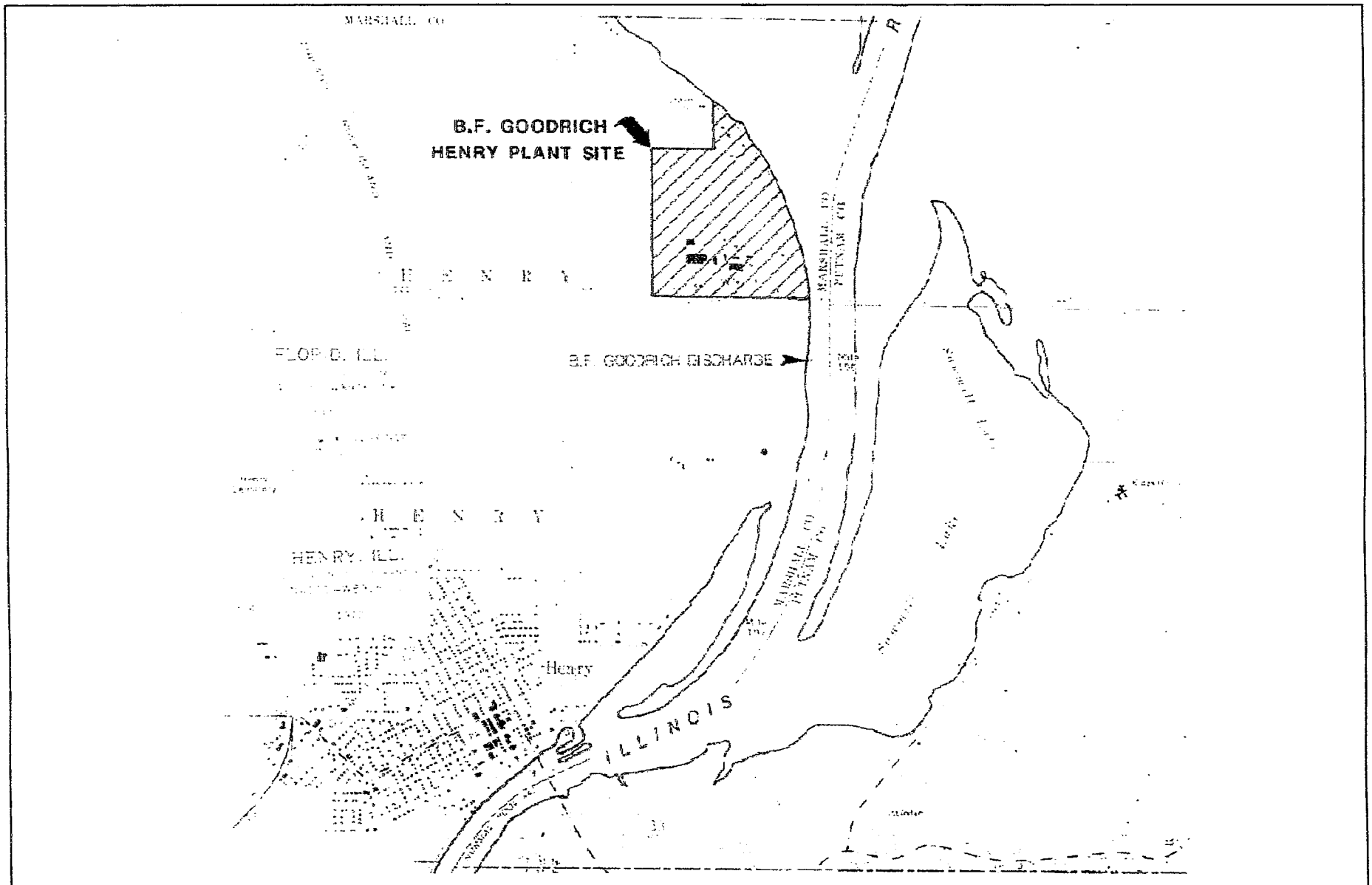
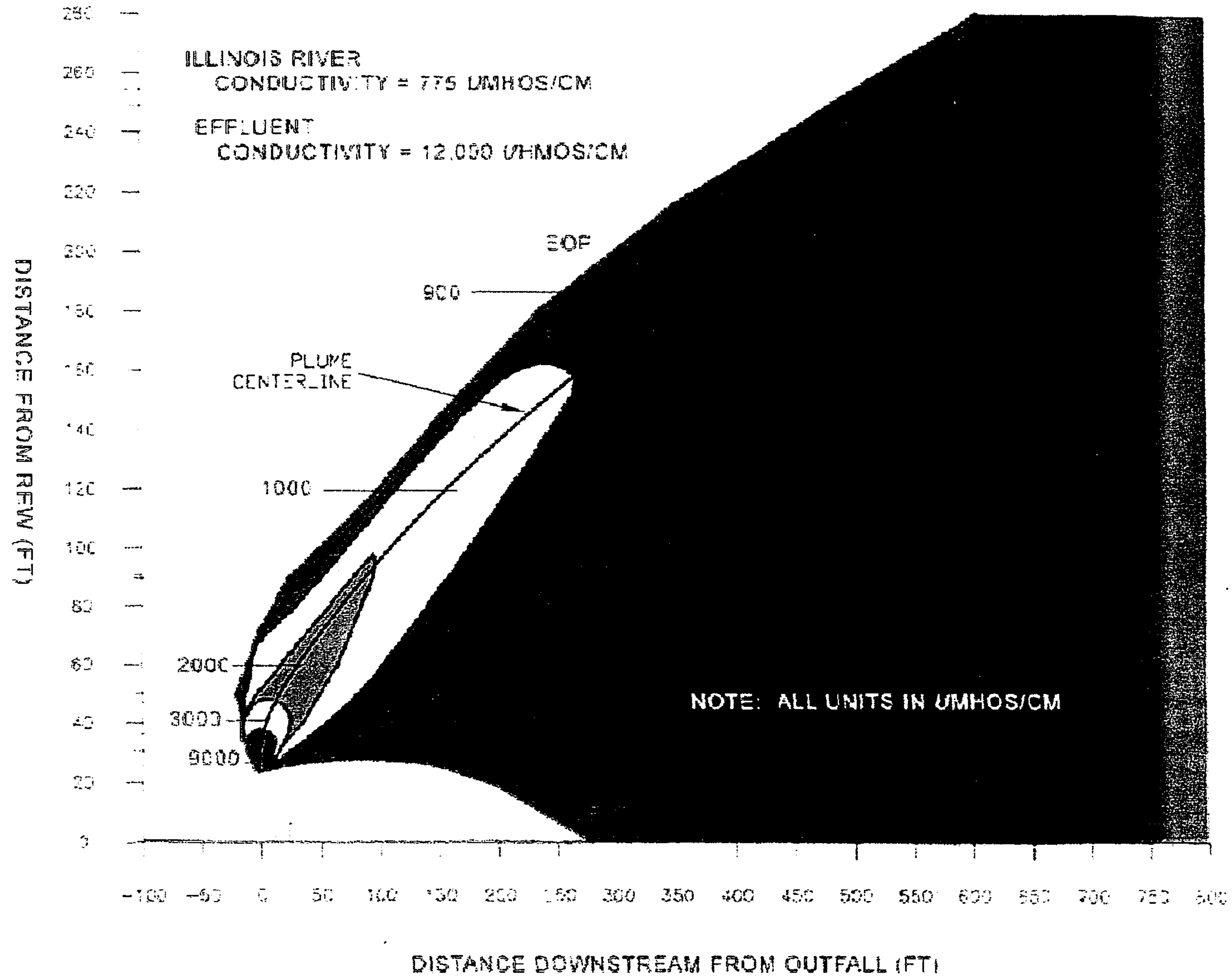


