APPENDIX B.

Analytical Methods

Sampled Volumes, Containers, and Preservation Techniques

Quality Assurance, Quality Control Objectives

CONTENTS OF APPENDIX B

Table B-1. Summary of Methods and Accuracy, Precision, and Detection-Limit Objectives

Parameter	Method	Accuracy, % Bias	Precision, RSD[a]	Detection Limits
Anions				
Alkalinity	EPA 310.1	25	5	10 mg/L
HCO_3^-, CO_3^{2-}	SM 406C	NA[b]	NA[b]	NA[b]
Br^-, Cl^-	SM 429, modified	10	10	0.5 mg/L
F^-	EPA 340.2 SM 429, modified	5	5	0.2 mg/L
S^{2-}	EPA 376.1	NA[b]	NA[b]	1 mg/L
SO_4^{2-}	EPA 375.4 or EPA 375.2	5	10	5 mg/L
Cyanides				
CN^-	EPA 335.2 or EPA 335.3	15	15	20 µg/L
SCN^-	SM 412L	15	10	0.5 mg/L
Nitrogen				
Free NH_3-N	EPA 351.2, modified	5	10	0.2 mg/L
Total Kjeldahl NH_3-N	EPA 351.2	5	10	0.5 mg/L
NO_2/NO_3-N	EPA 353.2 or Alpkem A303 S170 02	10	15	0.03 mg/L
Organics				
Phenol	EPA 420.2	10	10	20 µg/L
Volatiles	CLP modified	40	25	Sample and analyte dependent
Semivolatiles[c]	TCLP modified	40	25	Sample and analyte dependent, typically 10 µg/L
Other				
COD	EPA 410.4 using Hach system program 45	NA[b]	NA[b]	50 mg/L
Conductivity	EPA 120.1	5	10	
Eh	USGS (1976)	NA[b]	NA[b]	
pH	EPA 150.2	1	5	

Table B-1. Summary of Methods and Accuracy, Precision, and Detection-Limit Objectives (continued)

Parameter	Method	Accuracy, % Bias	Precision, RSD[a]	Detection Limits
Temperature	SM 212	NA[b]	NA[b]	
TOC	SM 505 (combustion, coulometric titration)	15	15	10 mg/L
TDS	EPA 160.1	NA[b]	NA[b]	10 mg/L
TSS	EPA 160.2	NA[b]	NA[b]	
Trace Elements				
As	EPA 260.2	20	20	5 µg/L
Se	EPA 270.2	20	20	5 µg/L
Hg	EPA 245.1	20	20	0.5 µg/L
B, Ba, Ca, Cd, Cr, Cu, Fe, Li, Mo, Ni, V, Zn	EPA 200.7	20	20	0.01 mg/L
Al	EPA 200.7	20	20	0.03 mg/L
K	EPA 200.7	20	20	5 mg/L
Mg, Mn	EPA 200.7	20	20	0.005 mg/L
Na	EPA 200.7	20	20	0.5 mg/L
Pb	EPA 200.7	20	20	0.05 mg/L

[a] RSD = Relative Standard Deviation (or coefficient of variation = s/m x 100, where s is the standard deviation and m is the mean

[b] NA = Not available

[c] Includes acid extractables, base/neutral extractables, heterocyclics, and PNAs

References: EPA analyses (U.S. EPA 1983), SM analyses (AWWA 1985), CLP methods (U.S. EPA 1985), USGS method (Wood 1976), Alpkem method (Alpkem 1987)

Table B-2. Sampling Constituents, Volumes Required, Containers, Preservation Techniques, and Holding Times[a]

Constituents	Volume Required, mL	Container Required	Preservation Techniques	Holding Time
Phenolics	100	Glass	Unfiltered, add 0.1 g $CuSO_4$. Add 1:4 H_3PO_4 to pH less than 2. Cool to 4°C.	28 days
NH_3, TOC, COD, NO^{3-} plus NO^{2-}	500	Polyethylene	Unfiltered, add 1:10 H_2SO_4 to pH less than 2. Cool to 4°C.	28 days
Metals, thiocyanate[b]	1000	Polyethylene	Filter on site. Add 1:1 HNO_3 to pH less than 2. Cool to 4°C.	6 months
Sulfate, TDS, Br^- Cl^-, HCO_3^-, CO_3^{2-}	500	Polyethylene	Filter on site. Cool to 4°C.	28 days
Sulfide	1000	Polyethylene	Unfiltered. Add 10 mL 0.1 N Zinc acetate and 10 N NaOH to pH greater than 9. Cool to 4°C.	7 days
Cyanide	1000	Polyethylene	Unfiltered. Add 0.6 g ascorbic acid. Add 10 N NaOH to pH greater than 12. Cool to 4°C.	14 days
Semivolatile organics[c]	1000	Amber glass	Unfiltered. Cool to 4°C.	7 days
Volatile organics[c]	80	Two 40-mL glass vials	Unfiltered. Cool to 4°C.	7 days
TDS	100	Polyethylene	Unfiltered. Cool to 4°C.	7 days

[a] Obtained from U.S. EPA, EPA-600/4-79-020 (1983)
[b] Obtained from AWWA, Standard Methods (1985)
[c] Obtained from U.S. EPA, EPA-600/4-82-029 (1982)

Table B-3. Summary of Internal Quality Control Requirements for Laboratory and Field Analyses

Parameter	Method	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
Anions					
Alkalinity (field)	EPA 310.1	Blind control sample	Daily (1989-1992)	Within 20% of true value	Flag data
		Field duplicate	Once per outing (1989-1992)	RPD[a] within 20%	Resample
		Calibrate	Daily	RPD = 0	Recalibrate
		pH buffer analysis	Following calibration then every 4 hours	Within 0.1 pH unit of true value	Recalibrate
Bicarbonate, Carbonate	SM 406C	Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing (1989-1992)	RPD within 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	RPD within 25% of expected value	Investigate cause, reanalyze if necessary
		Repeat calculation	Every sample	Values must be identical	Recalculate
Bromide, Chloride, Fluoride	EPA 300.0	Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing (1989-1992)	RPD within 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	Within 25% of expected value	Investigate cause, reanalyze if necessary
		Calibration	Daily	Corr coeff >0.995	Recalibrate
	(or EPA 340.2 for F^-)	Standard analysis	10%	Within 10% of true value	Repeat and/or recalibrate
		Laboratory duplicate	10%	RPD <25%	Repeat
		Method blank	Daily	None	Background
		Matrix spike	10%	90% recovery	Flag data
Sulfide	EPA 376.1	Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing	RPD w/i 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	Within 25% of expected value	Investigate cause, reanalyze if necessary
		Calibration	Daily	RSD[b] <2	Repeat

Table B-3. Summary of Internal Quality Control Requirements for Laboratory and Field Analyses (continued)

Parameter	Method	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
Sulfate	EPA 375.4 or EPA 300.0	Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing (1989-1992)	RPD within 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	Within 25% of expected value	Investigate cause, reanalyze if necessary
		Calibration	Daily	Corr coeff >0.995	Recalibrate
		Standard analysis	10%	within 10% of true value	Repeat and/or recalibrate
		Laboratory analysis	10%	RPD <25%	Repeat
		Method blank	Daily	None	Background correction
		Matrix spike	10%	90% recovery	Flag data
Cyanides					
CN^-	EPA 335.2	Equipment	Once per outing	within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing	RPD within 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	Within 25% of expected value	Investigate cause, reanalyze if necessary
		Calibration	Daily	Corr coeff >0.995	Recalibrate
		Standard analysis	20% or a minimum of 1	Within 15% of true value	Repeat and/or recalibrate
		Laboratory duplicate	1 per matrix type	RPD <25%	Repeat
		Method blank	Daily	None	Background correction
		Matrix spike	1 per matrix type	90% recovery	Flag data
SCN^-	SM 412K	Equipment	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing (1989-1992)	RPD within 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	Within 25% of expected value	Investigate cause, reanalyze if necessary
		Calibration	Daily	Corr coeff >0.995	
		Standard analysis	10%	Within 10% of true value	Repeat and/or recalibrate
		Laboratory duplicate	10%	RPD <25%	Repeat
		Method blank	Daily	None	Background correction
		Matrix spike	10%	90% recovery	Flag data

Table B-3. Summary of Internal Quality Control Requirements for Laboratory and Field Analyses (continued)

Parameter	Method	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
Nitrogen					
Free NH_3-N	EPA 350.1 modified	Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing (1989-1992)	RPD within 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	Within 25% of expected value	Investigate cause, reanalyze if necessary
		Calibration	Daily	Corr Coeff >0.995	Recalibrate
		Standard analysis	10%	Within 25% of true value	Repeat or recalibrate
		Laboratory duplicate	10%	RPD <25%	Repeat
		Method blank	Daily	None	Background correction
		Matrix spike	10%	90% recovery	Flag data
Total Kjeldahl NH_3-N	EPA 351.2	Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing (1989-1992)	RPD within 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	Within 25% of expected value	Investigate cause, reanalyze if necessary
		Calibration	Daily	Corr Coeff >0.995	Recalibrate
		Standard analysis	10%	Within 10% of true value	Repeat or recalibrate
		Laboratory duplicate	10%	RPD <25%	Repeat
		Method blank	Daily	None	Background correction
		Matrix spike	10%	90% recovery	Flag data
NO_2/NO_3-N	EPA 300.0 or Alpkem A303 S170 02	Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing (1989-1992)	RPD within 20%	Flag data
		Calibration	Daily	Corr Coeff >0.995	Recalibrate
		Standard analysis	10%	Within 10% of true value	Repeat and/or recalibrate
		Laboratory duplicate	10%	RPD <25%	Repeat
		Method blank	Daily	None	Background correction
		Matrix spike	10%	90% recovery	Flag data

Table B-3. Summary of Internal Quality Control Requirements for Laboratory and Field Analyses (continued)

Parameter	Method	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
Organics					
Phenol	EPA 420.2	Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing (1989-1992)	RPD within 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	Within 25% of expected value	Investigate cause, reanalyze if necessary
		Calibration	Daily	Corr Coeff >0.995	Recalibrate
		Standard analysis	10%	Within 10% of true value	Repeat and/or recalibrate
		Laboratory duplicate	10%	RPD <25%	Repeat
		Method blank	Daily	None	Background correction
		Matrix spike	10%	90% recovery	Flag data
Volatiles	CLP modified	Equipment rinsate background sample	Once per outing	NA	NA
		Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Calibration	Daily	See table on calibration	See table on calibration
		Surrogate standard spike	All samples	CLP limits	Identify problem in narrative
		Method blank	1 per analytical batch	CLP limits	Identify problem in narrative
		Laboratory duplicate	1 per analytical batch	RPD within 20%	Reanalyze
Semivolatiles[c]	Equipment CLP modified	Equipment rinsate	Once per outing	Within 5% of background	Reclean sampling equipment
		Field duplicate	Once per outing (1989-1992)	RPD with 20%	Flag data
		Blind control sample	Once per outing (1989-1992)	Within 25% of expected value	Investigate cause, reanalyze if necessary
		Calibration	Daily	See table on calibration	See table on calibration
		Surrogate standard spike	All samples	CLP limits	Identify problem in narrative
		Method blank	1 per analytical batch	CLP limits	Identify problem in narrative

Table B-3. Summary of Internal Quality Control Requirements for Laboratory and Field Analyses (continued)

Parameter	Method	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
Other					
COD	EPA 410.4	Calibration	Daily	Within 10% of true value	Resolve problem
		Standard analysis	1 per analytical batch	Within 10% of true value	Repeat
		Method blank	Same	None	Background
Conductivity (field)	EPA 120.1	Calibration	Daily	Within 10% of true value	Recalibrate
Eh (field)	USGS (1976)	Calibration	Daily	Within 10% of true value	Recalibrate
pH (field)	EPA 150.1	Calibration	Daily	RPD = 0	Recalibrate
		Standard analysis	After calibration and every 4 hours	Within 0.1 pH unit of true value	Recalibrate
Temperature (field)	SM 212	Calibration	Daily	Within 0.5 degrees of true value	Recalibrate
TOC	EPA 415.1 modified	Calibration	Daily	Refer to table on calibration	Resolve problem
		Standard analysis	10%	Within 10% of true value	Repeat
		Duplicate	10%	RPD <25%	Repeat
		Method blank	Whenever standard recovery is unacceptable	Agree within 5 mg/L of calibration blank	Resolve problem
TDS	EPA 160.1	Calibration	Daily	Meets manufacturer's specs	Recalibrate
		Duplicate	10%	RPD <25%	Repeat
TSS	EPA 160.2	Calibration	Daily	Meets manufacturer's specs	Recalibrate
		Duplicate	10%	RPD <25%	Repeat

Table B-3. Summary of Internal Quality Control Requirements for Laboratory and Field Analyses (continued)

Parameter	Method	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
Trace Elements					
As	EPA 206.2	Calibration	Every analytical batch	See table on calibration	Recalibrate
		Method blank	10% and after last sample	+/- DL	Recalibrate and repeat last 10 samples
		Mid-range standard	Same	Within 10% of true value	Same
Se	EPA 270.2	Same	Same	Same	Same
Hg	EPA 245.1	Calibration	Every analytical batch	See table on calibration	Recalibrate
		Standard analysis	After last sample	Within 15% of true value	Repeat batch analysis
		NBS standard analysis	Every analytical batch	Within 20% of true value	Same
Ag, Al, B, Ba, Ca, Cd, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, V, Zn	EPA 200.7	Calibration	Daily or as required, whichever is more frequent	See table on calibration	Recalibrate
		Method blank	10% and after last sample	+/- DL	Recalibrate and repeat last 10 samples
		Mid-range standard	10% and after last sample	Within 10% of true value	Same

[a] RPD = Relative Percent Difference = [(Value A - Value B)/(Value A + Value B/2)] x 100

[b] RSD = Relative Standard Deviation (or coefficient of variation) = s/m x 100, where m is the standard deviation and m is the mean

[c] Includes acid extractables, base/neutral extractables, heterocyclics, and PNAs

References: EPA analyses (U.S. EPA 1983), SM analyses (AWWA 1985), CLP methods (U.S. EPA 1985), USGS method (Wood 1976), Alpkem method (Alpkem 1987)

REFERENCES

Alpkem Corporation, 1987, RFA™ Methodology, Nitrate + Nitrite Nitrogen, Clackamas, Oregon.

American Water Works Association, 1985, Standard Methods for the Examination of Water and Wastewater, 16th Edition, Washington, DC.

U.S. EPA, 1982, Handbook for Sampling and Sample Preservation of Water and Wastewater. Washington, DC, EPA-60014-82-029.

U.S. EPA, 1983, Methods for Chemical Analyses of Water and Waste. Washington, DC, EPA-600/4-79-020.

U.S. EPA, 1985, Contract Laboratory Program Statement of Work for Organics, Multi-Media, Multi-Concentration. Washington, DC.

Wood, W.W., 1976, Guideline for Collection and Field Analyses of Groundwater Samples for Selected Unstable Constituents, in Techniques of Water-Resources Investigations of the United States Geological Survey, Chapter D2. U.S. Government Printing Office, Washington, DC.

APPENDIX C.

Chemical Composition of Groundwater Samples from the RM1 Underground Coal Gasification Test Program

Radian Corporation, August 1990

RADIAN
CORPORATION

GRI DISCLAIMER

LEGAL NOTICE This report was prepared by Radian Corporation as an account of work sponsored by the Gas Research Institute (GRI). Neither GRI, members of GRI, nor any person acting on behalf of either:

a. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

b. Assumes any liability with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

RADIAN
CORPORATION

8501 Mo-Pac Blvd.
P.O. Box 201088
Austin, TX 78720-1088
(512)454-4797

CHEMICAL COMPOSITION OF GROUNDWATER SAMPLES FROM THE RM1 UNDERGROUND COAL GASIFICATION TEST PROGRAM

DRAFT

Prepared by:

Radian Corporation
8501 MoPac Blvd.
Austin, TX 78759

For:

GAS RESEARCH INSTITUTE
8600 West Bryn Mawr Avenue
Chicago, IL 60631

August 1990

RAPIAN

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

The overall objective of this effort was to characterize water samples that were associated with the DOE- and GRI-sponsored RM1 UCG test in Wyoming for organic constituents. The test was scheduled and performed in 1988 and samples were submitted to Radian for analysis in August of 1987, February of 1988 and September of 1988.

