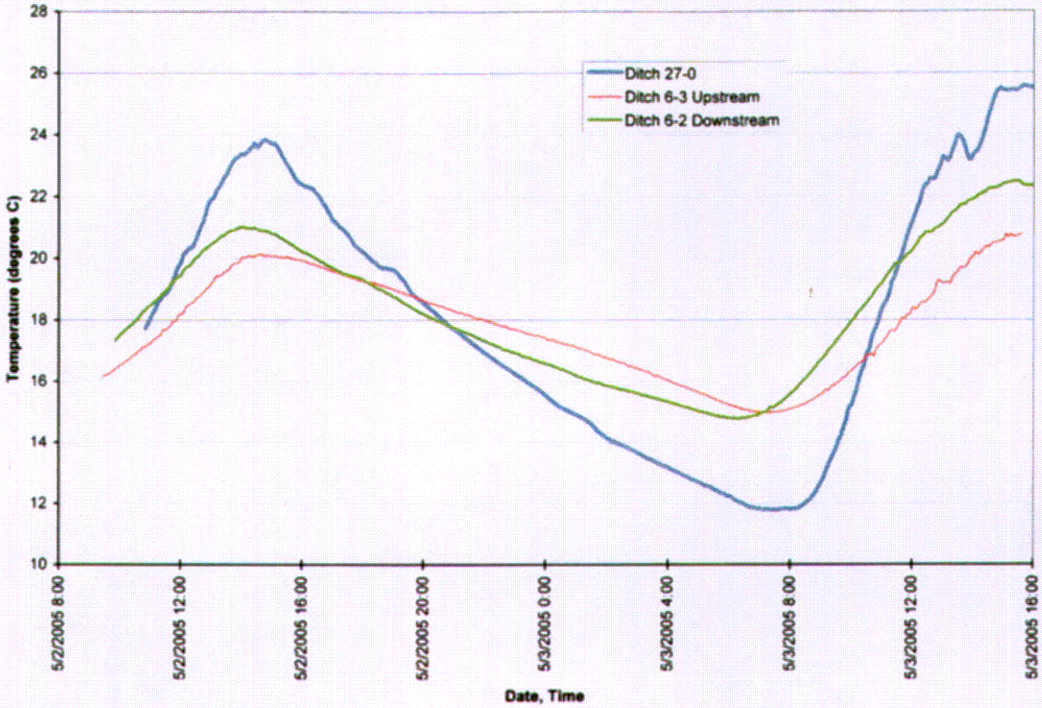

Figure 4.2. Plot of semi-continuous temperature in D6 and D27 on May 2 and 3, 2005.

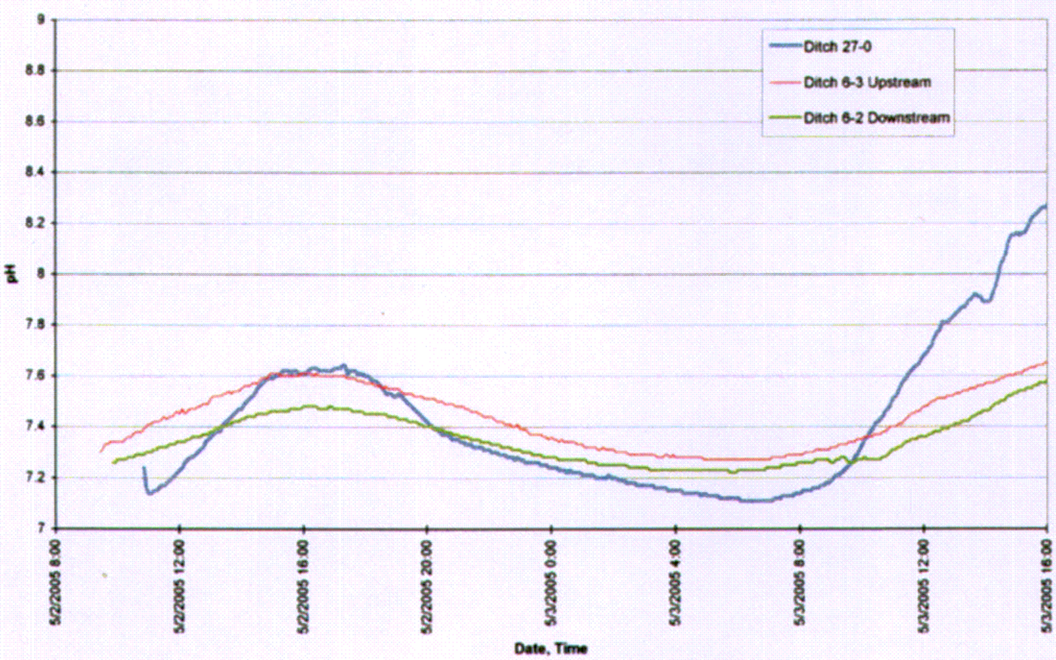

Figure 4.3. Plot semi-continuous pH in D6 and D27 on May 2 and 3, 2005.

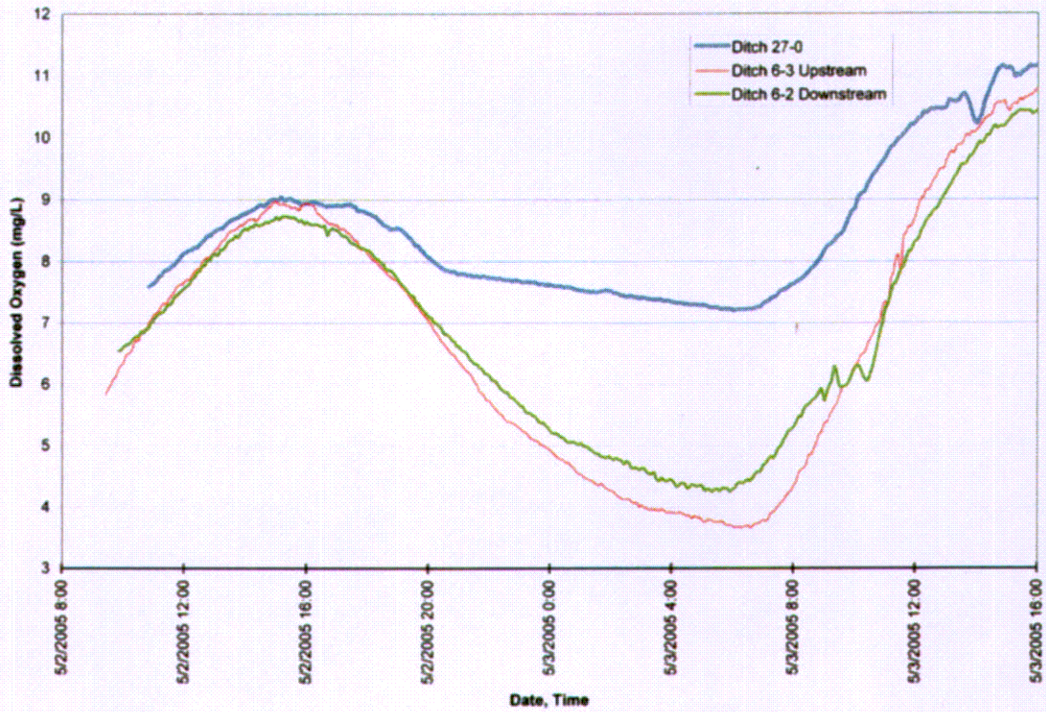

Figure 4.4. Plot of semi-continuous DO in D6 and D27 on May 2 and 3, 2005.

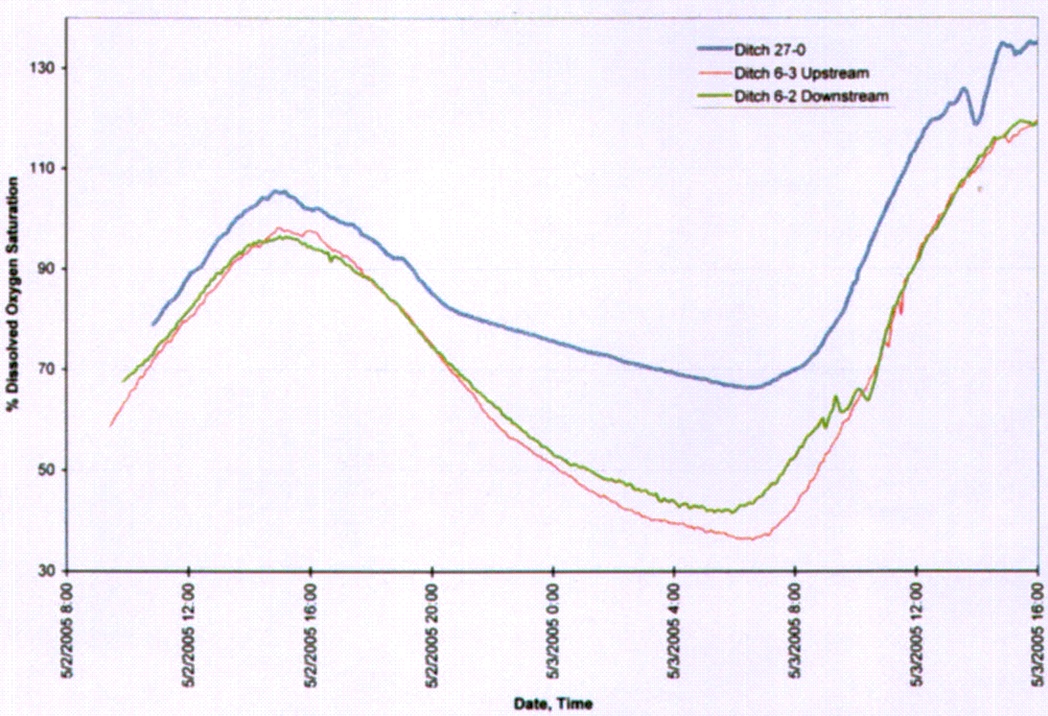

Figure 4.5. Plot of semi-continuous percent DO saturation in D6 and D27 on May 2 and 3, 2005.

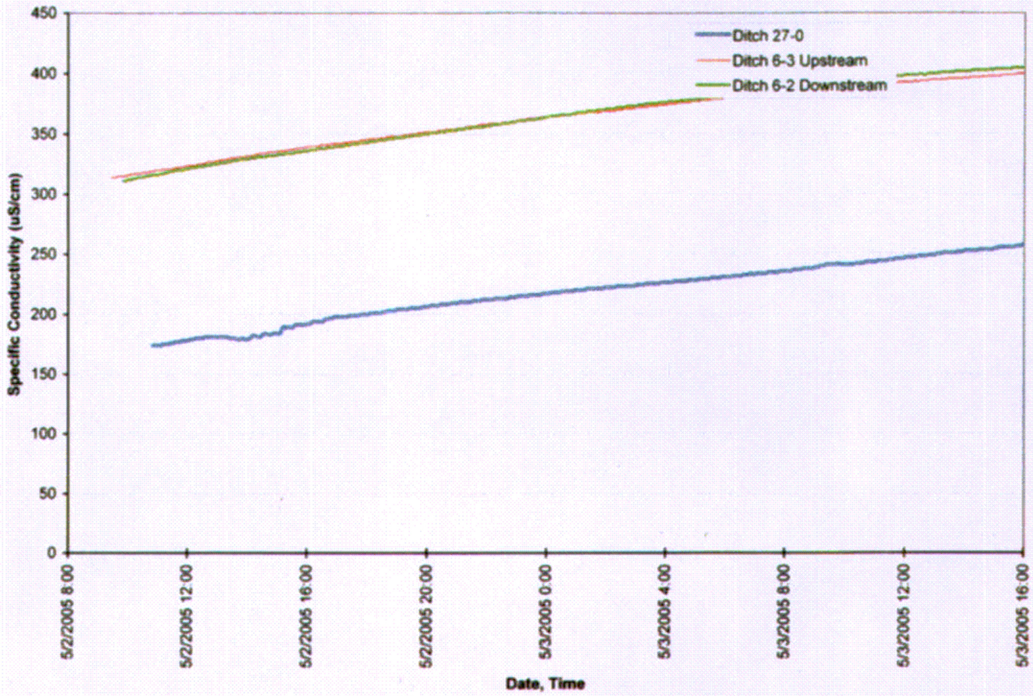

Figure 4.6. Plot of semi-continuous specific conductance in D6 and D27 on May 2 and 3, 2005.

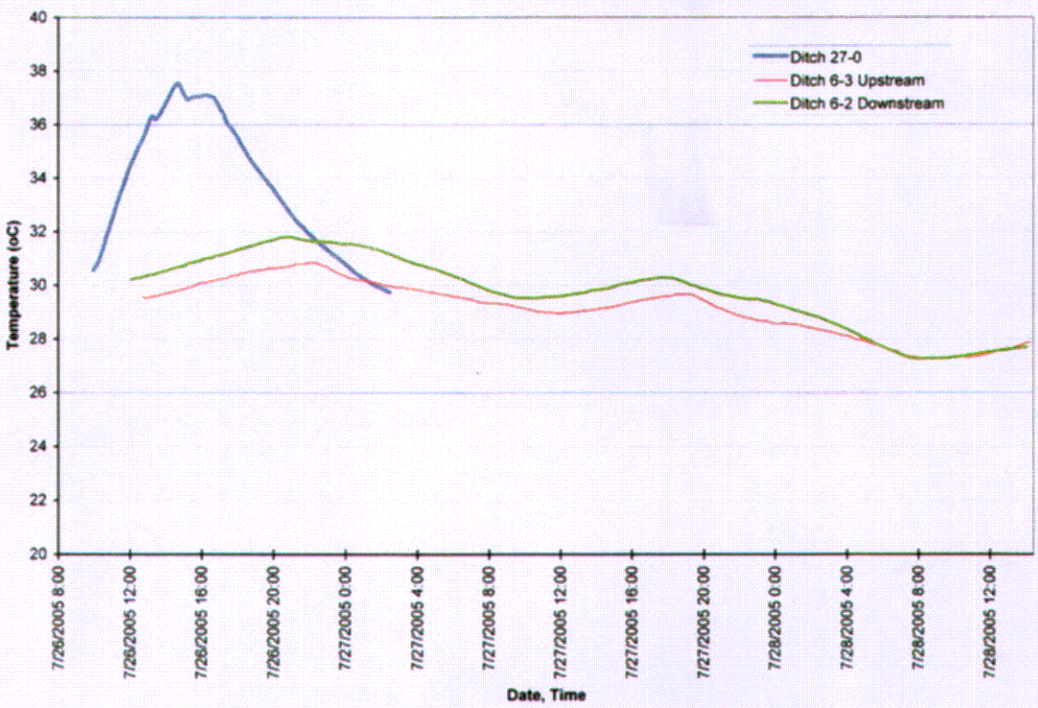

Figure 4.7. Plot of semi-continuous specific temperature in D6 and D27 on July 27 and 27, 2005.

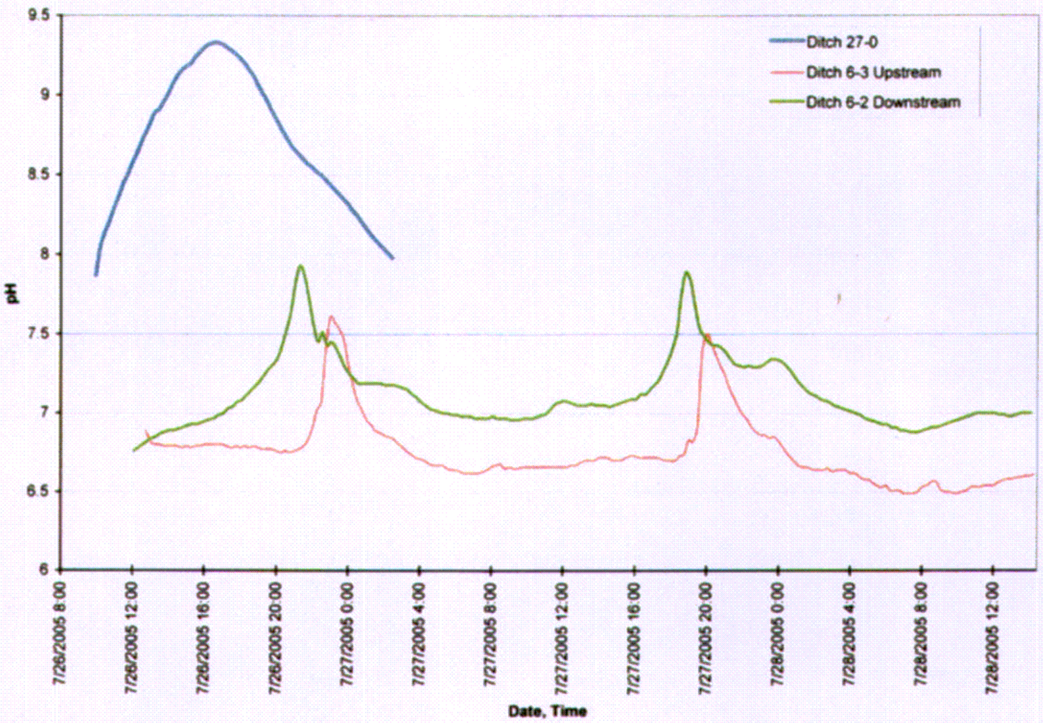

Figure 4.8. Plot of semi-continuous pH in D6 and D27 on July 26 and 27, 2005.

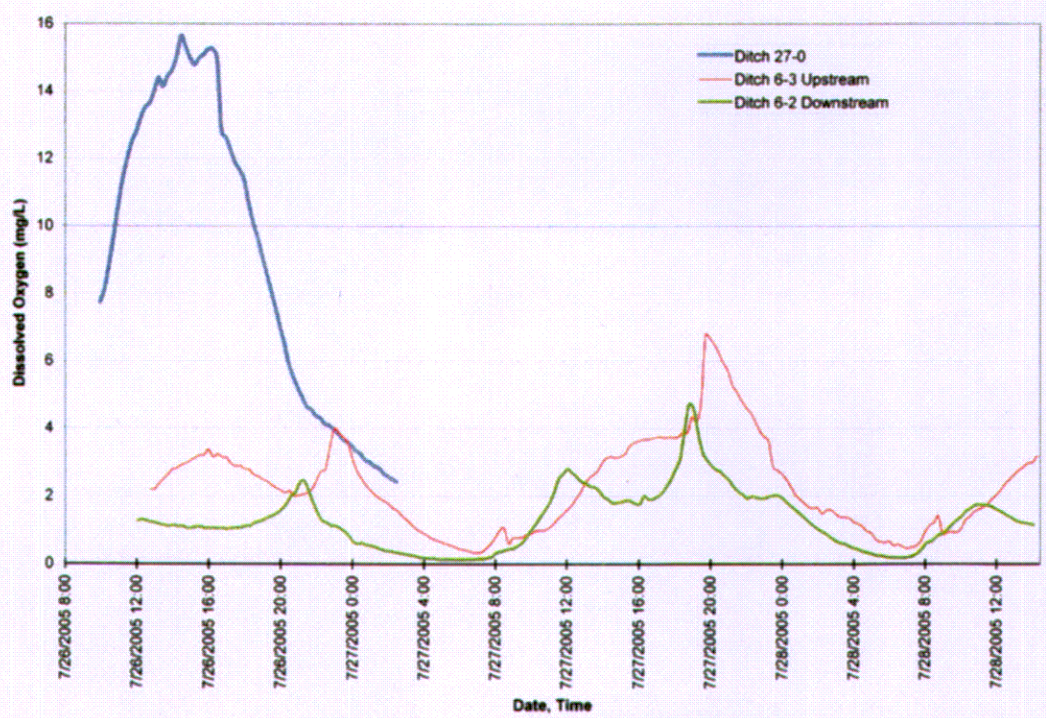

Figure 4.9. Plot of semi-continuous dissolved oxygen in D6 and D27 on July 26 and 27, 2005

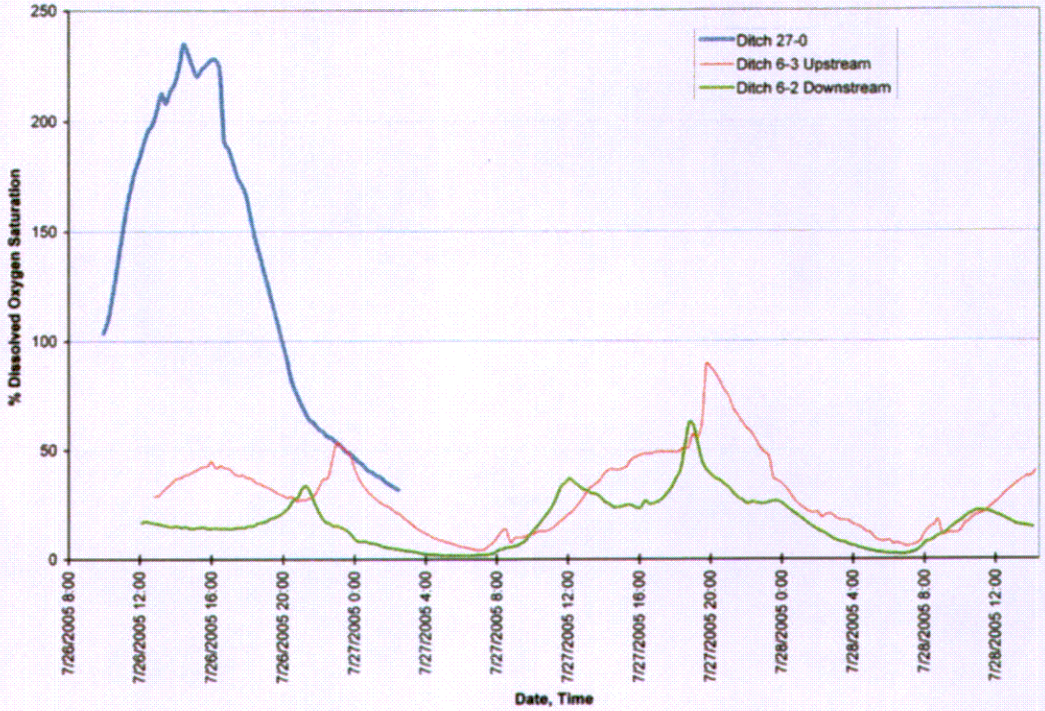

Figure 4.10. Plot of semi-continuous dissolved oxygen saturation (%) in D6 and D27 on July 26 and 27, 2005.

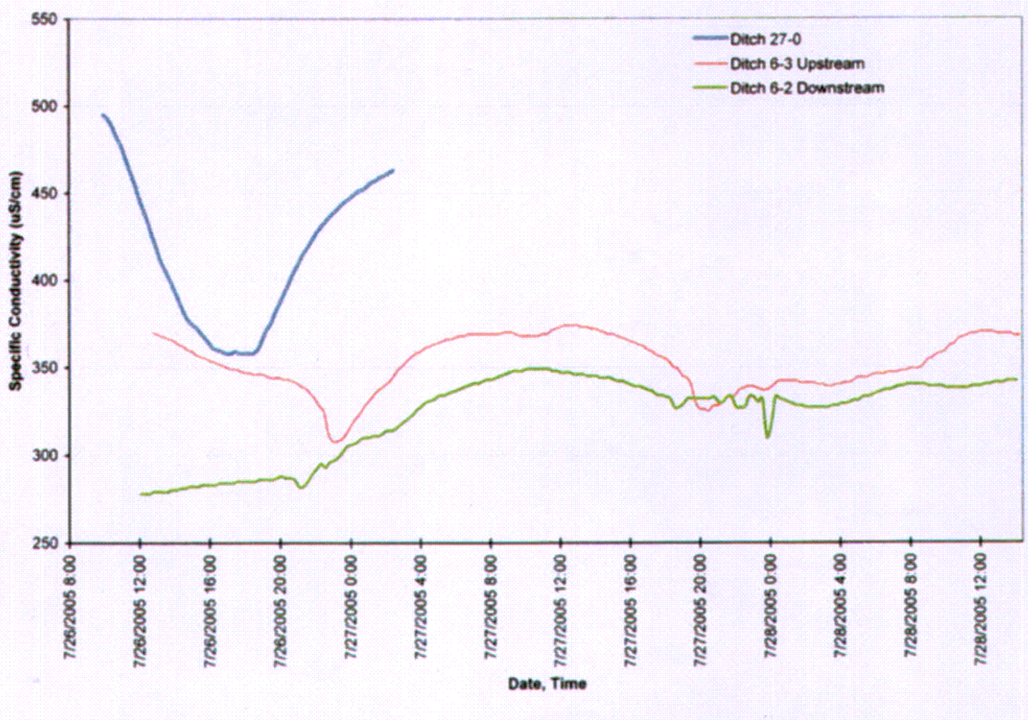

Figure 4.11. Plot of semi-continuous specific conductance in D6 and D27 on July 26 and 27, 2005.

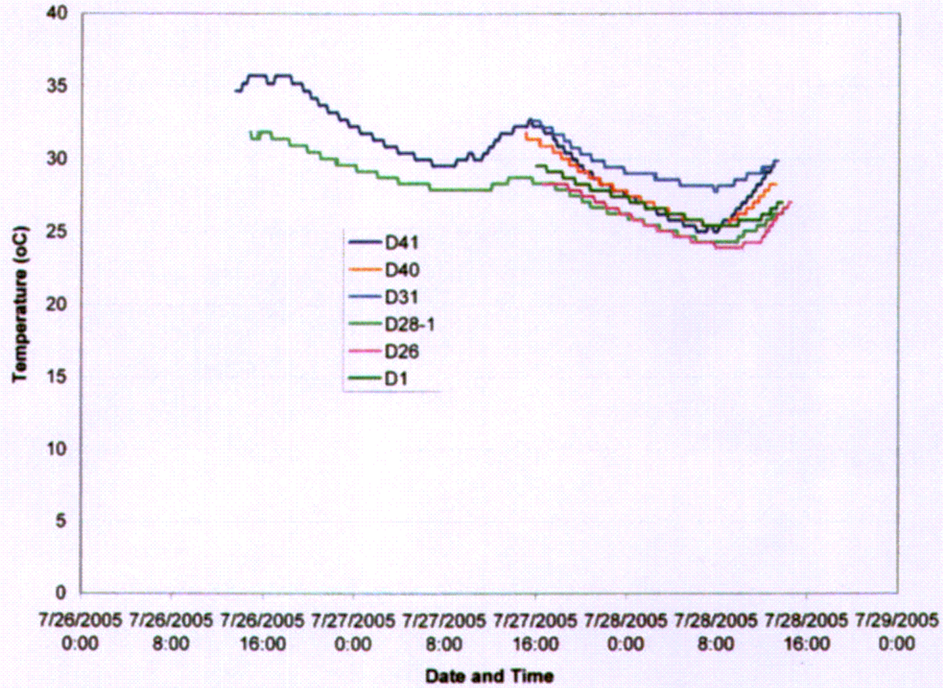

Figure 4.12. Additional semi-continuous temperature monitoring.

4.3.2 Diurnal *In situ* Measurement Results

Semi-continuous DO measurements show supersaturated DO conditions indicative of high photosynthetic rates at all locations (Figures 4.4 and 4.5) during May 2 and 3, 2005. These values were confirmed by discreet measurement taken during the afternoon at D27) on May 2, 2005 (Table 4.3).