AquAeTer

optimizing environmental resources
water, air, earth

EXHIBIT
Petitioners
Ex 18
AS-02-5

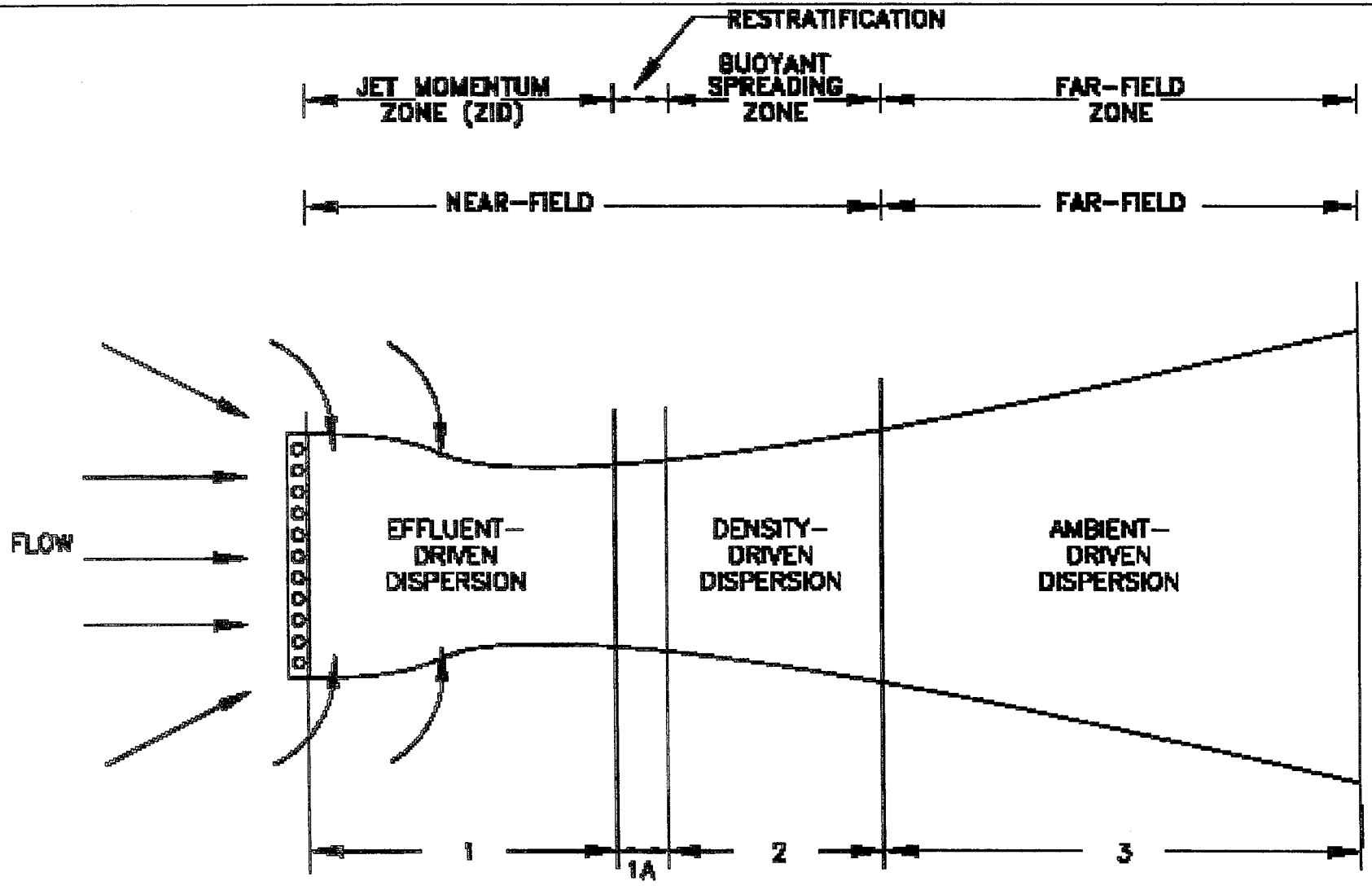
FIGURE 1
AREA MAP



AquAeTer
optimizing environmental resources
water, air, earth

EXHIBIT Petitioners Ex 19 AS02-5

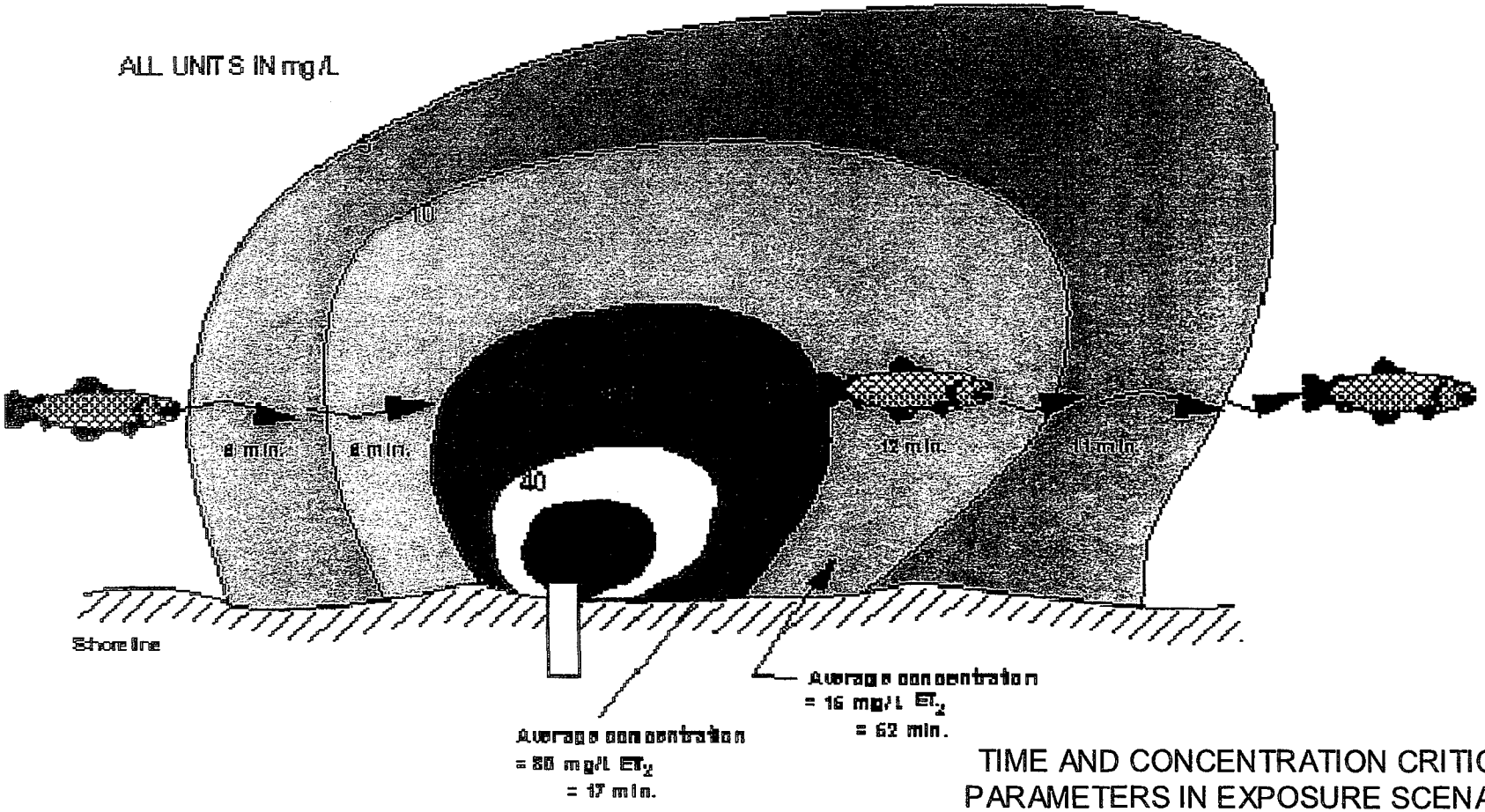
FIGURE 2
LATERAL AND LONGITUDINAL ISOPLETHS FOR BOTTOM SPECIFIC CONDUCTANCE



To Define the Dispersion from Effluent Momentum and Ambient Diffusion NOT TO SCALE