These water samples were analyzed by Radian using GC/MS techniques to identify and quantify the organic constituents found in the modified Skinner list (Guide to Petroleum Refinery Waste Analyses for Land Permit Applications from John Skinner of the Office of Solid Waste) which includes typical volatile and semivolatile petroleum- and coal-derived chemicals, as well as selected compounds of environmental concern.

This report contains the results from the analyses performed on these samples. All sample data and copies of the chain of custodies delivered with the samples can be found in the tables at the end of this report.

2.0 SAMPLE HANDLING AND CONTROL

The Western Research Institute (WRI) collected all samples. Sampling kits, which included pre-cleaned, QC checked containers, chain of custody forms and trip blanks were provided by Radian. All sample containers were series 300 obtained from I-Chem Research, Inc., which are cleaned to EPA protocols and QC analyzed. Samples were assigned numbers in the field by WRI. All samples in this report are referenced by this field identification number.

From the information given to Radian, the first sample taken on 8/21/87 was a background sample taken before testing began. Samples were received on four different occasions. A total of six field samples, plus appropriate field blanks, trip blanks and matrix spikes, were analyzed when submitted. While Radian provided bottles and trip blanks for all sampling events, trip blanks and field blanks were not resubmitted with the samples in several of the events. When a trip blank was not submitted for volatile

analysis (as noted in Table 1), the data from a system blank (deionized water) has been included to demonstrate lack of contamination in the analytical system. Adequate volume of sample for matrix spike and matrix spike duplicates was submitted for analysis with the initial baseline samples and for the final cleanup assessment. Adequate sample for a matrix spike only was submitted for the initial baseline sampling for semivolatiles.

Upon arrival at Radian, all samples were logged in the Radian Sample and Analysis Management System . They were assigned a unique internal laboratory number for each sample split. All samples were prepared and analyzed within the required holding times.

3.0 ANALYTICAL PROCEDURES

Tables 1 and 2 list the semivolatile and volatile organic compounds that were included in these analyses. As shown in the footnotes, standards were not available for several compounds at the time of the analyses. These compounds were searched for in sample analyses using a computer library search which matches the spectra of otherwise unidentified peaks against the NBS library of 42,000 compounds. If these compounds had been tentatively identified on either the volatile or semivolatile analysis, they would have been quantitated assuming a response factor of one.

Samples were analyzed for the volatile constituents on the modified Skinner list and additional compounds requested by ENSR following SW 846 Method 8240. The volatiles were quantitatively removed from the sample by an inert gas purge and trap procedure and then analyzed by GC/MS. All samples were spiked with labeled surrogate compounds before analysis which are reported to give an assessment of recovery.

Adequate sample was collected from the first sampling event (background samples) to analyze a matrix spike and matrix spike duplicate. A matrix spike is a split from a field sample spiked with known concentrations of reference materials and taken through the entire analytical process. The matrix spike allows the laboratory to assess the efficiency of the analytical

procedure and can indicate possible matrix effects. Recoveries of some of the analytes in the matrix spikes were higher than normal which could indicate a possible bias of results, however, recoveries for benzene, toluene and xylene, the major volatile compounds found in the samples, were within normal ranges.

Samples for semivolatile analysis were prepared using SW-846 Method 3520. This involves a liquid-liquid extraction with methylene chloride. One extraction is performed at a pH greater than 11 (to recover the base/neutral fraction) and a second extraction is performed at a pH less than 2 (to recover the acid fraction. As in the volatile analysis, all samples were spiked with labeled surrogate compounds before preparation which are reported to give an assessment of recovery. After extraction, the organic extracts were concentrated and analyzed for semivolatile constituents following SW846 Method 8270, a GC/MS technique.

Matrix spikes were performed on samples from the second and last sampling events. During the time between the two events the standard list of compounds required for matrix spiking changed in the laboratory, thus results for these two sets are on separate tables (Table 4 and Table 5). Results for all compounds with the exception of dinitrotoluene were within normal laboratory limits. Dinitrotoluene was not detected in any of the samples.

In both the volatile and semivolatile analyses, the instrument systems were calibrated and checked to be within the specifications of the method before the analyses were run. Tuning criteria, calibration check compounds and system performance checks were all within the limits defined in Methods 8240 and 8270.

In addition to the semivolatile analysis, the extracts prepared for this procedure were screened for the presence of 2,3,7,8-TCDD(tetrachlorodibenzo-P-dioxin) according to the procedure in EPA Method 625. This involves concentrating the extract to 0.2 mL and running it on the same GC/MS as used for the semivolatile analysis, only under isothermal conditions and scanning only the ions characteristic to 2,3,7,8-TCDD. The possible presence of

2,3,7,8-TCDD would be indicated if all three ions exhibit simultaneous peaks at any point. None of the samples gave any indication of 2,3,7,8-TCDD.

4.0 RESULTS AND DISCUSSION

Neither the initial background samples nor the final samples (post treatment and rinsing) had measurable quantities of any of the constituents of interest. Samples taken during the demonstration contained benzene, toluene, ethylbenzene, xylene, cresols, phenols and polyaromatic hydrocarbons. Samples taken at the gas shack on 2/3/88 had the highest concentrations of contaminants.

TABLE 1. SUMMARY OF VOLATILE ORGANIC COMPOUNDS FOR ANALYSIS RESULTS IN ug/L

	8/21/87 SAMPLING		2/3/88 SAMPLING			9/6/88 SAMPLING				9/22/88 SAMPLING		
COMPOUND	RM-EMW-9	TRIP BLANK	0429-66-1	0429-66-10	LAB BLANK[a]	373-82-CRW-CRW	373-83-ELW-VBW	FIELD BLANK	LAB BLANK[a]	Sample 7	Number 2 Field Blank	Trip Blank
Acetone	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acetonitrile	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acrolein	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acrylonitrile	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Benzene	< 2.0	< 2.0	< 2.0	35000	< 2.0	26	29	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Bis(Chloromethyl)ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Crotonaldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chloroform	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
1,2-Dibromoethane	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
1,2-Dichloroethane	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Dichloropropanol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dioxane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	< 2.0	< 2.0	< 2.0	690	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Ethylene oxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isobutyl alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methyl ethyl ketone	< 50	< 50	< 50	< 5000	< 50	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Methyl isobutyl ketone	< 50	< 50	< 50	< 5000	< 50	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Methyl mercaptan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	< 2.0	< 2.0	< 2.0	< 200	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
1,1,1,2-Tetrachloroethane	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Toluene	< 2.0	< 2.0	< 2.0	7800	< 2.0	6.6	3.6	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Xylenes	< 2.0	< 2.0	< 2.0	1800	< 2.0	4.0	4.6	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
SURROGATE RECOVERIES (%)												
d4-1,2-Dichloroethane	86	132	86	76	85	70	68	68	69	67	68	68
d8-Toluene	99	93	106	110	100	87	88	86	84	88	86	86
p-Bromofluorobenzene	89	79	131	133	135	88	88	86	89	92	93	90

ND – None detected and standard was not available; the compound was searched using an MBS library of 42,000 compounds.

[a] – Trip blank was not returned.

TABLE 2. JMMARY OF SEMIVOLATILE ORGANIC COMPOUNDS FOR ANALYSIS RESULTS IN ug/L

COMPOUND	8/21/87 Sampling		2/3/88 Sampling		9/6/88 Sampling			9/22/88 Sampling	
	RH-1-EH4-9	Field Blank	0429-66-3	0429-66-8	373-82-CRIP-CRWIB	373-83-EIH-VIWIB	Field Blank	Sample 4	Field Blank Number 1
Acridine	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aniline	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Anthracene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Benzenethiol	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Benzidine	< 50	< 50	< 50	< 5000	< 200	< 200	< 200	< 50	< 50
Benzo(a)anthracene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
2,3-Benzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	< 50	< 50	< 50	< 5000	< 200	< 200	< 200	< 50	< 50
Benzo(a)pyrene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
2,3-Benzopyrrole	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)thiophene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(j)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Benzyl alcohol	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Benzyl chloride	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Benz(c)acridine	ND	ND	ND	ND	ND	< 40	< 40	ND	ND
Biphenyl	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Bis (2-Ethylhexyl)phthalate	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Butyl benzyl phthalate	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Carbazole	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Chrysene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
m-Cresol	< 10	< 10	2400 a	520000 b	88 c	< 40	< 40	< 10	< 10
o-Cresol	< 10	< 10	1200 a	290000 b	130 c	< 40	< 40	< 10	< 10
p-Cresol	< 10	< 10	2400 a	520000 b	88 c	< 40	< 40	< 10	< 10
Dibenz(a,j)acridine	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Dibenz(a,h)anthracene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
7,H-Dibenzo(c,g)carbazole	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Dibenzothiophene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Dibenzo(a,e)pyrene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10

(Continued)

TABLE 2. (Continued)

COMPOUND	8/21/87 Sampling		2/3/88 Sampling		9/6/88 Sampling			9/22/88 Sampling	
	MW-1-EMW-9	Field Blank	0429-66-3	0429-66-8	373-82-CRIP-CIW1B	373-80-EIW-VIW1B	Field Blank	Sample 4	Field Blank Number 1
Dibenzo(a,h)pyrene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Dibenzo(a,i)pyrene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
1,2-Dichlorobenzene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
1,3-Dichlorobenzene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
1,4-Dichlorobenzene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Diethyl phthalate	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
2,3-Dihydroindene	ND	ND	ND	ND	ND	ND	ND	ND	ND
7,12-Dimethylbenz(a)anthracene	< 20	< 20	< 20	< 2000	< 80	< 80	< 80	< 20	< 20
2,4-Dimethylphenol	< 10	< 10	67 a	< 60000	77 c	< 40	< 40	< 10	< 10
Dimethylphthalate	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Di-n-butylphthalate	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
2,4-Dinitrophenol	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
1,2-Diphenyl hydrazine	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Di-n-octylphthalate	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Ethyleneimine	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Hexanoic acid	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Hydroquinone	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indene	< 10	< 10	< 10	1000	< 40	< 40	< 40	< 10	< 10
2-Methyl aziridine	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Methylcholanthrene	< 50	< 50	< 50	< 5000	< 200	< 200	< 200	< 50	< 50
Methyl chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Methyl fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Methyl naphthalene	< 10	< 10	< 10	2800	< 40	< 40	< 40	< 10	< 10
2-Methylnaphthalene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
2-Methyl pyridine	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
1,4-Naphthaquinone	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Naphthalene	< 10	< 10	95 a	25000	< 40	< 40	< 40	< 10	< 10
1-Naphthylamine	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
2-Naphthylamine	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
5-Nitroacenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitroaniline	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10

(Continued)

TABLE 2. (Continued)

COMPOUND	8/21/87 Sampling		2/3/88 Sampling		9/6/88 Sampling			9/22/88 Sampling	
	RH-1-EM4-9	Field Blank	0429-66-3	0429-66-8	373-82-CRIP-CRW1B	373-83-EIH-VIW1B	Field Blank	Sample 4	Field Blank Number 1
4-Nitrophenol	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
N-Nitrosodiethylamine	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	< 10	< 10	14	4200	< 40	< 40	< 40	< 10	< 10
Phenol	< 10	< 10	3400 b	1300000	820	< 40	< 40	< 10	< 10
Pyrene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Pyridine	< 10	< 10	106	< 5000	< 200	< 200	< 200	< 10	< 10
Quinoline	ND	ND	ND	2200	ND	ND	ND	ND	ND
Trichlorobenzene	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
2,4,5-Trichlorophenol	< 10	< 10	< 10	< 1000	< 40	< 40	< 40	< 10	< 10
Trimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND
SURROGATES									
2-Fluorophenol	98	100	41	161	59	65	65	118	131
Phenol-d5	94	95	14	16	49	51	51	83	86
Nitrobenzene	89	92	45	94	76	75	75	81	102
2-Fluorobiphenyl	101	98	57	107	56	62	62	122	156
2,4,6-Tribromophenol	101	94	50	111	60	75	69	39	51
Terphenyl-d14	100	89	64	125	75	77	78	115	190

FOOTNOTES

a - Value calculated from a 1:10 dilution

b - Value calculated from a 1:100 dilution

c - Value less than 5x detection limit

ND - None detected and standard was not available; the compound was searched using an NBS library of 42,000 compounds

RADIAN CORPORATION

TABLE 3. VOLATILE ANALYSIS MATRIX SPIKE RECOVERY
8/21/87 SAMPLING

Compound	A7080A5-03 RM1-EMW-9 #1 (44515)	#2 (44516)
Volatiles (Method 8240)		
Acetonitrile	216	214
Acrylonitrile	195	208
Benzene	109	113
Bromodichloromethane	139	145
Bromomethane	82	81
Carbon disulfide	160	154
Carbon tetrachloride	80	84
Chlorobenzene	73	79
Chlorodibromomethane	87	93
Chloroethane	162	150
Chloroform	119	115
Chloromethane	151	142
1,2-Dibromo-3-chloropropane	70	80
1,2-Dibromoethane	98	106
Dibromomethane	98	105
Dichlorodifluoromethane	70	68
1,1-Dichloroethane	142	141
1,2-Dichloroethane	113	115
1,1-Dichloroethylene	134	130
trans-1,2-Dichloroethene	129	130
trans-1,4-Dichloro-2-butene	156	166
1,2-Dichloropropane	118	120
trans-1,3-Dichloropropene	105	109
cis-1,3-Dichloropropene	105	109
Hexanone	204	211
Iodomethane	72	70
Methyl ethyl ketone	127	137
Methylene chloride	165	153
1,1,1,2-Tetrachloroethane	83	87
1,1,2,2-Tetrachloroethane	90	103
Tetrachloroethene	63	72
Toluene	89	93
Tribromomethane	73	80
1,1,1-Trichloroethane	96	104
1,1,2-Trichloroethane	122	128
Trichloroethene	81	89
Trichlorofluoromethane	88	90
1,2,3-Trichloropropane	111	123
Vinyl chloride	132	125
Ethylbenzene	87	89
Xylenes	107	99
Styrene	82	87
Acetone	60	73
Methyl isobutyl ketone	112	138

RADIAN CORPORATION

TABLE 4. SEMIVOLATILE ANALYSIS MATRIX SPIKE RECOVERY FOR EMW9 8/21/87 SAMPLING

COMPOUND	% RECOVERY
Acenaphthalene	91
Acenaphthene	77
4-Aminobiphenyl	73
Aniline	56
Anthracene	88
Benz(a)anthracene	88
Benzo(a)pyrene	93
Benzo(b)fluoranthene	101
Benzo(g,h,i)perylene	66
Benzo(k)fluoranthene	99
Benzyl alcohol	78
bis(2-Chloroethoxy)methane	88
bis(2-Chloroethyl)ether	86
bis(2-chloroispropyl)ether	73
bis(2-ethylhexyl)phthalate	84
4-Bromophenyl phenyl ether	85
butyl benzyl phthalate	89
p-Chloroaniline	80
p-Chloro-m-cresol	84
2-Chloronaphthalene	97
2-Chlorophenol	82
4-Chlorophenyl phenyl ether	99
Chrysene	92
o-Cresol	77
m/p-Cresol	75
Dibenzofuran	94
Dibenzo(a,h)anthracene	90
1,2-Dichlorobenzene	73
1,3-Dichlorobenzene	67
1,4-Dichlorobenzene	75
3,3'-Dichlorobenzidine	84
2,4-Dichlorophenol	83
2,6-Dichlorophenol	82
Diethylphthalate	75
p-Dimethylaminoazobenzene	78
12-Dimethylbenz(a)anthracene	46
3,3'Dimethylbenzidine	45
2,4-Dimethylphenol	76
Dimethylphthalate	54
1,4-Dinitrobenzene	92
4,6-Dinitro-o-cresol	103
2,4-Dinitrophenol	84