The Hydrolab monitor deployed at D27-0 on July 26, 2005 malfunctioned after approximately 16 hrs. of operation. During this time supersaturated DO concentrations were observed at D27-0 (Figures 4.9 and 4.10) during daytime hours. During this time high pH levels (up to 9.3 su) and high temperatures (up to 37.5°C or 99.5°F) were also observed (Figures 4.8 and 4.7, respectively). By the end of the record period, DO levels at D27-0 had dropped to 2.3 mg/L. DO concentrations at D6-2 and D6-3 reached very low levels, often falling below 1.0 mg/L (Figures 4.9 and 4.10). Maximum pH and DO levels at D6-2 and D6-3 were attained during the nighttime hours (Figures 4.8 through 4.10).

Results of *in situ* temperature monitoring at selected additional sites are shown in Figure 4.12. Temperature monitoring at selected additional sites was begun on the afternoon of July 26, 2005 at the D41 and D1 locations and on the afternoon of July 27, 2005 at the remaining locations. Field personnel noted that the weather preceding monitoring on July 26, 2005 was very warm. However, during the evening of July 26, 2005 a change in the weather resulted in cooler air temperatures. Therefore only the data from and D1 and D41 (in addition to the data from D27-0, Figure 4.7) indicate the potential range of ditch temperatures during warm weather. These data indicate that the maximum water temperatures during warm weather were 31. 9°C (89.4°F), 35.7°C (96.3°F) and 37.5°C (99.5°F) for D1, D41 and D27-0, respectively.

4.3.3 Diurnal *In situ* Measurement Conclusions

Semi continuous *in situ* data collected in the May and June indicate diurnal (daily) fluctuations in temperature, DO, pH and conductivity indicative of baseline conditions for D6 and D27. Diurnal fluctuations in all parameters were greater in July than May. This result is consistent with warmer weather and higher rates of overall productivity typically observed during warmer seasons. Supersaturated daytime DO values in July measurements at D27 indicate high levels of primary productivity. Low minimum DO values in both D6 and D27 are consistent with large amounts fine particulate organic matter observed in evaluation of physical and habitat characteristics (See below). Temperature data, particularly at D27 and D41, reached levels near or exceeding 89.6°F (32°C). Diurnal monitoring data indicate that ecoregion criteria for temperature and DO are frequently not attained under baseline conditions in these ditch environments.

4.4 Physical Habitat Characteristics

4.4.1 Physical Habitat Characteristics Methods

Physical and habitat characteristics based on the entire length of each sampling reach were documented by visual assessment using the approach outlined in Barbour *et al.* (1999). Field forms (Appendix D) used for this assessment of physical characteristics were taken directly from Barbour *et al.* (1999).

Physical variables assessed included:

1. Canopy Cover;
2. Substrate Type;
3. Sediment Characteristics;
4. Dominant Aquatic Vegetation;
5. Proportion of reach with aquatic vegetation;
6. Pool/Riffle Ratio;
7. Pool Depths;
8. Pool Widths;
9. Dominant Riparian Vegetation; and
10. Watershed Features.

Habitat characterization followed low gradient stream habitat assessment procedures per Barbour *et al.* (1999). Field forms (Appendix D) used for the habitat assessment were taken directly from Barbour *et al.* (1999). In contrast to the evaluation of physical variables, the habitat characterization per Barbour *et al.* (1999) provides a scoring methodology that allows a rough comparison of habitat quality among sites.

Scored habitat variables included:

1. Epifaunal Substrate/Available Cover;
2. Pool Substrate Characterization;
3. Pool Variability;
4. Sediment;
5. Channel Flow Status Deposition;
6. Channel Alteration;
7. Channel Sinuosity;
8. Bank Stability;
9. Vegetative Protection; and
10. Riparian Vegetative Zone Width.

Assessment of physical and habitat characteristics was performed only once for each site. The assessment for sampling reaches D6-2, D6-3, D27-0, D27-3 and D28 were performed during the May sampling. Assessment of the D41 sampling reach was performed during the July sampling.

4.4.2 Physical Habitat Characteristics Results

Results of the assessment of physical characteristics of each site are presented in Table 4.5. Results of the scoring assessment of habitat variables are presented in Table 4.6.

Habitat comparisons between sampling periods were not an intended objective of this study. However, field personnel noted a substantial increase in rooted emergent and submergent vegetation in the July sampling. This increase affected the efficiency of fish sampling efforts described below.

Table 4.5 Summary of physical characteristics evaluation performed during May and July sampling.

Physical Parameter	D6-2	D6-3	D27-8	D27-3	D-24	D-41*
Canopy Cover	100% open	100% open	100% open	100% open	100% open	Partly open
Inorganic Substrate	30% silt 70% clay	10% silt 90% clay	0% silt 100% clay	0% silt 100% clay	30% silt 70% clay	20% silt 80% clay
Organic Substrate	30% detritus 70% fine organic matter	10% detritus 90% fine organic matter	15% detritus 85% fine organic matter	10% detritus 90% fine organic matter	20% detritus 80% fine organic matter	100% Fine organic matter
Dominant Aquatic Vegetation	Rooted submergent (*Sagitoria*)	Rooted submergent (*Sagitoria*)	Rooted emergent (*Vallisnecia*)	Attached algae	Rooted emergent (*Polygonium*)	Rooted emergent
Proportion of reach with aquatic vegetation	20%	20%	55%	Not recorded	Not recorded	30%
Pool/Riffle Ratio	100% Pool	100% Pool	100% Pool	100% Pool	100% Pool	100% Pool
Pool Depths	1.5-2 ft.	1.5-2 ft.	< 1 ft.	< 1 ft.	1.5 ft.	Not recorded
Pool Widths	40-50 ft.	40-50 ft.	12-22 ft.	7-18 ft.	40 ft.	Not recorded
Dominant Riparian Vegetation	Herbaceous	Herbaceous	Herbaceous	Herbaceous	Trees; Herbaceous	Trees; Herbaceous
Watershed Features	Agricultural	Agricultura l	Agricultural	Agricultural	Agricultural	Agricultural
Weather	0–10% cloud cover	0–10% cloud cover;	0–10% cloud cover;	0–10% cloud cover;	0–10% cloud cover;	20% cloud cover;

*July sampling only

Table 4.6. Summary of habitat evaluations performed during May and July sampling.

Habitat Parameter	D6-2	D6-3	D27-0	D27-3	D-28	D-41
Epifaunal Substrate/Available Cover	6	8	10	6	12	11
Pool Substrate Characterization	8	13	13	6	9	11
Pool Variability	11	13	3	8	10	5
Sediment Deposition	13	13	9	7	4	10
Channel Flow Status	13	18	6	13	6	4
Channel Alteration	6	6	6	7	6	1
Channel Sinuosity	1	1	1	1	1	1
Bank Stability	8	2	12	13	10	12
Vegetative Protection	14	14	10	12	16	14
Riparian Vegetative Zone Width	0	0	2	0	0	4
Total Score	80	88	72	73	74	72

4.4.3 Physical Habitat Characteristics Conclusions

Visual assessments indicated physical conditions were similar among locations with respect to substrate (clay/silt with a high proportion of fine organic matter), pool/riffle ratio (100% pools), and watershed features (agricultural). Primary differences in the D27 vs the D28 and D41 locations were in canopy cover and dominant riparian vegetation (presence of trees and partly open canopy at D28 and D41 vs. herbaceous only and open canopy at D27 locations). Water depth was similar at all locations, but pool width and depth was substantially greater at the D6 locations where the rooted submergent aquatic vegetation dominated (vs. rooted emergent vegetation at other locations).

The habitat scoring assessment (Table 4.6) indicated somewhat higher habitat quality at the D6 locations versus D27, D28 and D41. The scored habitat differences between D6 locations and other locations were due primarily to pool variability, sediment deposition and channel flow status. Although clay, silt and fine organic matter dominated the substrate of all locations, there were fewer shallow depositional areas in the D6 locations. The assessment also indicated larger deep pools and a fuller channel in the D6 locations (Tables 4.5 and 4.6).

Physical and habitat characteristics were relatively uniform habitat quality across all location with respect to channel morphology, riparian vegetation and substrate characteristics. Differences in physical and habitat characteristics (most pronounced at the D6 locations) and were primarily related to variations in flows between stations.

4.5 Biological Characteristics

4.5.1 Biological Characteristics Methods

Biological assessment procedures followed rapid bioassessment protocols for fish and invertebrates given in Barbour *et al.* (1999). Representative stream reaches were identified in D6, D27 and D28 as described above. Five stream reaches ranging in length from approximately 200 to 1,000 ft. were sampled (Figure 4.1).

4.5.1.1 Invertebrates

Prior to sampling each reach, the upper and lower ends of the reach were cordoned off using block nets. Invertebrate sampling was conducted before fish sampling in order to avoid disturbing substrate. Invertebrates were sample using D-frame kick nets with 0.5 mm mesh net. A total of 12 individual samples were collected from all available habitat including woody debris, emergent vegetation, snags, undercut banks, open substrate and riffles (if present). The sampling effort was distributed among habitat types in proportion to the availability of habitats as assessed by visual inspection. After removal and washing of large debris the entire contents of the net was washed into wide-mouth glass jars and immediately preserved with 70% ethanol.

Samples were sorted in the laboratory by dispensing the entire sample onto a Caton grid. All organisms were sorted from randomly selected grids until a minimum of 300±20 organisms were collected. Sorted organisms were transferred to 70% ethanol in glass vials. To assure thorough removal of specimens from the sample, the sorted residue was retained and examined by a second biological technician. If the second sorting produced fewer than 10% of the number of organisms found in the initial sorting the sorting of that sample was considered complete. If the second sorting produced more than 10% of the number of organisms found in the initial sorting, the sample was resorted until the 10% goal was reached.

Taxonomic identifications were carried out to the lowest practical taxon according to Merritt and Cummins (1996), Thorp and Covich (2001) and Houston (1980). In general, macroinvertebrates were identified to genus except for bivalve mollusks, gastropods, dipteran larvae, and decapod shrimp which were identified to family. A voucher collection of invertebrate taxa collected at the sites was retained for further reference. All invertebrate taxa were classified into functional feeding groups (Predator, Shredder, Omnivore, Gatherer/collector, Scraper, and filterer/collector) per Barbour *et al.* (1999).

Benthic invertebrate samples included individuals of freshwater bivalve mollusks. All bivalve mollusks were removed from the samples, counted and preserved. An informal taxonomic identification of the individuals in the samples was performed by Mr. William Posey, Malacologist, Arkansas Game and Fish Commission.

Benthic invertebrate data were evaluated by visually examining changes and/or differences in taxa richness and relative abundance of functional feeding groups.

4.5.1.2 Fish Sampling

Fish sampling was conducted using a Smith-Root LR-24 DC current backpack electroshocker. Sampling of each reach was conducted by probing all available habitat beginning at the downstream end of the reach and proceeding upstream. Two sampling passes were performed on each reach. Stunned fish were collected in a plastic bucket and maintained with aeration until processed. Each individual captured was identified in the field to species according to Robison and Buchanan (1984). Individuals that could not be positively identified in the field were killed, preserved in formalin and identified in the laboratory. Up to 25 individuals of each species were weighed to the nearest 0.1 g and measured (total length) to the nearest mm. After processing, all living fish were returned to the sampling reach.

Fish data were evaluated by visually examining differences in species richness among locations in relation to habitat.

4.5.2 Biological Characteristics Results

4.5.2.1 Benthic Invertebrates

Benthic invertebrate taxa and counts for each sampling location are presented in Tables 4.7 and 4.9 for May and July, respectively. Relative abundance of functional feeding groups for each sampling location are presented in Tables 4.8 and 4.10 for May and July, respectively.

Table 4.7. Macroinvertebrate counts for each location for May sampling.

Order	Family	Genus	Feeding Group	Site				
				6-2	6-3	27-4	27-3	28
Pulmonata	Lymnaeidae	*Fossaria*	SC	86	9	26	166	16
Pulmonata	Lymnaeidae	*Radix*	SC		64			
Pulmonata	Planorbidae	*Planorbella*	SC	1		5	1	11
Pulmonata	Physidae		SC	7				
Pulmonata	Physidae	*Physella*	SC		6	17	20	9
Prosobranchia	Viviparidae	*Viviparus*	SC	49	93	7		
Decapoda	Cambaridae		SH	5		2	2	2
Decapoda	Cambaridae	*Procambarus*	SH		1			6
Decapoda	Palaemonidae	*Macrobrachium*	SH	15	6		2	8
Bivalvia			FC	See Table 4.11				
Coleoptera	Chrysomelidae		PR					1
Coleoptera	Dytiscidae		PR				1	
Coleoptera	Haliplidae	*Peltodytes*	SH		1			1
Coleoptera	Hydrophilidae	*Tropisternus*	PR				1	
Coleoptera	Pytiscidae	*Copotomus*	PR			5		
Diptera	Chironomidae		GC	2				
Diptera	Muscidae		PR					1
Hemiptera	Belostomatidae	*Belastoma*	PR				2	1
Odonata	Anisoptera	*Nasinaeshna*	PR					2
Odonata	Libellulidae	*Perithemis*	PR	1				
			*Total Taxa	11	9	6	10	12

*Totals include bivalve taxa from Table 4.11.

Table 4.8. Percent relative abundance of benthic macroinvertebrate function feeding groups (based on number of individuals) for each location for the May sampling.

Feeding Group	Site				
	6-2	6-3	27-4	27-3	28
Predator	1	0	8	2	6
Shredder	12	4	3	2	20
Omnivore	0	0	0	0	0
Gather/Collector	1	0	0	0	0
Scraper	84	95	89	93	42
Filter/Collector	2	1	0	3	32

Table 4.9. Macroinvertebrate counts for each location for July sampling.

Order	Family	Genus	Feeding Group	Site				
				6-2	**6-3**	**27-0**	**41**	**28**
Pulmonata	Planorbidae	*Planorbella*	SC	1	7	14		7
Pulmonata	Physidae	*Physella*	SC	84	56	74		22
Pulmonata	Lymnaeidae	*Fossaria*	SC	15	4	62		88
Pulmonata			SC				1	
Prosobranchia	Viviparidae	*Viviparus*	SC	3	22			
Decapoda	Cambaridae		SH	1				
Decapoda	Palaemonidae	*Macrobrachium*	SH	3	1			8
Bivalvia			FC	See Table 4.11				
Oligochaeta			GC		1	2	1	
Coleoptera	Hydrophilidae	*Tropisternus*	PR	1	2	2		1
Coleoptera	Halipidae	*Peltodytes*	SH	2	6			2
Coleoptera	Hydrophilidae	*Berosus*	PR	6		3	1	
Coleoptera	Carabidae		PR		4			
Coleoptera	Curculionidae		SH		2			
Coleoptera	Noteridae	*Hydrocanthus*	OM		1			
Coleoptera			PR		1			
Diptera	Chironomidae		GC	3	1	2	1	1
Ephemeroptera	Caenidae	*Caenis*	GC	25	12			
Ephemeroptera	Baetidae		GC	8	14			
Ephemeroptera			GC				1	
Hirudinea	Erpobdellidae		PR			1		
Hirudinea	Glossiphoniidae		PR		1	1		
Hirudinea			PR					1
Hemiptera	Corixidae	*Trichocorixia*	PR	8	1	1	67	
Hemiptera	Notonetidae		PR		1			
Hemiptera	Belostomatidae	*Belostoma*	PR		8			2
Hemiptera	Nepidae	*Ranata*	PR		1			
Hemiptera	Gerridae	*Trepobates*	PR		1			
Lepidoptera	Pyralidae	*Acentria*	SH		4			1
Odonata	Coenagnonidae		PR	1		1		
Odonata	Coenagribnidae	*Enallugma*	PR		3			
Odonata	Corduliidae	*Somatochlora*	PR					1
Ostracoda			GC		7			
Trichoptera					1			
Trichoptera	Leptoceridae	*Oecetis*	PR					2
			*Total Taxa	14	25	11	6	13

*Totals include bivalve taxa from Table 4.11.

Table 4.10 Percent relative abundance of benthic macroinvertebrate functional feeding groups (based on number of individuals) for each location for the July sampling.

Feeding Group	Site				
	6-2	6-3	27-0	41	28
Predator	10	14	6	94	4
Shredder	4	9	0	0	7
Omnivore	0	1	0	0	0
Gather/Collector	22	22	2	4	1
Scraper	64	55	92	1	70
Filter/Collector	0	0	0	0	19

Table 4.11. Results of taxonomic identification of bivalve mollusks from benthic macroinvertebrate collections.

Station ID	Sampling Date	Taxon	Number of individuals
6-2	5/3/05	*Corbicula* sp.	1
		Utterbackia imbecillis	1
		Uniomus tetralasmus	2
6-3	5/3/05	*U. imbecillis*	1
		U. tetralasmus	1
27-3	5/2/05	*U. tetralasmus*	1
		Sphaeriidae	4
28	5/3/05	Sphaeriidae	27
28-1	7/26/05	Sphaeriidae	32

Pulmonate and prosobranch snails overwhelmingly dominated all locations at all times except in the July sample from D41. Differences in taxa richness (number of taxa) were noted among sampling locations and between the May and July sampling periods.

Bivalve mollusks collected from all on both sampling dates are summarized in Table 4.11. No individuals of the federally endangered *Potamilus capax* were collected.

May Sampling

May sampling indicated somewhat uniform taxa richness across all locations, with the highest number of taxa (11) present at D28 (Table 4.7). Scrapers (pulmonate and prosobranch snails) dominated the benthic fauna of all locations (with minor contributions by predators and shredders) with the exception of D28 where there were more shredders and filter/collectors (Table 4.8). Second to scrapers in relative abundance were decapod shredders, primarily palaemonid shrimp.

July Sampling

July sampling revealed an overall decrease (versus the May sampling) in the relative abundance of decapod shredders and an increase in taxa richness at D6-2 and D6-3 (Table 4.9). The increase in the number of taxa at D6-2 and D6-3 was related to an increase in the relative abundance of predators and gatherer/collectors (Table 4.10). There was a slight increase in species richness at D27-0 and D28 (Table 4.9). Functional feeding group composition at D27 remained essentially unchanged. The functional feeding group composition at D28 changed slightly with a decrease in relative abundance of shredders and an increase in relative abundance of scrapers. Functional feeding group composition at D41 was distinctly different from all other locations at all other time with predators making up the dominant (94%) feeding group.

4.5.2.2 Fish

Fish taxa and counts for each sampling location are presented in Tables 4.12 through 4.14 for May and July, respectively. Substantially fewer numbers of individuals and taxa were collected in the July sampling. However, the July sampling contained some taxa (e.g. *Notropis atherinoides, Micropterus salmoides, Dorosoma petenense*) that were rare or absent in the May sampling. Field personnel reported that July collections were hampered by dense growths of rooted emergent and submergent vegetation which allowed fish to elude capture.

The highest species richness (12 species) occurred in the May collection at D6-2, downstream of the confluence of D6 and D27. The lowest species richness (2 species) occurred in the July collection in D41.

Table 4.12. Summary of fish collections obtained on May 2 and 3, 2005.

Species	Site									
	6-2		6-3		27-0		27-3		28	
	RA %	**Count**	**RA %**	**Count**	**RA %**	**Count**	**RA %**	**Count**	**RA %**	**Count**
Lepomis cyanellus	15.2	5	1.4	1	16.9	23	6.2	25	36.5	27
L. gulosus	15.2	5	5.8	4	0.0		0.0		4.1	3
L. macrochirus	12.1	4	1.4	1	0.0		0.0		5.4	4
L. megalotis	15.2	5	2.9	2	0.7	1	0.2	1	9.5	7
L. microlophus	3.0	1	0.0		0.0		0.0		0.0	
Micropterus salmoides	0.0		0.0		0.0		0.0		0.0	
Gambusia affinis	3.0	1	33.3	23	80.1	109	92.8	376	33.8	25
Fundulus notatus	0.0		1.4	1	0.0		0.0		0.0	
Notemigonus crysoleucas	0.0		36.2	25	0.7	1	0.2	1	9.5	7
Notropis antherinoides	0.0		0.0		0.0		0.0		0.0	
N. emiliae	12.1	4	10.1	7	0.0		0.0		0.0	
N. maculatus	3.0	1	2.9	2	0.7	1	0.5	2	0.0	
Pimephales notatus	3.0	1	0.0		0.7	1	0.0		0.0	
Cyprinis carpio	3.0	1	1.4	1	0.0		0.0		0.0	
Lepisosteus oculatus	6.1	2	0.0		0.0		0.0		0.0	
Dorosoma petenense	0.0		0.0		0.0		0.0		0.0	
Ictalurus melas	0.0		0.0		0.0		0.0		1.4	1
I. natalis	0.0		2.9	2	0.0		0.0		0.0	
I. punctatus	9.1	3	0.0		0.0		0.0		0.0	
Total Taxa	12		11		6		5		7	

%RA=percent relative abundance

Table 4.13. Summary of fish collections obtained on July 26 through July 28, 2005.

Species	Site									
	6-2		6-3		27-0		41		28	
	RA %	Count	RA %	Count	RA %	Count	RA %	Count	RA %	Count
Lepomis cyanellus	2.7	9	0.0		94.4	286	12.5	1	5.1	2
L. gulosus	0.0		0.0		0.0		0.0		0.0	
L. macrochirus	0.0		0.0		0.0		0.0		0.0	
L. megalotis	0.0		0.0		0.0		0.0		0.0	
L. microlophus	0.0		0.0		0.0		0.0		0.0	
Micropterus salmoides	0.0		0.0		0.0		0.0		2.6	1
Gambusia affinis	84.8	284	96.1	516	5.6	17	87.5	7	33.3	13
Fundulus notatus	2.1	7	2.6	14	0.0		0.0		12.8	5
Notemigonus crysoleucas	0.3	1	0.0		0.0		0.0		35.9	14
Notropis antherinoides	7.5	25	0.0		0.0		0.0		0.0	
N. emiliae	0.0		0.0		0.0		0.0		0.0	
N. maculatus	0.0		0.0		0.0		0.0		0.0	
Pimephales notatus	0.3	1	0.0		0.0		0.0		0.0	
Cyprinis carpio	1.2	4	1.3	7	0.0		0.0		0.0	
Lepisosteus oculatus	0.0		0.0		0.0		0.0		0.0	
Dorosoma petenense	0.6	2	0.0		0.0		0.0		0.0	
Ictalurus melas	0.0		0.0		0.0		0.0		10.3	4
I. natalis	0.6	2	0.0		0.0		0.0		0.0	
I. punctatus	0.0		0.0		0.0		0.0		0.0	
Total Taxa	9		3		2		2		6	

%RA=percent relative abundance

Table 4.14 Summary of fish collections obtained on May 2 and 3 and July 26 through July 28, 2005.

Species	Site							
	D6		D27		D28		D41	
	RA %	Count	RA %	Count	RA %	Count	RA %	Count
Lepomis cyanellus	1.5	15	39.6	334	25.7	29	12.5	1
L. gulosus	0.9	9	0.0	0	2.7	3	0.0	0
L. macrochirus	0.5	5	0.0	0	3.5	4	0.0	0
L. megalotis	0.7	7	0.2	2	6.2	7	0.0	0
L. microlophus	0.1	1	0.0	0	0.0	0	0.0	0
Micropterus salmoides	0.0	0	0.0	0	0.9	1	0.0	0
Gambusia affinis	84.6	824	59.5	502	33.6	38	87.5	7
Fundulus notatus	2.3	22	0.0	0	4.4	5	0.0	0
Notemigonus crysoleucas	2.7	26	0.2	2	18.6	21	0.0	0
Notropis antherinoides	2.6	25	0.0	0	0.0	0	0.0	0
N. emiliae	1.1	11	0.0	0	0.0	0	0.0	0
N. maculatus	0.3	3	0.4	3	0.0	0	0.0	0
Pimephales notatus	0.2	2	0.1	1	0.0	0	0.0	0
Cyprinis carpio	1.3	13	0.0	0	0.0	0	0.0	0
Lepisosteus oculatus	0.2	2	0.0	0	0.0	0	0.0	0
Dorosoma petenense	0.2	2	0.0	0	0.0	0	0.0	0
Ictalurus melas	0.0	0	0.0	0	4.4	5	0.0	0
I. natalis	0.4	4	0.0	0	0.0	0	0.0	0
I. punctatus	0.3	3	0.0	0	0.0	0	0.0	0
Total Taxa		17		6		9		2

%RA=percent relative abundance

4.5.3 Biological Characteristics Conclusions

4.5.3.1 Benthic Invertebrates

Benthic invertebrate data collected in May and July indicate habitats that are, in general, dominated by scrapers (primarily pulmonate and prosobranch snails) and decapod shredders (primarily palaemonid shrimp). This result is comparable regarding one finding, to the ADEQ (then known as the Arkansas Department of Pollution Control & Ecology (ADPCE 1987)) survey of least disturbed Delta streams which found that the Delta ecoregion was the only ecoregion in which decapods (primarily palaemonid shrimp) were the dominant invertebrate order present[1]. However, the benthic communities of the ditch environments in this study are in sharp contrast to ADPCE (1987) in having far lower taxa richness than the least disturbed

[1] ADPCE (1987) did not enumerate snails.

streams. Sampling of least disturbed Delta streams reported in ADPCE (1987) showed and average of 50 taxa, whereas the maximum taxa richness in this study was 25 (D6-2, July sampling).

No dense areas of freshwater mussel abundance were observed and no individuals of the federally endangered *Potamilus capax* or other endangered or threatened freshwater mussel species were noted or collected.

Although some differences in taxa richness among locations were noted in the July samples, taxa richness was in general, low and showed the same dominance pattern with respect to functional feeding groups. This result reflects the relatively uniform substrate observed in the evaluation of physical and habitat characteristics presented above.

The benthic community in the ditch environments sampled in this study can be characterized as having low taxa richness dominated by snails and paleomonid decapods.

4.5.3.2 Fish

The number of species from the July collection was substantially less than found in the May collection (Tables 4.12 and 4.13). This difference could be related to the low minimum DO levels (Section 4.1) observed with semi-continuous monitoring at D6-2, D6-3 and D27-0. However, field personnel reported seeing numerous fish at all locations that were able to escape capture because of the dense rooted emergent and submergent vegetation present. Therefore, the lower number of species in the July collection may be due to a combination of low DO and reduced vulnerability of the fish to the sampling gear.

Because of the difficulty experienced in capturing fish during the July collection and because of the flows that remained in the ditches in July (Tables 4.3 and 4.4), the combined data (Table 4.14) probably provide an appropriate representation of the existing fish community at the locations sampled.

Virtually all fish caught at all locations and times were sunfish and minnows. Green sunfish (*Lepomis cyanellus*) and mosquitofish (*Gambusia affinis*) were by far the dominant fish species present in D27, D28 and D41 (Table 4.14). This result is comparable to the APCEC (2004) "Channel-altered Delta Ecoregion" fishery which is described as "…characterized by an absence of sensitive species; sunfishes and minnows dominate the population followed by catfishes." APCEC (2004) further states that the Channel-altered Delta Ecoregion fish community can be "generally characterized" by the key and indicator fish species listed in Table 4.15. In addition to the Channel-altered Delta Ecoregion key and indicator species, the collections included some species characteristic of a "Least Altered Delta Ecoregion" fishery such as bluegill sunfish, yellow bullhead and largemouth bass.