AquaEter
optimizing environmental resources
water & earth

FIGURE 3
HYDRAULIC MIXING ZONE CONCEPTS



TIME AND CONCENTRATION CRITICAL PARAMETERS IN EXPOSURE SCENARIO

NATIONAL ACADEMY OF SCIENCES, WATER QUALITY COMMITTEE, 1972

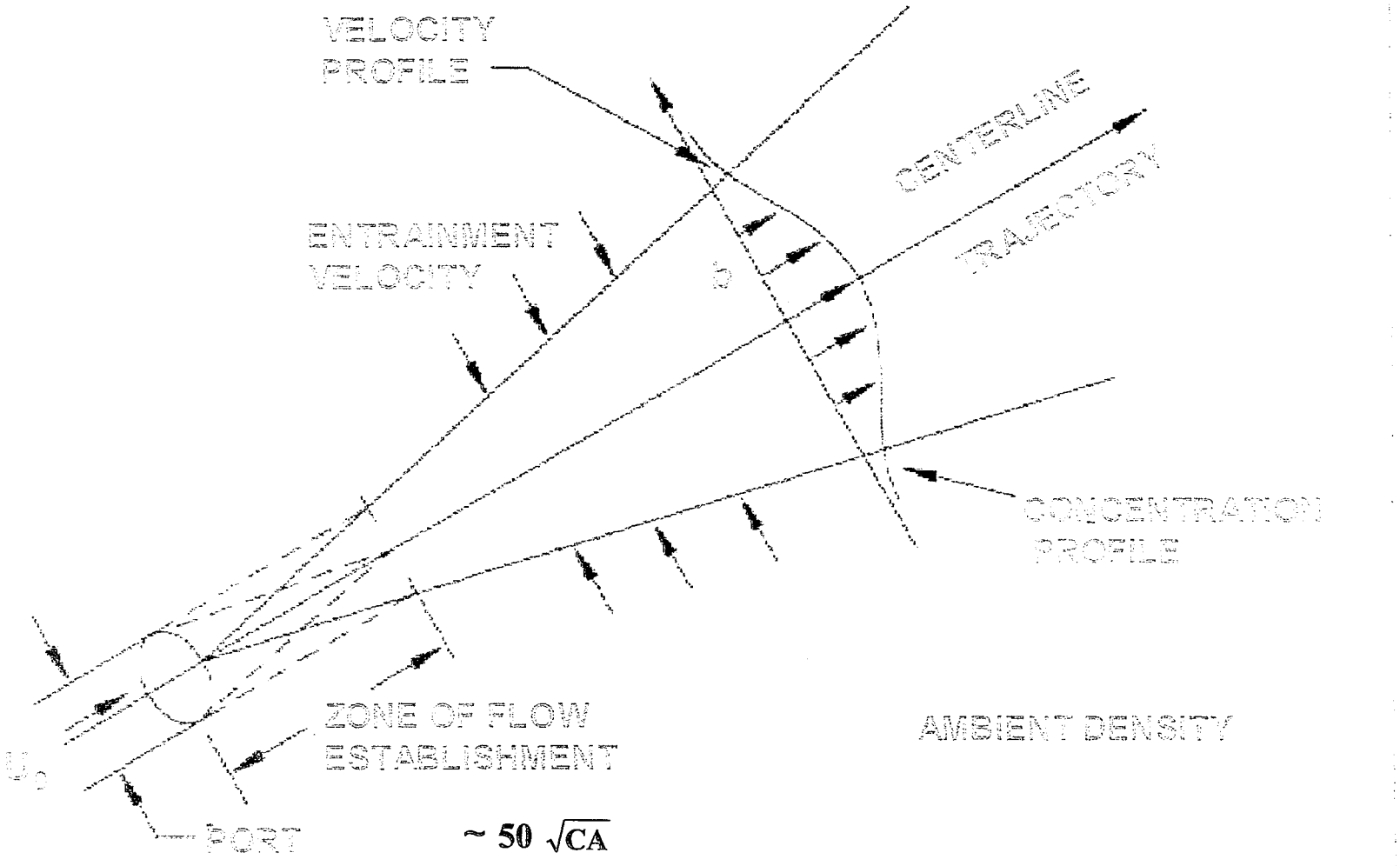
HYPOTHETICAL EXPOSURE SCENARIO FOR FISH PASSING THROUGH A ZID

AquAeTer

optimizing environmental resources
water, air, earth

EXHIBIT Bob Pettinato Ex 21 AS02-5

FIGURE 4
HYPOTHETHICAL EXPOSURE FOR FISH PASSING THROUGH ZID