(Continued)

TABLE 4. (Continued)

COMPOUND	% RECOVERY
2,4-Dinitrotoluene	103
2,6-Dinitrotoluene	90
Di-n-butylphthalate	94
Di-n-octylphthalate	84
Fluoranthene	98
Fluorene	117
Hexachlorobenzene	92
Hexachlorobutadiene	100
Hexachlorocyclopentadiene	27
Hexachloroethane	71
Hexachloropropene	82
Indeno(1,2,3-c,d)pyrene	85
Isosafrole	96
3-Methylcholanthrene	86
4,4Methylenebis(2-chloroaniline)	87
Methyl methanesulfonate	41
2-Methylnaphthalene	86
Naphthalene	85
1-Naphthylamine	60
2-Naphthylamine	47
2-Nitroaniline	92
3-Nitroaniline	92
4-Nitroaniline	84
Nitrobenzene	82
2-Nitrophenol	85
4-Nitrophenol	81
N-Nitrosodi-n-butylamine	91
N-Nitrosodiethylamine	85
N-Nitrosodimethylamine	70
N-Nitrosodiphenylamine	96
N-Nitrosomethylethylamine	82
N-Nitrosomorpholine	84
N-Nitrosopiperidine	83
N-Nitrosopyrrolidene	82
Pentachlorobenzene	99
Pentachloronitrobenzene	101
Pentachlorophenol	140
Phenacetin	81
Phenanthrene	92
Phenol	79
2-Picoline	67
Pronamide	144

(Continued)

TABLE 4. (Continued)

COMPOUND	% RECOVERY
Pyrene	98
Pyridine	43
Safrole	91
1,2,4,5-Tetrachlorobenzene	100
2,3,4,6-Tetrachlorophenol	93
1,2,4-Trichlorobenzene	98
2,4,5-Trichlorophenol	107
2,4,6-Trichlorophenol	82

SURROGATE RECOVERIES

2- Fluorophenol	104
Phenol-d_5	103
Nitrobenzene	95
2-Fluorobiphenyl	111
2,4,6-Tribromophenol	128
Terphenyl-d_{14}	77

RADIAN CORPORATION

TABLE 5. SEMIVOLATILE ANALYSIS MATRIX SPIKE RECOVERIES FOR 9/22 SAMPLING (SAMPLE POINT #4)

COMPOUND	RESULTS IN % MS	MSD
Acenaphthene	81	79
p-Chloro-m-cresol	48	43
2-Chlorophenol	76	80
1,4-Dichlorobenzene	67	75
Di-n-propylnitrosamine	61	62
2,4-Dinitrotoluene	274QC	30QC
4-Nitrophenol	3.4	2.9
Pentachlorophenol	59	62
Phenol	41	53
1,2,4-Trichlorobenzene	85	84
SURROGATE RECOVERIES	(RESULTS IN % RECOVERY)	
2-Fluorophenol	90	101
Phenol-d_5	53	55
Nitrobenzene-d_5	75	79
2-Fluorobiphenyl	128	121
2,4,6-Tribromophenol	33	28
Terphenyl-d_{14}	121	114

QC = Outside control limits

RADIAN
CORPORATION

CHAIN OF CUSTODY

A8909041

RADIAN
CORPORATION
8501 Mo-Pac Blvd.
P.O. Box 201088
Austin, TX 78720-1088

Chain of Custody Record

PROJECT: RMI-GWR (Western Research Institute)
SITE: RMI-UC6 Site
COLLECTOR: Rebecca A. Wills

Analyses: Volatiles; Semivolatiles

SAMPLE I.D.	TYPE	DATE/TIME	Volatiles	Semivolatiles	REMARKS
373-92-CRIP-CPW1 (A+B) *	Cavity H_2O	9/6/88 1430	X	X	note sample ID
373-93-EIW-VIW1 (A+B) *	Cavity H_2O	9/6/88 1500	X	X	A = Volatiles
Type I H_2O trip blank	OURS (from lab)	9/6/88 1530	X		B = Semivolatiles
D.I. H_2O field blank	OURS (made in field)	9/6/88 1530	X	X	** Blanks made by Radian on 6/7/88
Field blank transfer	YOURS	6/7/88 1530	X	X	Transferred field blank on 9/6/88
Trip blank	YOURS	6/7/88 1530	X	X	

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Rebecca A. Wills	9/6/88	1700					
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

RECEIVED FOR LABORATORY BY	DATE	TIME	REMARKS
~~Leah Bimmerle~~ RAH	9/7/88	1100	

RADIAN CORPORATION
8501 Mo-Pac Blvd.
P.O. Box 201088
Austin, TX 78720-1088

1307394

Chain of Custody Record

Analyses

PROJECT: Rocky Mtn. 1 Ground Water Restoration
SITE: RM1 Site at Hanna, Wyoming
COLLECTOR: James Dean

SAMPLE I.D.	TYPE	DATE/TIME	REMARKS
1 FB (first)	water	9/22/88	the first set of bottles were replaced because I had to sample a second time with treated water — the first set was filter ruined. JD
2 - FB (second)	"	1000	
3 - FB (third)	"	"	
4	"	"	
5	"	"	
6	"	"	
7	"	"	
8	"	"	
9	"	"	

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
J. Dean	9/22/88		K Meiko 10:45 9/23/88				
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

RECEIVED FOR LABORATORY BY:	DATE	TIME	REMARKS

CHAIN OF CUSTODY RECORD

1708045

Project Name						No. of Containers	1 liter Ambr	VOA vials				Remarks (Include Sample Tag Numbers)
Rocky Mt-1, Hanna Wyoming												
Samplers: (Signature) Bob Donavan												
Station ID	Date	Time	Comp.	Grab	Sample ID							
EMW9	8/21/87	1310	:	X		14	5	9				no preservatives

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Bob Donavan	8/21/87 1310				

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks

Distribution: Original Accompanies Shipment; Yellow Accompanies Shipment – Lab Returns to Sender for Sample Receipt Verification; Pink is Sampling Team Copy

WESTERN RESEARCH INSTITUTE

CHAIN of CUSTODY RECORD

A802.029

Project Name: Rocky Mountain I

Samplers: (Signature) Brian Munkhoy

Station ID	Date	Time	Comp.	Grab	Sample ID	No. of Containers	Organic	Inorganic				Remarks (Include Sample Tag Numbers)
GAS SHACK	2/3/88	11:15 AM	X		0429-66-1 THRU 13	15	13	0				Sample Tag #s Not used

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Brian Munkhoy	2/3/88				

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks

Distribution: Original Accompanies Shipment, Yellow Accompanies Shipment – Lab Returns to Sender for Sample Receipt Verification, Pink is Sampling Team Copy

APPENDIX D.

Acute and Chronic Toxicity of Underground Coal Gasification Waters to *Ceriodaphnia dubia* and Fathead Minnows (*Pimephales promelas*)

ENSR Consulting and Engineering, July 1993

ACUTE AND CHRONIC TOXICITY OF UNDERGROUND COAL GASIFICATION WATERS TO *Ceriodaphnia dubia* AND FATHEAD MINNOWS (*Pimephales promelas*)

Prepared by:

ENSR Consulting and Engineering
Fort Collins Environmental Toxicology Laboratory
1716 Heath Parkway
Fort Collins, Colorado 80524

Prepared for:

Gas Research Institute
8600 West Bryn Mawr Avenue
Chicago, Illinois 60631

Contract No. 5804-253-1117

GRI Project Manager
James M. Evans
Environment and Safety Research

July 1993

DISCLAIMER

LEGAL NOTICE: This report was prepared by ENSR Consulting and Engineering as an account of work sponsored by the Gas Research Institute (GRI). Neither GRI, members of GRI, nor any person on behalf of either:

a. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

b. Assumes any liability with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

CONTENTS

CONTENTS
(Cont'd)

LIST OF TABLES

1.0 INTRODUCTION

This report describes a series of aquatic toxicity tests conducted by ENSR Consulting and Engineering's Fort Collins Environmental Toxicology Laboratory (FCETL) on several water samples collected in conjunction with an underground coal gasification research project sponsored by the Gas Research Institute. Acute toxicity tests were conducted according to USEPA (1985a) guidelines using fathead minnows (*Pimephales promelas*) and water fleas (*Ceriodaphnia dubia*). In addition, chronic toxicity tests (USEPA 1985b) were conducted using *Ceriodaphnia* only. All study data are maintained in the FCETL archives, which can be accessed through ENSR's office at 1716 Heath Parkway, Fort Collins, Colorado.

2.0 MATERIALS AND METHODS

2.1 Test Waters

All test waters were delivered, packed on ice, to the FCETL by Western Research Institute (WRI) personnel. Results in this report are referred to by FCETL sample number; the WRI well identification and corresponding FCETL sample numbers are presented in Table 2-1. Initial chemical characterization of the samples at the FCETL is given in Table 2-2. It was noted in the FCETL test substance log that sample numbers 492 and 493 had a distinct odor of hydrogen sulfide.

2.2 Dilution Water

Dilution water for all tests was moderately hard reconstituted water prepared according to USEPA (1985a) guidelines. This reconstituted water is generally characterized by USEPA as having hardness of 80 to 100 mg/L (as $CaCO_3$), alkalinity of 60 to 70 mg/L (as $CaCO_3$), and pH of 7.4 to 7.8. Chemistry of the dilution water measured during testing was comparable to these values, although pH tended to be 8.0 to 8.4.

2.3 Test Organisms

All *Ceriodaphnia dubia* were obtained from the FCETL in-house cultures. On the day prior to test initiation, gravid females were isolated in dilution water at test temperature. On the day of test initiation <24-hour old neonates were collected for use in the toxicity tests.

Fathead minnows were obtained from commercial suppliers (Aquatic BioSystems, Fort Collins, Colorado, and Florida Bioassay Supply, Gainesville, Florida). All fathead minnows were <24 hours old and appeared to be in good physical condition at the initiation of the tests.

2.4 Acute Test Methods

The acute tests were conducted according to USEPA (1985a) guidelines under static conditions. During 1987/88 tests, *Ceriodaphnia dubia* were tested in 300-ml crystallization dishes containing 200 ml of test solution; during 1990, *Ceriodaphnia dubia* were tested in 30-ml plastic cups containing 15 ml of test solution. The test duration for all *Ceriodaphnia dubia* acute tests was 48 hours.

Table 2-1

Sample Identification for Underground Coal Gasification Waters

FCETL Sample #	Collection Date	Receipt Date	WRI Well Identification - Time Period
248	08/21/87	08/21/87	EMW 9 - Pre-Burn
259	11/04/87	11/04/87	EMW 9 - Pre-Burn
492	09/06/88	09/07/88	CPW1 - 1st Restoration
493	09/06/88	09/07/88	ViW1 - 1st Restoration
536	09/21/88	09/22/88	TWT (Treated) - 1st Restoration
1702	09/09/90	09/10/90	ViW1
1703	09/09/90	09/10/90	EMW 9

Table 2-2

Initial Chemical Characterization of Underground Coal Gasification Waters[a]

Sample #	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Conductivity (μmhos/cm)
248	760	33	1,650
259	763	30	2,100
492	780	82	3,160
493	815	232	3,460
536	681	100	3,420
1702	484	920	4,200
1703	568	560	3,200

[a]Chemical characterization conducted at the FCETL.

Fathead minnows were tested in 1-L beakers containing either 500 ml (1987/88) or 250 ml (1990) of test solution under static renewal test conditions. Test solutions were renewed on a daily basis using freshly prepared dilutions of the initial samples; test duration was 96 hours.

In all acute tests, the test organisms were exposed to 6.25, 12.5, 25, 50, and 100 percent test water (v:v, test water:dilution water). A dilution water control was also tested concurrently. For 1987/88 studies (both species), ten test organisms were randomly distributed to each test chamber and two replicates were tested per treatment. For 1990 *Ceriodaphnia dubia* tests, five organisms were randomly distributed to each of four replicate chambers per treatment; for 1990 fathead minnow tests, ten organisms were randomly distributed to each of four replicates per treatment. *Ceriodaphnia dubia* were not fed during the test. Fathead minnows were fed 0.1 ml of newly hatched brine shrimp nauplii once daily during testing. All acute tests were conducted at 20°C under fluorescent lighting with a photoperiod of 16 hours light and 8 hours dark.

In addition to the underground coal gasification water tests, reference toxicant tests, using either sodium dodecyl sulfate (1987/88) or sodium chloride (1990), were conducted as appropriate according to USEPA (1985a) guidelines. Acute (24 hour) reference toxicant tests were conducted monthly with organisms from the FCETL in-house *Ceriodaphnia dubia* culture. Each lot of fish obtained from a commercial supplier was also tested to determine the sensitivity range of the test organisms.

2.5 Chronic Test Methods

Chronic *Ceriodaphnia dubia* survival and reproduction tests were conducted according to USEPA (1985b; Method 1002.0) methods. Each sample was tested at the five concentrations used for acute testing plus a dilution water control. Test chambers were 30-ml plastic beakers each containing 15 ml of test solution. One *Ceriodaphnia dubia* neonate was placed in each test chamber and 10 replicates were tested per concentration. Test solutions were renewed daily using freshly-prepared dilutions of the original sample. Each chamber was fed 0.1 ml of an incubated mixture of yeast, trout chow, and ground alfalfa leaves and 0.1 ml of an algal suspension daily (Note: *Ceriodaphnia dubia* in the chronic study with sample #248 received no algal supplement). Testing was conducted at 25°C under a 16h:8h light:dark photoperiod. Test duration was generally 7 days, although tests may have been terminated earlier or later, depending on the time required for production of three broods by at least 60 percent of the control organisms.

2.6 Data Analysis

2.6.1 Acute Tests

Acute test results are expressed as the LC_{50} concentration, that concentration estimated to cause 50 percent mortality of the test organisms in the specified time period. The LC_{50} values and their 95 percent confidence limits were calculated, where possible, using an IBM compatible personal computer and USEPA (1985a) software which uses moving average, probit, and binomial probability methods. The specific method selected for reporting the test results was determined by the characteristics of the data (Stephan 1977).

2.6.2 Chronic Tests

Chronic test results were analyzed using a point estimate method to calculate the IC_{25} value, that concentration that reduced organism performance by 25 percent relative to the control. Methods for calculating the IC_{25} were as described by USEPA (1989).

3.0 RESULTS

3.1 Toxicity Results

3.1.1 Sample #248 (EMW9 - Pre-Burn)

LC_{50} values for both *Ceriodaphnia dubia* and fathead minnows were greater than 100 percent test material, indicating negligible acute toxicity for the EMW9-Pre-Burn sample (Table 3-1). Survival was somewhat reduced among *Ceriodaphnia dubia* exposed to 100 percent test material (65 percent survival in the 100 percent treatment group); however, this effect was not sufficient to influence the LC_{50} value.

The EMW-Pre-Burn did cause chronic toxicity to *Ceriodaphnia dubia*, with both survival and reproduction being adversely effected. Performance was, in fact, reduced by more than 25 percent in the lowest concentration treatment group, providing only an estimated IC_{25} value of <6.25 percent test material.

3.1.2 Sample #259 (EMW9 - Pre-Burn)

Fathead minnow acute tests were not conducted with this sample. Control mortality during the *Ceriodaphnia dubia* acute test exceeded the protocol-prescribed limit of 10 percent, thereby placing into question the quality of the test results. However, given that no mortality was observed among test organisms exposed to 100 percent EMW9-Pre-Burn test water, the sample was apparently not acutely toxic (Table 3-2).

Poor reproductive performance was observed in all chronic *Ceriodaphnia dubia* treatment groups; average control reproduction (7.3) was below the protocol-prescribed minimum of 15 young per female. Nevertheless, survival and reproduction did show a decreasing trend with increasing test concentration. An IC_{25} value of 14.2 percent was calculated, although this value should be qualified because of the sub-standard control performance.