More species of fish were collected at the D6 locations. This may result may be related to somewhat higher quality habitat present at those locations (Table 4.6). However, as discussed earlier, the evaluation of physical and habitat characteristics indicated relatively uniform habitat that varied mainly in relation to flow. Given the relatively uniform nature of the habitat, and the low minimum DO conditions observed, the fish diversity of these ditch environments is likely limited by habitat. It seems likely that, given sufficient stream depth and width, virtually any Delta Ecoregion ditch would support any of the fish listed in Table 4.14.

Table 4.15 Key and indicator species that generally characterize the Channel-Altered Delta Ecoregion fishery. * = present in ditch environments sampled in this study.

Key Species	Indicator Species
Blacktail shiner (*Notropis venustus*)	Mosquito fish (*Gambusia affinis*) *
Drum (*Aplodinotus grunniens*)	Gizzard shad (*Dorosoma cepedianum*)
Carp (*Cyprinis carpio*) *	Emerald shiner (*N. atherinoides*) *
Channel catfish (*Ictalurus punctatus*)	Spotted gar (*Lepisosteus oculatus*) *
Green sunfish (*Lepomis cyanellus*) *	

The fish community in the ditch environments sampled in this study can be characterized as being dominated by sunfish and minnows, particularly, in some cases, by green sunfish and mosquitofish. The fish community present at any time probably represents a subset, depending on stream depth and width, of "Least Altered Delta Ecoregion" and "Channel-Altered Delta Ecoregion" fisheries. The species richness of the fisheries of these ditch environments appears to be limited by uniform substrate (clay/silt with fine particulate organic matter), uniform stream morphology (100% pools) and low DO.

5.0 TOXICITY TESTS

Two types of toxicity evaluations were performed. The first involved acute 48-hour static renewal toxicity tests conducted on grab samples collected on (May 3 and July 27, 2005). The purpose of these tests was to identify potential instream toxicity due to other sources in the watershed of D27.

The second type of toxicity evaluation involved testing of a simulated effluent sample prepared using laboratory water and analytical grade reagents to match the predicted ionic strength of the plant effluent. The purpose of this test was to evaluate potential toxicity due to the ionic composition of the effluent particularly with respect to sulfate, chloride and TDS.

5.1 Toxicity Test Methods

5.1.1 Acute Toxicity Tests on D27 Grab Samples

Acute 48 hour static renewal toxicity tests were performed on undiluted grab sample collected from D27 with a laboratory water control ("moderately hard" water) using *Daphnia pulex* and *Pimephales promelas* per USEPA (1991).

5.1.2 Chronic Toxicity Tests on Simulated Effluent

Synthetic effluent was prepared by combining reagent grade inorganic salts with deionized water to produce a solution that closely matched the predicted ionic composition of the plant effluent (Table 3.2). The primary objective in preparing the synthetic effluent was to closely match the sulfate, chloride and TDS concentrations predicted in the plant effluent. Matching the concentration of other ions sodium and calcium was considered to be of secondary importance. The amounts of salts added to deionized water and the resulting nominal ionic concentrations are provided in Table 5.1. The ionic composition of the synthetic effluent closely matched the predicted concentrations of chloride, sulfate, magnesium, potassium and total alkalinity. Nominal concentrations of calcium and sodium were 64% and 56%, respectively, of the target concentrations.

Table 5.1 Target and actual (nominal) concentrations of selected ions in synthetic effluent sample.

Salt	mg/L	Ion Concentration (mg/L; Nominal)							
		SO_4	Cl	Mg	Ca	Na	K	HCO_3	Total Alkalinity as $CaCO_3$
Na_2SO_4	243.0	165.2	0.0	0.0	0.0	77.8			
K_2SO_4	48.0	26.4					21.6		
$CaSO_4$ ($2H_2O$)	201.0	112.6			46.2				
$MgSO_4$	216.0	172.8		43.2					
NaCl	0.0		0.0			0.0			
KCl	0.0		0.0				0.0		
$CaCl_2$	17.5		11.2		6.3				
$NaHCO_3$	337.0					91.0		246.0	280.3
	Total	477.0	11.2	43.2	52.5	168.8	21.6	246.0	280.3
	Target	477.0	11.2	43.2	82.4	304.0	21.6		280.7
	TDS	1020							

The simulated effluent sample was prepared and aerated for two days prior to its use in the test to allow the solution to equilibrate. The sample was then tested using chronic static renewal toxicity tests with *Ceriodaphnia dubia* and *Pimephales promelas* per USEPA (2002). Each test consisted of two concentrations (1x and 1.5x the concentrations indicated in Table 5.1) plus a control. Survival growth and reproduction data were analyzed per USEPA (2002) to evaluate lethal and/or sub-lethal effects at each of the two concentrations relative to the control.

5.1.3 Toxicity Test Results

Results of acute screening tests on ambient grab samples collected on May 2 and July 26, 2005 are provided in Table 5.2. Results of chronic static renewal toxicity tests on simulated effluent are presented in Table 5.3. No significant lethal toxicity was observed in acute tests on ambient grab samples and no significant lethal or sub-lethal toxicity was observed in chronic tests on simulated effluent.

Table 5.2 Results of acute toxicity screening tests on ambient grab samples collected on May 2 and July 26, 2005.

Sampling Date	Sampling Location	Test Organism	Test Concentration	% Survival at 48 Hrs.
5/2/05	D27-0	*P. promelas*	Control	100
			100%	100
		D. pulex	Control	100
			100%	100
7/26/05	D27-0	*P. promelas*	Control	100
			100%	100
		D. pulex	Control	100
			100%	100
	D6-3	*P. promelas*	Control	100
			100%	100
		D. pulex	Control	100
			100%	95

Table 5.3 Summary of results of chronic static renewal toxicity tests on simulated effluent using *Ceriodaphnia dubia* and *Pimephales promelas*.

Test Species	Test Concentration	Percent Survival	Mean Growth (mg/fish)	Mean Reproduction (neonates/female)
C. dubia	Control	100	NA	21.5
	1x	100	NA	29.5
	1.5x	100	NA	21.8
P. promelas	Control	100	0.424	NA
	1x	100	0.474	NA
	1.5x	100	0.449	NA

5.1.4 Toxicity Test Conclusions

Toxicity tests on ambient samples indicate no ambient toxicity in D27. Toxicity tests on simulated effluent indicate that the anticipated effluent concentrations of sulfate and TDS are not toxic to aquatic life.

6.0 MASS BALANCE MODEL

A steady state mass balance model was developed to evaluate sulfate, TDS, and chloride concentrations in D27 and D6 resulting from the Dell Power Plant discharge to D27. The model calculates flow and dissolved mineral concentrations at several key points in the D27, D6 and D1 drainage system (map with sampling points).

6.1 Flow Assumptions

Various assumptions were used to estimate the D27, D6, and D1 flow conditions used in the modeling scenarios. Flow relationships were based on the nearest flow monitoring station historical record. The USGS gauge (07046600) at the Right Hand Chute of Little River at Riverale, Arkansas was used to calculate a runoff coefficient per square mile of drainage. At this gauge, the contributing drainage area is 2,106 mi^2. The period for the USGS management of this gauge is 1947 to 1977. In 1981, the U.S. Army Corps of Engineers (COE) assumed operation and maintenance of this gauge. There is a significant difference in the calculated 7Q10 Low-flow data collected by the two agencies. The US COE 7Q10 data is approximately 40% lower than the USGS calculated 7Q10 data.

Environmental Consulting & Technology, Inc. (ECT 2001) prepared a 7Q10 Low-Flow Analysis for the Dell Power Plant Station (Table 6.1). The analyses showed that the 7Q10 flow in the Right Hand Chute of the Little River at Rivervale was 85 cfs. The USGS 7Q10 published value is 142 cfs. The lower 7Q10 value (85 cfs) was used in the 7Q10 model simulation to represent a conservative scenario.

To better understand the flow characteristics of the region and select representative flow data, FTN compared the USGS annual rainfall runoff to back calculated rainfall from the USGS flow data. The USGS Water Resources Investigations Report 84-4363 states the average annual runoff for the project site is 20 inches per year. The USGS Rivervale gauging station data back-calculated to average annual runoff is 18.3 inches. It was assumed that the USGS gauge station best represents the normal flow conditions for the study area. The period of record for the USGS data is 30 years and is considered a statistical significantly data set. The monthly flow conditions and statistics were calculated using the long term daily Riverale USGS Gauge data (Table 6.2). The long term, 10% low-flow (90% of flow are greater than) conditions were also calculated using the same USGS data. The long term 10% low-flow for the Right Hand Chute of the Little River is 406 cfs.

Table 6.1. 7-day low-flow analysis.

Return Period (years)	**7-Day Low Flow (1981 to 1998 data) (cfs)**
1.01	440
2	235
5	129
10	85
25	50
50	34
100	23

Table 6.2. Monthly flow data summary (units are Cubic Feet per Second – CFS).

Flows	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average	4231	4702	4953	4777	3841	2562	1769	1129	934	883	1645	2772
Maximum	28200	29100	23800	33500	23700	19000	12100	7380	6230	7510	31300	14800
Minimum	303	287	488	960	698	546	241	168	88	101	80	212
# of Days	930	848	930	930	944	930	961	961	926	930	900	930
Sdev Month	4680	4726	3738	4060	3724	2203	1466	886	856	1083	3258	2919
Skew Month	2.31	2.32	1.92	2.58	2.36	3.16	3.35	3.32	2.64	3.60	5.37	1.66
Exceedence												
1%	23242	23206	20000	21597	18457	12042	8930	5358	4235	6748	16116	12971
5%	13575	14830	12600	11500	12185	7708	4490	2550	2858	2606	6202	8752
10%	9250	10590	9722	9323	8641	4266	3030	1910	1895	1975	2831	7532
20%	7022	6330	6758	7164	5228	3262	2200	1470	1270	1060	1762	4884
50%	2520	2940	4000	3810	2320	1830	1370	920	680	617	787	1525
80%	888	1634	2088	1580	1556	1300	897	542	368	242	312	637
90%	430	851	1679	1330	1220	1099	682	430	268	177	241	392
95%	380	643	1227	1220	1012	937	568	335	175	153	190	333
99%	341	380	742	1100	820	792	408	253	124	124	129	277
Harmonic Mean	1397	2057	3031	2757	2227	1785	1210	769	517	408	531	1017

The Dell Power Plant discharge flow rate used for the mass budget modeling was set to 700 gpm (approximately 1 MGD).

6.2 Sulfate, TDS, and Chloride

The May and July, 2005 data used in the model for predicting in-stream concentrations were assumed to be representative of water quality conditions in the ditches (Table 6.3).

Table 6.3. Measured water quality values downstream of D27 and D6 confluence.

Parameter	May 2005 Sampling Event	July 2005 Sampling Event	Average Concentration at Rivervale
Sulfate (mg/L)	17	11	17.6
TDS (mg/L)	240	220	102
Chloride (mg/L)	6.4	4.1	9.1

The Dell Power Plant effluent water quality was predicted by GE/Betz, a power plant water treatment chemical representative, based on an estimated eight cycles in the cooling towers. The pertinent predicted parameters are listed in Table 6.4.

Table 6.4. Modeled effluent water quality and flows.

Parameter	Outfall 001 (based on 8 cooling tower cycles)
Discharge Flow (gpm)	700
Sulfate (mg/L)	480
TDS (mg/L)	1200
Chloride (mg/L)	11

6.3 Model Calibration

The model was calibrated by comparing the model's calculated values to the measured May and July sampled values without including the proposed Dell Power Plant discharge. The results of the model calibration runs are in located in Appendix E.

6.4 Model Results and Predictions

The steady state model simulated three flow conditions; the harmonic mean, 10% Low-Flow, and 7Q10 flow conditions. The harmonic mean flow condition was evaluated based on the ADEQ's use of harmonic mean flow values to calculate minerals NPDES discharge permit limits. The 10% low-flow condition model represents flow conditions that would not be exceeded for 90% of the time. The 7Q10 flow condition was used to evaluate a worse case scenario and the ADEQ staff indicated this flow condition should be used for evaluation criteria modifications. Results of the modeled conditions are summarized in Table 6.5.

The predicted effluent chloride concentrations are below the ARWQS prior to discharging. Therefore it was assumed that chloride will not exceed ARWQS and this parameter was not considered for the remaining evaluations.

The predicted D27 water quality at its mouth, including the Dell Plant discharge, exceeds ARWQS for TDS and sulfate under all flow conditions modeled.

Only the sulfate ARWQS in D6, at the confluence of D27 and D6, was exceeded in the 10% low-flow (73 mg/L) and the harmonic mean flow simulation (46 mg/L) at this location. TDS and sulfate concentrations in D6 at confluence of D27 and D6, were exceeded during both the 7Q10 low-flow condition (201 and 623 mg/L, respectfully).

Under 7Q10 low-flow, 10% flow, and harmonic mean flow condition simulations, on the predicted sulfate concentrations exceed ARWQS in the Tyronza River immediately downstream of the D6 inflow (59 mg/L, 36 mg/L and 31 mg/L, respectively). TDS ARWQS were not exceeded under any flow condition in the Tyronza River.

No TDS or sulfate exceedences in the St. Francis River were predicted by the model under any of the flow conditions modeled.

Table 6.5. Mass budget model summary.

		St. Francis Watershed											
		Ditch 27 Mouth			Ditch No. 6 Immediately D/S of Ditch No. 27			Tyronza River Immediately D/S of Ditch No. 6			St. Francis River Immediately D/S of Tyronza River		
Parameter	**001 Effluent Conc.**	**7Q10**	**10% Low-Flow**	**Harmonic Mean**	**7Q10**	**10% Low-Flow**	**Harmonic Mean**	**7Q10**	**10% Low-Flow**	**Harmonic Mean**	**7Q10**	**10% Low-Flow**	**Harmonic Mean**
Flow (gpm)	700	758	977	1,280	1,750	5,730	11,200	9,790	31,600	65,400	164,000	513,000	1,073,000
S04 (mg/L)	478	443	347	269	201	73	46	59	[illegible]	[illegible]	20	19	18
TDS (mg/L)	1200	1,130	928	765	623	357	300	307	260	249	244	241	240

Existing Water Quality Standard Predicted to be Exceeded (shaded)

	S04 (mg/L)	TDS (mg/L)
Delta Ecoregion (Plate D-2) Water Quality Standard	37	411
Tyronza River Water Quality Standard	30	350
St. Francis River @ Mouth Water Quality Standard	30	330

D/S = Downstream

7.0 EXISTING USES

The following sections provide an evaluation of existing uses in D27 and D6 as indicated by the results of the field survey and other observations.

7.1 D27

7.1.1 Secondary Contact Recreation

This use was assigned by default to D27 and is assumed to be an existing use because theoretically people can come in contact with water in D27. However, the field surveys did not find evidence that this is an existing use. The physical conditions (2:1 side slopes, lack of consistent flow, mud bottom, etc.) are not conducive to secondary contact recreation in this ditch system.

7.1.2 Industrial Water Supply

D27 is not presently used as a source of water for industry and no evidence of such use was discovered during the field surveys.

7.1.3 Agricultural Water Supply

The Arkansas Natural Resources Conservation Commission (ANRCC) requires that irrigation (or other) water withdrawals from these drainage ditches be registered. No ANRCC registered water withdrawals exist for D27. D27 functions as drainage ditch to convey runoff from rain and irrigation. As such, flows in this ditch are either non-existent or minimal during much of each year (i.e. it is not a dependable water supply). D27 is not presently used as a source of water for irrigation or livestock watering and no evidence was discovered during the field surveys that it ever has been.

7.1.4 Domestic Water Supply

For the same reasons stated in 7.1.3, it is not likely that D27 has ever been used for domestic water supply. The field surveys did not find any evidence that D27 is presently used for domestic water supply. A review of the Arkansas Department of Health (DOH) public water supply database (http://www.healthyarkansas.com/eng/pwslist0.htm) verifies that D27 is not used for domestic water supply. The town of Dell provides water for its residents and those in the vicinity of D27.

7.1.5 Aquatic Life

An aquatic life use presently exists in D27 however it is impaired due to habitat. This ditch is a regularly maintained drainage ditch. Maintenance is performed by Subdistrict 3 of Grassy Lake and Tyronza Drainage District No. 9 with headquarters in Osceola, AR. The fish community in the ditch environments sampled in this study can be characterized as being dominated by sunfish and minnows. The benthic community in the ditch environments sampled in this study can be characterized as having low taxa richness dominated by snails and paleomonid decapods.

7.2 D6

7.2.1 Primary and Secondary Contact Recreation

These uses were assigned by default to D6. Although these are assumed to be potential existing uses because theoretically people can come in contact with water in D6, the field surveys did not find evidence that these are existing uses. The physical conditions (2:1 side slopes, lack of consistent flow, mud bottom, etc.) are not conducive to either primary or secondary contact recreation in these ditch systems.

7.2.2 Industrial Water Supply

D6, in the vicinity of the D6/D27 confluence and downstream to its mouth, is not reported to be used as a source of water for industry and no evidence of such use was discovered during the field surveys.

7.2.3 Agricultural Water Supply

The ANRCC requires that water withdrawals from any of these ditches as well as the Tyronza River be registered. The ANRCC does not list a registered water withdrawer from D6. The field surveys documented a potential water withdrawer (agricultural) at a location approximately 5 miles downstream of the D27/D6 confluence. Discussions with Drainage District staff indicated this entity uses D31 rather than D6 as a agricultural irrigation water source. There is no evidence of D6 water being withdrawn in the vicinity of the D27/D6 confluence as determined during the field surveys.

7.2.4 Domestic Water Supply

For the same reasons stated in 7.2.3, it is not likely that D6 has ever been used for domestic water supply. The field surveys did not find any evidence that D6 is presently used for domestic water supply. A review of the Arkansas Department of Health (DOH) public water supply database (http://www.healthyarkansas.com/eng/pwslist0.htm) verifies that D6 is not used for domestic water supply. A phone survey of towns in the vicinity along D6 indicated that groundwater is the primary drinking water source for these residents.

7.2.5 Aquatic Life

An aquatic life use presently exists in D6 however it is impaired due to habitat. This ditch is a regularly maintained drainage ditch. The benthic community in the ditch environments sampled in this study can be characterized as having low taxa richness dominated by snails and paleomonid decapods. The fish community in the ditch environments sampled in this study can be characterized as being dominated by sunfish and minnows.

7.3 Tyronza River

7.3.1 Primary And Secondary Contact Recreation

These uses were assigned by default to the Tyronza River and it is assumed that they are existing uses.

7.3.2 Industrial Water Supply

ANRCC requires that withdrawals from the Tyronza River be registered. The ANRCC lists 3 registered water withdrawals (agricultural) from the Tyronza River and 10 from D31, upstream of the Tyronza River, none of which are for industrial purposes.

7.3.3 Agricultural Water Supply

ANRCC requires that withdrawals from the Tyronza River be registered. The ANRCC lists 3 registered water withdrawals from the Tyronza River downstream of where D31 becomes the Tyronza River. The ANRCC database lists 10 registered withdrawers from D31 (upstream of the Tyronza River). These withdrawals are for agricultural uses.

7.3.4 Domestic Water Supply

A review of the Arkansas Department of Health (DOH) public water supply database (http://www.healthyarkansas.com/eng/pwslist0.htm) verifies that the Tyronza River is not used for domestic water supply.

7.3.5 Aquatic Life

The Tyronza River represents a low gradient, channel altered stream typical of the Delta Ecoregion. Fish communities within this ecoregion are typically comprised of fish species tolerant of relatively low dissolved oxygen and turbid conditions. The following species of fish have been collected within the Tyronza River (Robison and Buchanan 1986): gizzard shad (*Dorosoma cepedianum*), common carp (*Cyprinus carpio*), pugnose minnow (*Notropis emiliae*), bluntnose minnow (*Pimephales notatus*), black bullhead (*Icatalurus melas*), channel catfish (*Icatalurus punctatus*), black-spotted topminnow (*Fundulus olivaceus*), mosquitofish (*Gambusia affinis*), green sunfish (*Lepomis cyanellus*), warmouth (*L. gulosus*), longear sunfish (*L. megalotis*), bluegill (*L. macrochirus*), largemouth bass (*Micropterus salmoides*) and freshwater drum (*Aplodinotus grunniens*).

7.4 Conclusions

This evaluation of existing uses in D27, D6 and the Tyronza River indicates the following:

1. It is possible, though unlikely that secondary contact recreation occurs in D27 and that primary and secondary contact recreation occurs in D6 and the Tyronza River,
2. A lack of consistent flows prohibits domestic, agricultural or industrial water supply uses from becoming existing uses for D27,
3. Adequate flow exists in D6 and the Tyronza River to support agricultural or industrial water supply use as existing,
4. The existing aquatic life use for both D27 and D6 can be characterized as a fish community dominated by sunfish and minnows, and a benthic community having low taxa richness dominated by snails and paleomonid decapods. The existing aquatic life use in these ditch systems represent a limited Channel-Altered Delta Ecoregion fishery.
5. Biological samples (fish, macroinvertebrates) were not collected to evaluate the existing aquatic life use in the Tyronza River: however, the species collected/ identified in this waterbody and reported the literature are what would be expected in a Delta Ecoregion Channel-Altered fishery.

8.0 ATTAINABLE USES

This Section evaluates predicted attainable uses in D27 and D6 in the presence of the plant discharge. This evaluation is based on predicted effluent flows and water quality as presented in Section 6.

In evaluating attainable uses for D27 and D6, it is assumed that the Dell Power Plant discharge is occurring at maximum predicted flow, TDS, SO4 and temperature at low flow conditions (i.e. at effluent characteristics of 1,200 mg/L TDS, 480 mg/L SO4, <15 mg/L chloride, temperature 95°F and 700 gpm flow).

8.1 D27

8.1.1 Secondary Contact Recreation

This use was assigned by default to D27. Although this is assumed to be an existing use because theoretically people can come in contact with water in D27, the field surveys did not find evidence that this is an existing use. The physical conditions (2:1 side slopes, lack of consistent flow, mud bottom, etc.) are not conducive to secondary contact recreation in these ditch systems. Therefore, hydrologic and water quality changes due to the Dell Power Plant Discharge should not affect the attainability of this use.

8.1.2 Industrial Water Supply

Changes in water availability due to the Dell Power Plant discharge should not effect the attainability of an industrial water supply use for this ditch.

8.1.3 Agricultural Water Supply

According to information provided by the University of Arkansas Agricultural Extension Service[2] a water supply suitable for irrigation should provide minimum flows of 5, 10 or 15 gpm per acre for center pivot, furrow and levee irrigation, respectively, of soybeans. Dry weather (July 2005) flow for the upper approximately two-thirds of D27 was zero. Flow measurements at

[2] http://www.uaex.edu/Other_Areas/publications/HTML/MP197/chapter8_irrigation_methods.asp

the mouth of D27 during the May and July 2005 sampling periods were 11 and 5 gpm, respectively. These data indicate that agricultural supply is clearly not an attainable use in D27. An increase in D27 flows by 700 gpm, could provide a source of irrigation water for approximately 48 to 150 acres of agricultural land. The operational plan for the Dell Power Plant (i.e. an intermittent operation with basically no "set" schedule) would prohibit D27, even after discharge start up, from attaining an agricultural water supply use. However, because a slight potential exists for agricultural withdrawals from D27, the possibility of negative effects from the effluent on agricultural activities (i.e. crop viability) were investigated. Accordingly, literature values and guidelines for salinity tolerance for crops and salinity of irrigation waters were reviewed and summarized in the following sections.

As a related issue, a hydraulic analysis was performed on D27 to determine if the proposed discharge from Dell Power Plant would cause flooding problems for agricultural lands downstream of the Dell Power Plant. The flow capacity of D27 was determined using the software package FlowMaster v 7.0 and assuming a trapezoidal channel based on design drawing for the ditch from 1925. The ditch was designed to have a bottom width of 6 ft, with side slopes of 2:1 (H:V) resulting in a top width of about 38 ft assuming a design depth of approximately 8 ft as shown on the 1925 design drawings. Field measurements taken in May 2005 showed the ditch to have a bottom width of the order of 10 ft, a depth of approximately 10 ft, and a top width of the order of 65 ft to 70 ft. This is not unexpected because D27 was cleaned out or dredged in 2001. This indicates the use of design criteria for the capacity analysis is conservative.

The hydraulic analysis consisted of determining the flow capacity of the ditch at 0.1 ft depth of flow increments at four different roughness or Manning n values (0.0, 0.25, 0.03, 0.035, 0.04). For a roughness of 0.035, which represents a natural channel with vegetation, the capacity of the ditch at a design full flow depth of 8 ft is about 520 to 530 cfs. Adding 1 cfs discharge from the power plant to this capacity, would not result in a measurable increase in stage. The computed result is less than 0.01 ft. This analysis should be considered conservative because the existing channel is larger than the design channel and the assumed roughness is less than the existing roughness.

It is therefore concluded that the proposed discharge to D27 would not have any measurable impact on flow conditions in the ditch.

8.1.3.1 TDS

The most commonly used guideline for salinity tolerance of crops is Ayers and Westcot (1985). In this document, yield potentials for a number of crops are associated with soil and water salinity values measured as electrical conductance. Salinity values associated with yield potentials for cotton, soybeans, and rice are summarized in Table 8.1. The water salinity values reported in Ayers and Westcot (1985) have been calculated from the soil salinity values reported (ECw= ECe/1.5). TDS values shown in Table 8.1 were calculated from the conductivity values (TDS = 650*Conductivity). The calculated irrigation water TDS values summarized in Table 8.1 indicate that an effluent TDS of 1000 mg/L would not be expected to negatively affect crop productivity.

Table 8.1 Influence of soil salinity (Ece) and irrigation water salinity (Ecw) on crop tolerance and yield potential of selected crops (Ayers and Westcot 1985).

Crop	Parameter	100% yield		90% yield		75% yield		50% yield		0% yield	
		ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw
Cotton	Cond, dS/m	7.7	5.1	9.6	6.4	13	8.4	17	12	27	18
	TDS, mg/L		3315		4160		5460		7800		11700
Rice	Cond, dS/m	3	2	3.8	2.6	5.1	3.4	7.2	4.8	11	7.6
	TDS, mg/L		1300		1690		2210		3120		4940
Soybean	Cond, dS/m	5	3.3	5.5	3.7	6.3	4.2	7.5	5	10.	6.7
	TDS, mg/L		2145		2405		2730		3250		4355

The U.S. Salinity Laboratory, USDA-ARS, has calculated linear regressions of irrigation water salinity (measured as the conductivity) to relative rice yield measurements based on experiments conducted in the late 1990s (Zeng and Shannon 2000). These relationships are based on the response of rice to sodium chloride (NaCl) solutions of various strengths that were used for irrigation in the experiments. Table 8.2 shows irrigation water conductivities for relative yields of grain weight per panicle and grain weight per plant that correspond to the yield potentials that are shown in Table 8.1. These values were calculated using Zeng and Shannon's (2000) linear regression equations. TDS values in Table 8.2 are calculated using the same equation as for Table 8.1 values. The linear regression relationships developed by the U.S. Salinity Laboratory indicate that a TDS (due primarily to NaCl) of 1000 mg/L could reduce rice productivity by about 10%. Tacker *et al.* (1994) also report that irrigation water with conductivity greater than 1.2 dS/m (approximately 780 mg/L TDS) is borderline for use on rice. The University of Arkansas Cooperative Extension Service reports that levels greater than 770 ppm in irrigation water for rice are cause for concern (www.aragriculture.org/agengineering/irrigation /crop/rice/quality.asp).