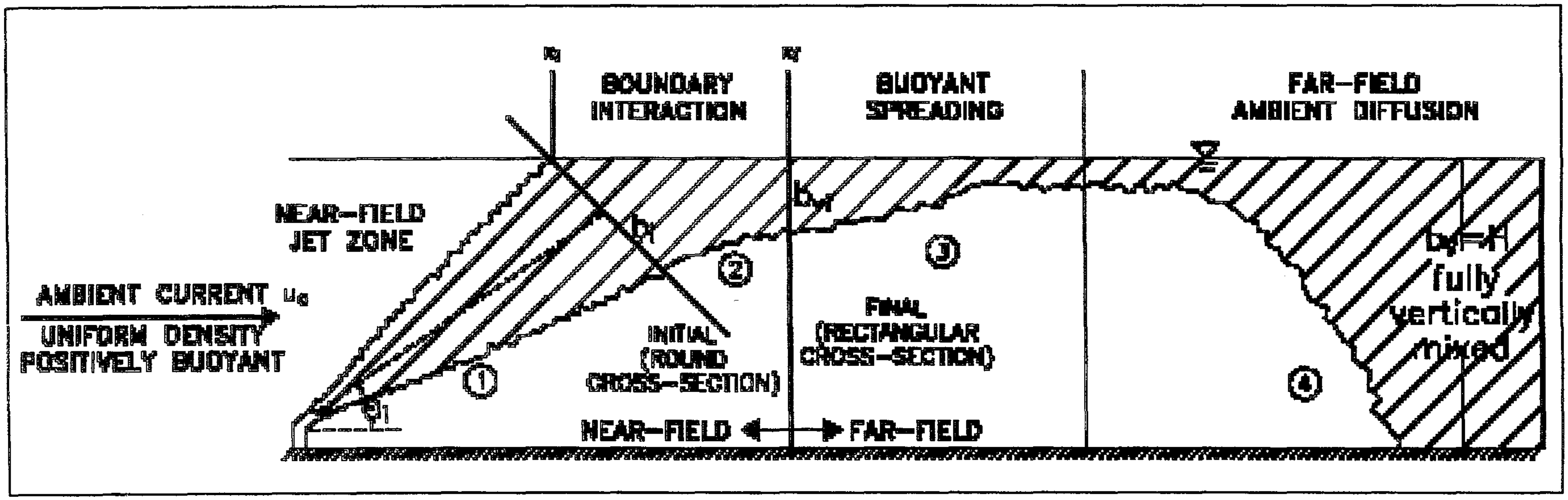


AquAeTer

optimizing environmental resources
water, air, earth

EXHIBIT BPA
Petitioners
Ex 22
AS025

FIGURE 5
ZONE OF FLOW ESTABLISHMENT

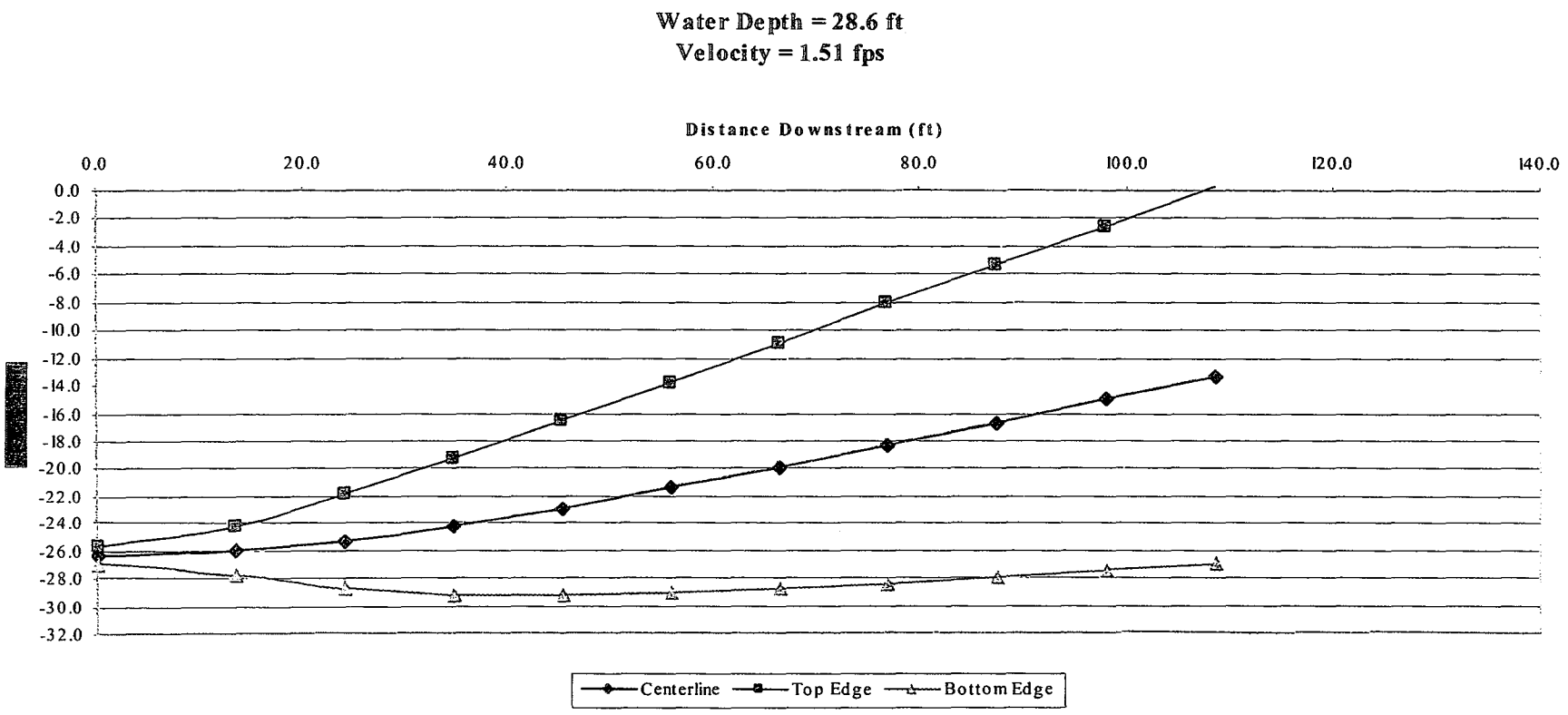


AquAeTer

optimizing environmental resources
water, air, earth

EXHIBIT BPU
Petitioners
Ex 23
AS02.5

FIGURE 6
SCEHMATIC FOR DISPERSION
FROM A DIFFUSER



AquAeTer

optimizing environmental resources
water, air, earth

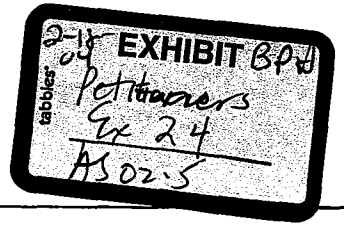
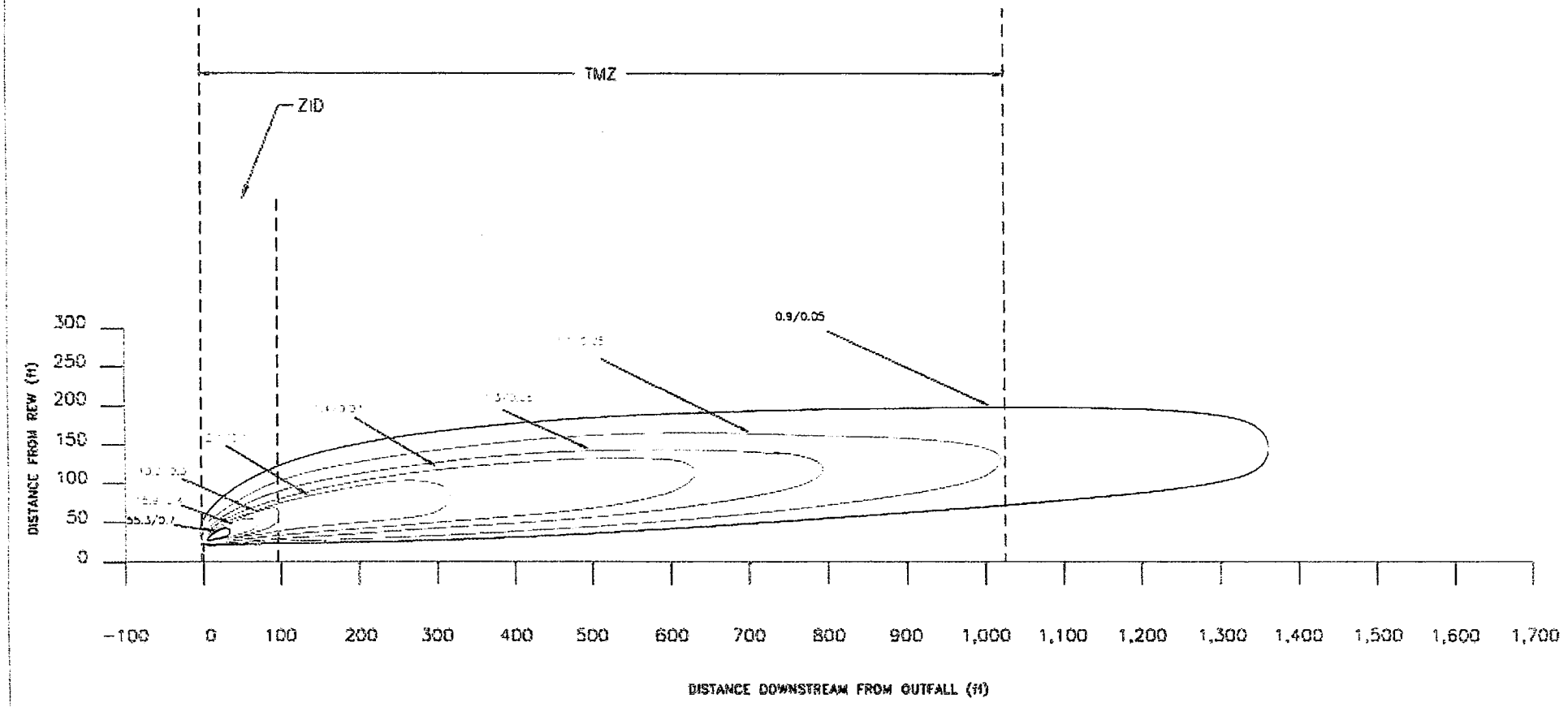