3.1.3 Sample #492 (CPW1 - 1st Restoration)

Significant mortality was observed among *Ceriodaphnia dubia* and fathead minnows exposed to the CPW1-1st Restoration cavity water sample. LC_{50} values were 28.7 and 17.7 percent test material, respectively, for these two test species (Table 3-3).

Table 3-1

Toxicity Test Results for Sample #248 (EMW9 - Pre-Burn)

	Survival (%) in Acute Tests		*Ceriodaphnia* Chronic Test Results	
Concentration	*Ceriodaphnia* (48h)	Fathead minnow (96h)	Survival	Mean Young per Female
Control	100	95	80	15.8
6.25%	100	100	90	9.1
12.5%	80	100	90	6.9
25%	95	100	80	4.2
50%	95	100	30	0
100%	65	100	0	0
LC_{50}	>100[a]	>100[a]	IC_{25}	<6.25[a]

[a] By inspection

Table 3-2

Toxicity Test Results for Sample #259 (EMW9 - Pre-Burn)

Concentration	Survival (%) in Acute Tests		*Ceriodaphnia* Chronic Test Results[a]	
	Ceriodaphnia (48h)	Fathead minnow (96h)	Survival	Mean Young per Female
Control	30	NA[b]	90	7.3
6.25%	100	NA	100	6.3
12.5%	100	NA	100[c]	7.7
25%	100	NA	100	4.2
50%	100	NA	40	0.1
100%	100	NA	10	0
LC_{50}	>100	NA	IC_{25}	14.2

[a] Reproduction was below the minimum protocol-prescribed quality criterion (15 young per female).
[b] NA - Not applicable: no fathead minnow test was conducted with this test material.
[c] One organism was inadvertently killed in this treatment due to a technician error.

Table 3-3

Toxicity Test Results for Sample #492 (CPW1 - 1st Restoration)

	Survival (%) in Acute Tests		*Ceriodaphnia* Chronic Test Results	
Concentration	*Ceriodaphnia* (48h)	Fathead minnow (96h)	Survival	Mean Young per Female
Control	100	100	90	15.0[a]
6.25%	100	100	100	16.2[b]
12.5%	95	100	90	14.5[c]
25%	80	0	90	12.7[b]
50%	0	0	0	0
100%	0	0	0	0
LC_{50}	28.7	17.7	IC_{25}	25.3

[a] Two male test organisms were observed in this treatment; these individuals were excluded from the average reproduction calculation (i.e., n=8).
[b] One male test organism was observed in this treatment; this individual was excluded from the average reproduction calculation (i.e., n=9).
[c] Four male test organisms were observed in this treatment; these individuals were excluded from the average reproduction calculation (i.e., n=6).

Although total young production during the CPW1 exposure appeared to be below quality control limits, numerous male test organisms were observed among the treatment groups. While male test organisms are used in determining treatment group mortality rates, only female test organisms are included in the calculation of average young production. Calculating reproductive performance based on sample sizes adjusted to include only females indicated that the test results for this study were of acceptable quality (control reproduction was 15 young/female). The CPW1 test material was chronically toxic to *Ceriodaphnia dubia*; the IC_{25} value for the sample was 25.3 percent test material.

3.1.4 Sample #493 (VIW1 - 1st Restoration)

Acute toxicity of the VIW1-1st Restoration sample was observed among both fathead minnows and *Ceriodaphnia dubia*. LC_{50} values for these two species were 85.6 and 35.4 percent test material, respectively (Table 3-4). Fathead minnows appeared to be more sensitive to the exposure.

Similar to the CPW1 study, numerous male test organisms were observed in the VIW1 *Ceriodaphnia dubia* chronic test. In this study, however, average control reproduction (13.3) fell below the minimum required 15 young per female. Still, a marked decrease in survival and reproduction was observed in the 100 percent test material treatment, and the calculated IC_{25} value of 55.5 percent test material should generally reflect the chronic toxicity of the sample.

3.1.5 Sample #536 (TWT [treated] - 1st Restoration)

Tests with TWT treated water indicated no acute toxicity to either *Ceriodaphnia dubia* or fathead minnows (LC_{50} values >100 percent test material, 100 percent survival in all treatment groups) (Table 3-5).

Despite the lack of acute toxicity, this sample did show some chronic toxicity to *Ceriodaphnia dubia*. The IC_{25} value for the TWT sample was 62.8 percent test material.

3.1.6 Sample #1702 (VIW-1)

Tests with the VIW-1 water sample indicated no acute toxicity to *Ceriodaphnia dubia* and fathead minnows (LC_{50} values >100 percent test material, >92.5 percent survival in all treatment groups) (Table 3-6).

Control reproduction in the *Ceriodaphnia dubia* chronic test (14.1) was slightly below the protocol-prescribed minimum of 15 young per female. The test results, though potentially

Table 3-4

Toxicity Test Results for Sample #493 (ViW1 - 1st Restoration)

	Survival (%) in Acute Tests		*Ceriodaphnia* Chronic Test Results	
Concentration	*Ceriodaphnia* (48h)	Fathead minnow (96h)	Survival	Mean Young per Female[a]
Control	100	100	100	13.3[b]
6.25%	100	100	80	15.2[c]
12.5%	100	100	100	13.0[d]
25%	100	100	100	17.0[d]
50%	100	0	80	12.4[e]
100%	30[f]	0	20	0
LC_{50}	85.6	35.4	IC_{25}	55.5

[a] Reproduction was below the minimum protocol-prescribed quality criterion (15 young per female).
[b] Four male test organisms were observed in this treatment; these individuals were excluded from the average reproduction calculation (i.e., n=6).
[c] Six male test organisms were observed in this treatment; these individuals were excluded from the average reproduction calculation (i.e., n=4).
[d] Three male test organisms were observed in this treatment; these individuals were excluded from the average reproduction calculation (i.e., n=7).
[e] One male test organism was observed in this treatment; this individual was excluded from the average reproduction calculation (i.e., n=9).
[f] One organism in this treatment could not be found on Day 2 of testing and was presumed to have died.

Table 3-5

Toxicity Test Results for Sample #536 (TWT [treated] - 1st Restoration)

Concentration	Survival (%) in Acute Tests		*Ceriodaphnia* Chronic Test Results	
	Ceriodaphnia (48h)	Fathead minnow (96h)	Survival	Mean Young per Female
Control	100	100	100	17.2
6.25%	100	100	100	22.5
12.5%	100	100	100	22.7
25%	100	100	100	24.3
50%	100	100	100	23.8[a]
100%	100	100	80	0.5
LC_{50}	>100	>100	IC_{25}	62.8

[a] One male test organism was observed in this treatment; this individual was excluded from the average reproduction calculation (i.e., n=9).

Table 3-6

Toxicity Test Results for Sample #1702 (ViW-1)

	Survival (%) in Acute Tests		*Ceriodaphnia* Chronic Test Results	
Concentration	*Ceriodaphnia* (48h)	Fathead minnow (96h)	Survival	Mean Young per Female
Control	100	100	90	14.1
6.25%	100[a]	97.5	90	12.1
12.5%	100	97.5	90	18.4
25%	100	95	100	25.6
50%	95	97.5	100	21.8
100%	95	92.5	90	14.0
LC_{50}	>100	>100	IC_{25}	>100

[a] One organism in this treatment could not be found on Day 1 of testing (1st observation). It was assumed that only four organisms were added to the test chamber at test initiation.

qualified for poor control performance, indicated no chronic toxicity of the test material (i.e., no measurable effect on reproduction in the test material treatment groups relative to that in the control group). The IC_{25} value was >100 percent, given that performance was not reduced by 25 percent or more in any treatment group.

3.1.7 Sample #1703 (EMW-9)

Tests conducted with the EMW-9 water sample indicated negligible acute toxicity to either *Ceriodaphnia dubia* or fathead minnows (LC_{50} values >100 percent test material, >95 percent survival in all treatment groups) (Table 3-7).

Chronic toxicity was observed among *Ceriodaphnia dubia* exposed to the EMW-9 test material. The IC_{25} value calculated for this study was 16.5 percent test material.

3.1.8 Reference Toxicant Testing

Results of reference toxicant tests conducted concurrently with the present testing program indicate (1) that the test organisms were of acceptable sensitivity and (2) that laboratory performance was satisfactory and consistent. These results are summarized in Table 3-8.

3.2 Chemical/Physical Monitoring

Throughout all tests, water quality parameters generally remained within acceptable levels (Test Data). With one exception, temperature was maintained at 20 ± 1 and 25 ± 1 °C in the acute and chronic studies, respectively. The acute *Ceriodaphnia dubia* study with the EMW9 Pre Burn sample, #259 (11/04/87), was conducted at 25°C, rather than at 20°C. Measured pH values in all test treatments ranged from 6.8 to 9.2, and dissolved oxygen was maintained at ≥40% of saturation. Test samples and/or chambers were aerated as required to maintain acceptable dissolved oxygen concentrations (see Test Data for information on any aeration performed during specific tests).

Table 3-7

Toxicity Test Results for Sample #1703 (EMW-9)

	Survival (%) in Acute Tests		*Ceriodaphnia* Chronic Test Results	
Concentration	*Ceriodaphnia* (48h)	Fathead minnow (96h)	Survival	Mean Young per Female
Control	100	97.5	100	22.5
6.25%	100	100	80	16.8
12.5%	100[a]	100	90	20.4
25%	100	100	80	13.8
50%	100	100	80	10.2
100%	100	95	20	0
LC_{50}	>100	>100	IC_{25}	16.5

[a] None of the organisms in one replicate for this treatment could be found on Day 1 of testing (1st observation). It was assumed that no organisms were added to the test chamber at test initiation.

Table 3-8

Results of Reference Toxicant Tests Conducted Concurrently with Underground Coal Gasification Water Testing

Test Species	Test Date	Reference Toxicant	24-Hour LC_{50} (mg/L)	Acceptable Range (mg/L)
Ceriodaphnia dubia	08/87	SDS[a]	3.1	2.1 - 7.5
	11/87	SDS	11.7	0.8 - 15.1
	09/88	SDS	9.2	3.7 - 18.9
	09/90	NaCl[b]	1260	1109 - 1932
Fathead Minnow	08/21/87	SDS	3.8	0.9 - 6.9
	09/07/88	SDS	3.5	2.4 - 7.2
	09/22/88	SDS	3.8	2.4 - 6.7
	09/10/90	NaCl	5833	4080 - 7574

[a]SDS - Sodium Dodecyl Sulfate.
[b]NaCl - Sodium Chloride.

4.0 SUMMARY AND DISCUSSION

Results of all toxicity tests conducted are summarized in Table 4-1. Neither of the pre-burn samples showed acute toxicity; in contrast, both the CPW1 and VIW1 samples collected in September 1988 were acutely toxic to both *Ceriodaphnia* and fathead minnows. Laboratory staff made note of a strong sulfide odor from these two samples. As hydrogen sulfide is reasonably toxic to aquatic life, it is quite possible that sulfide was the cause of toxicity. The TWT sample collected later in September 1988 was not acutely toxic to either species, nor were either sample collected in 1990.

With respect to chronic toxicity, EMW9 showed chronic toxicity to *Ceriodaphnia* in all samples pre- and post-burn. The two pre-burn samples in particular had relatively high alkalinity (760 mg/L as $CaCO_3$); although this high alkalinity would be expected to cause some chronic toxicity to *Ceriodaphnia*, it cannot account for all of the chronic toxicity observed. Previous experiments conducted by ENSR for GRI indicated that the threshold for chronic toxicity of bicarbonate to *Ceriodaphnia* is about 400 to 500 mg/L as $CaCO_3$.

As part of another research effort sponsored by GRI, ENSR developed a series of logistic regression equations called Salinity/Toxicity Relationships (STRs). These equations predict the acute toxicity of a solution to *Ceriodaphnia dubia*, *Daphnia magna*, and fathead minnows based on its major ion composition (for more information on the STRs and their derivation, consult Gulley and Mount 1992). Because several of the present samples contained relatively high concentrations of several major ions, the STRs were used to predict the amount of acute toxicity that would be expected from these ions.

Ion concentrations used for STR calculations are shown in Table 4-2. Predictions for the August 21, 1987 sample from EMW9 corresponded well with the observed toxicity, with little acute toxicity predicted or observed. Comparing predictions for the September 6, 1988 samples is confounded by the lack of specific ion chemistry data. The available data are for a composite of both CPW1 and VIW1 samples from that day; accordingly, the exact ion composition for each sample individually is not known. Predicted toxicity to *Ceriodaphnia* was bracketed by the two observed values, but the predicted LC_{50} for fathead minnows was considerably higher than either of the observed values. This suggests that the acute toxicity of the CPW1 and VIW1 samples collected September 6, 1988 was caused primarily by something other than major ions, possible sulfide as suggested previously.

Table 4-1

Summary of Underground Coal Gasification Water Sample Toxicity Testing Results

ENSR Sample Number	Sample Description	Acute Tests LC_{50} in %		Chronic Tests IC_{25} in %
		Ceriodaphnia (48h)	Fathead minnow (96h)	*Ceriodaphnia* (3 Brood)
248	EMW9 - Pre-Burn	>100	>100	<6.25
259	EMW9 - Pre-Burn	>100	NA	14.2
492	CPW1 - 1st Rest.	28.7	17.7	25.3
493	ViW1 - 1st Rest.	85.6	35.4	55.5
536	TWT (treated) - 1st Rest.	>100	>100	62.8
1702	ViW-1	>100	>100	>100
1703	EMW-9	>100	>100	16.5

Table 4-2

Major Ion Concentrations (mg/L) and Predicted Toxicity

Parameter		Sample		
		EMW9 -- 8/21/87	CWE[1] - 9/6/88	TWT -- 9/88[2]
Sodium		539	800	930
Potassium		6	70	70
Calcium		7	50	9
Magnesium		4	14	13
Sulfate		370	1,130	1,210
Chloride		12	51	147
Alkalinity (as HCO_3)		926	972[3]	830
Ceriodaphnia LC_{50} (%)	Observed	>100	29/86	>100
	Predicted	99	67	67
Fathead Minnow LC_{50} (%)	Observed	>100	18/35	>100
	Predicted	>100	80	85

[1]The CWE sampling point was a composite of the CPW1 and ViW1 sampling points used for toxicity tests.
[2]The TWT sample was a composite of several samples collected September 15 to 19, 1988.
[3]Average of alkalinity in CPW1 and ViW1 samples.

Interestingly, the TWT sample showed no acute toxicity, even though the predicted toxicity was similar to that for the CPW1 and VIW1 samples. The ion concentration data (except for bicarbonate) were not for that particular sample, but actually for a composite sample collected a few days prior. It is possible that the chemistry data for the TWT sample is not representative, although this does not seem terribly likely in that conductivity of the TWT sample was comparable to that of the CPW1 and VIW1 samples (Table 2-2). Sulfate and bicarbonate were the ions primarily responsible for the predicted toxicity of the TWT, CPW1, and VIW1 samples. The lack of toxicity in the TWT sample reinforces the previous conclusion that toxicants other than major ions were likely responsible for the toxicity observed in the CPW1 and VIW1 samples.

5.0 REFERENCES

Mount, D.R. and D.D. Gulley. 1992. Development of a Salinity/Toxicity Relationship to Predict Acute Toxicity of Saline Waters to Freshwater Organisms. Gas Research Institute: Chicago, Illinois. GRI-92/0301.

Stephan, C. E. 1977. "Methods for Calculating an LC50", Aquatic Toxicology and Hazard Evaluation, ASTM STP 634, F. L. Mayer and J. L. Hamelink, Eds., American Society for Testing and Materials, pp. 65-84.

USEPA. 1985a. Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms. EPA/600/4-85/013.

USEPA. 1985b. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. EPA/600/4-85/014.

USEPA. 1989. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Second Edition. EPA/600/4-89/001.