Table 8.2 Irrigation water salinity for selected relative rice yield measurements calculated using U.S. Salinity Laboratory linear regression equations (Zeng and Shannon 2000).

Yield Measurement	Parameter	Percent Yield				
		100	90	75	50	0
Grain weight per panicle (1)	Cond, dS/m	0.49	1.71	3.54	6.59	12.68
	TDS, mg/L	317	1110	2299	4280	8244
Grain weight per plant (2)	Cond, dS/m	0.46	1.52	3.12	5.78	11.10
	TDS, mg/L	297	989	2026	3755	7212

1. ECw = (1.040 - relative yield)/0.082, r^2=0.87
2. ECw = (1.043 – relative yield)/0.094, r^2=0.83

8.1.3.2 Sulfate

Sulfate in irrigation is generally considered to be beneficial to crops rather than harmful (Tracy and Hefner 1993, Bauder *et al.* 2004, Glover 2001, Baser and Gilmour 1982). James *et al.* (1982) classify irrigation water with sulfate concentrations of 673 mg/L to 1153 mg/L and TDS concentrations of 488 mg/L to 1300 mg/L as useable for crop irrigation when leaching is used. The proposed sulfate limit is less than 673 mg/L, so no negative effect on crop yield from sulfate is expected. It has been found (Baser and Gilmour 1982) that SO_4^{2-} in the soil forms gypsum ($CaSO_4$), which is insoluble. This reaction acts as a mechanism to limit the amount of SO_4^{2-} that can dissolve and damage rice or other crops.

The available literature information indicate that a sulfate concentration in the range of 400 mg/L to 500 mg/L would not be expected to have a negative effect on crops.

8.1.3.3 Chloride

Soybeans are more sensitive to chloride levels than rice or cotton (the most tolerant). A threshold of 100 mg/L of chloride was identified by Arkansas researchers for soybeans (F. Miller 2005). Sherrard *et al.* (1987) recommend chloride concentrations <250 mg/L for irrigation water. James *et al.* (1982) classify irrigation water with >12 mg/L of chloride and conductivity >2000 umhos (approximately 1300 mg/L TDS) as being of doubtful use. Tacker *et al.* (1994) state that irrigation water with chloride concentrations >3 mq/L (100 ppm) are not recommended for rice production. Foliar injury to cotton can result when sprinkler water has chloride levels >700 mg/L (Tanji 1990, Bauder *et al.* 2004). Soybean cultivars vary in their chloride tolerance (Ames *et al.* 2000, Rupe *et al.* 2000).

8.1.3.4 Conclusions: Agricultural Water Supply as an Attainable Use for D27

The overall conclusion is that the low flow volume and intermittent nature of this proposed discharge makes it extremely unlikely that agricultural interests bordering in D27 would attempt to use these flows as irrigation water. If the undiluted effluent were somehow used to irrigate crops, the proposed sulfate and chloride levels in the effluent are not expected to affect yields of rice, soybeans, or cotton. The proposed TDS criteria of 1,200 mg/L is not expected to negatively affect rice which is more sensitive to salinity (TDS) than soybeans and cotton. The threshold for effects of TDS on rice yield reported by the FAO is 1300 mg/L (Ayers and *Westcot*, 1985) whereas the University of Arkansas Cooperative Extension reports that conductivity (TDS) greater than 770 ppm could cause decreased rice yields. The literature studies reviewed focused on TDS <u>due solely or primarily to sodium chloride</u>, which is the most harmful form of TDS to crops (Ayers and *Westcot*, 1984). Because the TDS in the Dell effluent is due primarily to sodium, calcium, magnesium and sulfate salts, TDS concentrations in the range of these reported values should have little or no adverse effects if applied directly to crops.

8.1.4 Public Water Supply

Public water supply is not an attainable use for D27 due to cessation of flows that will occur in the late summer and early fall.

8.1.5 Aquatic Life

With increased flows, available habitat in D27 will increase. Benthic invertebrate and fish communities present in D6 provide a representation of the communities that might be expected with increased flows in D27. Therefore the existing aquatic life use in D6 represents the attainable aquatic life use in D27 in the presence of the plant discharge. Increases in flow due to the effluent will also cause increases in TDS, sulfate as well as increases in temperature which theoretically could affect D27's ability to achieve its attainable aquatic life use. The following two Sections discuss potential impacts from dissolved minerals and temperatures from the effluent, if discharged to D27.

8.1.5.1 Potential D27 Toxicity Due to TDS and Sulfate

Three lines of evidence that are discussed in the following subsections can be applied to address the possibility of toxicity done to increased TDS and sulfate from the effluent being discharged to D27.

1. Results of toxicity test on simulated effluent indicate that anticipated effluent concentrations of TDS and sulfate will not be toxic to aquatic life.
2. Little direct information on the toxicity of dissolved minerals or sulfate to mollusks is available in the published literature. However, unpublished data on sulfate toxicity were obtained from Dr. David Soucek (Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820, 217-265-5489) for juvenile fatmucket mussel (*Lampsilis siliquoidea*). In addition, unpublished sodium chloride reference toxicant data were obtained from Dr. Gregory Cope (North Carolina State University, Department of Toxicology, Raleigh , NC 27607, (919) 515-5296) for juvenile and glochidia wavyrayed lampmussel (*Lampsilis fasciola*), eastern creekshell (*Villosa delumbis*), notched rainbow (*V. constricta*), eastern elliptio (*Elliptio complanata*), fatmucket (*L. siliquoidea*), pink mucket (*L. abrupta*) and black sandshell (*Ligumia recta*) mussels. These data are summarized in Tables 8.3 and 8.4. Acute 96 h LC50 values for sulfate ranged from 1822 mg/L to 3729 mg/L depending on hardness and chloride concentration (Table 8.3).

Toxicity of sodium chloride ranged from 560 mg/L to 6310 mg/L (Table 8.4). The information summarized in Tables 8.3 and 8.4 indicates that anticipated receiving stream concentrations of sulfate and TDS are well below toxic levels to clams/mussels.

Table 8.3. Acute toxicity (96 h LC50) of sulfate to juvenile fatmucket mussels (*Lampsilis siliquoidea*), at various levels of hardness and chloride.

Hardness (mg/L)/ Chloride (mg/L)	96h LC50 (Sulfate, mg/L)
100/25	3377
300/25	3525
500/25	3729
100/5	1727
100/33	1822

Source: Unpublished data provided by Dr. David Soucek (Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820, 217-265-5489)

Table 8.4. Acute toxicity of sodium chloride (NaCl) to juvenile (96 h acute) and glochidia (48 h acute) life stages of several mollusk species.

Species	life stage	LC50 (NaCl mg/L)
Elliptio complanata	glochidia	2230
Lampsilis abrupta	juvenile	4110
L. fasciola	glochidia	1740
	juvenile	3980
L. siliquoidea	glochidia	560
	juvenile	6310
Ligumia recta	juvenile	4290
V. constricta	glochidia	2590
Villosa delumbis	glochidia	3630
	juvenile	5230

Source: Unpublished reference toxicant data obtained from Dr. Gregory Cope (North Carolina State University, Department of Toxicology, Raleigh , NC 27607, 919-515-5296)

3. Information collected from other TDS and sulfate impacted streams is available in a study conducted by FTN Associates, Ltd. (FTN) in streams impacted by acid mine drainage (FTN 1990) in the upper Hurricane Creek (AR) watershed. This study included concurrent water chemistry, benthic macroinvertebrate and fish sampling performed during low flow conditions in a Gulf Coastal ecoregion headwater stream impacted by TDS and sulfate. Sampling was performed at 4

impacted stations. The range and average values of conductivity, TDS and sulfates for the 4 stations are provided in Table 8.5.

Table 8.5 Ranges of TDS, conductivity and sulfates in 4 impacted streams in the upper Hurricane Creek watershed (from FTN 1990).

Parameter	Values from Samples Collected During Low Flow	
	Average	Range
TDS (mg/L)	1070	880-1200
Conductivity (uS)	1542	1350-1700
Sulfate (mg/L)	662	690-750

Habitat in these streams was characteristic of headwater streams in the Gulf Coastal Plain ecoregion and contained significant portions of cobble/gravel riffle as well as pools. Therefore the biological collections in these habitats represents the potential fish and benthic macroinvertebrate diversity in high TDS and sulfate environments that are less habitat limited than the ditch environments sampled in the present study.

Benthic macroinvertebrate samples from the Hurricane Creek locations included a total of 34 taxa. The impacted sites contained representatives of all major aquatic insect orders including diptera, tricoptera, ephemeraptera, odonata, coleopteran, gaetropoda, negalaptera,. Because of clear differences in substrate (abundant gravel/cobble in the Hurricane Creek sites vs silt and fine organic detritus in the ditch sites), a comparison of taxa between the two sites is not warranted. However, the taxa richness in the Hurricane Creek sites indicates that sulfate and TDS concentrations in excess of those predicted to occur in the presence of the Dell Power Plant discharge will support benthic invertebrate communities at least as rich taxonomically as what is now present in the ditch locations sampled.

Fish collections from the Hurricane Creek locations produced 28 species of fish. Although there are distinct zoogeographical differences expected between the fish communities of the Delta and Gulf Coastal Plain ecoregions, a number of overlap species can be identified. Table 8.6 compares fish species present in the Hurricane Creek and ditch locations of the present study. The table shows that most of the species present in the ditch locations were also present in the TDS and sulfate impacted Hurricane Creek sites. Exceptions include *Fundulus notatus* (blackstripe topminnow), *Notropis maculata* (taillight shiner), *Pimephales notatus* (bluntnose minnow), *Cyprinus carpio*(common carp) and *Lepisosteus oculatus* (spotted gar) and Dorosoma petenenase (threadfin shad) which were found in the ditch collections but not in the TDS/sulfate impacted streams. Some of these differences are due to zoogeographical differences between Delta and Gulf Coastal Plain ecoregions. For example *N. maculata* does not occur in the Gulf

Coastal ecoregion (Robison and Buchanan 1984) and *F. notatus* is uncommon. However, *F. olivaceus* is cogeneric with *F. notatus* and was abundant in the TDS/sulfate impacted streams. *C. carpio, L. oculatas, and D. petenense* may have been absent in the Hurricane Creek collections due to a general lack of quiet backwaters and pools which are favored by those species (Robison and Buchanan 1984). Only *P. notatus,* which is common Gulf Coastal ecoregion, but absent in the Hurricane Creek collections would seem to be potentially adversely affected by high TDS and/or sulfate. This comparison provides a strong indication that the attainable fish community in D27 will not be adversely impacted by the anticipated TDS and sulfate concentrations in the Dell Power Plant discharge.

The three lines of evidence presented above strongly suggest that increases in TDS sulfate and temperature due to increased flow from the Dell Power Plant discharge will support potentially attainable aquatic life uses in D27.

Table 8.6 Comparison of species present in ditch environments with their presence or absence present in TDS/sulfate impacted Hurricane Creek headwater streams.

Species Present	
Ditch Environments	**Hurricane Creek**
Lepomis cyanellus	present
L. gulosus	present
L. macrochirus	present
L. megalotis	present
L. microlophus	present
Micropterus salmoides	present
Gambusia affinis	present
Fundulus notatus	present
Notemigonus crysoleucas	present
Notropis atherinoides	present
N. emiliae	present
N. maculatus	not present
Pimephales notatus	not present
Cyprinis carpio	not present
Lepisosteus oculatus	not present
Dorosoma petenense	not present

8.1.5.2 Temperature Measurements in Ditch Environments

Semi-continuous temperature monitoring on July 26, 2005 at D27-0 (Figure 4.6) and D41 (Figure 4.12) indicates that maximum temperatures in the ditch environments may regularly reach and exceed the ecoregion temperature criterion of 32°C (89.6°F) during warm weather and may reach at high as 35°C (95°F) during portions of the day. As stated and supported in Section 3.4, effluent temperatures are not expected to exceed approximately 89°F (31.7°C). This information indicates that the temperature regime in D27 resulting from the Dell Power Plant discharge will not expose aquatic life to temperatures that they do not commonly experience under natural conditions.

Calculations were performed to evaluate potential thermal impacts to D27 and D6 during the winter when the difference between ambient and discharge temperatures is greatest. The Dell Plant effluent temperature was estimated for the confluence of Ditches 27 and 6 during January, the month when the coldest historical water temperature was measured in the St. Francis River (ADEQ site FRA0008). An effluent flow of 701.2 gpm was assumed, made up of heated cooling tower water mixed with plant flows at equilibrium water temperature. Average January meteorological conditions (wind speed, dew point temperature) for Memphis (the closest long term monitoring station) were used to calculate the equilibrium water temperature. These calculations indicated that water temperatures of the effluent at highest expected discharge temperature, are within 5°F of the equilibrium temperature by the end of Ditch 27.

8.2 D6

8.2.1 Primary, Secondary Contact Recreation

Although D6 could theoretically be used for primary and/or secondary contact, channel slopes and substrate make it undesirable for these uses. Predicted changes in water quality and flows due to the discharge should not effect the attainability of this use.

8.2.2 Industrial Water Supply

Predicted water quality and flows due to the discharge will not effect the attainability of this use.

8.2.3 Agricultural Water Supply

TDS and sulfate concentrations with the Dell Plant discharge predicted based on mass balance computations will be below concentrations of concern. The attainability of this use is not affected by the discharge.

8.2.4 Public Water Supply

The predicted TDS concentrations should exceed Secondary Drinking Water Criteria thereby requiring water treatment for this use. Even with the discharge to D27, flows in D6 will be intermittent as observed during the field study.

8.2.5 Aquatic Life

Increases in TDS, sulfate and temperature will be substantially less in D6 than in D27. Therefore, no impact on attainable aquatic life uses is anticipated.

8.3 Tyronza River

8.3.1 Primary, Secondary Contact Recreation

The Dell Power Plant discharge to D27 will not affect the attainability of these uses.

8.3.2 Industrial Water Supply

The Dell Power Plant discharge to D27 will not affect the attainability of this use.

8.3.3 Agricultural Water Supply

The Dell Power Plant discharge to D27 will not affect the attainability of this use.

8.3.4 Domestic Water Supply

The Dell Power Plant discharge to D27 will not affect the attainability of this use.

8.3.5 Aquatic Life

The Dell Power Plant discharge to D27 will not affect the attainability of this use.

8.4 Conclusions: Attainable Uses

This evaluation of attainable uses in D6, D27 and the Tyronza River indicates the following:

1. Attainable primary/secondary contact uses will not be affected by the presence of the Dell Power Plant discharge,
2. The sulfate and TDS concentrations in D27 and D6, with the discharge occurring, could preclude using these ditches as domestic water supplies without treatment for these constituents. The discharge to D27 will not affect the attainability of this use in the Tyronza River.
3. A marginal industrial or agricultural water supply (irrigation) use in D27 is possible due to the presence of the discharge. Literature information indicates that TDS and sulfate concentrations in the effluent will not be harmful to crops and will not impair this use,
4. The attainable agricultural and industrial water supply uses in D6 and the Tyronza River will not be affected by the discharge to D27.
5. Toxicity data and toxicity tests on simulated effluent indicate there will be no lethal or sub-lethal toxicity effects in D27, D6 or the Tyronza River due to sulfate or TDS levels predicted for the discharge.
6. Existing benthic invertebrate and fish communities in D6 and D27 represent the attainable aquatic life use with or without the increased flows from the Dell power Plant discharge,
7. The predicted "worst case" TDS and sulfate concentrations in D27, D6 and the Tyronza River due to the Dell Power Plant discharge will support the existing and attainable uses in these systems, and
8. Semi-continuous temperature monitoring indicates that water temperatures in these ditch systems commonly exceed the Delta Ecoregion temperature criterion but still support the existing uses in D27, D6 and the Tyronza River.

9.0 ALTERNATIVE EVALUATIONS

Cooling Tower (CT) blowdown from the AECI Dell plant, once it is completed, will contain elevated concentrations of dissolved minerals (TDS, sulfate and chloride) and temperature. The direct discharge of this wastewater would be the most direct and least expensive method for managing this wastewater. However, since the proposed receiving stream (D27) for this discharge is dry for much of the year, the elevated dissolved minerals and temperature concentrations downstream from the discharge would exceed ARWQS. Direct discharge would therefore require modified ARWQS and removal of the default use for D27 and D6, Domestic Water Supply.

UAA guidance requires that an evaluation be made of the alternatives to the direct discharge of the water. These alternatives should be evaluated for technical and economic considerations. Based on a number of similar evaluations in previous UAAs, the alternatives for management of effluents with elevated dissolved minerals are limited. Two alternatives that would be required in order to meet ARWQS are reverse osmosis treatment of the wastewater or pumping the wastewater to a larger stream that holds the potential for dilution of the minerals. Accordingly the following Section evaluates three alternatives to for an environmentally safe discharge of the plant effluent, namely:

- Reverse osmosis treatment to remove or reduce dissolved minerals,
- Pumping the wastewater to a larger stream that holds the potential for dilution of the minerals, or
- Site specific criteria for temperature, sulfate, and TDS.

The evaluation of these alternatives is documented in the following discussion.

9.1 TDS Treatment Through Reverse Osmosis

Wastewater technologies, such as conventional precipitation, can efficiently remove the heavy metals from wastewater to meet the effluent requirements. However, these systems do not remove the dissolved compounds like sulfate and TDS. As a result, the effluent flow from the treatment plant is limited by the dilution of the flow in the receiving stream to reduce these constituents to acceptable concentrations.

Reverse Osmosis (RO) is an advanced water/wastewater, treatment process capable of removing dissolved contaminants such as TDS, sulfate and chloride. It is essentially an extension of a filtration process in which highly pressurized feed water flows across a membrane, with a portion of the flow, identified as "permeate", going through the membrane. The rest of the feed is called "concentrate" because it carries off the concentrated contaminants rejected by the membrane. The concentrate amount depends on many factors and can vary between 10 to 30% of the feed. Depending on the size of the pores in the membrane, the process results in different classes of separation. For the removal of dissolved solids, a membrane capable of rejecting elemental particles must be utilized.

9.1.1 Technical Considerations

Based on the preliminary information available from equipment manufacturers, RO is a possible alternative treatment for the blowdown water to meet the limits for TDS and sulfate. The RO permeate would be of high quality and meet downstream ARWQS in this process.

The most common problems with RO involve the tendency for fouling problems when applied to concentrated waste streams and the cost of operation (i.e. electricity, membrane cleaning etc).

The disposal of the concentrated brine generated by this process is another problem if a direct discharge option is not available. In fact, this issue generally becomes the controlling factor in the selection of RO for many applications. RO separates the contaminants from water but it does not chemically change them to other non-polluting compounds. The concentrate would require disposal by other methods.

9.1.1.1 Concentrate Disposal Options

The brine solution may be solidified and disposed on site, transported off site for stabilization prior to landfilling, or transported off site to a municipal or industrial wastewater treatment system. The waste brine solution is not a hazardous waste in AR, but disposal in neighboring states may be restricted to industrial or hazardous waste facilities. Transportation will be a critical factor for two of the three options.

9.1.1.2 On Site Stabilization

The concentrate could be stabilized on site, using a cementitious element such as Portland cement or fly ash. This would require the construction of a mixing facility, purchase of the cementitious agent, crews and equipment to mix the waste solution, regulatory authority to dispose of the waste on site, and engineering support for selection and operation of a disposal area. The critical and unknown costs for this option are the mixing ratio for the waste solution/stabilization agent, and any required environmental protection controls for the disposal area. The mixing ratio determines the tonnage necessary for purchase of the stabilizing agent, and the environmental protection controls could range from open disposal on land adjacent to the facility or the installation of a landfill with liners and caps.

9.1.1.3 Off Site Treatment

The wastewater could be transported off site by truck to an industrial or municipal wastewater treatment facility. It would be necessary to provide waste profile information to each facility to obtain cost information. For treatment and discharge, the treatment facility would need to be located at a site with capabilities for discharging to a large water body. The critical cost component would be the cost of transportation and the cost per disposal on a per gallon basis.

9.1.1.4 Off Site Stabilization

The wastewater could be transported to an industrial or municipal landfill for stabilization and disposal. Offsite disposal offers several advantages. The site earthwork balance does not have to account for on site disposal and there is a minimum of regulatory approval required when the waste is removed to an offsite facility. For local landfills, the costs may be lower than for landfills dedicated to industrial or hazardous waste, but the environmental control can differ from cell to cell, requiring more oversight of disposal operations.

9.1.2 Economic Considerations

The water analysis and the design flow requirements are primary considerations in the sizing and cost of the equipment. Pumps and piping that are associated with the RO process would be required along with controls, building, utilities etc.

9.1.2.1 Assumptions

The basic assumptions used in the analysis of costs are shown below:

1. An average of approximately 150 gallons/minute of water will be treated in the RO system.
2. Approximately 0.63 million gallons/year will be generated as brine solution reject from the RO treatment system and will require disposal.
3. The system will consist of a minimum of three RO units in series, and a holding tank to facilitate disposal of the concentrate.
4. The treated effluent will be discharged to waters of the US.
5. The waste brine solution will be 20% solids, 80% water.
6. The solution will be concentrated 100 times from the blowdown concentration expected for 8 cycles of concentration. Concentrations were developed based on anticipated blowdown characteristics (Table 3.2) and are listed in Table 9.1.
7. For the pipeline option, the pipe will be sized for the maximum expected flow rate. This corresponds to blowdown rates resulting from 2 cycles of operation.

The following cost information is based upon a three stage RO system, able to sequentially concentrate the CT water approximately 100 times. The concentrate could then be stored in an onsite holding tank.

The capital costs of installing RO treatment have been estimated by the US Army Corps of Engineers (USACE) to range from $1.44 to $2.13 per gpd. This is for a single stage RO unit. For a three-stage RO unit, it is estimated that the costs would be a factor of 1.5 higher. For purposes of this discussion, the costs for installing a RO system are estimated at $3 per gpd. This provides an estimated capital cost of the treatment system of approximately $650,000.

Table 9.1. Estimated concentrations of selected elements of RO brine based on anticipated blowdown characteristics.

Compound	Blowdown concentration mg/L	Potential Brine Concentration, mg/L
Aluminum (Al)	5.1*	N/A
Arsenic (As)	ND	-
Barium (Ba)	0.488	50
Beryllium	ND	-
Boron	0.88	88
Cadmium	0.001	.1
Chloride	11.2	1100
Chromium	0.01	1
Copper	0.011	11
Fluoride	1.2	100
Iron	12.8*	N/A
Lead	ND	-
Manganese	0.57	57
Nickel	0.008	0.8
Selenium	ND	-
Sodium	304.0	30,400
Zinc	0.056	6
Vanadium	ND	-

*Requires pretreatment

The USACE further estimated the operating costs of a RO system (less the costs of brine disposal) at about $0.001/gallon for a large scale treatment system. This cost would translate to an annual operating cost of about $63,000.

For both the capital and operating costs, the factors provided by the USACE may be low due to the relative size of this application. However, the cost estimates should provide a method for comparison. Also, as stated above, the costs of disposal of the concentrate actually becomes the controlling factor with this application .

For the disposal of the concentrate, the critical cost components for off site treatment or disposal are the cost of transportation and the per ton disposal fee for the waste. Safety Kleen provided a preliminary cost quote for a similar project of $1.00/gallon for transport and disposal at an Oklahoma facility. The use of a local landfill, if acceptance of the waste can be obtained, may lower that cost to about $0.60/gallon. Even at this lower cost, the annual costs associated with disposal would be about $378,000.

Therefore, based on these preliminary calculations, RO treatment would have a capital cost of about $650,000 and an annual operating cost of about $440,000.

9.2 Pipeline

The original NPDES permit application from TECO included a proposal for piping the plant effluent approximately 7 mile to the west of the plant to a large drainage ditch (D3). This proposal was designed to take advantage of the perennial upstream flow in the ditch in order to meet ARWQS for dissolved minerals and temperature. The NPDES Permit for the Dell Power Plant was issued to TECO based on this proposal.

This alternative would require that all of the blowdown wastewater from the plant be pumped the 7 miles to D3. It would have required the construction of a 10-inch diameter force main and a pump station with adequate capacity for the operation.

For this size pipeline, a polyethylene line could be routed underground. The estimated costs for this project would be about $100,000 for the pump station and about $25/linear foot for the installed pipe. Based on these preliminary estimates, the capital costs associated with the pipeline alternative would be about $1,050,000.

The primary operating costs for this option would result from the electrical costs associated with pumping and the maintenance of the pumping station and pipeline. This is estimated at about $40,000 annually.

9.3 Site specific Criteria

For the purpose of this evaluation, the predicted Dell Power Plant effluent concentrations were assumed to be adopted as modified water quality criteria for D27 (TDS-1,200 mg/L, sulfate-480 mg/L, temperature-95°F (35°C)) and modified values for TDS and sulfate (630 mg/L, 210 mg/L, respectively and temperature - 95°F (35°C)) will be adopted for D6 (from the D27 confluence to its mouth). In addition a site-specific sulfate criterion of 60 mg/L is assumed for the portion of the Tyronza River from the mouth of D6 to its confluence with the St. Francis

River. The UAA analyses discussed previously indicate that these criteria will be protective of existing uses in D27, D6 and the Tyronza River.

9.4 Summary of Costs

There are three options available for the management of the blowdown from the facility:

1. Direct discharge to the adjacent ditch which will result in concentrations of TDS and dissolved minerals above the ARWQS for the ecoregion,
2. Installation of a reverse osmosis treatment system, and
3. Installation of a pipeline to a larger ditch with increased dilution capability.

Table 9.2 provides a summary of the estimated with each option. Any capital and operating costs associated with the direct discharge option (e.g. effluent monitoring) would also be required in the other options and therefore, were not added to the cost estimates. The implementation costs refer to costs for the UAA study and consulting and legal costs to support the rule making process for change in ARWQS and/or criteria.

Table 9.2. Summary of capital, operating and implementation costs.

Option Description	Estimated Capital Cost	Estimated Annual Operating Cost	Implementation Cost
Discharge to Ditch (Site specific criteria or designated use sub-category)	-	-	$150,000
Reverse Osmosis treatment	$650,000	$440,000	-
Pump to Ditch 27	$1,050,000	$40,000	-

9.5 Conclusions

The information presented in this Section indicates that the most cost effective option for the Dell Power Plant discharge is direct discharge to D27. Implementing this option, however, will require removal of domestic water supply designated uses in D27 and D6, and modified water quality criteria for TDS, sulfate and temperature in D27 and D6, and sulfate in the Tyronza River.