FIGURE 7
MULTIPORT JET ZONE DIFFUSER
ANALYSIS

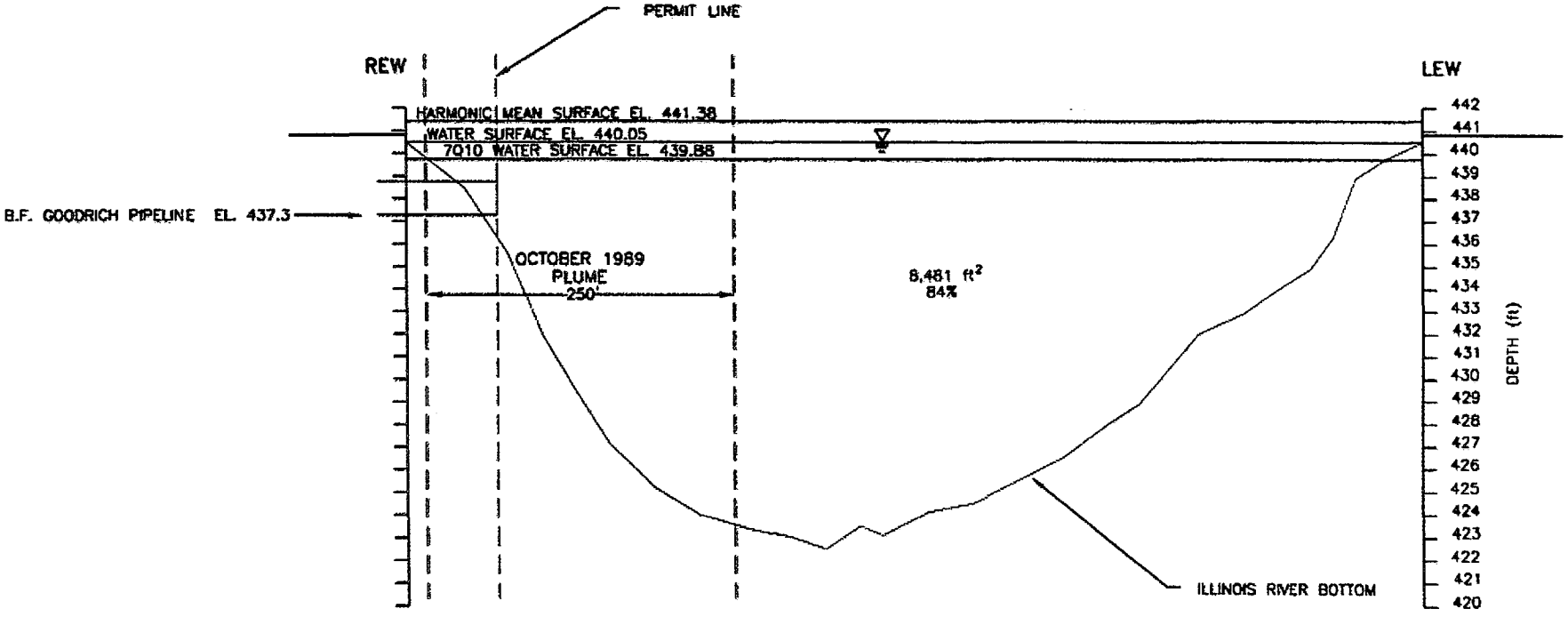


EFFLUENT 103 mg/L

ILLINOIS RIVER BACKGROUND 0.6 mg/L

FIGURE 8

TOTAL AMMONIA DISPERSION FOR THE NOVEON SUBMERGED SINGLE-PORT DIFFUSER – SUMMER



ILLINOIS RIVER CROSS SECTIONAL AREA = 10,044 ft² IN PLUME AREA

NOTE: WATER SURFACE ELEVATION BASED ON CORPS OF ENGINEERS SOUNDINGS OF SEPTEMBER 1970

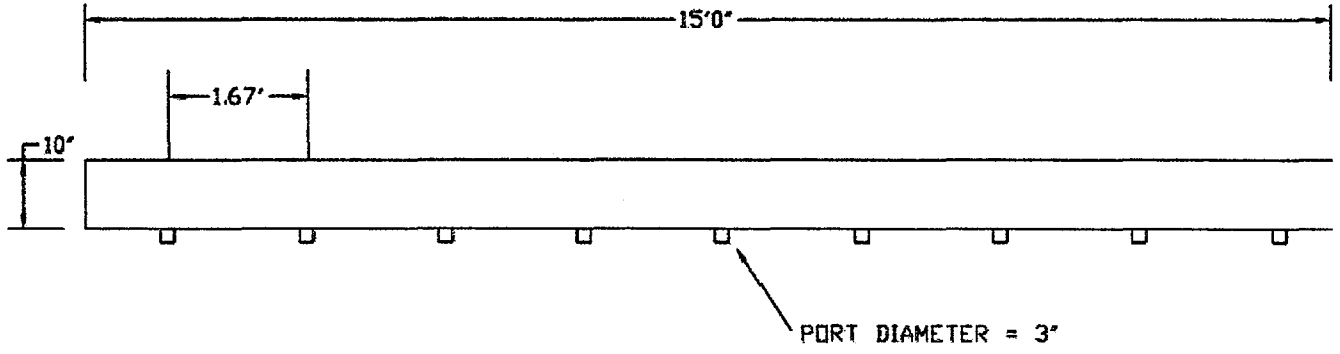
BASED ON 1989 CONDUCTIVITY MEASUREMENTS, PLUME WILL REQUIRE APPROXIMATELY 16% OF CROSS SECTIONAL AREA TO MEET DISPERSION REQUIRED DURING THE WINTER FOR AN EFFLUENT CONCENTRATION OF 103 mg/L

HORIZONTAL SCALE
1" = 200'

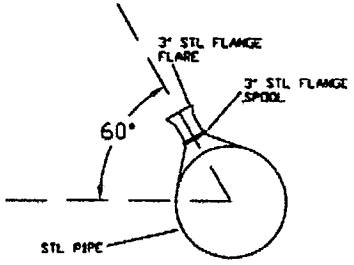
FIGURE 9
PROFILE OF ILLINOIS RIVER NEAR HENRY, ILLINOIS

Number of Ports	9
Port Spacing	1.67 ft
Diffuser Dia.	10 in
Diffuser Length	15 ft
Port Diameter	3 in
Port Angle	60°
Design Flowrate	1.3 mgd