TEST DATA

AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

5 of 6

EMW9 Pre Burn (8/21/87)

ERT QA Form No. 14
Effective: 3/87

SUBJECT: BIOLOGICAL AND CHEMICAL DATA FOR 48-HOUR STATIC ~~RENEWAL~~ EFFLUENT TOXICITY TEST

KKJ 6/8/90

TEST SUBSTANCE: Effluent
SPONSOR: GRI
ADDRESS: WEI
CONTACT: Jim Covell
OUTFALL: Rocky Mt-1
NPDES NO: NA

PROJECT NUMBER: D743-582-022
TEST SPECIES: Ceriodaphnia
SAMPLE TYPE: Grab
COMPOSITE: COLLECTED FROM: _____ TO: _____

BEGINING: DATE 8/21/87 TIME 1700
ENDING: DATE 8/23/87 TIME 1715
AGE: <24 hrs
LOT/BATCH: 082087
DILUTION WATER: CD-23

CONCENTRATION	REPLICATE	NUMBER OF SURVIVING ORGANISMS			DISSOLVED OXYGEN (mg/l)				TEMPERATURE (C)				pH			CONDUCTIVITY (umhos/cm)		ALKALINITY (mg/l)		HARDNESS (mg/l)		TRC (mg/l)		NH3 (mg/l)	
					NEW		OLD		NEW		OLD		NEW		OLD	NEW		NEW		NEW		NEW		NEW	
		0	24	48	0	24	48		0	24	48		0	24	48	0	24	0	24	0	24	0	24	0	24
Control	A	10	10	10	6.9	6.8	6.9		20	20	20		7.5	6.9	7.0	70	-	30	-	40	-				
	B	10	10	10	6.9	6.9	6.9		20	20	20		7.5	6.9	7.0	—	-	—	—	—	—				
6.25	A	10	10	10	6.9	6.9	6.9		20	20	20		7.9	7.5	7.6	-	-	—	—	—	—				
1	B	10	10	10	6.9	6.9	6.9		20	20	20		7.8	7.5	7.6	-	-	—	—	—	—				
12.5	A	10	9	8	7.0	6.9	6.9		20	20	20		8.0	7.8	7.9	-	-	—	—	—	—				
1	B	10	8	8	7.0	6.9	6.9		20	20	20		8.0	7.8	7.9	-	-	—	—	—	—				
25.0	A	10	10	10	7.0	6.9	6.0		20	20	20		8.1	8.0	8.1	-	-	—	—	—	—				
1	B	10	9	9	7.1	6.9	6.3		20	20	20		8.1	8.0	8.1	-	-	—	—	—	—				
50.0	A	10	9	9	7.2	6.9	6.3		20	20	20		8.2	8.0	8.1	-	-	—	—	—	—				
1	B	10	10	10	7.2	6.9	6.3		20	20	20		8.2	8.0	8.1	-	-	—	—	—	—				
100.0	A	10	8	8	7.5	6.6	6.6		20	20	20		8.3	8.2	8.2	1650	-	760	-	33	-				
1	B	10	6	2	7.5	6.6	6.7		20	20	20		8.3	8.2	8.2	—	-	—	—	—	—				
METER NO.		-	-	-	#1	1	1		#1	#1	#1		#1	#1	#1	7	-	7	-	7	-				
DATE		8/21	8/22	8/23	8/21	8/22	8/23		8/21	8/22	8/23		8/21	8/22	8/23	8/21	-	8/21	-	8/21	-				
TIME		1700	1700	1700	1700	1700	1700		1700	1700	1700		1700	1700	1700	1700	-	1700	-	1700	-				
INITITALS		DW	DW	DW	DW	DW	DW		DW	DW	DW		DW	DW	DW	DW	-	DW	-	DW	-				

LC50 : >100
95% CI NA TO NA
METHOD: NA

ERT QA Form No. 18
Effective: 3/87

Acute

SUBJECT: PHYSICAL & CHEMICAL DATA FOR FATHEAD MINNOW ~~SUBCHRONIC~~ TEST

KRS 6/8/90

SUBSTANCE: Effluent

BEGINNING: DATE 8/21/87 TIME 1745

3/21/87 SO4 - 33 mg/L
Acceptable Range 0-69

CLIENT: ENE

ENDING: DATE 8/25/87 TIME 1745

PROJECT NO. D743-582-003

Raky Mt-1

CONC.	TEST CONTAINER NUMBER	NO. OF SURVIVING ORGANISMS 0	1	2	3	4	5	6	7	DISSOLVED OXYGEN (mg/l) 0 NEW	0 OLD	1 NEW	1 OLD	2 NEW	2 OLD	3 NEW	3 OLD	4 NEW	4 OLD	5 NEW	5 OLD	6 NEW	6 OLD	7 NEW	7 OLD	TEMPERATURE (C) 0	1	2	3	4 NEW SOLUTIONS ONLY	5	6	7 OLD
Control	A	10	10	10	10	10				7.0	6.6	6.0	5.6	4.8	5.9	6.8	5.3									20	20	20	20	20			
	B	10	10	10	9	9				7.0	6.6	6.0	5.0	6.9	5.9	6.7	5.2									20	20	20					
6.25	A	10	10	10	10	10				7.0	6.5	6.7	5.3	6.9	5.7	6.6	4.9									20	20	20					
	B	10	10	10	10	10				7.0	6.5	6.7	5.3	6.4	5.6	6.6	4.8									20	20	20					
12.5	A	10	10	10	10	10				6.9	6.4	6.7	5.3	4.8	5.7	6.8	5.7									20	20	20					
	B	10	10	10	10	10				6.9	6.4	6.7	5.3	6.8	5.7	6.8	5.8									20	20	20					
25.0	A	10	10	10	10	10				6.7	6.4	6.7	5.3	6.9	5.7	6.9	6.0									20	20	20					
	B	10	10	10	10	10				6.7	6.4	6.7	5.3	6.9	6.0	6.9	6.3									20	20	20					
50.0	A	10	10	10	10	10				6.3	6.4	6.8	5.3	6.9	5.8	7.2	6.4									20	20	20					
	B	10	10	10	10	10				6.4	6.3	6.8	5.3	6.9	5.8	7.2	6.4									20	20	20					
100.0	A	10	10	10	10	10				7.0	6.4	7.2	6.5	7.3	6.0	7.2	6.2									20	20	20					
	B	10	10	10	10	10				7.0	6.4	7.2	6.5	7.3	6.0	7.2	5.6									20	20	20					
																										20	20	20					
METER NO.										#1	#1	#1	#1	#1	#1	#1	#1																
DATE																																	
TIME																																	
INITIALS																																	

D-31

ERT QA Form No. 19
Effective: 3/87

SUBJECT: CHEMICAL DTA FOR FATHEAD MINNOW SUBCHRONIC TEST

SUBSTANCE: Effluent

BEGINNING: DATE 8/11/87 TIME 1700 1745 DW

CLIENT: GRT

ENDING: DATE 8/25/87 TIME 1745

PROJECT NO. D143-582-003

CONC.	TEST CONTAINER NUMBER	pH 0	1	2	3	4	5	6	7	CONDUCTIVITY (umhos/cm) 0	1	2	3	4	5	6	7	ALKALINITY (mg/l) 0	1	2	3	4	5	6	7	HARDNESS (mg/l) 0	1	2	3	4	5	6	7
		NEW SOLUTIONS ONLY							OLD	NEW SOLUTIONS ONLY							OLD	NEW SOLUTIONS ONLY								NEW SOLUTIONS ONLY							
Control	A	8.0	7.9	8.0	7.9	8.1				162	162	170	163	161				23	21	42	31					32	30	42	30				
	B	8.0	7.9	8.0	7.9	8.1																									
6.25	A	7.6	7.6	7.6	7.6	7.7																									
	B	7.6	7.6	7.6	7.6	7.7																									
12.5	A	7.8	7.9	7.8	7.9	7.6																									
	B	7.8	7.9	7.8	7.9	7.6																									
25.0	A	8.0	8.2	8.0	8.1	8.1																									
	B	8.0	8.1	8.0	8.1	8.1																									
50.0	A	8.2	8.2	8.2	8.3	8.4																									
	B	8.2	8.2	8.2	8.3	8.4																					53				
100.0	A	8.3	8.4	8.3	8.4	8.6				167	159	157	150	150				164	148	144	150					150	154	134	137				
	B	8.3	8.4	8.3	8.4	8.6																									
METER NO.		63	10-70-7		10-70-7					7	7	7	7	8				I	I	I	I					I	I	I	I				
DATE		8/21	8/24	8/25	8/21	8/25				8/21	8/24	8/25	8/21	8/25				8/21	8/24	8/25	8/21	8/25				8/24	8/24	8/25	8/21	8/25			
TIME		1735	1500	1125	1200	1710				1700	1500	1500	1530	1700				1600	1500	1500	1530	1700				1700	1500	1500	1530	1700			
INITIALS		JK	DW	JK	DW	JK				JK	DW	DW	DW	JK				JK	DW	DW	DW	JK				JK	DW	DW	DW	JK			

ERT

Fathead 96 hr renewal KEN 6/18/87

SUBJECT: DAILY LOG

Δ743-582-003

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME:

8/22/87 1430 Old temps 20°C in all test groups DH
FHM's fed @ 1407, 1100

8/23/87 1530 Fed FHM's
old temps 20°C. all chambers DH

8/24/87 1530 ad Test Temp 20°C Seal @ 1100 KEN

SUBJECT: CHEMICAL DATA FOR CERIODAPHNIA SP. CHRONIC TEST

Task 001

SPONSOR: GRI PROJECT NUMBER: D743-582 BEGINING: DATE 8/21/87 TIME 1730

TEST SUBSTANCE: EFFLUENT ENDING: DATE 8/29/87 TIME 1720

Ruby MT-1

CONC.	TEST CONTAINER NO.	DO 0 NEW	DO 1 OLD	DO 1 NEW	DO 2 OLD	DO 2 NEW	DO 3 OLD	DO 3 NEW	DO 4 OLD	DO 4 NEW	DO 5 OLD	DO 5 NEW	DO 6 OLD	DO 6 NEW	DO 7 OLD
Control	1-10	6.9	6.3	6.3	6.2	7.2	6.0	7.0	5.6	6.7	5.8	6.5	5.4	6.6	6.0
6.25	11-20	6.8	5.9	6.3	6.0	7.2	5.4	7.0	5.1	6.9	5.0	6.7	5.8	6.7	6.2
12.5	21-30	6.7	5.9	6.3	5.9	7.2	5.6	7.0	5.3	7.0	4.4	6.8	5.9	6.8	6.3
25.0	31-40	6.5	5.8	6.4	5.8	7.2	6.1	7.0	5.5	7.0	4.8	6.9	6.1	7.0	6.4
50.0	41-50	5.9	5.8	6.5	5.7	7.2	6.1	7.0	5.7	7.0	4.0	7.0	6.2	7.0	6.5
100.0	51-60	5.1	6.2	7.3	6.0	7.5	—	—	—	—	—	—	—	—	—
	METER #	#1	#1	#1	1	1	#1	#1	#1	#1	#1	#1	#1	#1	#1
	DATE	8/21	8/22	8/22	8/23	8/23	8/24	8/24	8/25	8/25	8/26	8/26	8/27	8/27	8/28
	TIME	1700	1629	1530	1610	1535	1740	1650	1520	1700	1730	1620	1655	1600	1650
	INITIALS	[illegible]	DW	DW	DW	DW	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CONC.	TEMPERATURE (C) 0	1	2	3	4	5	6	7 (new/OLD)	pH 0	1	2	3	4	5	6	7 (new/OLD)
		NEW SOLUTIONS ONLY								NEW SOLUTIONS ONLY						
Control	24	24	24	25	25	25	25	25	7.1	7.0	6.9	7.0	7.0	7.0	7.0	7.0
6.25	24	24	24	25	25	25	25	25	7.6	7.4	7.6	7.6	7.6	7.6	7.6	7.6
12.5	24	24	24	25	25	25	25	25	7.9	7.9	7.8	7.9	7.9	7.7	7.9	7.9
25.0	24	24	24	25	25	25	25	25	8	8.0	8.0	8.1	8.1	8.1	8.1	8.1
50.0	24	24	24	25	25	25	25	25	8.2	8.2	8.1	8.3	8.3	8.3	8.3	8.3
100.0	24	24	24	—	—	—	—	—	8.3	8.3	—	—	—	—	—	—
METER #	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0-7	0-7	0-7	0-7	0-7	0-7	0-7	0-7
DATE	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28
TIME	1700	1524	1530	1700	1720	1620	1604	1545	1704	1540	1531	1720	1720	1655	1620	1545
INITIALS	[illegible]	DW	DW	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	DW	DW	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CONC.	TEST CONTAINER NO.	ALKALINITY (mg/l) 0	1	2	3	4	5	6	HARDNESS (mg/l) 0	1	2	3	4	5	6	CONDUCTIVITY (umhos/cm) 0	1	2	3	4	5	6	7 (new/OLD)
			NEW SOLUTIONS ONLY							NEW SOLUTIONS ONLY							NEW SOLUTIONS ONLY						
Control	1-10	30	31	31	31	35	45	45	40	36	36	36	40	43	43	147	72	70	70	100	100	110	110
6.25	11-20	-	-	-		-	-		-							183							
12.5	21-30	-	-	-	-		-									289							
25.0	31-40	-	-	-	-			-								489							
50.0	41-50	-	-	-			-	-								922							
100.0	51-60	260	243	244	250	264	268	269	33	34	34	34	34	35	35	1656	1624	1352	1360	1350	1500	1500	1454
	METER #	T	T	T	T	T	T	T	T	T	T	T	T	T	T	7	7	7	7	8	8	8	8
	DATE	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28
	TIME	1659	1524	1524	1520	1704	1540	1559	1650	1524	1520	1520	1704	1524	1600	1710	1524	1524	1520	1700	1520	1520	1559
	INITIALS	[illegible]	DW	DW	[illegible]	DW	[illegible]	[illegible]	[illegible]	DW	DW	[illegible]	DW	[illegible]	[illegible]	[illegible]	DW	DW	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

COMMENTS:
No Selenastrum
added supplement.
Animals slow to
develop.

ERT

6/18/90

SUBJECT: SURVIVAL AND REPRODUCTION DATA FOR CERIODAPHNIA SP. EFFLUENT TOXICITY TEST

SPONSOR: GRI PROJECT NUMBER: D743-552-001

TEST SUBSTANCE: Effluent

EFFLUENT CONC.	DAY NO.	DATE/TIME	IN.	REPLICATE A	B	C	D	E	F	G	H	I	J	TOTAL LIVE	NO. LIVE ADULTS	MOST YOUNG BY ANY ADULT
Control	1	8/22 1345	DW	0	X	0	0	0	0	0	0	X	0	0	8	0
	2	8/23 1535	DW	0	-	0	0	0	0	0	0	-	0	0	7	0
	3	8/24 1720	KW	0	|	0	0	0	0	0	0	|	0	0	8	0
	4	8/25 1730	KW	0	|	0	0	0	0	0	0	|	0	0	8	0
	5	8/26 1645	KW	7	|	0	8	8	0	0	7	|	0	30	8	8
	6	8/27 1610	KW	1	|	0	5	6	5	5	0	|	5	26	8	6
	7	8/28 1600	KW	3	|	9	7	9	7	11	9	|	7	67	8	11
	TOT	8/29 1720	KW	2	1	0	9	12	0	0	11	|	0	34	3	
				13		9	29	35	12	16	27		12	158		
6.25	1	8/22 1332	DW	0	0	0	0	0	0	0	0	0	0	0	10	0
	2	8/23 1540	DW	0	0	0	0	0	0	0	0	0	0	0	10	0
	3	8/24 1705	KW	0	0	0	0	0	0	0	0	X	0	0	9	0
	4	8/25 1730	KW	0	0	0	0	0	0	0	0	|	0	0	9	0
	5	8/26 1650	KW	0	0	0	0	0	0	0	0	|	0	0	9	0
	6	8/27 1620	KW	0	0	6	4	3	4	8	0	|	4	28	9	8
	7	8/28 1620	KW	0	7	8	8	7	8	5	9	|	11	63		
	TOT	8/29 1725	KW	0	0	0	0	0	0	0	0	|	0	0		
				0	7	14	12	9	12	13	9		15	91	9	
12.5	1	8/22 1600	DW	0	0	0	0	0	0	0	0	0	0	0	10	0
	2	8/23 1545	DW	0	0	0	0	0	0	0	0	0	0	0	10	0
	3	8/24 1720	KW	0	0	0	0	0	0	0	0	0	0	0	10	0
	4	8/25 1740	KW	0	0	0	0	0	0	0	0	0	0	0	10	0
	5	8/26 1705	KW	2	5	0	0	0	0	0	6	0	0	13	10	6
	6	8/27 1650	KW	2	0	4	0	4	2	0	0	0	0	12	10	4
	7	8/28 1600	KW	9	10	1	0	7	10	7X	0	0	0			
	TOT	8/29 1730	KW	0	0	0	0	0	0	1	0	0	0			
				13	15	5	0	11	12	7	6	0	0	69	9	

NOTE: X=Dead Adult, no young produced before death.
1x=Dead Adult, one young produced before death.