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APPENDIX A

Use Attainability Analysis Work Plan
FTN Associates, Ltd.
April 28, 2005>

USE ATTAINABILITY ANALYSIS STUDY PLAN
DELL POWER PLANT DISCHARGE TO DITCH NO. 27 NEAR DELL, ARKANSAS

Prepared for

Associated Electric Cooperative Inc.
PO Box 754
Springfield, MO 65801-0754

Prepared by

FTN Associates, Ltd.
3 Innwood Circle; Suite 220
Little Rock, AR 72211

REVISED
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1. INTRODUCTION AND OVERVIEW

a. Associated Electric Cooperative, Inc. (AECI) is considering purchasing a partially completed Gas Fired Combined Cycle electric generating plant in Dell, Arkansas (Dell Power Plant).

b. TECO Power Systems (TECO) started construction on the plant in late 2001/early 2002. For various reasons, construction was halted with the plant being approximately 70% complete. Groundwater from the Wilcox Aquifer will be used to supply raw water for the Dell Power Plant.

c. Cooling tower (CT) blowdown from the plant, once it is completed, will contain elevated concentrations of dissolved minerals (sulfate, total dissolved solids (TDS), chloride) that will exceed Arkansas State Water Quality Standards (AR WQS) based on ecoregional values from least disturbed streams in the Delta.

d. The original National Pollutant Discharge Elimination System (NPDES) Permit Application from TECO, included a proposal for piping the plant effluent approximately 7 miles to the west of the plant to a large drainage ditch (Ditch No. 3 to take advantage of its perennial upstream flow in order to meet AR WQS. The NPDES Permit for the Dell Power Plant was issued by the Arkansas Department of Environmental Quality (ADEQ) to TECO on July 1, 2002.

e. AECI asked FTN Associates, Ltd. (FTN) to evaluate the potential for discharging the plant effluent to a nearby small ditch (Ditch No. 27) that originates at the southern property boundary of the Dell Power Plant.

f. Ditch No. 27 (Figure 1) is dry for most of the year and has no upstream flow at the point where the potential plant discharge would enter it. The ditch is approximately 4.3 miles long and empties to Ditch No. 6 which, in turn, eventually flows to the St. Francis River, 33 miles downstream of the Ditch Nos. 27/6 confluence.

g. Ditch Nos. 27 and 6 are components of a vast network of regularly maintained, man-made ditches constructed in Mississippi County in northeast Arkansas in the early 1900s. The primary purpose of the system was to drain this delta area in order to establish agricultural activities (Sartrain 1998). The drainage ditches are regularly maintained to established specifications (i.e. widths/depths) by Subdistrict 3 of Grassy Lake and Tyronza Drainage District 9 (headquarters in Osceola, AR).

h. It is assumed that both Ditch No. 27 and Ditch No. 6 retain the designated uses and associated AR WQS reflecting a delta, channel altered stream (APCE Regulation No. 2).

Figure 1. Ditch No. 27 in Mississippi County, Arkansas.

i. This document describes the approach for conducting a use attainability analysis (UAA) to determine if developing subcategory of use and Ditch No. 27 and modified AR WQS for sulfate, TDS, and chloride may be applicable for Ditch No. 27 and potentially, a portion of Ditch No. 6 for some distance downstream of its confluence with Ditch No. 27. There is the potential, depending upon dilution available in Ditch No. 6 and the Dell Power Plant effluent minerals' concentration and timing of the discharge, that a portion of Ditch No. 6 sulfate, TDS and chloride AR WQS may also be modified as part of this UAA.

j. At this time, it is anticipated that establishing a subcategory of use for these ditches that reflects actual attained (or potentially attainable) uses and associated AR WQS that protect these uses, will be appropriate. Developing a subcategory of use that accurately describes these ditches and applies appropriate criteria should address questions regarding whether or not default designated uses and default AR WQS apply to these systems man-made ditches.

k. It is not anticipated that the domestic drinking water supply use will be applicable to either ditch as a result of this UAA assuming a subcategory of use is established as anticipated. The current AR WQS for minerals in a generic channel altered stream in the Arkansas Delta are sulfate, chloride and TDS values of 37 mg/L, 48 mg/L and 411 mg/L, respectively. The proposed, modified AR WQS for Ditch No. 27 sulfate, chloride and TDS will be on the order of 400 mg/L, 100 mg/L and 1100 mg/L, respectively for a subcategory of use reflective of a regularly maintained, delta drainage ditch. The actual REVISED values for these proposed changes will be determined during the UAA process and development of the subcategory of use.

l. This Plan includes the following:

  i. Section 2: Background information and data applicable to these ditch systems and the Dell Plant effluent

  ii. Section 3: Pertinent Data/Information for the waterbodies and future effluent

  iii. Section 4: The technical approach for developing data and information to determine if alternate AR WQS are feasible and appropriate

  iv. Section 5: Proposed Schedule

  v. Section 6: References

2. BACKGROUND

a. Project History:

i. TECO began construction of a Gas Fired Combined Cycle Plant (the Dell Power Plant) in 2001 located in Dell, AR (Figure 2). In a Combined Cycle Plant, there is a primary combustion turbine driven by natural gas combustion. The exhaust from the combustion turbine goes to a boiler and steam generated from this boiler also is routed to assist with power generation.

ii. TECO obtained an NDPES Permit (AR0049425) on July 1, 2002, from the ADEQ for discharge of CT blowdown, filter backwash, and low volume waste (boiler blowdown, wastewater from water treatment and effluent from floor and yard drains (CFR 423.15)).

iii. The NPDES Permit was necessary in order for TECO to obtain financing for the plant. During the permitting process, the ADEQ Permit engineer indicated AR WQS for dissolved minerals (sulfate, chloride, TDS), metals (copper, zinc) and temperature could be exceeded by this discharge if it went to a local ditch and suggested TECO consider piping the discharge to a stream/ditch with perennial upstream flow to benefit from upstream dilution.

iv. To speed the permit approval, TECO agreed to construct an approximate 7 mile long pipeline to route Dell Power Plant effluent to Ditch No. 3 south of Big Lake Wildlife Management Area (west of Dell). Ditch No. 3 eventually flows into the Right Hand Chute of the Little River.

v. The Right-Hand Chute of the Little River is designated as an Ecologically Sensitive Stream due to the presence of the fat pocketbook mussel (Plate D-2, Delta Ecoregion, APCE Regulation No. 2).

vi. TECO did not complete construction of the Dell Power Plan and it remains at 60 to 70% complete.

vii. AECI has expressed an interest in purchasing the Dell Power Plant as a continued cycle gas operated power plant in an intermediate loaded capacity.

viii. AECI asked FTN to evaluate the potential for developing a subcategory of use and/or modifying AR WQS for dissolved minerals to allow the Dell Power Plant to discharge to a nearby small ditch (Ditch No. 27) that originates across County Road 346 from the plant. It is questionable whether a pipeline is necessary or even desired.

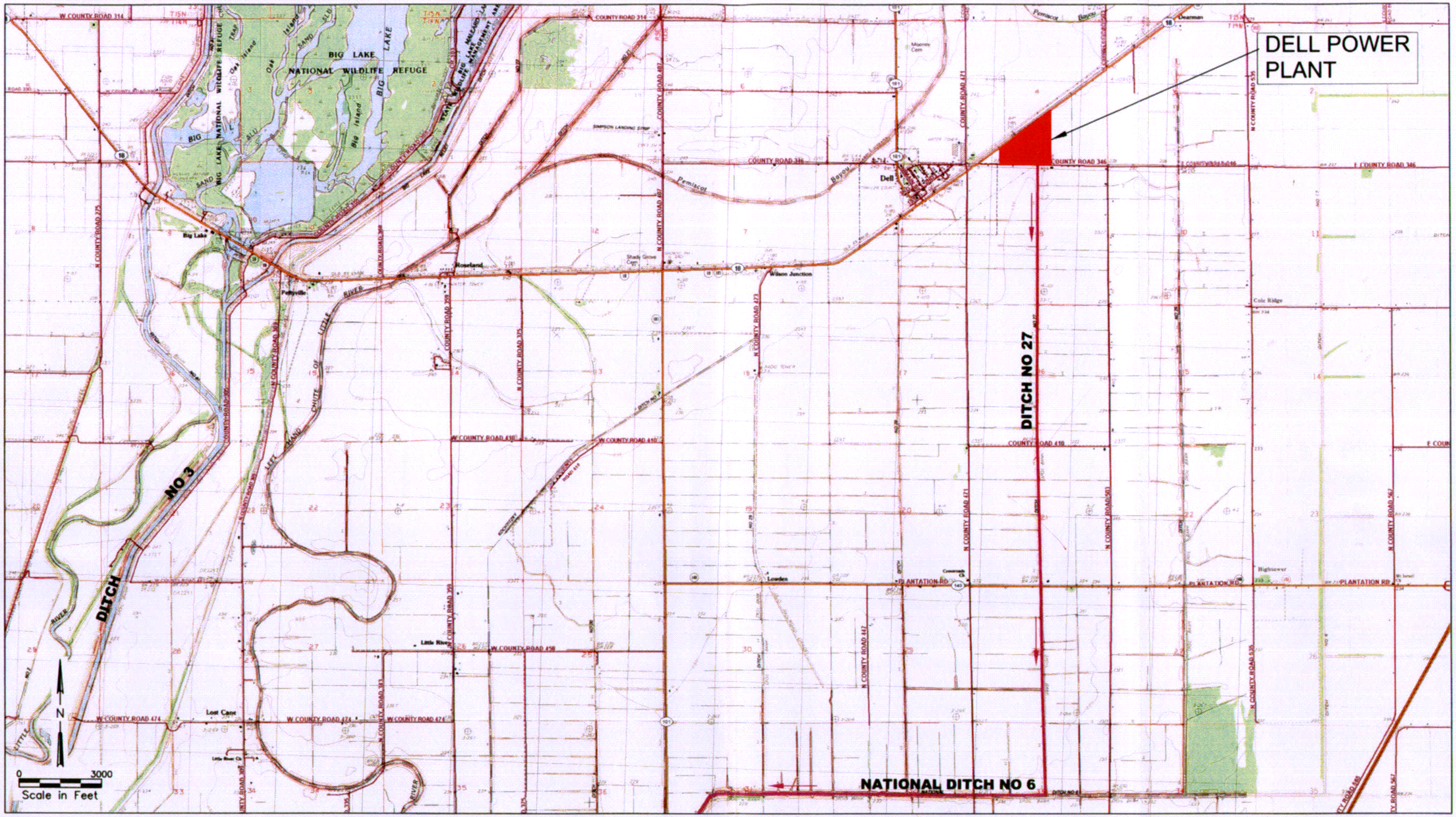

Figure 2. Project Location.

b. Ditch No. 27 Regulatory Background:

i. Ditch No. 27 is a man-made drainage ditch that was constructed in early 1900s as part of a vast ditch drainage system in Northeast Arkansas, particularly in Mississippi County.

ii. The ditch lies within Delta Ecoregion according to APCE Regulation No. 2 (Plate D-2 - although this small ditch is not shown on the plate).

iii. Applicable AR WQS:

1) Dissolved oxygen (DO) - (<10 square miles) Primary 5 mg/L, Critical 2 mg/L.

2) Dissolved minerals: Chloride 48 mg/L, Sulfate 37 mg/L, TDS 411 mg/L.

3) Designated Uses (assumed by default):

a) Secondary Contact

b) Domestic, Industrial and Agricultural Supply (questionable)

c) Seasonal Delta Fishery (questionable)

c. Ditch No. 6 Regulatory Background:

i. Ditch No. 6 is a man-made ditch that was constructed in Mississippi County Arkansas in the early 1900s.

ii. Ditch No. 6 lies within Delta Ecoregion (Plate D-2 of APCE Regulation No. 2) and is shown on this plate.

iii. Applicable AR WQS:

1) DO - (10 square miles to 100 square miles) Primary 5 mg/L, Critical 3 mg/L.

2) Dissolved minerals: Chloride 48 mg/L, Sulfate 37 mg/L, TDS 411 mg/L.

3) Designated Uses – (assumed by default):

a) Primary Contact Recreation (questionable)
b) Secondary Contact
c) Domestic, Industrial and Agricultural Supply
d) Perennial Delta Fishery (questionable)

3. PERTINENT DATA/INFORMATION

a. Ditch No. 27:

i. Originates at East County Road 346 just across the road (South) from the Dell Power Plant. There is a culvert under 346 at that point and additional drainage that enters the culvert (and Ditch 27) comes from the east in a roadside ditch along 346 starting approximately at County Road 503 (Figure 2). Drainage from the majority of the plant property flows south from Highway 18 and eventually into the culvert leading under 346 to Ditch No. 27.

ii. Is dry much of the year.

iii. Is approximately 4.3 miles long and flows south into Ditch No. 6 at its southern end.

iv. Is maintained regularly by Subdistrict 3 of Grassy Lake and Tyronza Drainage District 9. The Drainage District leases the right of ways for these ditches. Maintenance specifications for Ditch No. 27 (from the Drainage District) are:

1) Top Width: 38 ft

2) Top Depth: 8 ft

3) Bottom Width: 6 ft

4) Side Slopes: 2:1

v. Initial research into existing uses for Ditch No. 27 shows there are no existing or historical agricultural, domestic, industrial or other uses. This statement is based on:

1) A preliminary field reconnaissance.

2) A flyover with video taping and GPS positioning.

3) Interviews with Drainage District Officials in the Osceola, AR headquarters.

4) Telephone conversations with Arkansas State Soil and Water Conservation Commission (ASWCC) and review of the ASWCC water use registration records.

vi. An ASWCC Permit is required for any withdrawal from these ditches in this Drainage District. There are no registered permitted withdrawals from Ditch No. 27.

b. Ditch No. 6:

i. Flows approximately 33 miles from it's confluence with Ditch No. 27 eventually to the St. Francis River.

ii. Has no ASWCC registered water users (domestic, agricultural or industrial supply).

iii. Has significant dilution available immediately upstream of the Ditch No. 27 and Ditch No. 6 confluence due to an approximately 55 square mile watershed size at this point.

vi. Maintenance specifications for Ditch No. b (from the Drainage District) are:

1) Top Width: 112 ft

2) Top Depth: 18 ft

3) Bottom Width: 40 ft

4) Side Slopes: 2:1

c. Anticipated Dell Power Plant Effluent:

i. The Dell Power Plant will use groundwater from the Wilcox Aquifer in NE Arkansas for makeup water. Well completion depths are approximately 1,000 feet deep. Expected groundwater usage is approximately 4.7 to 5.6 mgd.

ii. The groundwater will be treated by granular filters prior to use in the plant to remove (other trace metals will also be removed by this process) as well as primarily solids.

iii. The Dell Power Plant design calls for pond prior to the discharge filter back-wash.

iv. The Dell Power Plant effluent is primarily CT blowdown. Dissolved minerals are concentrated in the CT blowdown due to evaporation. The blowdown (effluent) minerals' concentrations will exceed ecoregion based AR WQS and Secondary Drinking Water Standards for TDS and sulfate (500 mg/L and 250 mg/L, respectively). Drinking water standards for chloride should not be exceeded in the effluent and other AR WQS also should not be exceeded.

v. The predominant anion of the CT blowdown is sulfate which has inherent fertilizer value for agricultural usage. The projected effluent dissolved minerals' concentrations should not negatively affect crop production if this water is ever utilized for irrigation purposes. See Attachment No. 1 to this Plan for a discussion of potential effects of sulfate, chloride and TDS on agricultural activities in this area of Arkansas.

vi. Projected Dell Power Plant effluent minerals concentrations are not expected to be toxic to aquatic life.

vii. Any trace metals in CT blowdown are not expected to exceed AR WQS based on modeling and experience at similar plants for AECI technical staff.

viii. Water temperature of the plant effluent could exceed Arkansas' daily maximum temperature WQS of 89.6°F or the <5°F change in temperature WQS. It is documented frequently in the delta that ambient maximum water temperatures to exceed the daily maximum AR WQS. The question of whether a Delta fishery use is actually associated with either ditch is important regarding applicable AR temperature WQS. This issue will be addressed during the UAA as part of development of a subcategory of use for these drainage ditches.

4. PROJECT TECHNICAL APPROACH

a. The project technical objectives are to address the following questions:

   i. Is a Dell Power Plant discharge to Ditch No. 27 feasible and an environmentally acceptable alternative to building a 7 mile long pipeline to route the effluent to Ditch No. 3 and the Little River.

   ii. Is development of a subcategory of use, along with criteria to protect this subcategory of use, appropriately protective for Ditch Nos. 27 and 6 in lieu of default designated uses and associated AR WQS.

b. To accomplish the objectives, a comprehensive waterbody assessment will be performed to determine:

   i. The existing uses of Ditch Nos. 27 and 6.

   ii. What uses these waterbodies can support.

   iii. The approach contained within this Plan for developing the waterbody surveys is in accordance with:

      1) The United States Environmental Protection Agency (USEPA) Water Quality Standards Handbook (USEPA-823-B-94-005) Second Edition.

      2) The USEPA Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses (USEPA, November 1983).

      3) The Water Environment Research Foundation's reports "Suggesting Framework for Conducting UAAs and Interpreting Results (WERF 1997) and A Comprehensive UAA Technical Reference (WERF 1997).

c. UAA Technical Phase: This phase of the process includes development of a UAA Plan to lay out strategies and planned tasks for ADEQ and EPA review and comment. The technical phases of this UAA also include historical data compilation, sampling (physical/chemical/ biological) to characterize current conditions, and analysis and preparation of technical documentation for development of a subcategory of use and associated modified AR WQS for minerals.

   i. UAA Plan Development:

      1) FTN will prepare a UAA Plan (this document) that provides pertinent historical and regulatory information and history about the Dell Power Plant site and downstream drainages.

      2) The Plan describes the strategic and technical approach to the project for ADEQ/USEPA review and conceptual approval in order to identify and limit uncertainties in the process.

3) This Plan will be submitted to the Agencies in April 2005 in order to receive conceptual agreement for the approach in the Spring of 2005.

ii. Data Collection: Historical data compilation, review, and identification of data gaps will be performed. Of particular importance is the review of available historical data from the receiving streams to understand the biological communities present at the time designated uses were regulatory implemented (November 1975).

1) Sampling Periods: Late Spring (2005) high flow and Summer (2005) low flow sampling will be conducted.

2) Extent of Sampling: Data collection (chemical, physical, biological) will include all of Ditch No. 27, immediately upstream in Ditch No. 6 and within a reach of Ditch No. 6 approximately 1 mile downstream of the Ditch Nos. 27/6 confluence as well as a similar ditch in the vicinity.

3) Sampling Locations: Sampling locations (reaches) will be established at two locations (upstream/downstream) in Ditch No. 27, upstream of the Ditch Nos. 27/6 confluence on Ditch No. 6 (one location) and another location within the study reach in Ditch No. 6 downstream of the Ditch Nos. 27/6 confluence. A sampling station will also be located on an additional ditch in the vicinity that is similar to Ditch No. 27 (watershed, characteristics, size, etc.). This ditch will also be part of the Grassy Lake and Tyranza Drainage District.

4) Physical Data/Habitat: Physical data/habitat data will be collected from each sampling location and will include stream widths, depths, velocities, percent cover, substrate type, pool to riffle ratio, pool depths, widths, etc. following typical low gradient stream habitat assessment procedures.

5) Chemistry Data-In-situ Measurements (temperature, pH, DO, conductivity) will be collected at all stations during each sampling period. Continuous recording in-situ meters will be deployed during each sampling period at the mouth of Ditch 27, upstream of Ditch No. 27 in Ditch No. 6 and downstream of the Ditch Nos. 27/6 confluence.

6) Chemistry Data-Samples: Water samples will be collected at each station for each sampling period. Analytical parameters will include TDS, sulfate, chloride, metals, TSS and turbidity. Pesticides, herbicides and nutrients are not expected to be analyzed. These parameters may or may not be present in the

ditches but the Dell Power Plant effluent is not expected to contribute significantly to background levels for these parameters.

7) Biology: In addition to the habitat evaluation, benthics and fish will be sampled using standard methods (i.e. rapid bioassessment (Barbour, et. al, 1999) and electrofishing/netting) to evaluate aquatic biota of these ditch systems.

8) Toxicity Evaluations: In addition to the above sampling, the following toxicity evaluations will be conducted:

   a) Background acute test (48 hour static renewal) using minnows and ceriodaphnia on Ditch No. 27 and Ditch No. 6 water collected during each sampling period.

   b) Toxicity testing (7 day chronic test, single sample for renewals) using minnows and ceriodaphnia on synthetically prepared effluent to match predicted TDS, sulfate and chloride levels as well as approximately 1.5 times predicted effluent mineral concentrations.

iii. Analyses - the following types of analyses are anticipated:

1) An analysis of the hydraulic capacity of the receiving stream (Ditch No. 27) to evaluate if it has the capacity under wet weather conditions to handle effluent flows adequately.

2) An analysis of makeup water quality to assist with an to estimate of effluent water quality. This analysis will include groundwater sampling and model simulations to estimate effluent water quality.

3) Hydrologic and mass budget modeling to predict in-stream concentrations and dilution associated with the discharge of the water to Ditch No. 27 and thence to Ditch No. 6 and if these discharges will be protective of existing uses and any designated uses that may be applicable but not presently attained.

4) Use analyses, given the biological, chemical, and physical data, to determine existing and attainable uses. Data from the waterbody assessment will be compared to State criteria and EPA guidance to evaluate pollutants that may be limiting the attainment of the designated uses. Biological data will be evaluated to define what species exist in the water bodies evaluated (Ditch Nos. 27/6) in order to evaluate the health of the water bodies and determine what species could exist if the Dell Power Plant effluent was added to these systems.

5) Chemical and biological community analyses of the receiving streams.

6) Analysis of the toxicity evaluations to characterize the specific matrix of the effluent in relation to toxicity requirements versus USEPA screening levels. It is anticipated that this will be a key component of the technical justification process.

7) An alternatives analyses using engineering and economic evaluations of feasibility of removing or reducing the dissolved minerals' concentrations with available controls (i.e., address treatment feasibility of dissolved minerals) including:

   a) Treatment of the dissolved minerals in the effluent
   b) Piping the water to a dilution source
   c) An on-site discharge and modifying AR WQS

iv. Summary Report and Submittals: This task will involve preparing the technical report necessary to provide results of the waterbody assessments and determination if a subcategory of use/modified AR WQS are justified. The analysis and resulting report will be comprehensive and scientifically defensible. All data and analyses will be provided, integrated, and summarized to support a proposed subcategory use development and AR WQS modifications as necessary. The UAA Report will be submitted to ADEQ and EPA Region 6. Meetings with both ADEQ and EPA are planned in order to facilitate their understanding and review of the technical results and analyses.

v. Section 4.1.5 Stakeholder Coordination, Project Communications and Briefings: communication and coordination with parties (stakeholders) who will have an interest in the AR WQS changes will be necessary and addressed in the form of routine progress reports and presentations as necessary to address questions as well as third party rulemaking requirements. Based on experience with similar projects, the following stakeholders will likely be actively involved/interested in the UAA process at the Dell Power Plant.

1) The general public
2) Municipal and county governments
3) The Arkansas Department of Health
4) ADEQ
5) EPA Region 6
6) The APCE Commission
7) State and local legislators
8) US Fish & Wildlife Service (USFWS)
9) Any other point source dischargers Ditch No. 6
10) Local and/or downstream agricultural interests

vi. Section 4.1.6 Legal and Administrative Tasks: Once the technical justification for a new subcategory of use and modified AR WQS is developed, the following legal documents will be required during the UAA process. These documents, should they be justified and supported by the technical UAA analyses, will be prepared by appropriate legal and technical staff with previous UAA experience.

1) Petition for Third Party Rulemaking.
2) Various Public Notices.
3) Documents for the Full APCE Commission Review as well as The Rules and APCE Regulations Committee of the APCE Commission.
4) Documents for the Arkansas Legislative and Public Health Committees.
5) Responsiveness Summary to Public Comments.
6) Statements for Public Hearings.
7) Code Revisions to the Arkansas Code.
8) Others as necessary.

5. SCHEDULE

a. UAA Plan: FTN requests that the EPA and ADEQ facilitate their review of this Plan to provide feedback and technical input to the proposed approach and to limit uncertainty in later phases of the UAA. Conceptual agreement with this Plan is requested by the end of April 2005 although feedback following that date is obviously encouraged.

b. Technical Phases: FTN plans to complete the technical phases of the project by late summer of 2005. These technical phase tasks span wet and dry seasonal sampling periods in 2005 to address seasonal uses.

c. UAA Report: FTN will submit the REVISED UAA Report for agency review in October of 2005 and again petition the Agencies for expedited review in order to REVISEDize the report in January of 2006. At that time the REVISED report will be submitted for formal ADEQ and EPA review. We will enter into discussions and data exchanges with the Agencies prior to submitting the UAA Report to attempt to reduce agency review time to 3 months or less.

d. Administrative Rulemaking Processes: Assuming agreement between AECI and the Agencies, the rulemaking process will be initiated in order to develop the subcategory of use and modified AR WQS for the receiving stream(s). This task involves administrative and legal processes including:

   i. Preparation and submittal of a Petition for Third Party Rulemaking.

   ii. Public Notices.

   iii. Presentations before the APCE Commission and State of Arkansas legislative committees.

   iv. Development of a Statement of Basis for the proposed changes.

   v. Code Revisions to the Arkansas State Code.

   vi. It is estimated that this administrative process will take from 3 to 6 months to complete, depending upon the schedule for the legislative committees.

e. Total Project Timeframe: The total estimated project schedule for the tasks described above is estimated to end in June 2006 with agreement for the rule changes between parties assuming the technical justification is acceptable to the Agencies.

6. REFERENCES

a. Arkansas Pollution Control and Ecology Commission. April 23, 2004. Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas. Regulation No. 2.

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c. Environmental Protection Agency. November 1983. Technical Support Manual. Waterbody Surveys and Assessments for Conducting Use Attainability Analyses.

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e. Water Environmental Research Foundation. 1997. A Comprehensive Use Attainability Analyses Technical Reference Final Report.

Most references suggest that the anticipated effluent chloride concentration of <100 mg/L would not be expected to have a negative effect on crops.

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ATTACHMENT A

Preliminary Research Findings

Potential For Negative Affects On Crops Using Effluent For Irrigation

Estimated mineral concentrations in the Dell Power Plant effluent: 1000 mg/L TDS, 400 mg/L SO4, <100 mg/L Cl.

TDS

The most commonly used guidelines for salinity tolerance of crops is Ayers and Wocot (1985). In this document, yield potentials for a number of crops are associated with soil and water salinity values measured as electrical conductance. Salinity values associated with yield potentials for cotton, soybeans, and rice are summarized in Table 1. The water salinity values report in Ayers and Wocot (1985) have been calculated from the soil salinity values reported (ECw= ECe/1.5). TDS values shown in Table 1 were calculated from the conductivity values (TDS = 650*Conductivity). The calculated irrigation water TDS values summarized in Table 1 indicate that an effluent TDS of 1000 mg/L would not be expected to negatively affect crop productivity.

Table 1. Influence of soil salinity (Ece) and irrigation water salinity (Ecw) on crop tolerance and yield potential of selected crops (Ayers and Wocot 1985).