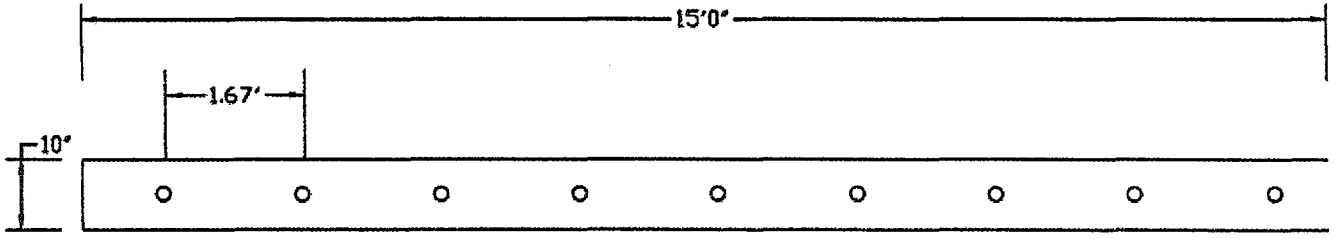
PLAN VIEW



SIDE VIEW



ELEVATION



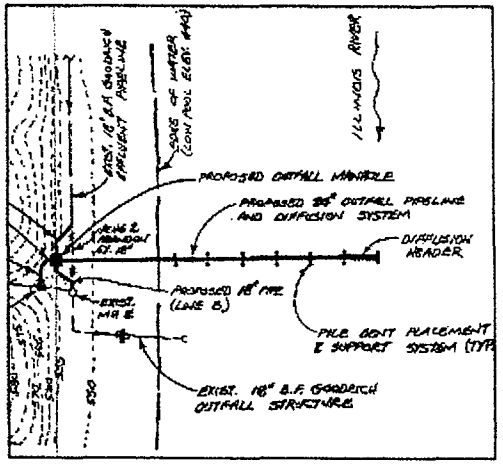


FIGURE 10
DIFFUSER SCHEMATIC

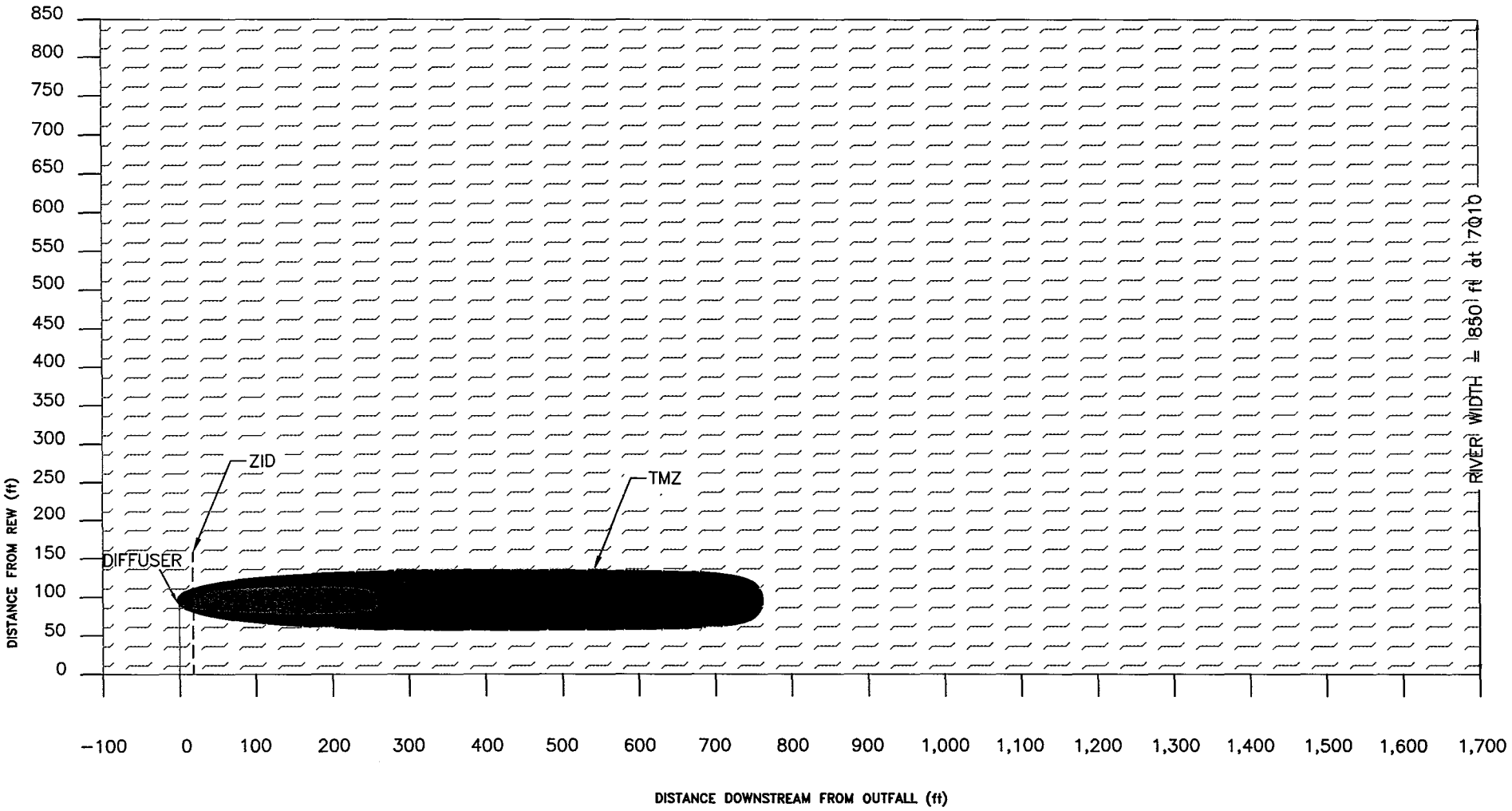


FIGURE 11
ZID AND TMZ FOR PROPOSED MULTIPORT DIFFUSER

RESULTS OF AN ACUTE TOXICITY IDENTIFICATION EVALUATION (TIE) ON A FILTER EFFLUENT SAMPLE FROM BF GOODRICH

Prepared for:

BF Goodrich
R.R. 1, Box 15
Henry, Illinois 61537
and
Gardner, Carton and Douglas
Chicago, Illinois

Prepared by:

EA Engineering, Science, and Technology, Inc.
15 Loveton Circle
Sparks, Maryland 21152

March 1999

EA Project No. 70003.10

Report Number 3020

RESULTS OF AN ACUTE TOXICITY IDENTIFICATION EVALUATION (TIE) ON A FILTER EFFLUENT SAMPLE FROM BF GOODRICH

Prepared for:

BF Goodrich
R.R. 1, Box 15
Henry, Illinois 61537
and
Gardner, Carton and Douglas
Chicago, Illinois

Prepared by:

EA Engineering, Science, and Technology, Inc.
15 Loveton Circle
Sparks, Maryland 21152

22 March 1999

William L. Goodfellow, Jr. — Date
Project Manager

16 March 1999

Wayne L. McCulloch — Date
Senior Scientist

March 1999

Report Number 3020

1. INTRODUCTION

At the request of Gardner, Carton and Douglas, EA Engineering, Science, and Technology conducted an acute Toxicity Identification Evaluation (TIE) on a grab sample of filter effluent from BF Goodrich, Henry, Illinois. The acute TIE methodology consisted of the EPA Phase I procedures (U.S. EPA 1991) and was performed using *Ceriodaphnia dubia* (water flea) as the test species. The objective of the TIE study was to characterize the physical/chemical properties of the compound(s) contributing to acute toxicity in the sample.

2. MATERIALS AND METHODS

2.1 SAMPLE DESCRIPTION

A grab sample of filter effluent was collected on 7 January 1999 from BF Goodrich's Henry facility, and shipped on wet ice via overnight carrier to EA's Ecotoxicology Laboratory in Sparks, Maryland. Upon receipt, the sample was logged in and assigned Aquatic Toxicology Accession Number AT9-002. Table 1 summarizes the sample collection data. Alkalinity, hardness, conductivity, salinity, ammonia, pH, dissolved oxygen and total residual chlorine measurements were made on the effluent sample using methods described in APHA (1998) and US EPA (1979), and these results are also presented in Table 1. The sample was stored in the dark at 4°C when not being used for testing.

2.2 TEST ORGANISMS

Ceriodaphnia dubia were cultured in EA's laboratory using synthetic moderately hard freshwater as described below. The cultures were kept in an environmentally controlled room at 25±2°C with a 16-hour light/8-hour dark photoperiod. Organisms were fed daily as described in US EPA 1993 and thinned as necessary to maintain healthy, productive cultures. Adults were separated from the bulk cultures at least one week prior to test initiation, placed in individual 30-ml plastic cups (15-ml volume) in brood boards, and fed heavily. Gravid adults were reisolated and fed the evening before the test to ensure that neonates (young) were less than 24-hours old at test initiation.

2.3 DILUTION WATER

The laboratory water used in culturing and testing the *C. dubia* was synthetic moderately hard freshwater (US EPA 1993). Batches of this water were made by passing deionized water through activated carbon, adding reagent grade chemicals, and aerating overnight. The water was stored at 25°C under gentle aeration until needed.