ERT QA Form No. 16
Effective: 3/87
6/18/90

SUBJECT: SURVIVAL AND REPRODUCTION DATA FOR CERIODAPHNIA SP. EFFLUENT TOXICITY TEST

SPONSOR: -RI PROJECT NUMBER: D743-582-001
TEST SUBSTANCE: Effluent

EFFLUENT CONC.	DAY NO.	DATE/TIME	IN.	REPLICATE A	B	C	D	E	F	G	H	I	J	TOTAL LIVE	NO. LIVE ADULTS	MOST YOUNG BY ANY ADULT
25	1	8/22 1605	DW	0	0	0	0	0	0	0	X	0	0	0	10	0
	2	8/23 1557	DW	6	6	6	6	6	0	0	X	X	0	6	8	0
	3	8/24 1730	DW	0	0	0	0	0	0	0			0	0	3	0
	4	8/25 1720	DW	0	0	0	0	0	0	0			0	0	3	0
	5	8/26 1715	DW	7	8	0	0	0	0	0			0	0	4	0
	6	8/27 1640	DW	7	5	5	7	3	5	0			2	34	3	7
	7	8/28 1640	DW	0	0	0	0	0	0	8			0			
	TOT	8/29 1720	DW	0	0	0	0	0	0	0			0	42	3	
	1	8/22 1610	DW	0	0	0	0	0	0	0	X	2x	0	0	4	0
	2	8/23 1600	DW	X	0	0	X	0	X	X	=	X	0	0	4	0
	3	8/24 1740	DW		0	0		0					0	0	4	0
	4	8/25 1800	DW		0	0		0					0	0	4	0
	5	8/26 1720	DW		0	0		0					0	0	4	0
	6	8/27 1640	DW		0	0		0					0	0	4	0
	7	8/28 1645	DW		X	0		0					0			
	TOT	8/29 1720	DW			0		0					0	0	3	
	1	8/22 1615	DW	X	X	0	X	X	X	X	X	X	X	0	1	0
	2	8/23 1605	DW	-	-	X	-	-	-	-	-	-	-	0	0	0
	3															
	4															
	5															
	6															
	7															
	TOT													0	0	

NOTE: X=Dead Adult, no young produced before death.
1x=Dead Adult, one young produced before death.

ERT

ERT TOXICOLOGY GROUP
FT. COLLINS, COLORADO

ERT QA Form No. 15
Effective: 3/87

Ceriodaphnia Chronic

6/18/90

SUBJECT: DAILY LOG D743-582-001

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME: no solenastrum apparent!

3/22/87: 1430 old temps 25°C all groups DW

8/23/87: 1610 old temps 25°C all groups DW

8/24/87 old Test Temp 25°C 1650

8/25/87 old test temp 25°C 1650

8/26/87 old test temp 25°C 1730

8/27/87 old test temp 25°C 1655

8/28/87 old test temp 25°C 1530 1220

	Alk	Hardness	Cond.
10% effluent	45	43	110
effluent	768	36	1450
new DW	6.4 - 7.0		

8/29/87 old test temp 25°C 1130

DO's	Control	6.25	12.5	25	50
	6.6	6.7	6.6	6.7	6.6

D743-552-001
Pg 5 of 7
KGD 6/18/90

SUMMARY OF FISHERS EXACT TESTS

GROUP	IDENTIFICATION	NUMBER EXPOSED	NUMBER DEAD	SIG (P=.05)
	CONTROL	10	2	
1	6.25	10	1	
2	12.5	10	1	
3	25	10	2	
4	50	10	7	*
5	100	10	10	*

‖ Press any key to continue ‖

page 6 of 7
KCM 6/18/90

D743-582-001 Ceriodaphnia Reproduction
File: A:001 Transform: NO TRANSFORMATION

Shapiro Wilks test for normality

D = 1875.000

W = 0.974

Critical W (P = 0.05) (n = 40) = 0.940
Critical W (P = 0.01) (n = 40) = 0.919

Data PASS normality test at P=0.01 level. Continue analysis.

D743-582-001 Ceriodaphnia Reproduction
File: A:001 Transform: NO TRANSFORMATION

Bartletts test for homogeneity of variance

Calculated B statistic = 16.59
Table Chi-square value = 11.34 (alpha = 0.01)
Table Chi-square value = 7.81 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 9.00
Used for Chi-square table value ==> df (#groups-1) = 3

Data FAIL homogeneity test at 0.01 level. Try another transformation.

NOTE: If groups have unequal replicate sizes the average replicate size is used to calculate the B statistic (see above).

D743-582-001 Ceriodaphnia Reproduction
File: A:001 Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Control	10	0.000	35.000	15.800
2	6.25	10	0.000	15.000	9.100
3	12.5	10	0.000	15.000	6.900
4	25	10	0.000	8.000	4.200

D743-582-001 Ceriodaphnia Reproduction
File: A:001 Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	Control	138.622	11.774	3.723
2	6.25	28.989	5.384	1.703
3	12.5	32.544	5.705	1.804
4	25	8.178	2.860	0.904

D743-582-001 Ceriodaphnia Reproduction
File: A:001 Transform: NO TRANSFORMATION

STEELS MANY-ONE RANK TEST - Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	Control	15.800				
2	6.25	9.100	87.00	77.00	10.00	
3	12.5	6.900	81.00	77.00	10.00	
4	25	4.200	73.00	77.00	10.00	*

Critical values use k = 3, are 1 tailed, and alpha = 0.05

THE NUMBER OF RESAMPLES IS 80 #248.PNW

EMWQ.PR Born C. dubia Reprod. 8-24-87

*** LISTING OF GROUP CONCENTRATIONS (% EFF.) AND RESPONSE MEANS ***

CONC. (%EFF)	RESPONSE MEAN	MEAN AFTER POOLING
.000	15.800	15.800
6.250	9.100	9.100
12.500	6.900	6.900
25.000	4.200	4.200
50.000	.000	.000
100.000	.000	.000

THE LINEAR INTERPOLATION ESTIMATE OF THE TOTAL IMPACT CONCENTRATION FROM THE INPUT SAMPLE IS 3.6847.

50.000	.000	.000
100.000	.000	.000

THE LINEAR INTERPOLATION ESTIMATE OF THE TOTAL IMPACT CONCENTRATION FROM THE INPUT SAMPLE IS 3.6847.

```
**********************************************************
*        BOOTSTRAP PROCEDURE TO ESTIMATE VARIABILITY     *
*                    OF THE ESTIMATED ICp                *
**********************************************************
```

THE MEAN OF THE BOOTSTRAP ESTIMATES IS 4.5766. IC 25 ASC 7-9-93

THE STANDARD DEVIATION OF THE BOOTSTRAP ESTIMATES IS 2.6097.
ES IS 2.6097.

AN EMPIRICAL 95.0% CONFIDENCE INTERVAL FOR THE BOOTSTRAP ESTIMATE IS (2.3583, 13.1181). ∠ 6.25%

EMW9 Pre Burn (11/4/87)

ERT QA Form No. 14
Effective: 3/87

EMW9 TOX 005

SUBJECT: BIOLOGICAL AND CHEMICAL DATA FOR 48-HOUR STATIC RENEWAL EFFLUENT TOXICITY TEST

TEST SUBSTANCE: EFFLUENT
SPONSOR: WRE / URI
ADDRESS: —
CONTACT: Jim Covell
OUTFALL: EMW9
NPDES NO: NA

PROJECT NUMBER: D743-582
TEST SPECIES: D. Ceriodaphnia
SAMPLE TYPE: _____
COMPOSITE: COLLECTED FROM: 1300 11/4 AGE: < 24 hr.
TO: 1415 11/4 LOT (BATCH): 110487
DILUTION WATER: CA-25

BEGINING: DATE 11/5/87 TIME 1015
ENDING: DATE 11/7/87 TIME _____
TEST ORGANISM: Ceriodaphnia

CONCENTRATION	TEST CONTAINER NUMBER	NUMBER OF SURVIVING ORGANISMS			DISSOLVED OXYGEN (mg/l)				TEMPERATURE (C)				pH			CONDUCTIVITY (umhos/cm)		ALKALINITY (mg/l)		HARDNESS (mg/l)		TRC (mg/l)		NH3 (mg/l)	
					NEW		OLD		NEW		OLD		NEW			NEW		NEW		NEW		NEW		NEW		
		0	24	48	0	24	0	24	0	24	0	24	0	24	48	0	24	0	24	0	24	0	24	0	24
CONTROL	A	10	10	10	7.0	6.7	7.0	6.9	25	25	24	25	7.9	7.3	7.3	560	570	26	29	32	34				
1	B	10	10	10	7.0	6.6	7.0	6.8	25	25	24	25	7.9	7.3	7.4	—	—	—	—	—	—				
6.25	A	10	10	10	7.0	6.5	7.0	6.8	25	25	24	25	7.6	7.2	7.3	—	—	—	—	—	—				
1	B	10	10	10	7.0	6.6	7.0	6.8	25	25	24	25	7.6	7.2	7.3	—	—	—	—	—	—				
12.5	A	10	10	10	7.0	6.6	6.9	6.8	25	25	24	25	7.6	7.2	7.3	—	—	—	—	—	—				
1	B	10	10	10	7.0	6.5	6.9	6.7	25	25	24	25	7.6	7.2	7.3	—	—	—	—	—	—				
25.0	A	10	10	10	7.0	6.5	6.8	6.7	25	25	24	25	7.7	7.3	7.4	—	—	—	—	—	—				
1	B	10	10	10	7.0	6.7	6.8	6.8	25	25	24	25	7.8	7.3	7.3	—	—	—	—	—	—				
50.0	A	10	10	10	6.9	6.6	6.6	6.7	25	25	24	25	7.8	7.4	7.4	—	—	—	—	—	—				
1	B	10	10	10	6.8	6.6	6.6	6.8	25	25	24	25	7.8	7.4	7.4	—	—	—	—	—	—				
100.0	A	10	10	10	6.3	6.7	6.0	6.4	25	25	24	25	7.8	7.5	7.4	2100	2100	763	771	30	34				
1	B	10	10	10	6.4	6.6	6.0	6.6	25	25	24	25	7.8	7.5	7.4	—	—	—	—	—	—				
METER NO.		—	—	—	#1	#1	#1	#1	[illegible]				#8	#8		I	I	I	I						
DATE		11/5	11/6	11/7	11/5	11/6	11/6	11/7	11/5	11/6	11/6	11/7	11/5	11/6	11/7	11/5	11/6	11/5	11/6	11/5	11/6				
TIME		1015	0910	0915	1015	0910	1015	0915	0930	0925	0930	0920	0930	0925	0920	0950	0935	0915	0910	0900	0900				
INITITALS		JW	[illegible]	[illegible]	JW	[illegible]	JW	[illegible]	JW	[illegible]	JW	[illegible]	JW	[illegible]	[illegible]	JW	JW	JW	JW	JW	JW				

LC50 : >100
95% CI NA TO NA
METHOD: NA

D-43

WRE

Test Scrapped due to unacceptable Control performance
KEC 01/31/90

ERT QA Form No. 17
Effective: 3/87

SUBJECT: CHEMICAL DATA FOR CERIODAPHNIA SP. CHRONIC TEST EMW9 Task 004

SPONSOR: WRI PROJECT NUMBER: D243-582 BEGINING: DATE 11/27/89 TIME 0830
TEST SUBSTANCE: EFFLUENT ENDING: DATE _____ TIME _____

CONC.	TEST CONTAINER NO.	DISSOLVED OXYGEN (mg/l) 0 NEW	0 OLD	1* NEW	1* OLD	2* NEW	2* OLD	3* NEW	3* OLD	4* NEW	4* OLD	5* NEW	5* OLD	6* NEW	6* OLD	7 NEW	7 OLD
Control	1-10	7.0	6.5	7.0	6.3	7.0	6.9	7.0	6.8	7.0	[illegible]	7.0	6.2	7.0	6.2	7.0	6.3
6.25	11-20	7.1	6.5	7.2	6.6	7.1	6.9	7.1	6.9	7.1	6.7	7.1	6.2	7.1	6.1	7.0	6.3
12.5	21-30	7.1	6.5	7.3	6.6	7.3	6.9	7.2	6.8	7.3	6.7	7.1	6.2	7.2	6.2	7.0	6.3
25.0	31-40	7.1	6.5	7.4	6.5	7.4	6.8	7.3	6.8	7.4	6.7	7.3	6.1	7.2	6.2	7.0	6.2
50.0	41-50	7.1	6.5	7.5	6.5	7.4	6.8	7.5	6.7	7.5	6.7	7.5	6.2	7.4	6.2	7.0	6.2
100.0	51-60	7.2	6.5	8.1	6.4	8.0	6.8	8.1	6.7	8.0	6.7	8.0	6.3	7.9	6.3	7.0	6.3
	METER #	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	224	
	DATE	11/27	11/28	11/28	11/29	11/29	11/30	11/30	12/1	12/1	12/2	12/2	12/3	12/3	12/4	12/5	
	TIME	0830	0845	0900	0830	0840	0825	0840	0825	0840	0825	0835	0830	0835	0830	0835	0845
	INITIALS	[illegible]															

*DO's supersaturated due to rapid warming of effluent 11/28

CONC.	TEST CONTAINER NO.	TEMPERATURE (C) 0	1	2	3	4	5	6	7 OLD	pH 0	1	2	3	4	5	6	7 NEW	7 OLD
		NEW SOLUTIONS ONLY								NEW SOLUTIONS ONLY								
Control	1-10	24	25	24	25	24	25	25	25	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.5	
6.25	11-20	24	25	24	25	24	25	25		7.9	7.9	7.8	7.9	7.9	7.9	7.9	7.7	
12.5	21-30	24	25	24	25	24	25	25		8.2	8.2	8.2	8.3	8.2	8.2	8.2	8.0	
25.0	31-40	24	25	24	25	24	25	25		8.3	8.3	8.3	8.4	8.3	8.3	8.3	8.2	
50.0	41-50	24	25	24	25	24	25	25		8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.3	
100.0	51-60	24	25	24	25	24	25	25		8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.4	
	METER #									10	10	10	10	10	10	10	10	
	DATE	11/27	11/28	11/29	11/30	12/1	12/2	12/3	12/4	11/27	11/28	11/29	11/30	12/1	12/2	12/3	12/4	
	TIME	0845	0900	0830	0840	0825	0840	0825	0835	0830	0845	0900	0830	0840	0825	0840	0825	
	INITIALS																	