Crop	Parameter	100% yield		90% yield		75% yield		50% yield		0% yield	
		ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw
Cotton	Cond, dS/m	7.7	5.1	9.6	6.4	13	8.4	17	12	27	18
	TDS, mg/L		3315		4160		5460		7800		11700
Rice	Cond, dS/m	3	2	3.8	2.6	5.1	3.4	7.2	4.8	11	7.6
	TDS, mg/L		1300		1690		2210		3120		4940
Soybean	Cond, dS/m	5	3.3	5.5	3.7	6.3	4.2	7.5	5	10.	6.7
	TDS, mg/L		2145		2405		2730		3250		4355

The U.S. Salinity Laboratory, USDA-ARS, has calculated linear regressions of irrigation water salinity (measured as the conductivity) to relative rice yield measurements based on experiments conducted in the late 1990s (Zeng and Shannon 2000). These relationships are based on the response of rice to NaCl solutions of various strengths that were used for irrigation in the experiments. Table 2 shows irrigation water conductivities for relative yields of grain weight per panicle and grain weight per plant that correspond to the yield potentials that are shown in Table 1. These values were calculated using Zeng and Shannon's (2000) linear regression equations. TDS values in Table 2 are calculated using the same equation as for Table 1 values. The linear regression relationships developed by the U.S. Salinty Laboratory indicate that a TDS of 1000 mg/L could reduce rice productivity by about 10%. Tacker et al. (1994) also report that irrigation water with conductivity greater than 1.2 dS/m (approximately 780 mg/L TDS) is borderline for use on rice. The University of Arkansas Cooperative Extension Service reports that levels greater than 770 ppm in irrigation water for rice are cause for concern (www.aragriculture.org/agengineering/irrigation/crop/rice/quality.asp). Gilmour (2001) outlines management alternative that can lessen the potential for negative effects on rice crop yield when using water high in soluble salts.

Table 2. Irrigation water salinity for selected relative rice yield measurements calculated using U.S. Salinity Laboratory linear regression equations (Zeng and Shannon 2000).

Yield Measurement	Parameter	1 (100% yield)	0.9 (90% yield)	0.75 (75% yield)	0.5 (50% yield)	0 (0 yield)
Grain weight per panicle (1)	Cond, dS/m	0.49	1.71	3.54	6.59	12.68
	TDS, mg/L	317	1110	2299	4280	8244
Grain weight per plant (2)	Cond, dS/m	0.46	1.52	3.12	5.78	11.10
	TDS, mg/L	297	989	2026	3755	7212

(1) ECw = (1.040 - relative yield)/0.082, r2=0.87
(2) ECw = (1.043 – relative yield)/0.094, r2=0.83

SULFATE
No specific information was found on the potential for negative effects of sulfate in irrigation water. Sulfur and sulfates are necessary for healthy crops. Tracy and Hefner (1993) report that irrigation water with sulfate levels of at least 5 ppm provide needed sulfur to crops. Bauder et al. (2004), in reporting on irrigation water quality criteria for Colorado, note that very high concentrations of sulfate can interfere with the uptake of other nutrients. Glover (2001) in a discussion of irrigation water states that "the sulfate ion causes no particular harmful effects on soils or plants…" Baser and Gilmour (1982) found that sulfate salts had relatively little effect on rice. They found that SO_4^{2-} in the soil forms gypsum ($CaSO_4$), which is insoluble. This reaction acts as a mechanism to limit the amount of SO_4^{2-} that can dissolve and damage rice seedlings.

James et al. (1982) classify irrigation water with sulfate concentrations of 7 to 12 meq/L (approximately 673 to 1153 mg/L) and conductivity of 750 to 2000 umhos (approximately 488 to 1300 mg/L TDS) as useable for irrigating crops when leaching is used.

Therefore, a sulfate concentration in the range of 400 mg/L to 500 mg/L would not be expected to have a negative effect on crops.

CHLORIDE
Sherrard et al. (1987) recommend chloride concentrations < 250 mg/L for irrigation water. James et al. (1982) classify irrigation water with >12 mg/L of chloride and conductivity >2000 umhos (approximately 1300 mg/L TDS) as being of doubtful use. Tacker et al. (1994) state that irrigation water with chloride concentrations > 3 meq/L (100 ppm) are not recommended for rice production. Foliar injury to cotton can result when sprinkler water has chloride levels >700 mg/L (Tanji 1990, Bauder et al. 2004). Soybean cultivars vary in their chloride tolerance (Ames et al. 2000, Rupe et al. 2000). Gilmour (2001) states that management alternatives can be used to reduce negative effects on rice production from irrigation with high chloride concentrations.

APPENDIX B

Photographs of Sampling Locations
May 3-5, 2005

Figure B1. Ditch No. 27-0 looking downstream during the May sampling event.

Figure B2. Ditch No. 27-3 looking downstream during the May sampling event.

Figure B3. Ditch No. 27-3 looking upstream during the May sampling event.

Figure B4. Ditch No. 27-4 looking downstream during the May sampling event.

Figure B5. Ditch No. 28-1 looking downstream during the May sampling event.

Figure B6. Ditch 6-2 looking upstream during the May sampling event and hydrolab placement.

Figure B7. Ditch 6-3 looking downstream during the May sampling event.

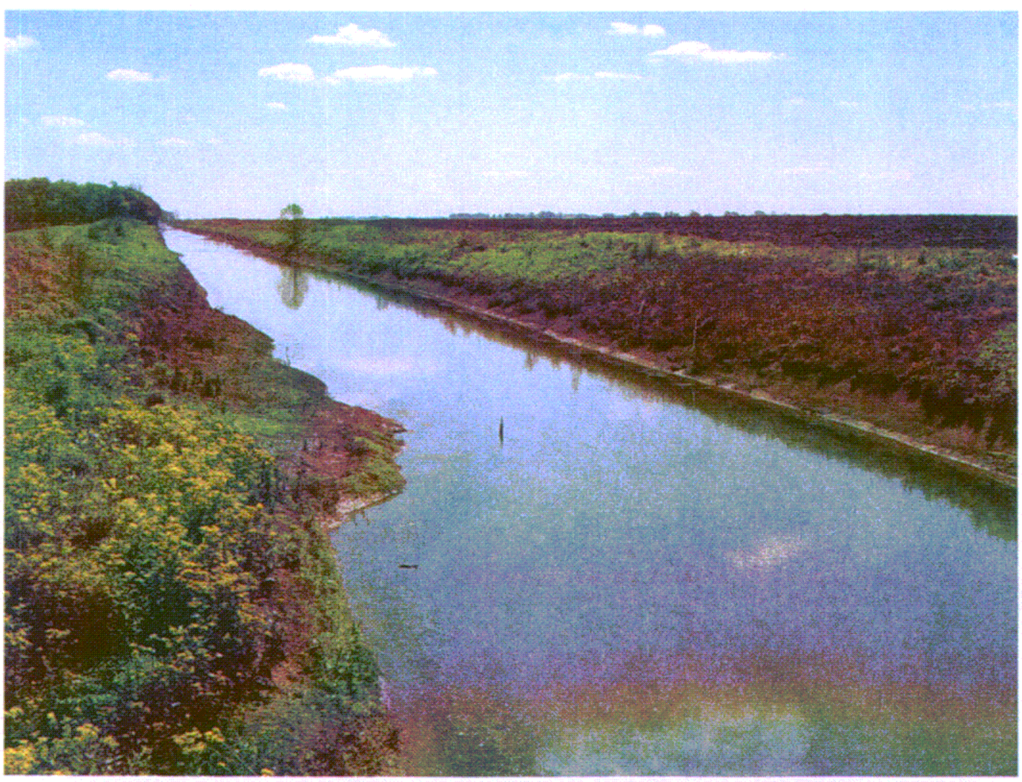

Figure B8. Ditch No. 6-3 looking upstream during the May sampling event.

APPENDIX C

Photographs of Sampling Locations
May 26-28, 2005

Figure C1. Ditch No. 27-0 during the July sampling event.

Figure C2. Ditch No. 27-1 looking downstream during the July sampling event.

Figure C3. Ditch NO. 27-1 looking upstream during the July sampling event.

Figure C4. Ditch No. 27-3 looking upstream during the July sampling event.

Figure C5. Ditch No. 28-1 looking downstream during the July sampling event.

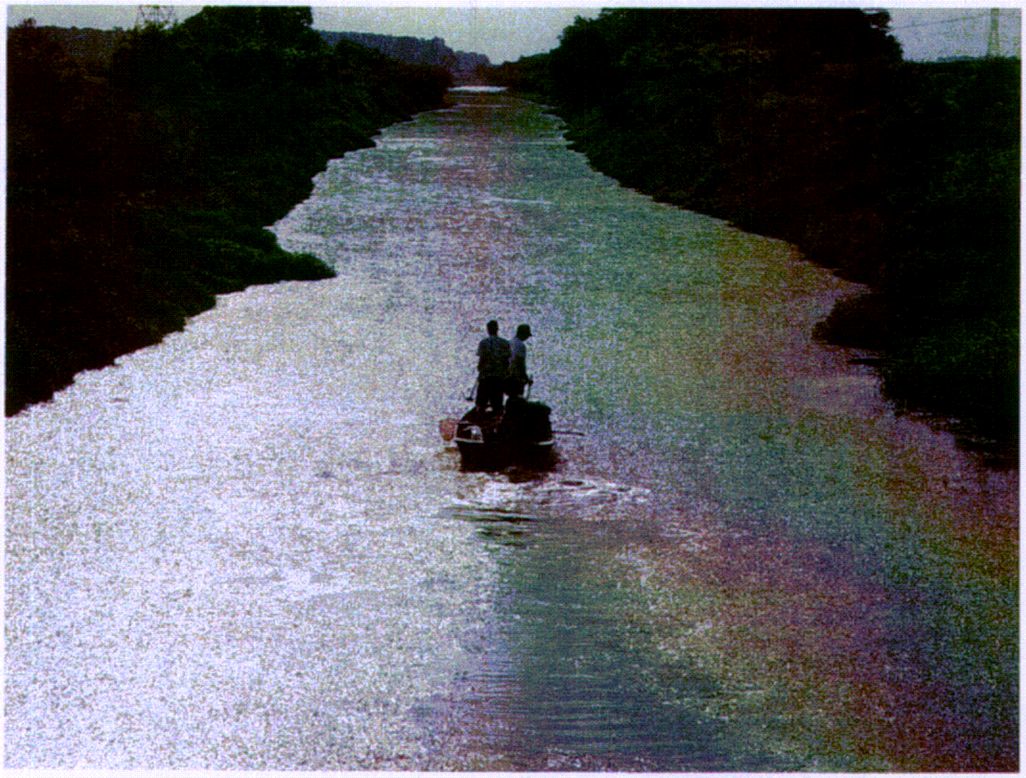

Figure C6. Ditch No. 6-2 looking upstream during the July sampling event and over grown with attached submerged aquatic vegetation (Heternthea Dubia).

Figure C7. Ditch No. 6-2 sampling small tributary inlet during the July sampling event.

Figure C8. Ditch No. 6-2 looking upstream during the July sampling event and over grown with attached submerged aquatic vegetation (Heternthea Dubia).

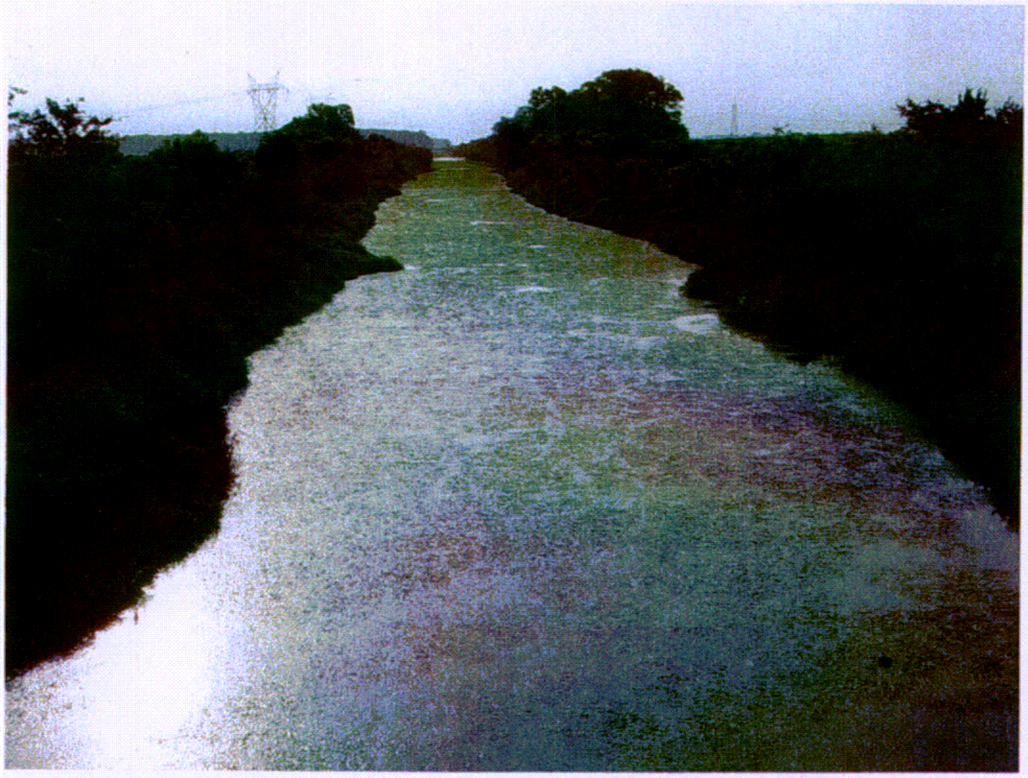

Figure C9. Ditch No. 6-2 looking upstream during the July sampling event and over grown with attached submerged aquatic vegetation (Heternthea Dubia).

Figure C10. Ditch No. 6-3 looking downstream during the July sampling event and block net.

Figure C11. Ditch No. 41 sampling reach during the July sampling event.

APPENDIX D

Physical Characteristics and Habitat Evaluation Field Forms

ftn

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (FRONT)

STREAM NAME Ditch 6	LOCATION d/s county road ditch
STATION # 2 (D/S) RIVERMILE ______	STREAM CLASS
LAT ________ LONG ________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS NJS / DMR / CRL	
FORM COMPLETED BY CRL	DATE 5/3/05 TIME 7:00 AM PM — REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition 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 stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE 6	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 or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. 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 25-27% 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

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (BACK)

6-2

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 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 long distance.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 4 **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 4 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed or grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	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 the streambank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 7 **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 7 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, 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 zone a great deal	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 0 **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 0 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ~~94~~ 80

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (FRONT)

STREAM NAME Ditch 6	LOCATION County Road bridge	
STATION # 3 RIVERMILE ______	STREAM CLASS	
LAT ______ LONG ______	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS NJS / DMR / CRL		
FORM COMPLETED BY CRL	DATE 5/3/05 TIME 10:45 AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition 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 stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE 8	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 or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. 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 25-27% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 18	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Parameters to be evaluated broader than sampling reach	Habitat Parameter	Condition Category			
		Optimal	Suboptimal	Marginal	Poor
	6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
	7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 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 long distance.
	SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
	8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
	9. Vegetative Protection (score each bank) trees mostly absent	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed or grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	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 the streambank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	SCORE 7 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	SCORE 7 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
	10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, 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 zone a great deal	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
	SCORE 0 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	SCORE 0 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ~~74~~ 88

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (FRONT)

STREAM NAME Ditch 27	LOCATION
STATION # 27-0 RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE 5/2/05 TIME 10:45 AM PM | REASON FOR SURVEY UAA

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition 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 stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE 10	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. 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 25-27% 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

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (BACK)

27-0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 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 long distance.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 6 **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 6 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed or grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	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 the streambank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 5 **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 5 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, 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 zone a great deal	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 1 **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 1 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ~~72~~ 62
8/7/2

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (FRONT)

STREAM NAME Ditch 27	LOCATION	
STATION # 3 RIVERMILE ______	STREAM CLASS	
LAT ______ LONG ______	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS NJS / CRL		
FORM COMPLETED BY CRL	DATE 5/2/05 TIME 2:50 AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition 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 stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE 6	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 or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation
SCORE 6	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 pools absent
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. 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 25-27% 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

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (BACK)

27-3

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 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 long distance.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank) **where culverts/ditches enter**	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 7 **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 6 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed or grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	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 the streambank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 6 **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 6 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, 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 zone a great deal	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 0 **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 0 **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ~~72~~ 73

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (FRONT)

STREAM NAME Ditch 28	LOCATION @148
STATION # 1 RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS NJS / DMR / CRL	
FORM COMPLETED BY CRL	DATE 5/3/05 TIME 1:45 AM PM / REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition 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 stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE 12	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 or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation
SCORE 9	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 pools absent
SCORE 10	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 4	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. 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 25-27% 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

HABITAT ASSESSMENT FIELD DATA SHEET – LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 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 long distance.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 5 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 5 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed or grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	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 the streambank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 8 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, 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 zone a great deal	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 0 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 0 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 74

APPENDIX E

Analytical Laboratory Data Reports

AMERICAN INTERPLEX CORPORATION LABORATORIES

FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
3 Innwood Circle, Suite 220
Little Rock, AR 72211

Dear Mr. Jim Malcolm:

Project Description: Six (6) water sample(s) received on May 4, 2005
AECI UAA Study
6028-020

This report is the analytical results and supporting information for the samples submitted to American Interplex Corporation (AIC) on May 4, 2005. The following results are applicable only to the samples identified by the control number referenced above. Accurate assessment of the data requires access to the entire document. Each section of the report has been reviewed and approved by the appropriate laboratory director or a qualified designee.

Data has been validated using standard quality control measures (blanks, laboratory control samples, spike and spike duplicates) performed on at least 10% of the samples analyzed. Quality Assurance, instrumentation, maintenance and calibration were performed in accordance with guidelines established by the cited methodology.

AMERICAN INTERPLEX CORPORATION

By ______________________
John Overbey
Laboratory Director

Enclosure(s): Chain of Custody

PDF cc: FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
jtm@ftn-assoc.com

AMERICAN INTERPLEX CORPORATION LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

CASE NARRATIVE

SAMPLE RECEIPT

Received Temperature: 1°C

Receipt Verification:		
	Complete Chain of Custody	Y
	Sample ID on Sample Labels	Y
	Date and Time on Sample Labels	Y
	Proper Sample Containers	Y
	Within Holding Times	Y
	Adequate Sample Volume	Y
	Sample Integrity	Y
	Proper Temperature	Y
	Proper Preservative	Y

QUALIFIERS

AIC Sample No.	Qualifiers	Definition
89977-3	H	Analytical holding time exceeded regulatory requirements
89977-4	H	Analytical holding time exceeded regulatory requirements
89977-5	H	Analytical holding time exceeded regulatory requirements
S15766-4	X	Spiking level is invalid due to the high concentration of analyte in the spiked sample
S15766-5	X	Spiking level is invalid due to the high concentration of analyte in the spiked sample

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).

"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.

"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.

"American Society for Testing and Materials" (ASTM).

"Association of Analytical Chemists" (AOAC).

AMERICAN INTERPLEX CORPORATION LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

ANALYTICAL RESULTS

AIC No. 89977-1
Sample Identification: Ditch No. 27-3 5-3-05 / 1645

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	210	10	mg/l	W13857	
Total Suspended Solids	EPA 160.2	27	4	mg/l	W13848	
Alkalinity as CaCO3	EPA 310.1	150	1	mg/l	W13858	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W13827	
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S15766	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S15766	
Chromium	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Copper	EPA 200.8	0.0067	0.006	mg/l	S15766	
Hardness as CaCO3	EPA 200.8	160	1	mg/l	S15766	
Iron	EPA 200.8	1.2	0.02	mg/l	S15766	
Lead	EPA 200.8	0.0010	0.001	mg/l	S15766	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S15766	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S15766	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Zinc	EPA 200.8	0.013	0.002	mg/l	S15766	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S15786	
Chloride	EPA 300.0	6.6	0.2	mg/l	S15781	
Sulfate	EPA 300.0	39	0.2	mg/l	S15781	

AIC No. 89977-2
Sample Identification: Ditch No.27-0 5-3-05 / 1600

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	180	10	mg/l	W13857	
Total Suspended Solids	EPA 160.2	82	4	mg/l	W13848	
Alkalinity as CaCO3	EPA 310.1	110	1	mg/l	W13858	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W13827	
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S15766	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S15766	
Chromium	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Copper	EPA 200.8	0.0075	0.006	mg/l	S15766	
Hardness as CaCO3	EPA 200.8	110	1	mg/l	S15766	
Iron	EPA 200.8	3.9	0.02	mg/l	S15766	
Lead	EPA 200.8	0.0027	0.001	mg/l	S15766	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S15766	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S15766	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Zinc	EPA 200.8	0.022	0.002	mg/l	S15766	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S15786	
Chloride	EPA 300.0	5.2	0.2	mg/l	S15781	
Sulfate	EPA 300.0	28	0.2	mg/l	S15781	

AIC No. 89977-3
Sample Identification: Ditch No.6-3 5-3-05 / 11:55

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	240	10	mg/l	W13857	

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FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

ANALYTICAL RESULTS

AIC No. 89977-3 (Continued)
Sample Identification: Ditch No.6-3 5-3-05 / 11:55

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Suspended Solids	EPA 160.2	5.0	4	mg/l	W13848	
Alkalinity as CaCO3	EPA 310.1	180	1	mg/l	W13858	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W13827	H
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S15766	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S15766	
Chromium	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Copper	EPA 200.8	< 0.006	0.006	mg/l	S15766	
Hardness as CaCO3	EPA 200.8	180	1	mg/l	S15766	
Iron	EPA 200.8	1.2	0.02	mg/l	S15766	
Lead	EPA 200.8	< 0.001	0.001	mg/l	S15766	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S15766	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S15766	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Zinc	EPA 200.8	0.017	0.002	mg/l	S15766	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S15786	
Chloride	EPA 300.0	6.4	0.2	mg/l	S15781	
Sulfate	EPA 300.0	17	0.2	mg/l	S15781	

AIC No. 89977-4
Sample Identification: Ditch No.6-2 5-3-05 / 0955

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	180	10	mg/l	W13857	
Total Suspended Solids	EPA 160.2	14	4	mg/l	W13848	
Alkalinity as CaCO3	EPA 310.1	170	1	mg/l	W13858	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W13827	H
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S15766	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S15766	
Chromium	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Copper	EPA 200.8	< 0.006	0.006	mg/l	S15766	
Hardness as CaCO3	EPA 200.8	170	1	mg/l	S15766	
Iron	EPA 200.8	1.2	0.02	mg/l	S15766	
Lead	EPA 200.8	< 0.001	0.001	mg/l	S15766	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S15766	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S15766	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Zinc	EPA 200.8	0.049	0.002	mg/l	S15766	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S15786	
Chloride	EPA 300.0	6.0	0.2	mg/l	S15781	
Sulfate	EPA 300.0	17	0.2	mg/l	S15781	

AIC No. 89977-5
Sample Identification: Ditch No.28-1 5-3-05 / 1415

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	150	10	mg/l	W13817	
Total Suspended Solids	EPA 160.2	73	4	mg/l	W13848	

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Little Rock, AR 72211

ANALYTICAL RESULTS

AIC No. 89977-5 (Continued)
Sample Identification: Ditch No.28-1 5-3-05 / 1415

Analyte	Method	Result	RL	Units	Batch	Qualifier
Alkalinity as CaCO3	EPA 310.1	40	1	mg/l	W13858	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W13827	H
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S15766	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S15766	
Chromium	EPA 200.8	0.012	0.007	mg/l	S15766	
Chromium, Trivalent	EPA 200.8	0.012	0.007	mg/l	S15766	
Copper	EPA 200.8	0.0097	0.006	mg/l	S15766	
Hardness as CaCO3	EPA 200.8	60	1	mg/l	S15766	
Iron	EPA 200.8	7.0	0.02	mg/l	S15766	
Lead	EPA 200.8	0.0048	0.001	mg/l	S15766	
Nickel	EPA 200.8	0.011	0.01	mg/l	S15766	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S15766	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Zinc	EPA 200.8	0.038	0.002	mg/l	S15766	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S15786	
Chloride	EPA 300.0	7.1	0.2	mg/l	S15781	
Sulfate	EPA 300.0	8.4	0.2	mg/l	S15781	

AIC No. 89977-6
Sample Identification: Ditch No.27-00 5-3-05 / 1605

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	190	10	mg/l	W13817	
Total Suspended Solids	EPA 160.2	79	4	mg/l	W13848	
Alkalinity as CaCO3	EPA 310.1	110	1	mg/l	W13858	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W13827	
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S15766	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S15766	
Chromium	EPA 200.8	0.0080	0.007	mg/l	S15766	
Chromium, Trivalent	EPA 200.8	0.0080	0.007	mg/l	S15766	
Copper	EPA 200.8	0.0075	0.006	mg/l	S15766	
Hardness as CaCO3	EPA 200.8	120	1	mg/l	S15766	
Iron	EPA 200.8	3.8	0.02	mg/l	S15766	
Lead	EPA 200.8	0.0028	0.001	mg/l	S15766	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S15766	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S15766	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S15766	
Zinc	EPA 200.8	0.022	0.002	mg/l	S15766	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S15786	
Chloride	EPA 300.0	5.5	0.2	mg/l	S15781	
Sulfate	EPA 300.0	29	0.2	mg/l	S15781	

AMERICAN INTERPLEX CORPORATION LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

SAMPLE PREPARATION REPORT

AIC No. 89977-1

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	Batch	Qualifier
Total Dissolved Solids	-		09MAY05 0913	223		W13857	
Total Suspended Solids	06MAY05 0948	07	06MAY05 1459	07		W13848	
Alkalinity as CaCO3	-		09MAY05 0940	93		W13858	
Chromium, Hexavalent	-		04MAY05 1426	240		W13827	
Metals	04MAY05 1500	253	04MAY05 1908	253		S15766	
Metals	-		04MAY05 1500	253		S15766	
Mercury	06MAY05 1146	253	09MAY05 1212	253		S15786	
Chloride	05MAY05 1901	252	06MAY05 0753	252		S15781	
Sulfate	05MAY05 1901	252	06MAY05 0753	252		S15781	

AIC No. 89977-2

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	Batch	Qualifier
Total Dissolved Solids	-		09MAY05 0913	223		W13857	
Total Suspended Solids	06MAY05 0948	07	06MAY05 1459	07		W13848	
Alkalinity as CaCO3	-		09MAY05 0940	93		W13858	
Chromium, Hexavalent	-		04MAY05 1426	240		W13827	
Metals	04MAY05 1500	253	04MAY05 1914	253		S15766	
Metals	-		04MAY05 1500	253		S15766	
Mercury	06MAY05 1146	253	09MAY05 1215	253		S15786	
Chloride	05MAY05 1901	252	06MAY05 0809	252		S15781	
Sulfate	05MAY05 1901	252	06MAY05 0809	252		S15781	