2.4 TOXICITY IDENTIFICATION EVALUATION

2.4.1 Toxicity Identification Evaluation Procedures

Chronic toxicity tests were initiated on 7 January 1999 with *Ceriodaphnia dubia* and *Pimephales promelas,* using a suite of three grab samples of filter effluent provided by BF Goodrich . The results of these test indicated that the second sample of the suite of three (AT9-002, collected 7 January 1999) was acutely toxic to both test species. The acute toxicity was confirmed through the performance of acute toxicity tests initiated on this sample on 9 January. The results from these tests are presented and discussed in EA Report #3016. An acute TIE was performed on sample AT9-002, using *C. dubia* as the test species to allow for smaller test solution volumes and thus conserve sample.

The acute TIE methodology included selected manipulations from the Phase I TIE procedures presented in U.S. EPA. 1991. This procedure is a tiered approach and involves fractionation of the wastewater and testing each of the individual fractions for acute toxicity (Figure 1). All of the various treatments include system blanks which help ensure that potentially toxic artifacts resulting from fractionation procedures are detected.

Sample AT9-002 was evaluated to determine whether treatments such as aeration, filtration, or various pH treatments (pH_3, pH_{11} and the initial pH of the sample at receipt [pH i]) were successful in reducing the observable acute toxicity of the sample. Comparison of the aerated versus unaerated sample test results provides an indication of the acute toxicity associated with volatile compounds. The filtration (1.0 μm glass fiber) treatment is designed to determine whether toxicity is present in the suspended particulate phase or the soluble phase of the sample. In addition, C_{18} column solid phase extraction (SPE) was performed on the composite sample adjusted to pH_3, pHi, and pH_9. Removal of the nonpolar organic compounds is accomplished by passing the sample through a 6 ml C_{18} solid phase extraction column (J.T. Baker Chemical Company, Phillipsburg, NJ). Sufficient sample volume is passed through the column (1,000 ml), and the pass-through is evaluated for acute toxicity. Nonpolar organic compounds (molecular

weight less than 2000) that were in the effluent sample are absorbed onto the C_{18} column, and thus the C_{18} pass-through contains a greatly reduced concentrations of potentially toxic non-polar organic compounds. The C_{18} column can also sorb certain surfactants and several metals (e.g., copper).

Methanol elution was also performed on the C_{18} column. In this procedure, two 2-ml subportions of high quality methanol (total of 4 ml) are passed through the column and nonpolar organic compounds are eluted from the column. Assuming 100 percent extraction and elution efficiency, the theoretical concentration back calculated to the original sample is 25,000 percent; or the nonpolar organic compounds are concentrated 250 times in the methanol elutions as compared to the original effluent concentrations. The toxicity tests for the C_{18} column methanol elution take advantage of the ability to concentrate the nonpolar organic compounds by dosing the highest treatment at four times the theoretical concentration of the effluent (i.e., theorectical effluent concentration of 400 percent). This approach is conservative because not all nonpolar organics have 100 percent extraction and elution efficiencies using the C_{18} columns.

As part of the EPA Phase I TIE, the composited sample was evaluated using the EDTA Chelation Test for cationic metals, and treatment with sodium thiosulfate, which reduces oxidants. It should be pointed out, that these treatments are not entirely specific to either metals or oxidants, and can interact with other components in the sample. Also, these compounds do not remove the potential toxicants from the sample; they only reduce the toxicant's biological availability. Evaluations were also performed on aliquots of the composite sample which had been pH adjusted to pH 6.0, 7.0 and 8.0 (graduated pH test). The test pH has a substantial effect on the toxicity of many compounds found in effluents. Changes in pH can affect the solubility, polarity, volatility, and speciation of a compound thereby affecting its bioavailability as well as it's toxicity. The graduated pH test employed the hydrogen ion buffers MES (2-[N-morpholino] ethanesulfonic acid; pH = 6.2), MOPS (3-[N-Morpholino] propanesulfonic acid; pH=7.2), and POPSO (Piperazine-N, N'-bis'[2-hydroxypropanesulfonic acid]; pH=8.2).

Figure 1 shows step-by-step procedures employed for this TIE Phase I assessment. When the tests on the TIE manipulated samples were initiated, the unmodified whole sample was again evaluated (baseline test) for its acute toxicity to *C. dubia* to determine if the toxicity of the composited sample changed with storage time.

Limited-scale acute toxicity tests were conducted at each individual fractionation step. The limited-scale acute tests were used to quantify the toxicity reduction resulting from each fractionation treatment. Details concerning the acute toxicity testing procedures are presented in Section 2.4.2.

A summary of TIE Phase I (Tier I) treatment steps utilized in this study included the following:

- Initial toxicity
- Baseline toxicity (pH i)
- pH Adjustment (pH_3, pH_{11})
- Aeration (pH_3, pH i, pH_{11})
- Filtration (pH_3, pH i, pH_{11})
- C_{18} SPE Column (pH_3, pH i, pH_9)
- MeOH Elution (pH_3, pH i, pH_9)
- EDTA Chelation (pH i)
- Oxidant Reduction (using sodium thiosulfate)(pH i)
- Graduated pH (pH 6.0, 7.0, 8.0)

2.4.2 Acute Toxicity Tests on Fractionation Treatments

The 48-hour *C.dubia* acute toxicity tests conducted on the fractionation treatments were initiated on 19 and 20 January 1999. Test chambers were 30 ml plastic cups containing 15 ml of test solution. The test organisms used in the fractionation tests were exposed to a laboratory control of moderately hard synthetic freshwater, and to 100, 30, 10 and 3 percent concentrations of each treatment (with the following exceptions). The baseline tests (pH *i*) which were initiated on 19 and 20 January had five exposure concentrations (100, 30, 10, 3 and 1 percent). The tests

performed on the methanol elution fractions included 3 exposure concentrations (100, 200 and 400 percent). The graduated pH tests consisted of 25 and 50 percent concentrations and a laboratory water control. The sodium thiosulfate and EDTA tests had 3 concentrations and a control (100, 30 and 10 percent treatment). Each test concentration and control had two replicates of five *C. dubia* each. The system blanks were also tested with 2 replicates of 100 percent concentration with five *C. dubia* per replicate. Test concentrations were measured using Class A glassware. Small volumes of effluent and dilution water were first measured in Class A pipets, added to a graduated cylinder, and brought to volume with dilution water. All tests were performed at 25±1 °C with a 16-hour light/8-hour dark photoperiod. Prior to preparation of test solutions, a subsample of effluent and dilution water was brought to the target test temperature, using a water bath.

The *C. dubia* were fed daily with a trout chow/yeast/cereal leaves solution supplemented with algae (*S. capricornutum*) as described in USEPA (1993). Forty-eight hour LC50 values were calculated from mortality observations performed at the end of the 48-hour exposure period following Stephan (1977). Acute Toxic Units (TU_a) were also calculated for each LC50 value. The term Acute Toxic Unit is defined as:

$$Acute\ Toxic\ Unit\ (TU_a) = \frac{100}{LC50}$$

where the *C. dubia* 48-hour LC50 value is expressed as percent effluent.

2.5 REFERENCE TOXICANT TESTS

In conformance with EA's quality assurance/quality control program, a reference toxicant test was performed with the species tested. The *C. dubia* were exposed to the reference toxicant sodium chloride (NaCl) to determine the 48-hour acute response of these test organisms. The test was performed with a graded concentration series of toxicant and a dilution water control. The results were compared to the established control chart limits set by EA.

2.6 ARCHIVES

Original data sheets, records, memoranda, notes, and computer printouts are archived at EA's Baltimore Office in Sparks, Maryland. These data will be retained for a period of 5 years unless a longer period of time is requested by Gardner, Carton and Douglas.

3. RESULTS

The results of the acute toxicity tests conducted on the whole effluent sample (baseline tests) and on the individual fractionation treatments are summarized in Table 2. The baseline tests, initiated on 19 and 20 January 1999 had a 48-hour LC50 of 17.3 percent effluent (TUa = 5.8). This was very similar to the 48-hour LC50 value from the acute toxicity test initiated with this sample on 9 January 1999 (16.9 percent effluent) as discussed in EA Report #3016, indicating that the observed toxicity was persistent with time.