CONC.	TEST CONTAINER NO.	ALKALINITY (mg/l) 0	1	2	3	4	5	6	HARDNESS (mg/l) 0	1	2	3	4	5	6	CONDUCTIVITY (umhos/cm) 0	1	2	3	4	5	6	7 OLD	COMMENTS:
		NEW SOLUTIONS ONLY							NEW SOLUTIONS ONLY							NEW SOLUTIONS ONLY								
Control	1-10	30	27	25	28	26	28	39	36	36	36	36	36	36	36	186	185	185	186	214	186	202	115	
6.25	11-20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	228	221	224	225	221	224	240		
12.5	21-30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	321	316	369	374	369	360	371	330	
25.0	31-40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	680	700	650	660	670	650	690	650	
50.0	41-50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1180	1180	1160	1220	1170	1200	1200	1050	
100.0	51-60	771	774	774	772	771	772	759	34	34	34	34	34	34	34	2220	2320	2220	2220	2260	2200	2150	2220	
	METER #	T	T	T	T	T	T	T	T	T	T	T	T	T	T	#8	#8	#8	#8	#8	#8	#8	#8	
	DATE	11/27	11/28	11/29	11/30	12/1	12/2	12/3	11/27	11/28	11/29	11/30	12/1	12/2	12/3	11/27	11/28	11/29	11/30	12/1	12/2	12/3	12/4	
	TIME	0830	0845	0900	0830	0840	0825	0840	0830	0845	0900	0830	0840	0825	0840	0830	0845	0900	0830	0840	0825	0840	0825	
	INITIALS																							

ERT QA Form No. 16
Effective: 3/87

SUBJECT: SURVIVAL AND REPRODUCTION DATA FOR CERIODAPHNIA SP. EFFLUENT TOXICITY TEST

SPONSOR: WRI PROJECT NUMBER: D743-582
TEST SUBSTANCE: EFFLUENT

EFFLUENT CONC.	DAY NO.	DATE/TIME	IN.	REPLICATE A	B	C	D	E	F	G	H	I	J	TOTAL LIVE	NO. LIVE ADULTS	MOST YOUNG BY ANY ADULT
Control	1	11/8 0915		0	0	0	0	0	0	0	0	0	0	0	10	0
	2	11/9 0800		0	0	0	0	0	0	0	0	0	0	0	10	0
	3	11/10 0855		0	0	0	0	0	0	0	0	0	0	0	10	0
	4	11/11 0755		?	0	0	1	3	0	0	0	1	4		10	4
	5	11/12 0835		0	1	0	4	0	0	1	1	2	6		10	6
	6	11/13 0910												0	10	0
	7	11/14 0850		0	0	0	0	0	0	0	X	1	0	1x01	9	1
	TOT	11/15 0850		1	0	0	3	0	5	15	1	19	3		9	
				3	1	0	8	3	5	16	1	23	13	73		
6.25	1	11/8 0820		0	0	0	0	0	0	0	0	0	0	0	10	0
	2	11/9 0805		0	0	0	0	0	0	0	0	0	0	0	10	0
	3	11/10 0900		0	0	0	0	0	0	0	0	0	0	0	10	0
	4	11/11 0805		0	0	2	1	0	0	0	0	1	2		10	2
	5	11/12 0835		0	0	0	0	1	0	1	0	0	0		10	1
	6	11/13 0815												0	10	0
	7	11/14 0910		2	0	14	1	0	0	0	0	10	0		10	
	TOT	11/15 0900		11	1	4	2	1	1	0	0	8	0		10	
				13	1	20	4	2	1	1	0	19	2	63		
12.5	1	11/8 0825		0	0	0	0	0	0	0	0	0	0	0	10	0
	2	11/9 0810		0	0	0	0	0	0	0	0	0	0	0	10	0
	3	11/10 0905		0	0	0	0	0	0	0	0	0	0	0	10	0
	4	11/11 0810		5	3	0	1	0	0	X	3	0	0		9	5
	5	11/12 0845		0	1	1	0	0	0	1	0	0	0	2	9	1
	6	11/13 0820												0	9	0
	7	11/14 0915		0	0	3	0	4x	3	1	17	14	1		8	17
	TOT	11/15 0915		0	0	0	0	1	0	1	8	0	0		8	
				5	4	4	1	4	3	0	28	14	1	69		

NOTE: X=Dead Adult, no young produced before death.
1x=Dead Adult, one young produced before death.

SUBJECT: SURVIVAL AND REPRODUCTION DATA FOR CERIODAPHNIA SP. EFFLUENT TOXICITY TEST

SPONSOR: WRI PROJECT NUMBER: D743-582
TEST SUBSTANCE: EFFLUENT

EFFLUENT CONC.	DAY NO.	DATE/TIME	IN.	REPLICATE A	B	C	D	E	F	G	H	I	J	TOTAL LIVE	NO. LIVE ADULTS	MOST YOUNG BY ANY ADULT
25		11/15 0935		0	0	1	5	0	0	1	1	0	13		10	
	1	11/9 0930		0	0	0	0	0	0	0	0	0	0	0	10	0
	2	11/9 0815		0	0	0	0	0	0	0	0	0	0	0	10	0
	3	11/10 0910		0	0	0	0	0	0	0	0	0	0	0	10	0
	4	11/11 0815		0	0	0	0	0	0	0	0	0	4	4	10	4
	5	11/12 0902		0	0	0	0	0	1	0	0	0	10	11	10	10
	6	11/13 0820												0	10	0
	7	11/14 0940		0	0	0	0	0	0	0	0	0	6	6	10	0
	TOT	~~11/15 0935~~		~~1~~	~~0~~	~~0~~	~~3~~	~~0~~	~~5~~	~~1~~	~~1~~	~~0~~	~~13~~			
						"0"		0	1	1	1	0	33	33		
50	1	11/8 0935		0	0	0	0	0	0	0	0	0	0	0	10	0
	2	11/9 0830		0	0	0	0	0	0	0	0	0	0	0	10	0
	3	11/10 0915		0	0	0	0	0	0	0	0	0	0	0	10	0
	4	11/11 0825		0	0	0	0	0	0	0	0	0	X	0	9	0
	5	11/12 0915		0	X	0	0	X	0	0	1	0	|	1	7	1
	6	11/13 0825		0	|	0	0	|	0	0	0	0	|	0	7	0
	7	11/14 0945		X	|	0	0	|	0	0	0	0	|	0	6	0
	TOT	11/15 0940		|	|	X	0	|	X	0	0	0	|		4	
100	1	11/8 0840		0	0	X	0	0	0	0	0	0	0	0	9	0
	2	11/9 0825		0	0	|	0	0	0	0	0	0	0	0	9	0
	3	11/10 0910		0	X	|	0	0	X	0	0	0	0	0	7	0
	4	11/11 0830		0	|	|	0	0	|	0	0	0	0	0	7	0
	5	11/12 0920		0	|	|	X	X	|	X	0	0	0	0	4	0
	6	11/13 0830		0	|	|	|	|	|	|	X	0	0	0	3	0
	7	11/14 0950		0	|	|	|	|	|	|	|	0	0	0	3	0
	TOT	11/15 0945		X	|	|	|	|	|	|	X	0	0	1	0

NOTE: X=Dead Adult, no young produced before death.
1x=Dead Adult, one young produced before death.

SUBJECT: DAILY LOG

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME:

11/7/87 - All D.O. levels above 7.0 show supersaturation due to rapid warming of effluent 0750 VGP

11/8/87 - All D.O levels above 7.0 are supersaturated due to rapid warming of effluent 0800 VGP

11/9/87 - Again, as above 0750 VGP

11/10/87 - Again, as above 0740 VGP

11/11/87 - Again, as above 0745 VGP

11/11/87 - One dead adult in 12.5% to was killed with the pipette during transfer 0810 VGP

11/12/87 - DOs supersaturated due to rapid warming 0800 VGP

11/12/87 - Most all chambers at all concentrations revealed molted carapaces full of "still-born" neonates 0930 VGP

11/13/87 - All D.O's above 7.0 show supersaturation due to rapid warming of effluent 0750 VGP

11/14/87 old ~~test~~ temp 25°C

11/15/87 old ~~test~~ temp 24°C

EMW 9- Pre-Burn
11-04-97 #259
C. Dubrin Reprod.

THE NUMBER OF RESAMPLES IS 80

*** LISTING OF GROUP CONCENTRATIONS (% EFF.) AND RESPONSE MEANS ***

CONC. (%EFF)	RESPONSE MEAN	MEAN AFTER POOLING
.000	7.300	7.300
6.250	6.300	6.947
12.500	7.667	6.947
25.000	4.200	4.200
50.000	.100	.100
100.000	.000	.000

THE LINEAR INTERPOLATION ESTIMATE OF THE TOTAL IMPACT CONCENTRATION FROM THE INPUT SAMPLE IS 19.1990.

100.000	.000	.000

THE LINEAR INTERPOLATION ESTIMATE OF THE TOTAL IMPACT CONCENTRATION FROM THE INPUT SAMPLE IS 19.1990.

****
* BOOTSTRAP PROCEDURE TO ESTIMATE VARIABILITY *
* OF THE ESTIMATED ICp *
****

THE MEAN OF THE BOOTSTRAP ESTIMATES IS 14.2117. IC_{25} ASC 7-9-93

THE STANDARD DEVIATION OF THE BOOTSTRAP ESTIMATES IS 6.5277.

AN EMPIRICAL 95.0% CONFIDENCE INTERVAL FOR THE BOOTSTRAP ESTIMATE IS (3.4990, 31.3602).

C:\STATS\BOOTSTRP>

CPW1 Restoration (9/7/88)

ERT #492

SDS LC50 - 9.16 Rnge - 3.70 - 18.86

WRI

 KRD W48190

ERT QA Form No. 6
Effective: 2/87

SUBJECT: ACUTE TOXICITY DATA SHEET

SPONSOR: WRI PROJECT NUMBER: 7950-001-582.007
TEST SUBSTANCE: Cavity H_2O TEST SPECIES: Ceriodaphnia
SAMPLE INFORMATION AND DESCRIPTION FOUND ON PAGE 492 OF THE TEST SUBSTANCE USAGE LOG

TEST ORGANISM HISTORY

LOT NO./BATCH NO. 090688 DATE MAINTENANCE/ACCLIMATION BEGAN: 9/6/88
LIFE STAGE/AGE: <24 hrs CONDITION OF ORGANISMS: GOOD
SEE PAGE N/A OF COLLECTION/RECEIPT LOG FOR RAW DATA MORTALITY (%) IN 48 HOURS PRIOR TO TESTING: unk %
SEE PAGE 220 221 OF Ceriodaphnia log FOR RAW DATA ON HOLDING

TEST CONDITIONS

___ RANGE-FINDING X DEFINITIVE	X STATIC ___ FLOW-THROUGH	TIME ADDED SUBSTANCE/ANIMALS 1345/1400	TEST LOCATION H_2O Bath #4	TEST SYSTEM X OPEN ___ CLOSED
TEST CONTAINER DIMENSIONS 100 X 50	SOLUTION HEIGHT ~26mm	TEST CHAMBER VOL. (L) (0.3) 1.6, 3.8, 38	TEST SOLUTION VOLUME (0.2) 1.0, 3, 35	TEST CONTAINER COMPOSITION GLASS

PROTOCOL: EPA 1985
DILUTION WATER: RW #105 TYPE LIGHTING: FLUORESCENT PHOTOPERIOD: 16/8D

CIRCLE ONE: TEST SUBSTANCE AS ACTIVE INGREDIENT/WHOLE MATERIAL	SOLVENT/CARRIER
TEST CONCENTRATION (X) mg/l ug/l ng/l: Control, 6.25, 12.5, 25, 50, 100	HOH
AMOUNT OF SUBSTANCE/STOCK ADDED (ml): N/A, 12.5, 25, 50, 100, 200	SOLVENT/CARRIER CONCENTRATION
STOCK SOLUTION USED (e.g. 1,2,3): N/A	N/A
AMOUNT OF SOLVENT ADDED ( ): N/A	?

COMMENTS:

ABOVE DATA RECORDED BY: SGP DATE: 9/7/88

ERT

SUBJECT: ACUTE TOXICITY DATA SHEET · BIOLOGICAL DATA

SPONSOR: WRI PROJECT NUMBER: 2950-001-582-007
TEST SUBSTANCE: County H_2O TEST SPECIES: Ceriodaphnia

DATE		0-HOUR 9/7/88		24-HOUR 9/8/88		48-HOUR 9/9/88		72-HOUR		96-HOUR	
ANIMALS FED		YTC		YTC		No					
TIME		1400		1600		1400					
DATA BY		KC-B		VSF		VSF					
NOMINAL CONCENTRATION mg/l ug/l ng/l	REP	OBS	NO. ALIVE	OBS	NO. ALIVE	OBS	NO. ALIVE	OBS	NO. ALIVE	OBS	NO. ALIVE
CONTROL	A	None	10	None	10	None	10				
	B		1		10		10				
6.25	A		10		10		10				
	B		1		10		10				
12.5	A		10		10	INF	7				
	B		1		10	None	10				
25	A		10		5	1	7				
	B		1		9	None	9				
50	A		10		0						
	B		1		0						
100	A		10		0						
	B		1		0						

OBSERVATION KEY

NONE · OBSERVATION WAS MADE AND NOTHING OUT OF THE ORDINARY WAS OBSERVED

AS · AT THE SURFACE	GY · GYRATING	PRE · PRECEPITATE
MSP · MUSCLE SPASM	DRK · DARK PIGMENTATION	FOS · FILM ON SURFACE
CLE · COMPLETE LOSS OF EQUILIBRUIM	HEM · HEMORRHAGIC	US · UNDISSOLVED CHEMICAL
PLE · PARTIAL LOSS OF EQUILIBRIUM	RAR · RAPID RESPIRATION	NF · NOT FOUND
LETH · LETHARGIC	G · GULPING	LT · LIGHT PIGMENTATION
HYP · HYPERACTIVE	CLDY · CLOUDY SOLUTION	
ERR · ERRATIC		

ERT QA Form No. 8
Effective: 2/87

SUBJECT: ACUTE TOXICITY DATA SHEET - CHEMICAL AND PHYSICAL DATA

KFI 61890

SPONSOR: WRI
TEST SUBSTANCE: County H_2O

PROJECT NUMBER: 2950-001-582-007
TEST SPECIES: Ceriodaphnia

DATE		9/7/88						9/8/88				9/9/88															
TIME		1445 1400 w/s 9/7						0810				0815															
DATA BY		KC-B						SJP				JDP															
NOMINAL CONCENTRATION mg/l ug/l ng/l	REP	TEMP C	SAL/ HARD	pH	DO	ALK	COND	TEMP C	SAL/ HARD	pH	DO	TEMP C	SAL/ HARD	pH	DO	TEMP C	SAL/ HARD	pH	DO	TEMP C	SAL/ HARD	pH	DO	TEMP C	SAL/ HARD	pH	DO
CONTROL	A	20	82	8.5	6.6	67	276	20		8.3	6.4	20		8.1	6.6												
	B		—	1	1	—	—			1	1			8.1	6.6												
6.25	A			8.8	6.6					8.5	6.6			8.4	6.6												
	B			1	1					1	1			8.4	6.6												
12.5	A			9.0	6.6					8.6	6.6			8.6	6.5												
	B			1	1					1	1			8.6	6.5												
25	A			9.1	6.4					8.8	6.5			8.8	6.6												
	B			1	1					1	1			8.8	6.6												
50	A			9.2	6.0					9.0	6.5			—	—												
	B			1	1					1	1			—	—												
100	A		82	9.2	7.4	780	2700			9.1	6.5			—	—												
	B		—	1	1	—	—			1	1			—	—												
TEMP. DEVICE		Therm.						Therm.				TNER															
SAL/HARD MEASUREMENT		Titration						N/A				N/A															
pH METER		#4						#4				#4															
DO METER		#5						#5				#5															
ALKALINITY METHOD		Titration						N/A				N/A															
CONDUCTIVITY METER		#7						N/A				N/A															

SAL/HARD = ppt/ppm DO = ppm ALK = ppm COND = umhos/cm

2950-001-582-007
page 4 of 5

24 hour

KAD 6/18/90

ERT # 492
WRI
Ceriodaphnia 48 hr. acute
9/19/85
VJP

2950-001-582-007
page 5 of 5

.161	26.[illegible]	21.[illegible]	33.547
[illegible]	27.241	21.811	33.249
[illegible]	28.810	24.[illegible]	35.877

				GOODNESS OF FIT PROBABILITY
[illegible]	0.177	1.009	7.536	0.057

[illegible] = 5.687217
[illegible] PERCENT CONFIDENCE LIMITS = 1.374537 AND [illegible]

48 hour
KMS 6/18/90

[illegible] = 20.77359
[illegible] PERCENT CONFIDENCE LIMITS = 24.11078 AND 34.2591

[illegible] = 12.90009
[illegible] PERCENT CONFIDENCE LIMITS = 6.957785 AND 16.75244

COMPARE RESULTS WITH ORIGINAL DATA TO SEE IF THEY ARE REASONABLE.