AIC No. 89977-3

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	Batch	Qualifier
Total Dissolved Solids	-		09MAY05 0913	223		W13857	
Total Suspended Solids	06MAY05 0948	07	06MAY05 1459	07		W13848	
Alkalinity as CaCO3	-		09MAY05 0940	93		W13858	
Chromium, Hexavalent	-		04MAY05 1426	240		W13827	H
Metals	04MAY05 1500	253	04MAY05 1921	253		S15766	
Metals	-		04MAY05 1500	253		S15766	
Mercury	06MAY05 1146	253	09MAY05 1219	253		S15786	
Chloride	05MAY05 1901	252	06MAY05 0825	252		S15781	
Sulfate	05MAY05 1901	252	06MAY05 0825	252		S15781	

AIC No. 89977-4

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	Batch	Qualifier
Total Dissolved Solids	-		09MAY05 0913	223		W13857	
Total Suspended Solids	06MAY05 0948	07	06MAY05 1459	07		W13848	
Alkalinity as CaCO3	-		09MAY05 0940	93		W13858	
Chromium, Hexavalent	-		04MAY05 1426	240		W13827	H
Metals	04MAY05 1500	253	04MAY05 1927	253		S15766	
Metals	-		04MAY05 1500	253		S15766	
Mercury	06MAY05 1146	253	09MAY05 1230	253		S15786	
Chloride	05MAY05 1901	252	06MAY05 0840	252		S15781	
Sulfate	05MAY05 1901	252	06MAY05 0840	252		S15781	

AMERICAN INTERPLEX CORPORATION LABORATORIES

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

SAMPLE PREPARATION REPORT

AIC No. 89977-5

Analyte	Date/Time Prepared By		Date/Time Analyzed By		Dilution	Batch	Qualifier
Total Dissolved Solids	-		09MAY05 0915	223		W13817	
Total Suspended Solids	06MAY05 0948	07	06MAY05 1459	07		W13848	
Alkalinity as CaCO3	-		09MAY05 0940	93		W13858	
Chromium, Hexavalent	-		04MAY05 1426	240		W13827	H
Metals	04MAY05 1500	253	04MAY05 1934	253		S15766	
Metals	-		04MAY05 1500	253		S15766	
Mercury	06MAY05 1146	253	09MAY05 1234	253		S15786	
Chloride	05MAY05 1901	252	06MAY05 0855	252		S15781	
Sulfate	05MAY05 1901	252	06MAY05 0855	252		S15781	

AIC No. 89977-6

Analyte	Date/Time Prepared By		Date/Time Analyzed By		Dilution	Batch	Qualifier
Total Dissolved Solids	-		09MAY05 0915	223		W13817	
Total Suspended Solids	06MAY05 0948	07	06MAY05 1459	07		W13848	
Alkalinity as CaCO3	-		09MAY05 0940	93		W13858	
Chromium, Hexavalent	-		04MAY05 1426	240		W13827	
Metals	04MAY05 1500	253	04MAY05 1941	253		S15766	
Metals	-		04MAY05 1500	253		S15766	
Mercury	06MAY05 1146	253	09MAY05 1238	253		S15786	
Chloride	05MAY05 1901	252	06MAY05 0917	252		S15781	
Sulfate	05MAY05 1901	252	06MAY05 0917	252		S15781	

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LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	% Recovery	% Recovery Limits	RPD	RPD Limit	Batch	Qualifier
Total Dissolved Solids	250 mg/l	103/99.6	85-115	3.74	10	W13817	
Total Dissolved Solids	250 mg/l	98.8/100	85-115	1.21	10	W13857	
Total Suspended Solids	200 mg/l	106/112	80-120	5.53	20	W13848	
Chromium, Hexavalent	0.5 mg/l	97.4/97.6	87.9-110	0.205	5.64	W13827	
Beryllium	0.05 mg/l	93.2/93.2	85-115	0.0135	20	S15766	
Cadmium	0.05 mg/l	95.2/96.4	85-115	1.29	20	S15766	
Chromium	0.05 mg/l	102/102	85-115	0.223	20	S15766	
Copper	0.05 mg/l	98.7/98.8	85-115	0.0620	20	S15766	
Iron	5 mg/l	95.5/98.4	85-115	2.98	20	S15766	
Lead	0.05 mg/l	97.2/97.1	85-115	0.0671	20	S15766	
Nickel	0.05 mg/l	96.7/98.0	85-115	1.30	20	S15766	
Selenium	0.05 mg/l	96.1/96.4	85-115	0.251	20	S15766	
Silver	0.02 mg/l	95.7/96.2	85-115	0.530	20	S15766	
Zinc	0.05 mg/l	99.1/99.1	85-115	0.0202	20	S15766	
Mercury	0.0025 mg/l	88.0/90.0	85-115	2.25	20	S15786	
Chloride	10 mg/l	97.8/95.8	90-110	2.09	10	S15781	
Sulfate	30 mg/l	103/102	90-110	1.31	10	S15781	

MATRIX SPIKE SAMPLE RESULTS

Analyte	Spike Amount	% Recovery	% Recovery Limits	RPD	RPD Limit	Batch	Qualifier
Chromium, Hexavalent	0.5 mg/l	98.2/98.4	79.8-114	0.203	5.64	W13827	
Beryllium	0.05 mg/l	78.2/80.5	75-125	2.87	20	S15766	
Cadmium	0.05 mg/l	87.7/87.7	75-125	0.0454	20	S15766	
Chromium	0.05 mg/l	98.6/98.6	75-125	0.0136	20	S15766	
Copper	0.05 mg/l	- / -	75-125	0.256	20	S15766	X
Iron	5 mg/l	88.8/91.1	75-125	1.67	20	S15766	
Lead	0.05 mg/l	- / -	70-130	0.904	20	S15766	X
Nickel	0.05 mg/l	87.3/88.5	75-125	1.31	20	S15766	
Selenium	0.05 mg/l	90.6/90.7	70-130	0.0921	20	S15766	
Silver	0.02 mg/l	85.0/84.6	75-125	0.481	20	S15766	
Zinc	0.05 mg/l	89.6/95.6	75-125	0.478	20	S15766	
Mercury	0.0025 mg/l	96.8/96.8	70-130	0.00	20	S15786	
Chloride	10 mg/l	100/99.5	80-120	0.652	10	S15781	
Sulfate	30 mg/l	99.7/97.8	80-120	0.846	10	S15781	

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LABORATORY BLANK RESULTS

Analyte	Method	Result	Units	RL	QC Sample	Qualifier
Total Dissolved Solids	EPA 160.1	< 10	mg/l	10	W13817-5	
Total Dissolved Solids	EPA 160.1	< 10	mg/l	10	W13857-1	
Total Suspended Solids	EPA 160.2	< 4	mg/l	4	W13848-2	
Alkalinity as CaCO3	EPA 310.1	< 1	mg/l	1	W13858-1	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	mg/l	0.007	W13827-1	
Beryllium	EPA 200.8	< 0.0003	mg/l	0.0003	S15766-1	
Cadmium	EPA 200.8	< 0.004	mg/l	0.004	S15766-1	
Chromium	EPA 200.8	< 0.007	mg/l	0.007	S15766-1	
Copper	EPA 200.8	< 0.006	mg/l	0.006	S15766-1	
Iron	EPA 200.8	< 0.02	mg/l	0.02	S15766-1	
Lead	EPA 200.8	< 0.001	mg/l	0.001	S15766-1	
Nickel	EPA 200.8	< 0.01	mg/l	0.01	S15766-1	
Selenium	EPA 200.8	< 0.002	mg/l	0.002	S15766-1	
Silver	EPA 200.8	< 0.007	mg/l	0.007	S15766-1	
Zinc	EPA 200.8	< 0.002	mg/l	0.002	S15766-1	
Mercury	EPA 245.2	< 0.0002	mg/l	0.0002	S15786-1	
Chloride	EPA 300.0	< 0.2	mg/l	0.2	S15781-1	
Sulfate	EPA 300.0	< 0.2	mg/l	0.2	S15781-1	

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QUALITY CONTROL PREPARATION REPORT

LABORATORY CONTROL SAMPLES

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	QC Sample	Qualifier
Total Dissolved Solids	-		03MAY05 1246	223		W13817-3	
Total Dissolved Solids	-		09MAY05 0915	223		W13817-6	
Total Dissolved Solids	-		09MAY05 0914	223		W13857-2	
Total Dissolved Solids	-		09MAY05 0914	223		W13857-3	
Total Suspended Solids	06MAY05 0948	07	06MAY05 1459	07		W13848-3	
Total Suspended Solids	06MAY05 0948	07	06MAY05 1459	07		W13848-4	
Chromium, Hexavalent	-		04MAY05 1427	240		W13827-2	
Chromium, Hexavalent	-		04MAY05 1427	240		W13827-3	
Metals	04MAY05 0856	253	04MAY05 1641	253		S15766-2	
Metals	04MAY05 0856	253	04MAY05 1647	253		S15766-3	
Mercury	06MAY05 1146	253	09MAY05 1148	253		S15786-2	
Mercury	06MAY05 1146	253	09MAY05 1152	253		S15786-3	
Chloride	05MAY05 1901	252	06MAY05 0459	252		S15781-2	
Chloride	05MAY05 1901	252	06MAY05 0527	252		S15781-3	
Sulfate	05MAY05 1901	252	06MAY05 0459	252		S15781-2	
Sulfate	05MAY05 1901	252	06MAY05 0527	252		S15781-3	

MATRIX SPIKE SAMPLES

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	QC Sample	Qualifier
Chromium, Hexavalent	-		04MAY05 1427	240		W13827-4	
Chromium, Hexavalent	-		04MAY05 1427	240		W13827-5	
Metals	04MAY05 0856	253	04MAY05 1654	253		S15766-4	X
Metals	04MAY05 0856	253	04MAY05 1700	253		S15766-5	X
Mercury	06MAY05 1146	253	09MAY05 1156	253		S15786-4	
Mercury	06MAY05 1146	253	09MAY05 1200	253		S15786-5	
Chloride	05MAY05 1901	252	06MAY05 0554	252		S15781-4	
Chloride	05MAY05 1901	252	06MAY05 0625	252		S15781-5	
Sulfate	05MAY05 1901	252	06MAY05 0554	252		S15781-4	
Sulfate	05MAY05 1901	252	06MAY05 0625	252		S15781-5	

LABORATORY BLANKS

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	QC Sample	Qualifier
Total Dissolved Solids	-		09MAY05 0915	223		W13817-5	
Total Dissolved Solids	-		09MAY05 0914	223		W13857-1	
Total Suspended Solids	06MAY05 0948	07	06MAY05 1459	07		W13848-2	
Alkalinity as CaCO3	-		09MAY05 0940	93		W13858-1	
Chromium, Hexavalent	-		04MAY05 1427	240		W13827-1	
Metals	04MAY05 0856	253	04MAY05 1634	253		S15766-1	
Mercury	06MAY05 1146	253	09MAY05 1144	253		S15786-1	
Chloride	05MAY05 1901	252	06MAY05 0446	252		S15781-1	
Sulfate	05MAY05 1901	252	06MAY05 0446	252		S15781-1	

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Date	Project Name AECI UAA Study	Project No. 6028-020	Project Manager (Print) Jim Malcolm	Page _1_ of _1_

Report and Bill to:

FTN Associates, Ltd.
Jim Malcolm
3 Innwood Circle, Suite 220
Little Rock, AR 72211
(501) 225-7779 • Fax (501) 225-6738

Submitted by:

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211
(501) 225-7779 • Fax (501) 225-6738

Sampler Signature(s)

Recorded By (Print)
Nathan Siria

Lab Turn-Around-Time

- ☐ 24 Hours
- ☐ 48 Hours
- ☐ Normal
- ☐ Other: Due: / /

SAMPLE DESCRIPTION

Parameters (Method Number)

	Sample Identification	Date	Time	Matrix* W	S	O	No. of Containers	Comp	Grab	Cd, Cr (III), Cr (VI0, Cu, Pb,gf, Hg,gf, Ni, Se,gf, Ag, Zn, Be, Fe, Hard	Alkalinity, TDS, SO4, TSS, Cl,				Acute Toxicity 48 hr FH, CD					Laboratory Notes
1	Ditch No. 27-23	5-3-05	1645	X			2		X	X	X									
2	Ditch No. 27-0	5-3-05	1600	X			3		X	X	X				X					AIC 89979-1
3	Ditch No. 6-3 U/S	5-3-05	11:55	X			3		X	X	X				X					AIC 89981-1
4	Ditch No. 6-2 D/S	5-3-05	09:55	X			2		X	X	X									
5	Ditch No. 28-1	5-3-05	1415	X			2		X	X	X									
6	Ditch No. 27-00	5-3-05	1605				2		X	X	X									
	Container Type									P	P				P					
	Preservative									N	NO				No					

* Matrix: W = Water S = Soil O = Other

G = Glass P= Plastic V = VOA vials H = HCl to pH2 T = Sodium Thiosulfate
NO = None S = Sulfuric acid pH2 N = Nitric acid pH2 B = NaOH to pH12 Z = Zinc acetate

Relinquished By (Signature)	Print Name	Date	Time	Received By (Signature)	Print Name	Date	Time
Relinquished By (Signature) [signature]	Print Name Nathan Siria	Date 5-4-05	Time 1200	Received By Laboratory (Signature) [signature]	Print Name Eugene Hampton	Date 5-4-05	Time 1200

Sampler Remarks:

E-mail Copy: Jim Malcolm

Laboratory Remarks:

AMERICAN INTERPLEX CORPORATION
LABORATORIES

FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
3 Innwood Circle, Suite 220
Little Rock, AR 72211

Dear Mr. Jim Malcolm:

Project Description: Seven (7) water sample(s) received on July 27, 2005
6028-020

This report is the analytical results and supporting information for the samples submitted to American Interplex Corporation (AIC) on July 27, 2005. The following results are applicable only to the samples identified by the control number referenced above. Accurate assessment of the data requires access to the entire document. Each section of the report has been reviewed and approved by the appropriate laboratory director or a qualified designee.

Data has been validated using standard quality control measures (blanks, laboratory control samples, spike and spike duplicates) performed on at least 10% of the samples analyzed. Quality Assurance, instrumentation, maintenance and calibration were performed in accordance with guidelines established by the cited methodology.

AMERICAN INTERPLEX CORPORATION

By ____________________
John Overbey
Laboratory Director

Enclosure(s): Chain of Custody

PDF cc: FTN Associates, Ltd.
ATTN: Mr. Jim Malcolm
jtm@ftn-assoc.com

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LABORATORIES

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3 Innwood Circle, Suite 220
Little Rock, AR 72211

CASE NARRATIVE

SAMPLE RECEIPT

Received Temperature: 1°C

Receipt Verification:		
	Complete Chain of Custody	Y
	Sample ID on Sample Labels	Y
	Date and Time on Sample Labels	Y
	Proper Sample Containers	Y
	Within Holding Times	Y
	Adequate Sample Volume	Y
	Sample Integrity	Y
	Proper Temperature	Y
	Proper Preservative	Y

QUALIFIERS

AIC Sample No.	Qualifiers	Definition
92410-1	H	Analytical holding time exceeded regulatory requirements
92410-2	H	Analytical holding time exceeded regulatory requirements
92410-3	H	Analytical holding time exceeded regulatory requirements
92410-4	H	Analytical holding time exceeded regulatory requirements
92410-5	H	Analytical holding time exceeded regulatory requirements
92410-6	H	Analytical holding time exceeded regulatory requirements

References:

"Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79-020 (Mar 1983) with updates and supplements EPA/600/5-91-010 (Jun 1991), EPA/600/R-92-129 (Aug 1992) and EPA/600/R-93-100 (Aug 1993).

"Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846)", Third Edition.

"Standard Methods for the Examination of Water and Wastewaters", 20th edition, 1998.

"American Society for Testing and Materials" (ASTM).

"Association of Analytical Chemists" (AOAC).

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ANALYTICAL RESULTS

AIC No. 92410-1
Sample Identification: Ditch No. 27-0 7-26-05 / 1000

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	280	10	mg/l	W14394	
Total Suspended Solids	EPA 160.2	14	4	mg/l	W14455	
Alkalinity as CaCO3	EPA 310.1	190	1	mg/l	W14463	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W14404	H
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S16393	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S16393	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Copper	EPA 200.8	< 0.006	0.006	mg/l	S16393	
Hardness as CaCO3	EPA 200.8	150	1	mg/l	S16393	
Iron	EPA 200.8	0.33	0.02	mg/l	S16393	
Lead	EPA 200.8	< 0.001	0.001	mg/l	S16393	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S16393	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S16393	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Zinc	EPA 200.8	0.0053	0.002	mg/l	S16393	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S16396	
Chloride	EPA 300.0	4.6	0.2	mg/l	S16400	
Sulfate	EPA 300.0	45	0.2	mg/l	S16400	

AIC No. 92410-2
Sample Identification: Ditch No. 6-2 D/S 7-26-05 / 1145

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	170	10	mg/l	W14443	
Total Suspended Solids	EPA 160.2	< 4	4	mg/l	W14455	
Alkalinity as CaCO3	EPA 310.1	130	1	mg/l	W14463	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W14404	H
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S16393	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S16393	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Copper	EPA 200.8	< 0.006	0.006	mg/l	S16393	
Hardness as CaCO3	EPA 200.8	110	1	mg/l	S16393	
Iron	EPA 200.8	0.23	0.02	mg/l	S16393	
Lead	EPA 200.8	< 0.001	0.001	mg/l	S16393	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S16393	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S16393	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Zinc	EPA 200.8	0.0061	0.002	mg/l	S16393	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S16396	
Chloride	EPA 300.0	3.8	0.2	mg/l	S16400	
Sulfate	EPA 300.0	6.6	0.2	mg/l	S16400	

AIC No. 92410-3
Sample Identification: Ditch No. 6-3 U/S 7-26-05 / 1215

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	220	10	mg/l	W14443	
Total Suspended Solids	EPA 160.2	< 4	4	mg/l	W14455	
Alkalinity as CaCO3	EPA 310.1	170	1	mg/l	W14463	

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ANALYTICAL RESULTS

AIC No. 92410-3 (Continued)
Sample Identification: Ditch No. 6-3 U/S 7-26-05 / 1215

Analyte	Method	Result	RL	Units	Batch	Qualifier
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W14404	H
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S16393	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S16393	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Copper	EPA 200.8	< 0.006	0.006	mg/l	S16393	
Hardness as CaCO3	EPA 200.8	140	1	mg/l	S16393	
Iron	EPA 200.8	0.44	0.02	mg/l	S16393	
Lead	EPA 200.8	< 0.001	0.001	mg/l	S16393	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S16393	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S16393	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Zinc	EPA 200.8	0.012	0.002	mg/l	S16393	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S16396	
Chloride	EPA 300.0	4.0	0.2	mg/l	S16400	
Sulfate	EPA 300.0	11	0.2	mg/l	S16400	

AIC No. 92410-4
Sample Identification: Ditch No. 6-33 7-26-05 / 1220

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	210	10	mg/l	W14443	
Total Suspended Solids	EPA 160.2	< 4	4	mg/l	W14455	
Alkalinity as CaCO3	EPA 310.1	170	1	mg/l	W14463	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W14404	H
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S16393	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S16393	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Copper	EPA 200.8	< 0.006	0.006	mg/l	S16393	
Hardness as CaCO3	EPA 200.8	140	1	mg/l	S16393	
Iron	EPA 200.8	0.41	0.02	mg/l	S16393	
Lead	EPA 200.8	< 0.001	0.001	mg/l	S16393	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S16393	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S16393	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Zinc	EPA 200.8	0.0026	0.002	mg/l	S16393	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S16396	
Chloride	EPA 300.0	4.1	0.2	mg/l	S16400	
Sulfate	EPA 300.0	11	0.2	mg/l	S16400	

AIC No. 92410-5
Sample Identification: Ditch No. 41 @ 119 7-26-05 / 1320

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	200	10	mg/l	W14443	
Total Suspended Solids	EPA 160.2	24	4	mg/l	W14455	
Alkalinity as CaCO3	EPA 310.1	130	1	mg/l	W14463	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W14404	H
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S16393	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S16393	

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Little Rock, AR 72211

ANALYTICAL RESULTS

AIC No. 92410-5 (Continued)
Sample Identification: Ditch No. 41 @ 119 7-26-05 / 1320

Analyte	Method	Result	RL	Units	Batch	Qualifier
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Copper	EPA 200.8	< 0.006	0.006	mg/l	S16393	
Hardness as CaCO3	EPA 200.8	110	1	mg/l	S16393	
Iron	EPA 200.8	1.4	0.02	mg/l	S16393	
Lead	EPA 200.8	< 0.001	0.001	mg/l	S16393	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S16393	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S16393	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Zinc	EPA 200.8	0.0053	0.002	mg/l	S16393	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S16396	
Chloride	EPA 300.0	2.2	0.2	mg/l	S16400	
Sulfate	EPA 300.0	15	0.2	mg/l	S16400	

AIC No. 92410-6
Sample Identification: Ditch No. 28-1 7-26-05 / 1440

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	81	10	mg/l	W14443	
Total Suspended Solids	EPA 160.2	22	4	mg/l	W14455	
Alkalinity as CaCO3	EPA 310.1	44	1	mg/l	W14463	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W14404	H
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S16393	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S16393	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Copper	EPA 200.8	< 0.006	0.006	mg/l	S16393	
Hardness as CaCO3	EPA 200.8	38	1	mg/l	S16393	
Iron	EPA 200.8	1.2	0.02	mg/l	S16393	
Lead	EPA 200.8	< 0.001	0.001	mg/l	S16393	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S16393	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S16393	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Zinc	EPA 200.8	0.0052	0.002	mg/l	S16393	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S16396	
Chloride	EPA 300.0	2.2	0.2	mg/l	S16400	
Sulfate	EPA 300.0	5.7	0.2	mg/l	S16400	

AIC No. 92410-7
Sample Identification: Rice Field Ditch 7-27-05 / 1055

Analyte	Method	Result	RL	Units	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	270	10	mg/l	W14443	
Total Suspended Solids	EPA 160.2	7.2	4	mg/l	W14455	
Alkalinity as CaCO3	EPA 310.1	220	1	mg/l	W14463	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	0.007	mg/l	W14404	
Beryllium	EPA 200.8	< 0.0003	0.0003	mg/l	S16393	
Cadmium	EPA 200.8	< 0.004	0.004	mg/l	S16393	
Chromium, Trivalent	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Copper	EPA 200.8	< 0.006	0.006	mg/l	S16393	
Hardness as CaCO3	EPA 200.8	170	1	mg/l	S16393	

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ANALYTICAL RESULTS

AIC No. 92410-7 (Continued)
Sample Identification: Rice Field Ditch 7-27-05 / 1055

Analyte	Method	Result	RL	Units	Batch	Qualifier
Iron	EPA 200.8	0.54	0.02	mg/l	S16393	
Lead	EPA 200.8	< 0.001	0.001	mg/l	S16393	
Nickel	EPA 200.8	< 0.01	0.01	mg/l	S16393	
Selenium	EPA 200.8	< 0.002	0.002	mg/l	S16393	
Silver	EPA 200.8	< 0.007	0.007	mg/l	S16393	
Zinc	EPA 200.8	0.0084	0.002	mg/l	S16393	
Mercury	EPA 245.2	< 0.0002	0.0002	mg/l	S16396	
Chloride	EPA 300.0	1.3	0.2	mg/l	S16400	
Sulfate	EPA 300.0	14	0.2	mg/l	S16400	

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SAMPLE PREPARATION REPORT

AIC No. 92410-1

Analyte	Date/Time Prepared By		Date/Time Analyzed By		Dilution	Batch	Qualifier
Total Dissolved Solids	-		28JUL05 0959	201		W14394	
Total Suspended Solids	29JUL05 1135	201	01AUG05 0828	201		W14455	
Alkalinity as CaCO3	-		01AUG05 1017	93		W14463	
Chromium, Hexavalent	-		27JUL05 1738	93		W14404	H
Metals	28JUL05 0808	235	02AUG05 1127	117		S16393	
Metals	-		28JUL05 0808	117		S16393	
Mercury	28JUL05 0916	256	28JUL05 1414	256		S16396	
Chloride	28JUL05 1333	117	28JUL05 1755	117		S16400	
Sulfate	28JUL05 1333	117	28JUL05 1755	117		S16400	

AIC No. 92410-2

Analyte	Date/Time Prepared By		Date/Time Analyzed By		Dilution	Batch	Qualifier
Total Dissolved Solids	-		28JUL05 0959	201		W14443	
Total Suspended Solids	29JUL05 1135	201	01AUG05 0828	201		W14455	
Alkalinity as CaCO3	-		01AUG05 1017	93		W14463	
Chromium, Hexavalent	-		27JUL05 1738	93		W14404	H
Metals	28JUL05 0808	235	02AUG05 1134	117		S16393	
Metals	-		28JUL05 0808	117		S16393	
Mercury	28JUL05 0916	256	28JUL05 1420	256		S16396	
Chloride	28JUL05 1333	117	28JUL05 1808	117		S16400	
Sulfate	28JUL05 1333	117	28JUL05 1808	117		S16400	

AIC No. 92410-3

Analyte	Date/Time Prepared By		Date/Time Analyzed By		Dilution	Batch	Qualifier
Total Dissolved Solids	-		28JUL05 0959	201		W14443	
Total Suspended Solids	29JUL05 1135	201	01AUG05 0828	201		W14455	
Alkalinity as CaCO3	-		01AUG05 1017	93		W14463	
Chromium, Hexavalent	-		27JUL05 1738	93		W14404	H
Metals	28JUL05 0808	235	02AUG05 1140	117		S16393	
Metals	-		28JUL05 0808	117		S16393	
Mercury	28JUL05 0916	256	28JUL05 1423	256		S16396	
Chloride	28JUL05 1333	117	28JUL05 1822	117		S16400	
Sulfate	28JUL05 1333	117	28JUL05 1822	117		S16400	

AIC No. 92410-4

Analyte	Date/Time Prepared By		Date/Time Analyzed By		Dilution	Batch	Qualifier
Total Dissolved Solids	-		28JUL05 0959	201		W14443	
Total Suspended Solids	29JUL05 1135	201	01AUG05 0828	201		W14455	
Alkalinity as CaCO3	-		01AUG05 1017	93		W14463	
Chromium, Hexavalent	-		27JUL05 1738	93		W14404	H
Metals	28JUL05 0808	235	02AUG05 1147	117		S16393	
Metals	-		28JUL05 0808	117		S16393	
Mercury	28JUL05 0916	256	28JUL05 1427	256		S16396	
Chloride	28JUL05 1333	117	28JUL05 1836	117		S16400	
Sulfate	28JUL05 1333	117	28JUL05 1836	117		S16400	

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SAMPLE PREPARATION REPORT

AIC No. 92410-5

Analyte	Date/Time Prepared By		Date/Time Analyzed By		Dilution	Batch	Qualifier
Total Dissolved Solids	-		28JUL05 0959	201		W14443	
Total Suspended Solids	29JUL05 1135	201	01AUG05 0828	201		W14455	
Alkalinity as CaCO3	-		01AUG05 1017	93		W14463	
Chromium, Hexavalent	-		27JUL05 1738	93		W14404	H
Metals	28JUL05 0808	235	02AUG05 1153	117		S16393	
Metals	-		28JUL05 0808	117		S16393	
Mercury	28JUL05 0916	256	28JUL05 1431	256		S16396	
Chloride	28JUL05 1333	117	28JUL05 1849	117		S16400	
Sulfate	28JUL05 1333	117	28JUL05 1849	117		S16400	