None of the fractionation treatments were successful in removing, or significantly reducing the observed acute toxicity. There were no surviving organisms in the 30 or 100 percent concentrations of any fractionation treatment; and survival in the 10% concentrations ranged from 80 – 100 percent. None of the tested methanol concentrations (100, 200 or 400 percent) had surviving organisms after 48 hours of exposure. Similarly, with one exception, there were no surviving organisms in the 25 or 50 percent concentrations of the graduated pH treatments. The exception was 10 percent survival in the pH_6 25 percent concentration.

With one exception, the treatment blanks performed during this TIE had a minimum of 90 percent survival after 48 hours of exposure, suggesting that the fractionation manipulations did not introduce acute toxicity to the treatments. The aeration pH_{11} blank had 80 percent survival.

The salinity for sample AT9-002 was 6.4 ppt. If this salinity was composed of only NaCl, it would yield an approximate 48-hour LC50 of 33 percent effluent. Since the 48-hour LC50 for this sample ranged between 16.9 and 17.3, the observed acute toxicity could likely be caused by factors other than the salinity, such as ammonia and non-polar organics.

The 48-hour LC50 value for the reference toxicant test performed during the month of January on EA-cultured *C. dubia* was 1.6 g/L NaCl. The acceptable ranged based on EA Ecotoxicology Control Charts was 1.3 – 2.5 g/L NaCl.

4. REFERENCES

American Public Health Association, American Water Works Association, Water Environment Federation. 1998. Standard Methods for Examination of Water and Wastewater, 20th Edition. APHA, Washington, D.C.

Stephan, C.E. 1977. Methods for calculating an LC50, in Aquatic Toxicology and Hazard Evaluation (F.L. Mayer and J.L. Hamelink, Eds.) ASTM STD 634. ASTM, Philadelphia, Pennsylvania.

U.S. EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA/600/4-79/020. Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

U.S. EPA. 1991. Methods for Aquatic Toxicity Identification Evaluations: Phase I Toxicity Characterization Procedures (Second Edition). EPA-600/6-91-003. Duluth, Minnesota.

US EPA. 1993. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fourth Edition. EPA/600/4-90/027F. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Cincinnati, Ohio.

TABLE 1 SAMPLE COLLECTION/RECEIPT AND INITIAL WATER QUALITY DATA FOR THE BF GOODRICH FILTER EFFLUENT SAMPLE COLLECTED 7 JANUARY 1999

EA Accession Number:	AT9-002
Sample Description:	Filter Effluent
Sample Collection:	1300, 7 January 1999
Sample Receipt:	1450, 8 January 1999
Temperature (°C):	11.0
pH:	6.8
Alkalinity (mg/L):	108
Hardness (mg/L):	96
Conductivity (μS/cm):	15,940
Total Residual Chlorine (mg/L):	<0.01
Salinity (ppt):	6.4
Dissolved Oxygen (mg/L):	5.3
Ammonia (mg/L):	194

TABLE 2 RESULTS OF ACUTE TOXICITY IDENTIFICATION EVALUATION ON EFFLUENT SAMPLE FROM BF GOODRICH

	Percent Survival (48-hours)							
Treatment	Control	1%	3%	10%	30%	100%	48-hr LC50 (percent sample)	TUa
Baseline (*1/19/99*)	90	100	100	100	0	0	17.3	5.8

	Control	3%	10%	30%	100%	48-hr LC50 (percent sample)	TUa
pH Adjustment							
pH_3	100	100	80	0	0	14.1	7.1
pH_i	100	100	90	0	0	15.4	6.5
pH_{11}	90	70	80	0	0	14.1	7.1
Aeration							
pH_3	100	100	100	0	0	17.3	5.8
pH_i	100	100	100	0	0	17.3	5.8
pH_{11}	100	100	100	0	0	17.3	5.8
Filtration							
pH_3	100	100	100	0	0	17.3	5.8
pH_i	100	80	100	0	0	17.3	5.8
pH_{11}	100	100	90	0	0	15.4	6.5
C_{18} Column							
pH_3	100	100	90	0	0	15.4	6.5
pH_i	100	100	80	0	0	14.1	7.1
pH_9	100	100	100	0	0	17.3	5.8
Sodium Thiosulfate							
2.5 mg/L	100	--	100	0	0	17.3	5.8
5.0 mg/L	100	--	100	0	0	17.3	5.8
10.0 mg/L	90	--	90	0	0	15.4	6.5
EDTA Chelation							
0.2 mg/L	100	--	100	0	0	17.3	5.8
0.4 mg/L	100	--	100	0	0	17.3	5.8
0.8 mg/L	100	--	100	0	0	17.3	5.8

TABLE 2 (Continued)

Treatment	Percent Survival (48-hours) Control	1%	3%	10%	30%	100%	48-hr LC50 (percent sample)	TUa
Baseline (*1/20/99*)	90	100	100	100	0	0	17.3	5.8

	Control	100%	200%	400%	48-hr LC50	TUa
MeOH Elution						
pH_3	100	0	0	0	<100	>1.0
pH_i	100	0	0	0	<100	>1.0
pH_9	90	0	0	0	<100	>1.0

Graduated pH	Control	25%	50%	48-hr LC50	TUa
pH_6	100	10	0	<25	>4.0
pH_7	100	0	0	<25	>4.0
pH_8	100	0	0	<25	>4.0

TABLE 3 TOXICITY IDENTIFICATION EVALUATION SYSTEM BLANKS PERFORMED FOR TESTING ON SAMPLE AT9-002 COLLECTED 7 JANUARY 1999

Treatment System Blanks	48-hour Survival (percent)
pH Adjustment	
pH_3	100
pH_{11}	100
Filtration	
pH_3	100
pH i	100
pH_{11}	100
Aeration	
pH_3	100
pH i	91
pH_{11}	80[(a)]
C_{18} Column Extraction	
pH_3	100
pH i	100
pH_9	100
MeOH Elution	
pH_3	100
pH i	100
pH_9	90
EDTA Chelation	
0.2	100
0.4	100
0.8	100
Sodium Thiosulfate	
2.5 mg/L	100
5.0 mg/L	100
10.0 mg/L	100

(a) Replicate B is considered anomalous and was not included in the reported data.

REPORT QUALITY ASSURANCE RECORD

Client: Gardner, Carton and Douglas EA Report No.: 3026

Project Number: 70003.10 Type Analysis: Acute TIE

Author: Virginia A. Sohn Test Organisms: C. dubia

REPORT CHECKLIST

QA/QC ITEM	REVIEWER	DATE
1. Samples collected, transported, and received according to study plan requirements.	Virginia A Sohn	2/15/99
2. Samples prepared and processed according to study plan requirements.	Virginia A Sohn	2/15/99
3. Data collected using calibrated equipment.	Virginia A Sohn	2/15/99
4. Calculations checked:		
- Hand calculations checked	Virginia A Sohn	2/15/99
- Documented and verified statistical procedure used.	Virginia A Sohn	2/15/99
5. Data input/statistical analyses complete and correct.	Richard A. Connelly	3/3/99
6. Reported results and facts checked against original sources.	Richard A. Connelly	3/3/99
7. Data presented in figures and tables correct and in agreement with text.	Richard A. Connelly	3/3/99
8. Results reviewed for compliance with study plan requirements.		3/1/99

	AUTHOR	DATE
9. Commentary reviewed and resolved.	Virginia A Sohn	3/22/99

10. All study plan and quality assurance/control requirements have been met and the report is approved:

PROJECT MANAGER	3/22/99 DATE
QUALITY CONTROL OFFICER: Richard A. Connelly	3/3/99 DATE
SENIOR TECHNICAL REVIEWER: Wayne McCulloch	3/16/99 DATE