EKT # 492
WRI
Ceriodaphnia 48 hr. acute
9/19/88
KJP

Page:
ERT QA Form No. 40
Effective: 2/83

SUBJECT: PHYSICAL & CHEMICAL DATA FOR FATHEAD MINNOW 96-HOUR STATIC RENEWAL TEST

KFD 6/18/90

SUBSTANCE: Cavity H_2O BEGINNING: DATE 9/7 TIME 1445

CLIENT: WRI ENDING: DATE 9/11 TIME 1445

PROJECT NO. 2950-001-582-008

ERT # 492
LOT # 88-45
SDS LC50 - 3.54 RNGE - 2.45 - 7.15
RW #105

CONC.	TEST CONTAINER NUMBER	NO. OF SURVIVING ORGANISMS					DISSOLVED OXYGEN (mg/l)								TEMPERATURE (C)								pH					
		0	1	2	3	4	0		1		2		3		4		0		1		2		3		4		0		1		2		3		4	
							NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW		OLD		NEW		OLD		NEW	
control	A	10	10	10	10	10	6.6	6.6	6.2	6.7	6.4	6.7	6.7	6.8	20	20	20	20	20	20	20	21	8.5	8.1	8.1	8.3	8.6	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
	B	10	10	10	10	10	1	1	1	6.7	1	1	1	1	20								8.5	1	1	1	1									
6.25	A	10	10	10	10	10	6.6	6.6	6.5	6.7	6.5	6.7	6.7	6.8	20								8.9	8.8	8.7	8.6	8.4									
	B	10	10	10	10	10	1	1	1	6.7	1	1	1	1									8.9	1	1	1	1									
12.5	A	10	10	10	10	10	6.6	6.6	6.5	6.7	6.5	6.7	6.8	6.8									9.0	9.0	8.8	8.4	8.8									
	B	10	10	10	10	10	6.6	1	1	6.7	1	1	1	1									9.0	1	1	1	1									
25	A	10	1	0	—	—	6.4	6.0	6.5	6.5	—	—	—	—									9.1	9.1	—	—	—									
	B	10	0	—	—	—	6.4	1	—	—	—	—	—	—									9.1	—	—	—	—									
50	A	10	0	—	—	—	6.0	6.6	—	—	—	—	—	—									9.2	—	—	—	—									
	B	10	0	—	—	—	6.0	1	—	—	—	—	—	—									9.2	—	—	—	—									
100	A	10	0	—	—	—	4.4	6.6	—	—	—	—	—	—									9.2	—	—	—	—									
	B	10	0	—	—	—	4.4	1	—	—	—	—	—	—									9.2	—	—	—	—									
METER NO.		—	—	—	—	—	#5	#5	#5	#5	#5	#5	#5	#5	Thn.	Thn.	Thn	Thn	Thn	Thn	Thn	Thn	#25	#4	#4	#4	#4									
DATE		9/7	9/8	9/9	9/10	9/11	9/7	9/8	9/8	9/9	9/9	9/9	9/10	9/10	9/7	9/8	9/8	9/9	9/9	9/10	9/10	9/11	9/7	9/8	9/9	9/10	9/11									
TIME		1445	1530	1500	1240	1445	1435	0805	1530	0815	1500	0900	1245	0850	1430	0805	1525	0805	1455	0900	1245	0850	1445	1530	1500	1250	0845									
INITIALS			SJC				KLB			SJC					KLB			SJC																		

D-55

ERT

Page: 1 of 1
ERT QA Form No. 41
Effective: 2/88

SUBJECT: CHEMICAL DATA FOR FATHEAD MINNOW 96-HOUR STATIC RENEWAL TEST

KFJ618190

SUBSTANCE: ____ BEGINNING: DATE 9/7 TIME 1445

CLIENT: WRI ENDING: DATE 9/11 TIME 1445

PROJECT NO. 2950-001-582

CONC.	TEST CONTAINER NUMBER	CONDUCTIVITY (umhos/cm)				ALKALINITY (mg/l)				HARDNESS (mg/l)				NH3 (mg/l as N)				TRC (mg/l)			
		0	1 NEW	2	3	0	1 NEW	2	3	0	1 NEW	2	3	0	1 NEW	2	3	0	1 NEW	2	3
Control	A	278				67				82											
	B	-				-				-											
6.25	A	-								-											
	B	-								-											
12.5	A	-				-				-											
	B	-				-				-											
25	A	-				-				-											
	B	-				-				-											
50	A	-				-				-											
	B	-				-				-											
100	A	2700				780				82											
	B	-																			
METER NO.		#7				TITR.				TITR.											
DATE		9/7				9/7				9/7											
TIME		1445				1330				1340											
INITIALS		KC-B				KC-B				KC-B											

2950-001-582-008
page 3 of 4

24 hour
LC50 KM 618190

ERT #492
WRI
FHM 96 hr. Acute
9/19/88 KJP

2950-001-582.008
page 4 of 4

HRS 6/18/90 48, 72, + 96 hr
LC50

ERT # 492
WRI
FHM 96 M. Acute
9/19/88
KJP

ZN " 11-
BATCH # 090688 / < 24 hrs

RW # 105

SDS LC50 - 9.16 RNGE 3.70-18.86

Page: 1 of 1
ERT QA Form No. 17
Effective: 3/87

SUBJECT: CHEMICAL DATA FOR CERIODAPHNIA SP. CHRONIC TEST

Task 006

SPONSOR: WRI PROJECT NUMBER: 2050-001-682 BEGINING: DATE 9/7 TIME 1500

TEST SUBSTANCE: Calcity H_2O ENDING: DATE 9/14 TIME 1500

CONC.	TEST CONTAINER NO.	DISSOLVED OXYGEN (mg/l)													
		0	1	2	3	4	5	6	7						
		NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD
Control	1-10	6.1	5.9	6.1	5.2	6.1	5.1	6.1	5.0	6.9	5.7	6.4	6.0	6.2	6.0
6.25	11-20	6.3	5.9	6.4	5.3	6.3	5.1	6.4	5.2	6.2	5.9	6.5	5.6	6.4	6.1
12.5	21-30	6.2	5.9	6.5	5.2	6.3	5.5	6.7	5.4	6.4	5.9	6.5	5.7	6.4	6.1
25	31-40	5.8	5.8	6.4	5.6	6.2	5.1	6.4	5.5	6.3	5.7	6.5	5.7	6.5	6.1
50	41-50	5.1	5.7	—	—	—	—	—	—	—	—	—	—	—	—
100	51-60	2.9	3.5	—	—	—	—	—	—	—	—	—	—	—	—
METER #		#5	#5	#5	#5	#5	#5	#5	#5	#5	#5	#5	#5	#5	#5
DATE		9/7	9/8	9/8	9/9	9/9	9/10	9/10	9/11	9/11	9/12	9/12	9/13	9/13	9/14
TIME		1430	1550	1525	1555	1530	1200	1224	1200	1400	1300	1245	1355	1500	1520
INITIALS		MC-B													

CONC.	TEST CONTAINER NO.	TEMPERATURE (C)								pH							
		0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
		NEW SOLUTIONS ONLY							OLD	NEW SOLUTIONS ONLY							OLD
Control	1-10	26	25	25	25	25	25	25	25	8.4	8.4	8.3	8.3	8.3	8.5	8.4	8.1
6.25	11-20									8.6	8.3	8.4	8.8	8.8	8.9	9.0	8.5
12.5	21-30									8.9	9.0	8.8	8.9	8.9	9.1	9.1	8.9
25	31-40									9.0	9.1	8.9	9.0	9.1	9.4	9.2	8.7
50	41-50									9.1	—	—	—	—	—	—	—
100	51-60									9.1	—	—	—	—	—	—	—
METER #		#25	#4	#4	#4	#4	#4	#4		#25	#4	#4	#4	#4	#4	#4	
DATE		9/7	9/8	9/8	9/9	9/9	9/10	9/10		9/7	9/8	9/8	9/9	9/9	9/10	9/10	
TIME		1430	1525	1550	1555	1530	1200	1224		1430	1525	1550	1555	1530	1200	1224	
INITIALS		MC-B															

4/5/88
9.0 old
4.0 old
WSP

CONC.	TEST CONTAINER NO.	ALKALINITY (mg/l)							HARDNESS (mg/l)							CONDUCTIVITY (umhos/cm)								COMMENTS:
		0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6	7	
			NEW SOLUTIONS ONLY							NEW SOLUTIONS ONLY							NEW SOLUTIONS ONLY						OLD	
Control	1-10	67							82							320	320	330						
6.25	11-20	~							~							530	510	500						
12.5	21-30	~							~							700	700	720						
25	31-40	~							~							1090	1020	1000						
50	41-50	~							~							1830	—	—						
100	51-60	780							1020							3160	—	—						
METER #		T100							T100							#7	#7	#7						
DATE		9/7							9/7							9/7	9/8	9/9						
TIME		1440							1440							1435	1530	1540						
INITIALS		MC-B							MC-B							MC-B	SWC	SWC						

D-59

D20

SUBJECT: SURVIVAL AND REPRODUCTION DATA FOR CERIODAPHNIA SP. EFFLUENT TOXICITY TEST

582.006
SPONSOR: WRI PROJECT NUMBER: 7950.001-~~545~~ KJ 10/11/88
TEST SUBSTANCE: Cavity Nets

EFFLUENT CONC.	DAY NO.	DATE/TIME	IN.	REPLICATE A	B	C	D	E	F	G	H	I	J	TOTAL LIVE	NO. LIVE ADULTS	MOST YOUNG BY ANY ADULT
Control		9/8 1540				*		*								
Control	1	1		0	0	0	0	0	0	0	0	0	0	0	10	0
	2	9/9 1550		0	0	0	0	0	0	0	0	0	0	0	10	0
	3	9/10 1250		0	0	0	0	0	0	0	0	0	2	2	10	2
	4	9/11 1140		2	3	0	3	0	4	4	4	3	0		10	4
	5	9/12 1255		5X	5	0	6	0	6	6	6	7	6		9	7
	6	9/13 1350		1	1	0	0	0	0	0	1	68		8	9	6
	7	9/14 1515		7	7	0	7	0	8	7	6	7	0		9	8
	TOT			15	16	0	16	0	18	17	16	18	14	120		
			VOP			*										
1.25	1	9/8 1545		0	0	0	0	0	0	0	0	0	0	0	10	0
	2	9/9 1550		0	0	0	0	0	0	0	0	0	0	0	10	0
	3	9/10 1255		0	0	0	0	0	0	0	0	0	0	0	10	0
	4	9/11 1145		3	3	0	2	3	2	3	2	3	2		10	3
	5	9/12 1300		7	7	0	6	6	6	6	6	7	6		10	7
	6	9/13 1350		0	0	0	0	0	0	0	0	0	0	0	10	0
	7	9/14 1515		5	6	0	9	8	6	8	6	9	8		10	8
	TOT			15	16	0	16	17	14	17	14	19	16	146		
			VOP			*	*					*	*			
1.25	1	9/8 1550		0	0	0	0	0	0	0	0	0	0	0	10	0
	2	9/9 1550		0	0	0	0	0	0	0	0	0	0	0	10	0
	3	9/10 1300		0	0	0	0	0	0	0	0	0	0	0	10	0
	4	9/11 1150		3	2	0	0	3	2	2	2	0	0		10	3
	5	9/12 1300		7	6	0	0	0	0	7	0	0	0	20	10	7
	6	9/13 1355		0	0	0	0	7	3	0	5	0	0	15	10	7
	7	9/14 1575		8	8	0	0	8	X	7	7	0	0		9	8
	TOT			18	16	0	0	18	5	16	14	0	0	87		

NOTE: X=Dead Adult, no young produced before death.
1x=Dead Adult, one young produced before death.

SUBJECT: SURVIVAL AND REPRODUCTION DATA FOR CERIODAPHNIA SP. EFFLUENT TOXICITY TEST

SPONSOR: WRI PROJECT NUMBER: 2950-001-582-006
TEST SUBSTANCE: Cavity Water

EFFLUENT CONC.	DAY NO.	DATE/TIME	IN.	REPLICATE A	B	C	D	E	F	G	H	I	J	TOTAL LIVE	NO. LIVE ADULTS	MOST YOUNG BY ANY ADULT
25						X	X									
25	1	9/5 1550		0	0	0		0	0	0	0	0	0	0	9	0
	2	9/9 1555		0	0	0		0	0	0	0	0	0	0	9	0
	3	9/10 1705		0	0	0		0	0	0	0	0	0	0	9	0
	4	9/11 1155		2	3	0		2	0	1	2	1	1		9	3
	5	9/12 1305		0	0	0		0	0	0	0	0	0		9	0
	6	9/13 1355		5	4	0		4	4	5	5	3	5		9	5
	7	9/14 1520		8	8	0		7	11	9	8	7	9		9	11
	TOT			15	15	0		13	15	15	15	11	15	114		
50	1	9/8 1555		X	X	X	X	X	X	X	X	X	X	0	0	0
	2															
	3															
	4															
	5															
	6															
	7															
	TOT													0		
100	1	9/8 1555		X	X	X	X	X	X	X	X	X	X	0	0	0
	2															
	3															
	4															
	5															
	6															
	7															
	TOT													0		

NOTE: X=Dead Adult, no young produced before death.
1x=Dead Adult, one young produced before death.

CRIP

ERT TOXICOLOGY GROUP
FT. COLLINS, COLORADO

Page: 4
ERT QA Form No. 15
Effective: 3/87

SUBJECT: DAILY LOG

D743.582-006

ALL ENTRIES MUST BE INITIALLED WITH DATE AND TIME:

9/7/88 - Effluent D.O. level <1.0 mg/l - Aerated prior to making dilutions 1320 PCP pertains to all 3 Tests 9/19/88 sd.

9/7/88 - 100% D.O.'s have dropped to 3.0 in FHM acute and 3.7 in Ceriodaphnia acute - initiated mild aeration @ 1700 PCP

ERT

CPW1. 1st Restoration
9-27-95 = 492
C. Austin Report.

THE NUMBER OF RESAMPLES IS 80

*** LISTING OF GROUP CONCENTRATIONS (% EFF.) AND RESPONSE MEANS ***

CONC. (%EFF)	RESPONSE MEAN	MEAN AFTER POOLING
.000	15.000	15.647
6.250	16.222	15.647
12.500	14.500	14.500
25.000	12.667	12.667
50.000	.000	.000
100.000	.000	.000

THE LINEAR INTERPOLATION ESTIMATE OF THE TOTAL IMPACT CONCENTRATION FROM THE INPUT SAMPLE IS 26.8382.

100.000	.000	.000

THE LINEAR INTERPOLATION ESTIMATE OF THE TOTAL IMPACT CONCENTRATION FROM THE INPUT SAMPLE IS 26.8382.

```
**********************************************************
*        BOOTSTRAP PROCEDURE TO ESTIMATE VARIABILITY     *
*                    OF THE ESTIMATED ICp                *
**********************************************************
```

THE MEAN OF THE BOOTSTRAP ESTIMATES IS 25.3382. IC25 ASC 7-8-93

THE STANDARD DEVIATION OF THE BOOTSTRAP ESTIMATES IS 4.9849.

AN EMPIRICAL 95.0% CONFIDENCE INTERVAL FOR THE BOOTSTRAP ESTIMATE IS (11.7121, 30.3779).

C:\STATS\BOOTSTRP>