AIC No. 92410-6

Analyte	Date/Time Prepared By		Date/Time Analyzed By		Dilution	Batch	Qualifier
Total Dissolved Solids	-		28JUL05 0959	201		W14443	
Total Suspended Solids	29JUL05 1135	201	01AUG05 0828	201		W14455	
Alkalinity as CaCO3	-		01AUG05 1017	93		W14463	
Chromium, Hexavalent	-		27JUL05 1738	93		W14404	H
Metals	28JUL05 0808	235	02AUG05 1200	117		S16393	
Metals	-		28JUL05 0808	117		S16393	
Mercury	28JUL05 0916	256	28JUL05 1442	256		S16396	
Chloride	28JUL05 1333	117	28JUL05 1903	117		S16400	
Sulfate	28JUL05 1333	117	28JUL05 1903	117		S16400	

AIC No. 92410-7

Analyte	Date/Time Prepared By		Date/Time Analyzed By		Dilution	Batch	Qualifier
Total Dissolved Solids	-		28JUL05 0959	201		W14443	
Total Suspended Solids	29JUL05 1135	201	01AUG05 0828	201		W14455	
Alkalinity as CaCO3	-		01AUG05 1017	93		W14463	
Chromium, Hexavalent	-		27JUL05 1738	93		W14404	
Metals	28JUL05 0808	235	02AUG05 1207	117		S16393	
Metals	-		28JUL05 0808	117		S16393	
Mercury	28JUL05 0916	256	28JUL05 1445	256		S16396	
Chloride	28JUL05 1333	117	28JUL05 1917	117		S16400	
Sulfate	28JUL05 1333	117	28JUL05 1917	117		S16400	

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SAMPLE DUPLICATE RESULTS

AIC No. 92410-2

Analyte	Method	Sample Result	Duplicate Result	Units	RPD	RPD Limit	Batch	Qualifier
Total Dissolved Solids	EPA 160.1	170	160	mg/l	3.64	10.0	W14443	

AIC No. 92410-1

Analyte	Method	Sample Result	Duplicate Result	Units	RPD	RPD Limit	Batch	Qualifier
Alkalinity as CaCO3	EPA 310.1	190	190	mg/l	0.525	3.88	W14463	

LABORATORY CONTROL SAMPLE RESULTS

Analyte	Spike Amount	% Recovery	% Recovery Limits	RPD	RPD Limit	Batch	Qualifier
Total Dissolved Solids	250 mg/l	96.4/97.6	85-115	1.24	10	W14394	
Total Dissolved Solids	250 mg/l	97.6/97.6	85-115	0.00	10	W14443	
Total Suspended Solids	200 mg/l	107/106	80-120	0.468	20	W14455	
Chromium, Hexavalent	0.5 mg/l	97.2/106	90-110	8.66	10	W14404	
Beryllium	0.05 mg/l	106/106	85-115	0.370	20	S16393	
Cadmium	0.05 mg/l	100/99.9	85-115	0.538	20	S16393	
Copper	0.05 mg/l	97.9/97.9	85-115	0.0423	20	S16393	
Iron	5 mg/l	98.6/98.1	85-115	0.496	20	S16393	
Lead	0.05 mg/l	97.9/98.0	85-115	0.0715	20	S16393	
Nickel	0.05 mg/l	96.1/96.4	85-115	0.234	20	S16393	
Selenium	0.05 mg/l	101/102	85-115	0.367	20	S16393	
Silver	0.02 mg/l	96.4/96.7	85-115	0.297	20	S16393	
Zinc	0.05 mg/l	99.9/100	85-115	0.279	20	S16393	
Mercury	0.0025 mg/l	94.8/93.2	85-115	1.70	20	S16396	
Chloride	10 mg/l	94.9/94.4	90-110	0.454	10	S16400	
Sulfate	30 mg/l	99.5/100	90-110	0.541	10	S16400	

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MATRIX SPIKE SAMPLE RESULTS

Analyte	Spike Amount	% Recovery	% Recovery Limits	RPD	RPD Limit	Batch	Qualifier
Chromium, Hexavalent	0.5 mg/l	82.3/82.5	79.8-114	0.173	10	W14404	
Beryllium	0.05 mg/l	109/108	75-125	1.17	20	S16393	
Cadmium	0.05 mg/l	99.1/98.2	75-125	0.913	20	S16393	
Copper	0.05 mg/l	97.2/96.2	75-125	1.06	20	S16393	
Iron	5 mg/l	97.6/96.6	75-125	1.07	20	S16393	
Lead	0.05 mg/l	98.0/97.5	70-130	0.448	20	S16393	
Nickel	0.05 mg/l	95.4/94.6	75-125	0.757	20	S16393	
Selenium	0.05 mg/l	99.6/100	70-130	0.362	20	S16393	
Silver	0.02 mg/l	96.1/94.3	75-125	1.85	20	S16393	
Zinc	0.05 mg/l	96.5/95.6	75-125	0.864	20	S16393	
Mercury	0.0025 mg/l	90.4/95.6	70-130	5.59	20	S16396	
Chloride	10 mg/l	94.8/95.7	80-120	0.380	10	S16400	
Sulfate	30 mg/l	99.6/100	80-120	0.186	10	S16400	

LABORATORY BLANK RESULTS

Analyte	Method	Result	Units	RL	QC Sample	Qualifier
Total Dissolved Solids	EPA 160.1	< 10	mg/l	10	W14394-7	
Total Dissolved Solids	EPA 160.1	< 10	mg/l	10	W14443-1	
Total Suspended Solids	EPA 160.2	< 4	mg/l	4	W14455-1	
Alkalinity as CaCO3	EPA 310.1	< 1	mg/l	1	W14463-1	
Chromium, Hexavalent	SM 3500-Cr B	< 0.007	mg/l	0.007	W14404-6	
Beryllium	EPA 200.8	< 0.0003	mg/l	0.0003	S16393-1	
Cadmium	EPA 200.8	< 0.004	mg/l	0.004	S16393-1	
Copper	EPA 200.8	< 0.006	mg/l	0.006	S16393-1	
Iron	EPA 200.8	< 0.02	mg/l	0.02	S16393-1	
Lead	EPA 200.8	< 0.001	mg/l	0.001	S16393-1	
Nickel	EPA 200.8	< 0.01	mg/l	0.01	S16393-1	
Selenium	EPA 200.8	< 0.002	mg/l	0.002	S16393-1	
Silver	EPA 200.8	< 0.007	mg/l	0.007	S16393-1	
Zinc	EPA 200.8	< 0.002	mg/l	0.002	S16393-1	
Mercury	EPA 245.2	< 0.0002	mg/l	0.0002	S16396-1	
Chloride	EPA 300.0	< 0.2	mg/l	0.2	S16400-1	
Sulfate	EPA 300.0	< 0.2	mg/l	0.2	S16400-1	

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QUALITY CONTROL PREPARATION REPORT

DUPLICATE SAMPLES

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	QC Sample	Qualifier
Total Dissolved Solids	-		28JUL05 0959	201		W14443-4	
Alkalinity as CaCO3	-		01AUG05 1549	93		W14463-2	

LABORATORY CONTROL SAMPLES

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	QC Sample	Qualifier
Total Dissolved Solids	-		26JUL05 1123	201		W14394-6	
Total Dissolved Solids	-		28JUL05 0959	201		W14394-8	
Total Dissolved Solids	-		28JUL05 0959	201		W14443-2	
Total Dissolved Solids	-		28JUL05 0959	201		W14443-3	
Total Suspended Solids	29JUL05 1404	201	01AUG05 0828	201		W14455-2	
Total Suspended Solids	29JUL05 1404	201	01AUG05 0828	201		W14455-3	
Chromium, Hexavalent	-		22JUL05 1612	240		W14404-3	
Chromium, Hexavalent	-		27JUL05 1739	93		W14404-7	
Metals	28JUL05 0808	235	29JUL05 1514	117		S16393-2	
Metals	28JUL05 0808	235	29JUL05 1520	117		S16393-3	
Mercury	28JUL05 0917	256	28JUL05 1313	256		S16396-2	
Mercury	28JUL05 0917	256	28JUL05 1317	256		S16396-3	
Chloride	28JUL05 1334	117	28JUL05 1349	117		S16400-2	
Chloride	28JUL05 1334	117	28JUL05 1403	117		S16400-3	
Sulfate	28JUL05 1334	117	28JUL05 1349	117		S16400-2	
Sulfate	28JUL05 1334	117	28JUL05 1403	117		S16400-3	

MATRIX SPIKE SAMPLES

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	QC Sample	Qualifier
Chromium, Hexavalent	-		22JUL05 1612	240		W14404-4	
Chromium, Hexavalent	-		22JUL05 1612	240		W14404-5	
Metals	28JUL05 0808	235	29JUL05 1527	117		S16393-4	
Metals	28JUL05 0808	235	29JUL05 1534	117		S16393-5	
Mercury	28JUL05 0917	256	28JUL05 1321	256		S16396-4	
Mercury	28JUL05 0917	256	28JUL05 1324	256		S16396-5	
Chloride	28JUL05 1334	117	28JUL05 1416	117		S16400-4	
Chloride	28JUL05 1334	117	28JUL05 1430	117		S16400-5	
Sulfate	28JUL05 1334	117	28JUL05 1416	117		S16400-4	
Sulfate	28JUL05 1334	117	28JUL05 1430	117		S16400-5	

LABORATORY BLANKS

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	QC Sample	Qualifier
Total Dissolved Solids	-		28JUL05 0959	201		W14394-7	
Total Dissolved Solids	-		28JUL05 0959	201		W14443-1	
Total Suspended Solids	29JUL05 1404	201	01AUG05 0828	201		W14455-1	
Alkalinity as CaCO3	-		01AUG05 1017	93		W14463-1	

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QUALITY CONTROL PREPARATION REPORT

LABORATORY BLANKS

Analyte	Date/Time Prepared	By	Date/Time Analyzed	By	Dilution	QC Sample	Qualifier
Chromium, Hexavalent	-		27JUL05 1739	93		W14404-6	
Metals	28JUL05 0808	235	29JUL05 1507	117		S16393-1	
Mercury	28JUL05 0917	256	28JUL05 1309	256		S16396-1	
Chloride	28JUL05 1334	117	28JUL05 1335	117		S16400-1	
Sulfate	28JUL05 1334	117	28JUL05 1335	117		S16400-1	

ftn

92410

Date 7/26/05	Project Name AECI UAA Study	Project No. 6028-020	Project Manager (Print) Jim Malcolm	Page 1 of 2

Report and Bill to:
FTN Associates, Ltd.
Jim Malcolm
3 Innwood Circle, Suite 220
Little Rock, AR 72211
(501) 225-7779 • Fax (501) 225-6738

Submitted by:
FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211
(501) 225-7779 • Fax (501) 225-6738

Sampler Signature(s)

Recorded By (Print)
Nathan Siria

Lab Turn-Around-Time
☐ 24 Hours
☐ 48 Hours
☐ Normal
☐ Other: Due: / /

Laboratory Notes

SAMPLE DESCRIPTION

Parameters (Method Number)

Sample Identification	Date	Time	Matrix* W	S	O	No. of Containers	Comp	Grab	Cd, Cr (III), Cr (VI6, Cu, Pb,sf, Hg,sf, Ni, Se,sf, Ag, Zn; Be, Fe, Hard	Alkalinity, TDS, SO4, TSS, Cl,				Acute Toxicity 48 hr FH, CD				
Ditch No. 27-0	7/26/05		X			~~3~~ 5		X	X	X				~~X~~				
Ditch No. 6-2 d/s	7/26/05		X			3		X	X	X								
Ditch No. 6-3 u/s	7/26/05		X			~~3~~ 5		X	X	X				~~X~~				
Ditch No 6-33	7/26/05		X			3		X	X	X								
Ditch No. 41 @ 119	7/26/05		X			3		X	X	X								
Ditch No. 28-1	7/26/05		X			3		X	X	X								
Tee Ditch	7-27-05		X			3		X	X	X								
								Container Type	P	P				P				
								Preservative	N	NO				No				

* Matrix: W = Water S = Soil O = Other

G = Glass P = Plastic V = VOA vials H = HCl to pH2 T = Sodium Thiosulfate
NO = None S = Sulfuric acid pH2 N = Nitric acid pH2 B = NaOH to pH12 Z = Zinc acetate

Relinquished By (Signature)	Print Name	Date	Time	Received By (Signature)	Print Name	Date	Time
[signature]	Nick Siria	7/26/05	17:00	[signature]	Shana Purchase	7-27-05	1650
Relinquished By (Signature) [signature]	David Ruscc	7/27/05	1650	Received By Laboratory (Signature)	Print Name	Date	Time

Remarks:

Laboratory Remarks:

Copy: Jim Malcolm

APPENDIX F

Steady State Mass Budget Model Runs

[redacted]

AECI Dsicharge and Receiving Stream Steady State Mass Balance Model -- SO4 and TDS
Predicting Water Quality and Quantity in the Watershed
7Q10 Flow Conditions

SIMULATION: 85 cfs, RIGHT HAND CHUTE OF LITTLE R AT RIVERVALE, ARK , Based on Low Flow 1981-1998 data and calculated by ECT
700 gpm, Outfall 001 Discharge

	Flow (cfs)	Flow (cfsm)	gpm/mile2	Cl (mg/L)	SO4 (mg/L)	TDS (mg/L)
# USGS 07046600 RIGHT HAND CHUTE OF LITTLE R AT RIVERVALE, ARK (2106 square miles)	85	0.04	18			
# USGS 07047700 Tyronza River Near Twist, Ark. (533 square miles)	33	0.06	28			
Dry Season Background Ditch No 6-3				4.1	11	220
Wet Season Background (highest)				6.4	17	240
ADEQ Monitoring Station #FRA0033 - Tyronza River (Average)				5 4	28 9	238
Delta Ecoregion (Plate D-2) Water Quality Standard				48	37	411
St.Francis River @ Mouth Water Quality Standard				10	30	330
Tyronza River Water Quality Standard				20	30	350

SOURCES OR SEGMENTS	DRAINAGE AREA Square Miles	FLOW gpm	Chloride mg/L	SO4 mg/L	TDS mg/L	% Discharge	Notes
Ditch 27 and Outfall 001 Mixed							
INFLOW							
AECI Outfall 001		700	11	478	1,200	100%	TDS calculated from Conductivity for GP Infrastructure
Ditch 27 U/S of Outfall 001	0.30	5 4	6 4	17	240		Delineated from Topo, Little River 7Q10 data
OUTFLOW							
Ditch 27 and Outfall 001 Mixed	0.30	705	11 2	474	1,193		
Ditch 27 Mouth							
INFLOW							
Ditch 27 and Outfall 001 Mixed	0.30	705	11 2	474	1,193		
Ditch 27 D/S of Outfall 001	2.9	53	6 4	17	240		Delineated from Topo, Little River 7Q10 data
OUTFLOW							
Ditch 27 Mouth	3 2	758	10 8	443	1,127	92%	
Ditch No. 6 Immediate D/S of Ditch No. 27							
INFLOW							
Ditch 27 Mouth	3 2	758	11	443	1,127		
Ditch No. 6 U/S of Ditch 27 Confluence	55	996	6.4	17	240		Delineated from Topo, Little River 7Q10 data
OUTFLOW							
Ditch No. 6 Immediate D/S of Ditch No. 27	58	1,754	8.3	201	623	40%	
Tyronza River Immediately D/S of Ditch No. 6							
INFLOW							
Ditch No 6 Immediately D/S of Ditch No 27	58	1,754	8	201	623		Delineated from Topo
Ditch No 6 Mouth	31	562	6 4	17	240		Delineated from Topo, Little River 7Q10 data
Tyronza River U/S of Ditch No 6 Confluence	269	7,475	5.4	28.9	238		Delineated from Topo, Tyronza 7Q10 Data
OUTFLOW							
Tyronza River Immediately D/S of Ditch No. 6	358	9,790	6 0	59	307	7%	USGS
St. Francis River Immediately D/S of Tyronza River Confluence							
INFLOW							
Tyronza River Immediately D/S of Ditch No 6	358	9,790	6	59	307		
Tryonza River D/S of Ditch No 6 Confluence	292	8,114	5 4	28 9	238		Delineated from Topo, Tyronza 7Q10 Data
St. Francis River U/S of Tyronza River Confluence	5,271	146,475	6 4	17	240		
OUTFLOW							
St. Francis River Immediately D/S of Tryonza River Confluence	5,921	164,379	6.3	20	244	0 43%	

Notes.
Predicted to exceed existing WQS.

AECI Dsicharge and Receiving Stream Steady State Mass Balance Model -- SO4 and TDS
Predicting Water Quality and Quantity in the Watershed
Longterm 10% Low-Flow Flow Conditions (90% of Flows are greater than)

SIMULATION: 406 cfs, RIGHT HAND CHUTE OF LITTLE R AT RIVERVALE, ARK , Based on Low Flow 1981-1998 data and calculated by ECT
700 gpm, Outfall 001 Discharge

	Flow (cfs)	Flow (cfsm)	gpm/mile2	Cl (mg/L)	SO4 (mg/L)	TDS (mg/L)
# USGS 07046600 RIGHT HAND CHUTE OF LITTLE R AT RIVERVALE, ARK (2106 square miles)	406	0 19	87			
Dry Season Background Ditch No. 6-3				4 1	11	220
Wet Season Background (highest)				6 4	17	240
ADEQ Monitoring Station #FRA0033 - Tyronza River (Average)				5.4	28.9	238
Delta Ecoregion (Plate D-2) Water Quality Standard				48	37	411
St Francis River @ Mouth Water Quality Standard				10	30	330
Tyronza River Water Quality Standard				20	30	350

SOURCES OR SEGMENTS	DRAINAGE AREA Square Miles	FLOW gpm	Chloride mg/L	SO4 mg/L	TDS mg/L	% Discharge	Notes
Ditch 27 and Outfall 001 Mixed							
INFLOW							
AECI Outfall 001		700	11	478	1,200	100%	TDS calculated from Conductivity for GE Infrastructure
Ditch 27 U/S of Outfall 001	0.30	26 0	6.4	17	240		
OUTFLOW							
Ditch 27 and Outfall 001 Mixed	0 30	726 0	11 0	462	1,166		
Ditch 27 Mouth							
INFLOW							
Ditch 27 and Outfall 001 Mixed	0.30	726.0	11.0	462	1,166		
Ditch 27 D/S of Outfall 001	2 9	251	6 4	17	240		
OUTFLOW							
Ditch 27 Mouth	3.2	977	9.8	347	928	72%	
Ditch No. 6 Immediate D/S of Ditch No. 27							
INFLOW							
Ditch 27 Mouth	3 2	977	10	347	928		
Ditch No. 6 U/S of Ditch 27 Confluence	55	4,756	6 4	17	240		
OUTFLOW							
Ditch No. 6 Immediate D/S of Ditch No. 27	58	5,732	7.0	73	357	12%	
Tyronza River Immediately D/S of Ditch No. 6							
INFLOW							
Ditch No. 6 Immediately D/S of Ditch No 27	58	5,732	7	73	357		Delineated from Topo
Ditch No. 6 Mouth	30	2,596	6.4	17	240		Estimated the area
Tyronza River U/S of Ditch No 6 Confluence	269	23,276	5.4	28.9	238		Estimated the area
OUTFLOW							
Tyronza River Immediately D/S of Ditch No. 6	357	31,604	5 8	36	260	2%	USGS
St. Francis River Immediately D/S of Tyronza River Confluence							
INFLOW							
Tyronza River Immediately D/S of Ditch No. 6	357	31,604	6	36	260		
Tryonza River D/S of Ditch No 6 Confluence	292	25,266	5.4	28.9	238		
St Francis River U/S of Tyronza River Confluence	5,271	456,083	6.4	17	240		
OUTFLOW							
St. Francis River Immediately D/S of Tryonza River Confluence	5,920	512,953	6 3	18 8	241	0.14%	

Notes

AECI Dsicharge and Receiving Stream Steady State Mass Balance Model -- SO4 and TDS
Predicting Water Quality and Quantity in the Watershed
Harmonic Mean Flow Conditions

SIMULATION: 850 cfs, RIGHT HAND CHUTE OF LITTLE R AT RIVERVALE, ARK , Based on Low Flow 1981-1998 data and calculated by ECT
700 gpm, Outfall 001 Discharge

	Flow (cfs)	Flow (cfsm)	gpm/mile2	Cl (mg/L)	SO4 (mg/L)	TDS (mg/L)
# USGS 07046600 RIGHT HAND CHUTE OF LITTLE R AT RIVERVALE, ARK (2106 square miles)	850	0 40	181			
Dry Season Background Ditch No. 6-3				4.1	11	220
Wet Season Background (highest)				6.4	17	240
ADEQ Monitoring Station #FRA0033 - Tyronza River (Average)				5.4	28.9	238
Delta Ecoregion (Plate D-2) Water Quality Standard				48	37	411
St Francis River @ Mouth Water Quality Standard				10	30	330
Tyronza River Water Quality Standard				20	30	350

SOURCES OR SEGMENTS	DRAINAGE AREA Square Miles	FLOW gpm	Chloride mg/L	SO4 mg/L	TDS mg/L	% Discharge	Notes
Ditch 27 and Outfall 001 Mixed							
INFLOW							
AECI Outfall 001		700	11	478	1,200	100%	TDS calculated from Conductivity for GE Infrastructure
Ditch 27 U/S of Outfall 001	0.30	54.3	6.4	17	240		
OUTFLOW							
Ditch 27 and Outfall 001 Mixed	0 30	754 3	10.9	445	1,131		
Ditch 27 Mouth							
INFLOW							
Ditch 27 and Outfall 001 Mixed	0.30	754 3	10.9	445	1,131		
Ditch 27 D/S of Outfall 001	2.9	525	6 4	17	240		
OUTFLOW							
Ditch 27 Mouth	3.2	1,280	9 0	269	765	55%	
Ditch No. 6 Immediate D/S of Ditch No. 27							
INFLOW							
Ditch 27 Mouth	3 2	1,280	9	269	765		
Ditch No 6 U/S of Ditch 27 Confluence	55	9,956	6 4	17	240		
OUTFLOW							
Ditch No. 6 Immediate D/S of Ditch No. 27	58	11,236	6.7	46	300	6%	
Tyronza River Immediately D/S of Ditch No. 6							
INFLOW							
Ditch No 6 Immediately D/S of Ditch No. 27	58	11,236	7	46	300		Delineated from Topo
Ditch No 6 Mouth	30	5,435	6 4	17	240		Estimated the area
Tyronza River U/S of Ditch No. 6 Confluence	269	48,730	5 4	28.9	238		Estimated the area
OUTFLOW							
Tyronza River Immediately D/S of Ditch No. 6	357	65,400	5 7	31	249	1%	USGS
St. Francis River Immediately D/S of Tyronza River Confluence							
INFLOW							
Tyronza River Immediately D/S of Ditch No. 6	357	65,400	6	31	249		
Tryonza River D/S of Ditch No 6 Confluence	292	52,896	5 4	28.9	238		
St. Francis River U/S of Tyronza River Confluence	5,271	954,853	6.4	17	240		
OUTFLOW							
St. Francis River Immediately D/S of Tryonza River Confluence	5,920	1,073,150	6.3	18.4	240	0.07%	

Notes

AECI Dsicharge and Receiving Stream Steady State Mass Balance Model -- SO4 and TDS
[redacted]ing W[redacted]ualit[redacted]Quant[redacted]he W[redacted]ed [redacted]
Model Calibration 7Q10 Flow Conditions

SIMULATION: 85 cfs, # USGS 07046600 RIGHT HAND CHUTE OF LITTLE R AT RIVERVALE, ARK.
0 gpm, Outfall 001 Discharge

	Flow (cfs)	Flow (cfsm)	gpm/mile2	Cl (mg/L)	SO4 (mg/L)	TDS (mg/L)
# USGS 07046600 RIGHT HAND CHUTE OF LITTLE R AT RIVERVALE, ARK (2106 square miles)	85	0 04	18			
# USGS 07047700 Tyronza River Near Twist, Ark (533 square miles)	33	0.06	28			
Dry Season Background Ditch No 6-3				4 1	11	220
Wet Season Background (highest)				6.4	17	240
ADEQ Monitoring Station #FRA0033 - Tyronza River (Average)				5.4	28 9	238
Delta Ecoregion (Plate D-2) Water Quality Standard				48	37	411
St Francis River @ Mouth Water Quality Standard				10	30	330
Tyronza River Water Quality Standard				20	30	350

SOURCES OR SEGMENTS	DRAINAGE AREA Square Miles	FLOW gpm	Chloride mg/L	SO4 mg/L	TDS mg/L	% Discharge	Notes
Ditch 27 and Outfall 001 Mixed							
INFLOW							
AECI Outfall 001		0	11	478	1,200	#DIV/0!	TDS calculated from Conductivity for GE Infrastructure
Ditch 27 U/S of Outfall 001	0 30	5.4	6.4	17	240		Delineated from Topo, Little River 7Q10 data
OUTFLOW							
Ditch 27 and Outfall 001 Mixed	0 30	5	6 4	17	240		
Ditch 27 Mouth							
INFLOW							
Ditch 27 and Outfall 001 Mixed	0.30	5	6 4	17	240		
Ditch 27 D/S of Outfall 001	2.9	53	6.4	17	240		Delineated from Topo, Little River 7Q10 data
OUTFLOW							
Ditch 27 Mouth	3.2	58	6 4	17	240	0%	
Ditch No. 6 Immediate D/S of Ditch No. 27							
INFLOW							
Ditch 27 Mouth	3.2	58	6	17	240		
Ditch No 6 U/S of Ditch 27 Confluence	55	996	6.4	17	240		Delineated from Topo, Little River 7Q10 data
OUTFLOW							
Ditch No. 6 Immediate D/S of Ditch No. 27	58	1,054	6 4	17	240	0%	
Tyronza River Immediately D/S of Ditch No. 6							
INFLOW							
Ditch No 6 Immediately D/S of Ditch No 27	58	1,054	6	17	240		Delineated from Topo
Ditch No. 6 Mouth	31	562	6.4	17	240		Delineated from Topo, Little River 7Q10 data
Tyronza River U/S of Ditch No. 6 Confluence	269	7,475	5.4	28.9	238		Delineated from Topo, Tyronza 7Q10 Data
OUTFLOW							
Tyronza River Immediately D/S of Ditch No. 6	358	9,090	5 6	27	238	0%	USGS
St. Francis River Immediately D/S of Tyronza River Confluence							
INFLOW							
Tyronza River Immediately D/S of Ditch No 6	358	9,090	6	27	238		
Tryonza River D/S of Ditch No. 6 Confluence	292	8,114	5.4	28.9	238		Delineated from Topo, Tyronza 7Q10 Data
St Francis River U/S of Tyronza River Confluence	5,271	146,475	6.4	17	240		
OUTFLOW							
St. Francis River Immediately D/S of Tryonza River Confluence	5,921	163,679	6 3	18	240	0.00%	

Notes

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